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Essays on Disclosures

Sumair Hussain

Department of Accounting

Supervisors:
Jeppe Christoffersen
Bjørn N. Jørgensen

CBS PhD School
Copenhagen Business School

Sumair Hussain
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Abstract

This thesis examines disclosures related to firms. The first chapter *"Disclosures Surrounding Cyber Attacks"* (solo-authored) investigates whether how US-domiciled firms disclose (i.e. filing choice and content) a cyber-attack incident is associated with differential stock market reaction surrounding the first disclosure made to the U.S. Securities and Exchange Commission (SEC). The first chapter uses empirical archival data to illustrate disclosure choice and content is associated with differential stock market reactions. The first chapter also provides evidence that cybersecurity risk factor disclosures reflect cybersecurity risk, as textual properties of these risk factor disclosures change following a cyber-attack incident when benchmarked with a control firm that did not disclose a cyber-attack incident in the same period. The results of the first chapter may help guide the SEC's ongoing task of improving cybersecurity-related disclosures.

The second chapter "*Seeing is Believing: The Effect of R&D as a Separate Income Statement Line Item on Financial Statement Users' Judgement"* (co-authored with Jeppe Christoffersen and Thomas Plenborg) investigates the flexibility permitted under International Accounting Standard 1 (IAS 1), where firms can report the income statement using either the by function or by nature format. Specifically, the second chapter investigates the effect of (not) reporting research and development (R&D) expenses as a separate line item on the income statement. The second chapter uses an experimental setting to investigate if this (non) disclosure affects the users' perception of the firm's level of innovativeness and future profitability. The results suggest that the (non) disclosure does lead to differential perception, despite the final net income being held constant. The results of the second chapter may contribute to the ongoing debate related to the presentation format flexibility permitted under IAS 1.

The third chapter "*How Similar are CAMs and KAMs? Evidence from Twin Audit Matters"* (co-authored with Brian Burnett and Bjørn Jørgensen) examines the similarity between Critical Audit Matters (CAMs) and Key Audit Matters (KAMs). CAMs and KAMs are recent disclosure requirements that are part of the expanded auditor report disclosure initiative that aims to increase audit transparency in the US and EU, respectively. Auditors of firms listed in the US are required to disclose CAMs whereas those listed on a European Union (EU) regulated stock exchange are required to disclose KAMs. The third chapter exploits a unique set of EU-domiciled firms that for the same fiscal year, have both CAMs and KAMs disclosures. Furthermore, this chapter exploits a subset of firms that disclose financial statements under both IFRS and US GAAP for the same fiscal year. Therefore, the two sets of firms allow for a difference-in-differences analysis to isolate the effect(s) of accounting standards on audit matters. The results of the third chapter may help guide the Public Company Accounting Oversight Board (PCAOB)'s ongoing task of evaluating audit matter disclosures.

Abstract (Danish)

Denne afhandling undersøger offentliggørelser af firma-relateret information. Det første kapitel ”Offentliggørelser omkring cyberangreb” undersøger hvorvidt måden hvorpå amerikanske firmaer offentliggør at de har været udsat for et cyberangreb (dvs. både indgivelsesform og indhold) er forbundet med forskellige aktiekursreaktioner omkring tidspunktet for den første offentliggørelse til det amerikanske finanstilsyn (SEC). Det første kapitel bruger empirisk data til at illustrere, at måden hvorpå offentliggørelsen sker, samt dets indhold, er forbundet med forskellige markedsreaktioner. Det første kapitel giver også evidens for at offentliggørelsen af cyber-risikofaktorer afspejler cyber-sikkerhedsrisici, da de skriftlige egenskaber af disse risikofaktorer ændres efter cyberangreb, sammenlignet med et benchmark kontrol firma der ikke offentliggjorde et cyberangreb i samme periode. Resultaterne fra det første kapitel bidrager til SECs igangværende opgave med at forbedre cybersikkerheds- relaterede offentliggørelser.

Det andet kapitel ”At se er at tro: Effekten af forsknings- og udviklingsomkostninger (R&D) som en separat linje i resultatopgørelsen på regnskabsbrugers vurdering” (med Jeppe Christofferen og Thomas Plenborg) undersøger den fleksibilitet tilladt af internationale regnskabsstandarder (IAS1), hvor firmaer må præsentere resultatopgørelsen som enten funktions- eller artsbaseret. Dette andet kapital undersøger specifikt konsekvensen af (ikke) at rapportere R&D som en separat linje i resultatopgørelsen. Det andet kapitel anvender et eksperiment for at undersøge om den (manglende) information påvirker regnskabsbrugers opfattelse af firmaets innovationsevne og fremtidig profitabilitet. Resultaterne viser at den (manglende) information påvirker vurderingen af firmaer, selv når den totale profitabilitet er konstant. Dette bidrager til den igangværende debat angående den fleksibilitet som IAS 1 tillader i forhold til præsentationsformat i resultatopgørelsen.

Det tredje kapital ”Hvor ens er CAM og KAM? Evidens fra tvillinge revisionssager” (med Brian Burnett og Bjørn Jørgensen), undersøger ensartetheden mellem nøgle revisionssager (KAM) og kritiske revisionssager (CAM). CAM og KAM er begge nye initiativer, der er en del af en udvidet revisionsrapport i årsregnskabet, som har til formål at forøge gennemsigtigheden i henholdsvis USA og EU. Revisor skal rapportere CAM for firmaer der er børsnoteret i USA, mens firmaer på en EU-reguleret børs skal rapportere KAM. Det tredje kapitel udnytter at EU-baserede firmaer, der er børsnoterede i både USA og EU, hvert år skal rapportere både CAM og KAM. Dertil bruger dette kapitel også de firmaer, der skal rapportere under både IFRS og US GAAP i samme regnskabsår. Disse to firmagrupper tillader en difference-in-differences analyse, der kan isolere effekten af regnskabsstandarder på revisionssager. Kapitlets resultater kan hjælpe det amerikanske revisortilsyn (PCAOB) i deres igangværende arbejde med at evaluere rapporteringen af revisionssager.

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Introduction

1. Research Motivation

Disclosures in financial reporting are crucial for facilitating transparency, enhancing decision-making processes, and fostering accountability among various stakeholders (Healy and Palepu, 2001). Disclosures encompass a wide array of information provided in financial statements, footnotes, management discussions, and other supplementary reports (Lang and Lundholm, 1993).

One objective of disclosures is to address information asymmetry between corporate management and external stakeholders such as investors and creditors (Bushman and Smith, 2001). Agency theory suggests that managers may possess superior knowledge about a firm's performance and prospects, which may create a disparity in information availability. Firms can reduce uncertainty and mitigate agency conflicts through comprehensive disclosures by providing timely, relevant, and accurate information to external stakeholders.

Signaling theory provides further insights into the role of disclosures as signals of a firm's financial health, management competence, and prospects (Leuz et al., 2003). Firms can disclose voluntarily beyond regulatory requirements to convey positive signals to the market, thereby signaling their commitment to transparency and investor protection. Prior studies (Francis et al., 2004; Barth et al., 2013) document a positive association between the quality of disclosures and investor perceptions which highlights the value of transparent communication for market participants.

Disclosures also serve as essential tools for external stakeholders to assess a firm's profile. Investors use disclosures to obtain insights into key financial metrics, such as revenue trends and debt levels to make informed investment decisions (Botosan, 1997; Penman, 2007). Creditors rely on disclosures to evaluate a firm's risk profile and assess the likelihood of default to determine lending terms and conditions better (Altman, 1968; Beaver, 1966). Firms can also improve access to capital markets by disclosing relevant information about their risks and uncertainties (Verrecchia, 2001; Gao and Zhou, 2016).

Disclosures are crucial in enhancing corporate accountability and stewardship as they serve as a mechanism for holding management accountable for their actions and decisions. Firms can demonstrate their corporate governance practices by disclosing information about executive compensation, related-party transactions, and internal control weaknesses. These disclosures further improve transparency, which enhances the reputation and long-term sustainability of the organization.

Disclosures also serve as a cornerstone of financial reporting standards and corporate governance frameworks from a regulatory perspective (FASB, 2020; IASB, 2020; SEC, 2020). Regulatory bodies prescribe disclosure requirements to promote transparency, comparability, and consistency in financial reporting. These requirements encompass a wide range of topics to reflect the evolving needs of investors and regulators in a dynamic business environment.

Disclosures in practice are not without challenges and limitations. For example, excessive disclosures may overwhelm users and obscure material information. Firms must strike a balance between providing comprehensive disclosures and avoiding information clutter. Additionally, disclosures may lack comparability and consistency across industries and jurisdictions. Standard-setting organizations or regulatory bodies therefore often engage in harmonization and standardization initiatives.

Emerging trends such as sustainability disclosures and digital reporting (e.g. XBRL) are reshaping the landscape of financial reporting and disclosures. Integrated reporting frameworks encourage firms to provide a holistic view of their value creation process by including environmental, social, and governance (ESG) as well as financial dimensions. Sustainability disclosures enable firms to communicate their environmental (such as carbon footprint) and social impact and demonstrate their commitment to sustainable development goals.

To summarize, disclosures have multiple roles in accounting practices which range from transparent communication to stakeholder engagement, and firms can benefit from providing relevant disclosures to market participants.

2. Research Questions

This thesis consists of three chapters related to disclosures that aim to answer three different research questions. Chapter 1 and chapter 2 examine disclosure choices made by managers of the firms whereas chapter 3 examines disclosures made by auditors of the firms. Chapter 1 examines the relationship between cybersecurity incident **disclosures manner** and the stock market reaction for US-domiciled firms. Prior studies suggest cybersecurity incidents are associated with negative stock market consequences. However, the evidence on the relationship between cybersecurity incidents and stock market reactions is not consistent. Chapter 1 aims to contribute to this stream of literature by considering the role of disclosure manner.

Chapter 2 examines the effect of presenting research and development (R&D) expenses as a separate line item on the income statement. Under International Accounting Standard 1 (IAS 1), firms are permitted to report their income statement using one of the two formats – by function or by nature. However, R&D expense is only a line item under the by function format. IAS 1 requires separate disclosure in the notes using by nature format for firms that reporting using by function format but no requirement for firms that use by nature format. Therefore, firms may "hide" their R&D expense by using the by nature format.

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Chapter 3 examines the similarity between Critical Audit Matters (CAMs) and Key Audit Matters (KAMs). CAMs and KAMs are recent disclosure requirements that are part of the expanded auditor report disclosure initiative that aims to increase audit transparency. Firms that are listed in the US are required to disclose CAMs whereas firms listed on a European Union (EU) regulated stock exchange are required to disclose KAMs. We identify a sample of EU-domiciled firms that in the same fiscal year disclose both CAMs and KAMs. This sample permits us to test the similarity between the two disclosures for the same set of transactions.

3. Methodological Approach

I primarily use empirical-archival data in this thesis. In Chapter 1, I hand-collect cyber-attack incidents disclosed by US-domiciled firms. I then employ an event study approach to examine if the disclosure manner is associated with differential stock market reactions surrounding the first disclosure to the U.S. Securities and Exchange Commission (U.S. SEC). Further, I use textual analysis (e.g. similarity analysis, sentiment analysis, etc.) to examine the change in cybersecurity risk factor disclosure for firms that disclose a cyber-attack incident. I benchmark this change with firms that did not disclose a cyber-attack incident to (better) isolate the effect of disclosing a cyber-attack incident on cybersecurity risk factor disclosures.

In Chapter 2, we use an experimental approach to examine if disclosing R&D expenses on the income statement as a separate line item affects financial statement users' perception of the firm. We use a classic 2 × 2 research design where we vary the level of R&D expense for a benchmark firm and the sequence in which the participants observe the two presentation formats – by function and by nature. Thus, we can compare the difference in perception (i.e. ratings) both within and across subjects. The random assignment of participants into one of the four groups eliminates selection bias.

In Chapter 3, we exploit a unique set of firms that in the same fiscal year disclose both CAMs and KAMs. Further, we identify a subset of firms that for the same fiscal year disclose two sets of financial statements, one prepared under IFRS and another under US GAAP. These two sets of firms permit us to isolate the effect(s) of accounting standards on audit matters by employing a difference-in-differences design. We verify that these firms are the same consolidated entities across filings. Hence, we can hold fixed the underlying transactions. This approach is equivalent to matching except we do not have to perform matching. This approach also eliminates the need for regression analysis, as univariate tests are sufficient to estimate mean differences.

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4. How the Chapters Connect

A common theme among the three chapters in this thesis is disclosures. The first two chapters explore the firm managers' choice when making disclosures and the consequences, while the final chapter examines two distinct yet related disclosures (made by auditors) that some firms disclose in the same fiscal year.

Another connection between the three papers is the level of counterfactuals. Counterfactuals are crucial for estimating causal effects. Angrist and Pischke (2009) illustrate the importance of counterfactuals using a hospital analogy. They suggest that the experimental ideal to answer the research question "Do hospitals make people healthier?" would be to observe a person not receiving hospital treatment and the same person traveling back in time to receive hospital treatment. The difference would then be the causal effect of hospital treatment. The authors then immediately state that often the experimental ideal is impossible to observe, and one can only rely on common econometrics techniques to better estimate the true causal effect. The three chapters in this thesis have varying levels of counterfactuals.

Counterfactuals are absent in the first chapter of this thesis. Firms cannot disclose the same cyber-attack incident for the first time to the SEC using different filings (e.g. using both Form 8-K and 10-K) or providing different information. The first chapter is still of interest despite the lack of counterfactuals, as cyber-attack incidents are frequent exogenous events that are difficult (if not impossible) to avoid completely.

Next, we create a counterfactual in chapter two of this thesis. We randomly assign participants to one of the four groups. Random assignment eliminates selection bias and permits us to estimate the causal effect. Further, each participant observes both presentation formats, hence the participants also act as their own control.

Lastly, we identify a sample with a pre-existing counterfactual in chapter three of this thesis. We identify a unique sample of firms that disclose both CAMs and KAMs in the same fiscal year. The underlying transactions are held constant as the consolidated entity is the same. Therefore, we observe the CAMs and KAMs for the same set of transactions and hence can compare the similarity of the audit matters directly.

5. Findings

All three chapters in this thesis have policy implications. In Chapter 1, I find that firms that disclose cyber-attacks in Form 8-Ks filings are associated with a more negative stock market reaction, compared with firms that disclose cyber-attacks in annual filings (Form 10-Ks) or quarterly filings (Form 10-Qs). Further, I find firms that disclose immaterial cyber-attacks in Form 8-Ks are associated with a more negative market reaction. I also find that firms that disclose that they purchased cybersecurity insurance in Form 8-Ks help mitigate the negative stock market reaction. Taken together, my results suggest that how firms disclose cyber-attack incidents does matter. These results may inform the SEC in their policy setting as the SEC has repeatedly mentioned the importance of timelier disclosure of cyber-attack incidents. In Chapter 1, I also

document the change in cybersecurity risk factor disclosures following a cyber-attack incident using textual analysis.

In Chapter 2, we find that income statement presentation formats (by function or by nature) affect financial statement users' perception of firms. Specifically, we find that financial statement users' perception of the firm's innovativeness differs depending on whether R&D is listed as a separate line item. The results of this paper contribute to IASB's ongoing debate related to IAS 1, where the IASB is pondering whether to standardize reporting formats. Further, the results highlight (unintended) consequences of R&D-intensive firms when they switch from using function format to by nature format.

In Chapter 3, we find that CAMs are always a subset of KAMs from EU-domiciled firms that report using the same accounting standard, IFRS, in both the US and the EU. However, this finding does not extend to EU-domiciled firms that report using different accounting standards: US GAAP in the US and IFRS in the EU. Furthermore, we find the similarity between KAM and CAM disclosure is higher for firms that file using the same accounting standard. Taken together, our results suggest that the additional disclosure of CAMs by EU firms that file using only IFRS is redundant. However, firms that file using different accounting standards should continue to disclose both CAMs and KAMs. The results of the third chapter may help guide the Public Company Accounting Oversight Board (PCAOB)'s ongoing task of evaluating audit matter disclosures.

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Chapter 1
Disclosures Surrounding Cyber Attacks*

Abstract

Cybersecurity continues to be a subject of significant interest for the public and regulators. I examine disclosures made to the United States Securities and Exchange Commission (SEC) surrounding cyber-attack incidents. First, I investigate the impact of different disclosure types on stock returns. I find that cyber-attack incidents disclosed in Form 8-Ks result in a more significant decline in stock returns for the firm than cyber-attack disclosures made in Form 10-Ks or Form 10-Qs. Moreover, I provide evidence that the content of cyber-attack disclosures is associated with differential stock returns dependent on the medium of disclosure. Second, I examine the change in cybersecurity risk factor disclosures in the Form 10-K filings following cyber-attack incidents using textual analysis. I find significant changes in several textual properties (including length and tone) for firms that disclosed cyber-attack incidents, compared with size-matched control firms that did not disclose any cyber-attack incidents during the sample period. Finally, I examine the impact of ex-ante cybersecurity risk factor disclosures on stock returns surrounding the (first) disclosure of cyber-attack incidents to the SEC. I find no statistically significant impact. My results should inform standard setters who express concerns regarding the limited disclosures related to cybersecurity.

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1. Introduction

Cybersecurity remains a topic of substantial interest to the public and regulatory bodies, and prominent cyber-attacks frequently garner attention in the mainstream media. A 2015 survey conducted by Duke University in conjunction with CFO Magazine's Global Business Outlook reveals that over 80 percent of the surveyed companies in the United States reported successful security breaches in their systems.[1] Unsurprisingly, regulatory bodies therefore express concerns about limited disclosures related to such cybersecurity events. To illustrate, the U. S. Securities and Exchange Commission (SEC) issued guidelines in 2011[2] and, more recently, in 2018[3], concerning cybersecurity-related disclosures for registrants.

Prior studies document negative consequences associated with cyber-attack incidents (e.g. Janakiraman et al. (2018); Kamiya et al. (2021); Huang and Wong (2021), and Lattanzio and Ma (2023)), but the evidence on the influence of cyber-attack incidents on stock market reactions is inconclusive (e.g. Cavusoglu et al. (2004); Kannan et al. (2008); Gordon et al. (2011); Hilary et al. (2016), and Amir et al. (2018)). I investigate the significance of how cyber-attack incidents are disclosed to the SEC for the first time. Specifically, I examine if varying approaches to the disclosure of cyber-attack incidents to the SEC (for the first time) leads to differential stock returns following the disclosure. Prior literature documents an increase in cyber-security-related keyword count in the entire Item 1A Risk Factors section following cyber-attack incidents (Chen et al. (2022)). I perform textual analysis on cybersecurity risk factor disclosures post-cyber-attack incidents to better understand the effect of an exogenous event on management's risk perception as reflected in the disclosures. Lastly, prior literature suggests risk factor disclosures reflect cybersecurity risk and are informative (e.g. Berkman et al. (2018); Li et al. (2018); Gao et al. (2020); and Florackis et al. (2023)). I examine if pre-incident cybersecurity risk factor disclosures are associated with differential stock returns surrounding cyber-attack incident disclosure to the SEC.

I examine cyber-attack incident disclosures made to the SEC (for the first time) by firms in the Russell 3000 Index between the first quarters of 2018 and 2023. Firms in my sample disclose a cyber-attack incident in either Form 10-Ks, Form 10-Qs, or Form 8-Ks. Form 10-K is used for filing annual reports whereas Form 10-Q is used for filing quarterly reports. In addition, the SEC provides Form 8-K to public firms to report material corporate events on a more current basis. The SEC states on its website that "Form 8-K is the "current report" companies must file with the SEC to announce major events that shareholders should know about."[4]

[1] See: https://cfosurvey.fuqua.duke.edu/press-release/more-than-80-percent-of-firms-say-they-have-been-hacked/
[2] See: https://www.sec.gov/divisions/corpfin/guidance/cfguidance-topic2.htm
[3] See: https://www.sec.gov/files/rules/interp/2018/33-10459.pdf
[4] See: https://www.sec.gov/answers/form8k.htm

First, I find that cyber-attack incidents disclosed in Form 8-Ks result in more negative abnormal stock returns than cyber-attack incidents disclosed in Form 10-Ks or Form 10-Qs. Curiously, I find immaterial cyber-attack incidents disclosed in Form 8-Ks are associated with more negative abnormal stock returns compared with immaterial cyber-attack incidents disclosed in Form 10-Ks or Form 10-Qs. I also find that the mention of having cybersecurity insurance mitigates the negative stock returns for incidents disclosed in Form 8-Ks, but not for incidents disclosed in Form 10-Ks or Form 10-Qs. Overall, I find evidence that the content or characteristics of cyber-attack incident disclosures affect stock returns.

I then examine changes in cybersecurity risk factor disclosures following cyber-attack incidents. I focus specifically on cybersecurity risk factor disclosures. I remove part of the text that describes the cyber-attack incident, and sentences in the cybersecurity risk factor disclosures that are identical or largely similar in the pre- and post-incident periods to better isolate the effect of cyber-attack incidents. I document that following a cyber-attack incident, cybersecurity risk factor disclosures are greater in length, less negative in tone, and less similar compared to the cybersecurity risk factor disclosures of size-matched firms that do not disclose a cyber-attack incident. Moreover, I find that the text in the post-incident period contains more cybersecurity-related keywords and becomes less standardized compared with the text in the pre-incident period. Overall, my results suggest that firms update their cybersecurity risk factor disclosure following cyber-attack incidents, which provides evidence that cybersecurity risk factor disclosures are not sticky disclosures and reflect firm-specific cybersecurity risk.

Finally, I examine whether cybersecurity risk factor disclosures from the pre-incident period are informative. That is, I examine if the content or characteristics of cybersecurity risk factor disclosures from the pre-incident period are associated with differential stock returns surrounding the cyber-attack incident disclosure. I fail to find evidence that the content or characteristics of cybersecurity risk factor disclosures from the pre-incident period affect stock returns surrounding cyber-attack incident disclosures.

My paper examines exogenous events with endogenous reporting choices. Cyber-attacks can be categorized as exogenous occurrences.[5] However, the decisions surrounding (a) the disclosure of cyber-attack incidents and (b) how such incidents are disclosed to the SEC fall into the category of endogenous choices. Unlike other endogenous disclosure choices firms make, disclosures of cyber-attack incidents are difficult (if not impossible) to anticipate. Furthermore, these cyber-attack incidents are frequent exogenous events. As a result, the presence of the endogenous element does not diminish the significance of this setting.

[5] One may question whether cyber-attack incidents are entirely exogenous events given that prior studies design measures to predict cyber-attack incidents (see, Li et al. (2018); Florackis et al. (2023), among others). Notwithstanding, the timing and severity of cyber-attack incidents are largely exogenous.

My paper offers two contributions. First, it expands the literature on cyber-attacks by examining the connection between how cyber-attacks are disclosed and stock returns surrounding the disclosure. It also expands the literature related to cybersecurity risk factor disclosures by analyzing the change in these disclosures following a cyber-attack incident using textual analysis techniques. Second, the results of my paper may be informative to regulatory bodies such as the SEC in their discussions about whether additional guidance is required for cybersecurity-related disclosures.

The remainder of the paper proceeds as follows. In section 2, I provide a background on cyber-attacks. In Section 3, I summarize prior literature and develop my hypothesis. I illustrate my sample and research design in section 4. Section 5 presents my empirical findings. Section 6 presents my robustness checks. Section 7 presents supplemental analyses. Finally, I summarize my study in section 8. A summary of variables and other illustrations are included as Appendix.[6]

2. Background

In this section, I first define cyber-attacks. Next, I provide an overview of developments or events within my sample period. Lastly, I summarize relevant prior literature on cyber-attacks and cyber security.

2.1 Cyber-attacks

According to the technology firm IBM, a cyber-attack is "any intentional effort to steal, expose, alter, disable, or destroy data, applications or other assets through unauthorized access to a network, computer system or digital device."[7]

I consider cyber-attacks to be interruptions to the firm's operation caused by unauthorized access to a network, computer system, or digital device that may or may not lead to material loss. This interruption can range from employees' email accounts being compromised by a malicious third party to a firm's operation forced to be shut down due to system intrusion. I classify a firm to be affected by a cyber-attack when an identifiable cyber-attack is disclosed by the firm. Moreover, I only focus on the cyber-attack incidents that either affect the firm or a subsidiary of the firm. I do not examine cyber-attack incidents that affect a third-party vendor of the firm. I will discuss this in more detail in the sample selection section.

[6] An Online Appendix with additional information and tables could be provided upon request.
[7] See: https://www.ibm.com/topics/cyber-attack#:~:text=Cyberattacks%20are%20attempts%20to%20steal,unauthorized%20access%20to%20computer%20systems.

2.2 Developments and Major Events

Several developments or events occurred within my sample period that may affect the number of cyber-attack incidents. These developments or events range from policy implementations such as the introduction of the General Data Protection Regulation (GDPR) by the European Union (EU) to exogenous events like COVID-19. I briefly describe the background of these events along with their possible effect on the number of cyber-attack incidents in the Online Appendix.

3. Prior Literature and Hypothesis Development

My analysis consists of three parts. In the first part, I examine firms' initial disclosures of cyber-attack incidents in their SEC filings. The initial disclosure is of special interest because stakeholders first learn about the cyber-attack via the SEC from this filing. In the second part, I examine the change in cybersecurity risk factor disclosures after the cyber-attack incident. In the last part, I examine pre-incident cybersecurity risk factor disclosures' effect on cyber-attack incident disclosures.

3.1 Stock Returns Surrounding Disclosure to the SEC

Previous studies provide mixed results regarding the impact of cyber-attack incidents on stock-market reactions. Cavusoglu, Mishra, and Raghunathan (2004) report a statistically significant negative effect of cyber-attack incidents on the stock returns. However, Kannan, Rees, and Shridhar (2007) find that, on average, the effect of cyber-attack incidents on the market is insignificantly different from zero. Gordon, Loeb, and Zhou (2011) document a decrease in the effect of cyber-attack incidents on the stock market over their sample period. Hilary, Segal, and Zhang (2016) find that the market reaction is not significantly different from zero, even in the cases of major cyber-attack incidents. Amir, Levi, and Livne (2018) suggest that cyber-attack incidents that were initially concealed and subsequently discovered independently by external sources outside the firm tend to exhibit a more negative market reaction than incidents that were voluntarily disclosed.

Prior studies suggest cyber-attack incidents are associated with negative consequences. For instance, Janakiraman, Lim, and Rishika (2018) use transaction data from individual customers of a publicly owned retailer headquartered in the United States and find that customers affected by a data breach tend to decrease their spending following the announcement of the breach. Kamiya et al. (2021) suggest that successful cyberattacks harm the target firm's reputation and lead to significant shareholder wealth loss. Huang and Wang (2021) show that firms affected by cyber-attacks face higher bank loan spreads as well as stricter collateral and covenants requirements. More recently, Lattanzio and Ma (2023) show managers' reliance on trade secrets diminishes as exposure to cybersecurity risk intensifies.

I expect stock returns to decline surrounding cyber-attack disclosures to the SEC as market participants would logically regard the cyber-attack incidents as "bad news" with negative consequences. However, prior studies that investigate the association between cyber-attack incidents and stock returns demonstrate mixed results. Moreover, market participants may learn about cyber-attack incidents from sources other than firms' own disclosures (Amir et al. (2018)) and hence stock returns surrounding disclosure to the SEC may become statistically insignificantly different from zero. Taken together, this motivates the first hypothesis stated in the null form:

H1: Cyber-attack disclosures do not affect stock returns.

I then examine whether the characteristics or content of the cyber-attack incident disclosures affect stock returns. The first disclosure characteristic I examine is the filing type. Firms in my sample disclose cyber-attack incidents through either Form 10-K, Form 10-Q, or Form 8-K. Form 10-K is used for filing annual reports whereas Form 10-Q is used for filing quarterly reports. In addition, the SEC provides Form 8-K to public firms to report material corporate events on a more current basis. The SEC states on its website that "Form 8-K is the 'current report' companies must file with the SEC to announce major events that shareholders should know about." Given the intended use of Form 8-Ks, I expect market participants to react more strongly to cyber-attack disclosures using this form. Cyber-attack incidents disclosed in Form 8-Ks are less likely to be accompanied by other disclosures or information while those disclosed using Form 10-K or Form 10-Q are accompanied by other disclosures of information. The effect of the cyber-attack incident may be dampened in Form 10-Ks or Form 10-Qs. Therefore, market participants may react differently to cyber-attack incidents disclosed in Form 8-Ks, compared with cyber-attack incidents disclosed in Form 10-Ks or Form 10-Qs, leading to differential stock returns. However, given that cyber-attack incidents are "bad news" and have negative consequences, the disclosure choice may not matter. That is, market participants react in the same manner regardless of the filing type. Taken together, these considerations motivate the following hypothesis stated in the null form:

H1a: Stock return following cyber-attack disclosures made through Form 8-K are the same as stock returns following cyber-attack disclosures made through Form 10-Q or Form 10-K.

The content or characteristics of cyber-attack disclosures could also lead to different impacts on stock returns as market participants may obtain additional information leading to an altered perception of the materiality or impact of the cyber-attack incident. One cannot rule out the possibility that market participants will also ignore the information content and consider all cyber-attack incidents to be equally "bad." This latter hypothesis is more valid for cyber-attack disclosures made through Form 10-K or Form 10-Q where cyber-attack incidents are disclosed along with other information, increasing market participants' information acquisition or search costs. Some content may also be confusing. For example, if a firm discloses that it engaged a third-party cybersecurity firm to help with the investigation of the cyber-attack incident, market participants could interpret this as either the firm is committed to solving the problem,

or the firm is incapable of solving the problem due to the severity of the incident. For this reason, the reaction of market participants becomes unclear. Taken together, these considerations motivate the following hypothesis stated in the null form:

H1b: The disclosure contents or characteristics do not affect stock returns surrounding cyber-attack incidents.

3.2 Post-Incident Change in Cybersecurity Risk Factor Disclosures

In the second part of my analysis, I examine changes in cybersecurity risk factor disclosures following cyber-attack incidents. In 2005, the SEC mandated that public firms must disclose the most significant risk factors in their annual filings on Form 10-K in the new "Item 1A Risk Factors" section and update them quarterly for any material changes (Regulation S-K, Item 105, SEC, 2005).

Prior literature relates risk factors in Item 1A to cybersecurity. For example, Berkman, Jona, Lee, and Soderstrom (2018) construct a cybersecurity awareness index using the content of the full Form 10-K filing and document a positive association between firms' cybersecurity awareness and market valuation. Gao, Calderon, and Tang (2020) examine cybersecurity disclosures in various sections of Form 10-K. They conclude that cybersecurity risk disclosures are mostly included in Item 1A Risk Factors, and occasionally in Item 1 Business as well as Item 7 Management Discussion and Analysis (MD&A).

Two papers focus on the specific cybersecurity risk factors disclosed in Item 1A instead of the entire Form 10-K or Item 1A risk factor. Li, No, and Wang (2018) focus on cybersecurity risk factor disclosures made in Item 1A of Form 10-K filings and find a positive association between the disclosures and subsequently reported cyber incidents. Their results suggest that cybersecurity risk factor disclosures are predictors of future data breaches. Florackis, Louca, Michaely, and Weber (2023) use the cybersecurity risk factors disclosed in Item 1A to construct a cybersecurity index using textual analysis. They then document that their cybersecurity index construct explains cross-sectional stock price differences and predicts future cyber-attack incidents.

More closely related to my paper, Chen, Henry, and Jiang (2022) document an increase in cybersecurity-related keywords in the entire Item 1A Risk Factors following a cyber-attack incident. However, the change in cybersecurity risk factor disclosure is not restricted to the number of keywords. For example, firms may also increase the length of cybersecurity risk factor disclosures to signal their confidence in defending against future cyber-attack incidents following a cyber-attack incident. At the same time, firms may continue to discuss only generic risks related to cybersecurity, and hence, the length of disclosure remains unchanged. The tone of cybersecurity risk factor disclosures could also change as firms may choose more positive words to signal their confidence and optimism in handling current and future cyber-attack incidents. Firms may also use more negative words to discuss the difficulty in detecting and avoiding cyber-attack incidents in the future. The (net) change in cybersecurity risk factor disclosure thus becomes unclear. This motivates the second hypothesis stated in the null form:

H2: Cyber-attack incidents do not affect cybersecurity risk factor disclosures.

Firms also discuss cyber-attack incidents in their cybersecurity risk factor disclosures. Therefore, any observed change in cybersecurity risk factor disclosures (including cybersecurity-related keyword count) may be completely attributable to the part of the text that describes the cyber-attack incident. This analysis motivates the following hypothesis stated in the null form:

H2a: Cyber-attack incidents do not affect cybersecurity risk factor disclosures, after removing part of the text that describes the cyber-attack incident.

Firms may also alter sentences slightly without including additional information related to cybersecurity risk. For example, a firm could change the sentence from "we may be subject to cybersecurity risk" to "we are subject to cybersecurity risk." As such, examining the part of the text that is unique in the pre- and post-incident periods is important because this part of the text better captures the change in cybersecurity risk factor disclosures following cyber-attack incidents. The change in cybersecurity risk factor disclosures may be completely attributable to minor changes in sentences without additional information related to cybersecurity risk. For simplicity, I label sentences with minor changes as largely similar sentences as they remain similar in the pre-and post-incident periods. These possible textual changes motivate the following hypothesis stated in the null form:

H2b: Cyber-attack incidents do not affect cybersecurity risk factor disclosures, after removing the part of the text that describes the cyber-attack incident and largely similar sentences.

3.3 Pre-Incident Cybersecurity Risk Factor Disclosures and Stock Returns Surrounding Disclosure to the SEC

In the last part of my analysis, I examine the effect of cybersecurity risk factor disclosures from the pre-incident period on cyber-attack incident disclosure to the SEC.

Prior literature documents that Item 1A Risk Factors are informative. For example, Campbell et al. (2014) find that Item 1A Risk Factors increase investors' risk perception and reduce information asymmetry. Hope, Hu, and Lu (2016) document that market returns and trading volume surrounding Form 10-K filing dates are associated with the specificity of risk factors, suggesting more specific risk factors are associated with greater movement in stock prices and trading volume. Chiu, Guan, and Kim (2018) find a significant decrease in credit default swap spreads following the SEC risk factor mandate, suggesting the mandated disclosures also affect the debt market. Campbell et al. (2019) focus on disclosed tax risk factors and find a negative association with firms' tax-related cash payments over the subsequent years. Their finding suggests that risk factors about tax are related to tax positions that are rewarded with future tax savings.

More closely related to my paper, Li et al. (2018) document that cybersecurity risk factor disclosures are informative as they predict future cyber-attack incidents, and Florackis et al. (2023) document that cybersecurity risk factor disclosures help explain cross-sectional stock prices. Therefore, the content of cybersecurity risk factor disclosures from the pre-incident period may lead to differential stock returns when firms encounter cyber-attack incidents. For example, market participants may react differently to firms with more detailed and specific cybersecurity risk factor disclosures compared to firms with less detailed and more standardized cybersecurity risk factor disclosures when both firms encounter a cyber-attack incident. This is consistent with the findings of Hail, Muhn, and Oesch (2021), who use Swiss Franc shock to show firms with more transparent disclosures regarding their foreign exchange risk ex-ante exhibit significantly lower information asymmetry ex-post. However, market participants may simply regard all cyber-attack incidents as equally "bad" and may not consider the content of cybersecurity risk factor disclosures from the pre-cyberattack incident period. Taken together, this motivates the third hypothesis stated in the null form:

H3: The content or characteristics of pre-incident cybersecurity risk factor disclosures do not affect stock returns surrounding cyber-attack incidents.

4. Sample and Research Design

I focus on firms that file Form 10-K to the SEC on an annual basis as these firms are required to disclose risk factors in their filings. Moreover, these firms are also expected to file quarterly using Form 10-Q and report any material events such as cyber-attacks using Form 8-K.

In February 2018, the SEC published interpretive guidance to assist public companies in preparing disclosures about cybersecurity risks and incidents. The guidance contains detailed information regarding how firms should disclose cybersecurity incidents as well as risk factors. Given the availability of this new guidance that may assist firms in disclosing cyber-attack incidents and cybersecurity risk factors, I set 1 January 2018, as the start of my sample period as most US firms have a 31 December fiscal year-end.[8] My sample period ends in Q1 of 2023. That is, I am interested in cyber-attacks that occurred between 2018 Q1 and 2023 Q1.

I start my data collection procedure by first identifying firms that are part of the Russell 3000 index. The Russell 3000 index consists of the 3,000 largest US firms that comprise 96% of the investible equity. I include all firms that appear on the Russell 3000 index in 2018, which is the starting year of my sample period.[9] I then merge these firms with Compustat Annual and CRSP. I keep firms that appear at least once between 2018 and 2023 in both databases. This step generates 2,729 firm observations. I then examine if these 2,729 firms incurred a cyber-attack in my sample period. I start this process by ensuring data availability to maximize the possibility of obtaining firm and stock data for identified cyber-attacks.

[8] The (now former) SEC Chairman Jay Clayton stated, "I believe that providing the Commission's views on these matters will promote clearer and more robust disclosure by companies about cybersecurity risks and incidents, resulting in more complete information being available to investors." (See: https://www.sec.gov/news/press-release/2018-22)

[9] [9] I acknowledge that by including firms only present in the 2018 Russell 3000 index creates a bias as the index is reconstituted every year on the fourth Friday of June. However, this bias does not affect my results.

I identify possible cyber-attacks using EDGAR Full-Text search. I searched for possible cyber-attacks using a list of keywords I constructed with reference to Chen, Henry, and Jiang (2022) (see Appendix 1). I search for keywords in Form 8-K filings submitted between 1 January 2018 and 31 March 2023, and Form 10-K and 10-Q filings submitted between 1 April 2018 and 15 May 2023 (see Appendix 2). This ensures that the 2018 and 2023 first quarter filings (10-Qs) for a firm with 31 December fiscal year end are examined. This also ensures that I can examine annual filings for fiscal years ending 2018 through 2022.[10] I save the search results and match them with the 2,729 firms identified above. I remove duplicate observations as some filings contain several keywords. I then examine all 8-K filings as well as all 10-K and 10-Q filings except those that are present for all possible periods.[11] If a cyber-attack was identified, I locate the first filing that mentions the cyber-attack as firms may mention a cyber-attack in multiple filings over time.[12]

Table 1 summarizes my sample selection criteria. I identify 233 cyber-attack incidents disclosed by 211 firms. I then remove cyber-attacks that did not occur between 2018 and 2023. I focus on the subsample of 164 (disclosed by 157 firms) cyber-attack incidents targeting the firm or a subsidiary of the firm. I ignore cyber-attacks targeting a third-party vendor of the firm. I provide examples of cyber-attack disclosures in all three types of filings in Appendix 3.

My sample differs from the prior literature for three reasons. First, I focus on the Russell 3000 index constituents. The Russell 3000 index consists of the 3,000 largest US firms. Large firms are more likely to spend more resources on cybersecurity. Some large firms may also have an in-house cybersecurity team. As a result, large firms may be less likely to suffer from a cyber-attack. However, the Russell 3000 index constituents' sample is meaningful as it consists of firms that represent 96% of the investible equity. Second, my sample period differs. As mentioned in section two, several developments may have directly or indirectly affected the number of cyber-attacks. Third, my sample focuses on disclosures made by the management. The choice of disclosing a cyber-attack can be voluntary as management may not disclose a cyber-attack considered to be immaterial. Moreover, Amir et al. (2018) find that firms withhold cyber-attack

[10] The filing deadline for Form 10-Qs and Form 10-Ks both depend on the public float of the filer. One concern related to my sample period restriction is that I do not observe the 2017 Form 10-K filings for firms with 31 December fiscal year-end, which may contain disclosure of a cyber-attack that occurred in the first quarter of 2018. However, this concern does not affect my results but only the power of my tests.

[11] The maximum number of Form 10-Q (10-K) filings within my sample period is 16 (5). Firms that have a matching keyword in all of their quarterly or annual filings within my sample period are most likely to be firms that contain boilerplate disclosures. However, not examining these firms creates a potential bias towards new firms that are only present for some quarters. As a result, I randomly examined 100 firms that have a matching keyword in all of their quarterly (1,600 Form 10-Q filings) and 100 firms that have a matching keyword in all of their annual filings (500 Form 10-K filings) within my sample period. I identified six cyber-attacks from the 1,600 quarterly filings and zero cyber-attacks from the 500 annual filings. Given the small likelihood of identifying a cyber-attack incident from these firms, I do not further examine firms with a matching keyword in all of their quarterly or annual filings. Moreover, not examining these firms does not affect my results – only the power of my tests.

[12] For example, a firm may mention a previously announced cyber-attack incident in its Form 10-K filing. In these cases, I locate the first filing with the cyber-attack incident disclosure. Moreover, some firms mention a cyber-attack incident that occurred in the past. For example, a firm may mention in its 2020 Form 10-K filing that it was affected by a cyber-attack incident in 2013.

disclosures and only disclose when they believe the cyber-attack is highly likely to be discovered by outsiders. That is, firms may be "forced" to disclose cyber-attacks. Therefore, the actual number of cyber-attacks may be greater than those disclosed. I believe my sample is suitable for my intended aim of examining disclosures related to cyber-attacks.

Table 2 illustrates the characteristics related to cyber-attack incidents in my sample. Panel A reveals the by-year distribution of cyber-attack incidents across my sample period. The number of cyber-attacks increase in 2018, peaked in 2020, and then decrease. Note that 2023 only contains cyber-attacks that occurred in the first quarter of 2023. Panel B of Table 2 illustrates the distribution of cyber-attacks across quarters for the 155 cyber-attack incidents that provide the quarter in which the incident occurred.

I document the cyber-attack disclosure characteristics in Table 2 Panel C. I first separate cyber-attack disclosures into 8-K and Non-8-K disclosures. 8-K (Non-8-K) cyber-attack disclosures refer to cyber-attacks disclosed in Form 8-Ks (10-Ks or 10-Qs). The number of 8-K (Non-8-K) disclosures is 92 (72). Next, I document characteristics related to cyber-attack disclosures. I briefly describe the disclosure characteristics below and summarize them in Appendix 4 along with other variable definitions. *Separate Disclosure* is an indicator variable that takes the value of one if the disclosure only contains the cyber-attack incident or the cyber-attack incident disclosure is made in a separate section (e.g. under subsequent events in Form 10-Ks or 10-Qs). *Immaterial Cyber Attack* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm does not believe the cyber-attack incident to be material. *Engage Cybersecurity Firm* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm engaged a cybersecurity firm to help investigate the cybersecurity incident. *Maintain Insurance* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm maintains cybersecurity insurance. *Discovery Date* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions a discovery date (different from the filing date) of the cyber-attack incident. *Wordcount Raw* (*Processed*) is the word count of the raw (processed) cyber-attack incident disclosure text in the filings.[13] [14]

[13] I use Python's Natural Language Toolkit (NLTK) library for my textual analysis in this paper. NLTK is an open-source natural language processing package (documentation: https://www.nltk.org/). See Bochkay et al. (2022) for an overview on the use of textual analysis in accounting.

[14] Throughout my paper, I perform the following procedures to process the raw text:

(1) Tokenization: I break the raw text into separate words. For example, the sentence "This is my job market paper." would be broken into ["This", "is", "my", "job", "market", "paper", "."]

(2) Removing stop words: Stop words refer to words that may be essential in human communication but do not contribute to computerized language processing. For example, "a", "an", and "the" are common stop words. Given that all the texts I examine are in English, I use NLTK's built-in English stop-word list. (Documentation: https://pythonspot.com/nltk-stop-words/)

(3) Normalization: I use the lemmatization technique instead of stemming as it retains more information. Lemmatization reduces a word to its root form, known as a lemma. For example, the verb "attack" may appear as "attack", "attacking", "attacked" or "attacks". The lemmatization algorithm groups these words as their lemma "attack".

(4) I join the processed text back into a paragraph. This last step is not necessary and does not affect my results. Note that in my word count analysis, I only count the number of words or numbers, not the punctuations. For example, the word count of sentence in point (1) would have a word count of six instead of seven.

All characteristics other than *Maintain Insurance* are significantly different across the two disclosure types (i.e. 8-K and Non-8-K disclosures).

5. Empirical Results

5.1 Market Reaction Surrounding Cyber-Attack Disclosure

In assessing stock returns following cyber-attack disclosures, I first calculate the buy-and-hold abnormal return (BHAR) and the cumulative abnormal return (CAR) using the disclosure filing dates as the event dates. The disclosure dates can be directly used as event dates as the filings must be filed on a trading day. Following Amir et al. (2018), I calculate BHAR and CAR over five trading days, starting with one day before the event date and three days after the event date. That is, I choose event windows of [-1, 3], where 0 represents the event date I also calculate BHAR and CAR for [-1, 1] and [-2, 2]. I adjust for risk related to stock returns using the Fama French Three Factor Model. I estimate the BHAR and CAR for 158 cyber-attack incidents using this approach.[15] One concern related to this approach is having to estimate firm-specific betas which can be noisy, especially for moderate sample sizes (Fama and French, 1996). Prior studies also use other risk adjustment models, such as the Market Adjusted Model and the Market Model. In my untabulated supplement analysis, I find consistent results using these less restrictive alternative adjustment models.

Table 3 Panel A illustrates the BHAR and CAR for the entire sample of 158 cyber-attack incidents for all three estimation windows. I expect negative stock returns surrounding the cyber-attack incident disclosures given that a cyber-attack incident is negative news to the market participants. Panel A suggests the coefficients are negative, but not statistically significantly different from zero for conventional levels of statistical significance. I therefore cannot reject the null stated in hypothesis 1 that the impact on stock returns surrounding cyber-attack disclosure is zero.

I then separate cyber-attack disclosures into 8-K (Non-8K) disclosures. 8-K (Non-8-K) cyber-attack disclosures refer to cyber-attacks disclosed (for the first time) in Form 8-K (10-K or 10-Q). Table 3 Panel B illustrates the existence of a decline in stock returns in all three estimation windows for cyber-attack disclosures made in Form 8-Ks, as indicated by the statistically significant negative coefficients. However, the coefficients are positive and statistically insignificant for cyber-attack disclosures reported in Form 10-Ks or Form 10-Qs. Moreover, the difference between the two groups of disclosures (8-K and Non-8K) is statistically significant. This finding lends support to hypothesis 1a as I reject the null hypothesis of no differential abnormal stock returns. I offer two possible explanations for this phenomenon. First, the cyber-attack disclosures in Form 10-Ks or Form 10-Qs are bundled with other (positive) news that cancels out the negative news of a cyber-attack incident. Second, shareholders may fail to identify cyber-attack incidents when bundled with other disclosures.

[15] The number of observations decreased from 164 to 158 due to data limitations.

I then test for the difference in stock returns following a cyber-attack incident disclosure based on disclosure characteristics using a regression model. Specifically, I estimate the following cross-sectional model:

$$BHAR_i = \beta_0 + \beta_1 8\text{-}K_i + \beta_2 Disclosure\ Characteristic_i + \sum_{3}^{k} \beta_3 Control_{i,k} + \sum_{3+k}^{j} \beta_{3+k} Fixed\ Effect_{i,j} \quad (1)$$

with variable definitions summarized in Appendix 4. The dependent variable is the buy-and-hold abnormal return for cyber-attack incident *i*. I only report results from using the [-1,3] window, that is the buy-and-hold abnormal return starting one day prior to the disclosure of the cyber-attack incident and three days after. I find consistent results using the [-1,1] and [-2,2] estimation windows. I also find consistent results using the cumulative abnormal return instead. *8-K* is an indicator variable that takes the value one (zero) if the cyber-attack disclosure was made in Form 8-K (Form 10-K or Form 10-Q).

Disclosure Characteristics include *Immaterial Cyber-Attack* which is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm does not believe the cyber-attack incident to be material; *Separate Disclosure* is an indicator variable that takes the value of one if the disclosure only contains the cyber-attack incident or the cyber-attack incident disclosure is reported in a separate section (e.g. under subsequent events in Form 10-Ks or 10-Qs); *Engage Cybersecurity Firm* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm engaged a cybersecurity firm to help investigate the cybersecurity incident, and *Maintain Insurance* is an indicator variable that takes the value of one if the cyber-attack incident disclosure mentions that the firm maintains cybersecurity insurance.

I include several control variables to control for the underlying economics of the firms. I include *Ln (Raw Word Count),* which is the natural log of the word count of the cyber-attack incident disclosure text to control for the length of the disclosure. I use *Size,* defined as the natural log of total assets as a proxy of the size of a firm; *Leverage,* defined as total liabilities scaled by total assets, and multiplied by 100 to proxy for the riskiness of a firm; *Cash,* calculated as cash scaled by total assets, and multiplied by 100 to proxy for the liquidity. I proxy for the profitability of a firm using *Loss*, which is an indicator variable that takes the value of one (zero) if a firm has a negative (positive) value for net income and *ROA*, calculated as net income scaled by total assets, and multiplied by 100. I proxy for the value of a firm using *MTB*, defined as the market value of the firm scaled by the book value of the firm. I include a firm's institutional ownership percentage (*Ownership*) to proxy for the ownership structure. Lastly, I use the 100-day average bid-ask spread (*Bid-Ask*) as a control for the firm's information environment. I calculate *Bid-Ask* by taking the average of daily bid-ask spreads starting (ending) at 102 (2) trading days before the cyber-attack incident disclosure and multiplying by 100 to express the result as a percentage.

All my control variables (except for *Ln (Raw Word Count)*) are calculated using annual values from the fiscal year immediately *before* the cyber-attack. This controls for the pre-cyber-attack firm characteristics to a certain extent. I also include industry and year-fixed effects to remove general trends across years and industries.[16] I do not provide an expectation for the signs of the control variables, as my goal is not to explain the dependent variable but to examine if the characteristics related to disclosures have incremental explaining power. Therefore, I do not present the coefficients of the control variables or the fixed effects to conserve space.

Table 4 presents my results. The sample size is 150 cyber-attack incidents as eight incidents had missing information needed to estimate the model. Columns 1 and 2 serve as base cases without any disclosure characteristics. The coefficient for *8-K* is negative and significant in both columns, which suggests that cyber-attack disclosures made in Form 8-K have a more negative reaction than those made in Form 10-K or 10-Q, holding pre-cyber-attack firm characteristics constant. In columns 3 through 7, I include additional disclosure characteristics related to the cyber-attack incident disclosures. For example, column 3 includes the raw word count of the disclosure, and column 7 includes an indicator variable that takes the value of one if the cyber-attack disclosure mentions the firm maintains cybersecurity insurance. In columns 3 through 7, I fail to reject hypothesis 1b as I do not find any evidence that the disclosure characteristics have incremental power to explain stock returns beyond where the disclosure was made, as suggested by the consistent statistically significant negative coefficient of *8-K*. In column 8, I include all disclosure characteristics into my regression equation. Again, only the coefficient of *8-K* is statistically significant and negative. Moreover, the coefficient of *8-K* remains largely consistent across all models.

The estimations above only capture the effect of disclosure characteristics of their own. However, the disclosure characteristics may have differential effects depending on where the cyber-attack incident was disclosed, i.e. they are dependent on the *8-K*. To examine this relationship, I apply the following cross-sectional model:

$$BHAR_i = \beta_0 + \beta_1 8\text{-}K_i + \beta_2 Disclosure\ Characteristic_i + \beta_3 8\text{-}K_i \times Disclosure\ Characteristic_i + \sum_{4}^{k} \beta_4 Control_{i,k} + \sum_{4+k}^{j} \beta_{4+k} Fixed\ Effect_{i,j} \quad (2)$$

[16] I do not use a stronger specification like firm-fixed effects as I only have several observations of firms that suffer a cyber-attack twice. For a summary on the use of fixed effects, see Breuer and deHaan (2023).

In the above equation (2), estimates of β_3 capture the effect of a given disclosure characteristic condition on the medium through which the cyber-attack incident was disclosed (Form 8-K vs. Form 10-K or 10-Q). Table 5 presents my results. The first two columns present the base cases as in Table 4. In columns 3 through 7, I estimate the above model using different disclosure characteristics. I find evidence that the disclosure characteristics affect stock returns following the cyber-attack incident. Column 4 suggests that immaterial cyber-attacks disclosed in Form 8-Ks are associated with a greater decline in stock returns compared with immaterial cyber-attacks disclosed in Form 10-Ks or 10-Qs, as the coefficient on the interaction term is negative and statistically significant. One possible explanation is market participants penalize managers for misusing Form 8-Ks to disclose an immaterial event, as the intended use of Form 8-Ks is to disclose material events. Column 7 suggests that cyber-attack incident disclosures reported in Form 8-Ks, and those that mention the maintenance of cybersecurity insurance, lead to a less negative stock return as the coefficient on the interaction term is positive and statistically significant. This is overall consistent with market participants realizing that the cybersecurity incident may not be financially material as the insurance will cover part or all of the costs. The coefficient on *8-K* is largely consistent as well as statistically significant. Overall, I find some results that the disclosure characteristics of the cyber-attack incident affect the stock return surrounding the disclosure, hence rejecting hypothesis 1b.

5.2 Cybersecurity-Related Risk Factors

Chen et al. (2022) document an increase in cybersecurity-related keywords in the entire Item 1A Risk Factors section of Form 10-Ks following a cyber-attack incident. To better understand the effect of cyber-attack incidents on risk factor disclosures, I focus on the risk factor disclosures specifically related to cybersecurity and conduct textual analysis. Given the moderate size of my sample, I manually collect pre- and post-cyber-attack cybersecurity risk factor disclosures.[17]

My sample collection starts from 164 cyber-attack incidents reported by 157 firms. I focus on this sample as these firms (or their subsidiaries) are directly affected by a cyber-attack incident. I keep cyber-attack incidents that have both the pre-and post-cyber-attack Form 10-K filing available. I remove duplicate cyber-attack incidents that share the same pre- and post-cyber-attack Form 10-K filings. This process generates 145 pairs of cybersecurity risk factors disclosed before and after a cyber-attack incident.

I was concerned that an analysis of these disclosed cybersecurity risk factors may simply reflect a general trend related to time or industry, but uncorrelated with a cyber-attack incident. Therefore, I perform matching to identify cybersecurity risk factor disclosures from firms that were not affected by a cyber-attack incident. That is, each pair (pre and pos) cybersecurity risk factor disclosures for firms affected by a cyber-attack incident.

[17] Alternatively, one could follow the approach illustrated by Li et al. (2018) to extract cybersecurity risk factor disclosures. Most firms in my sample only disclose one cybersecurity risk factor. I only collect one cybersecurity risk factor for firms with more than one cybersecurity risk factor disclosed to avoid complications in my analysis. My results are robust to combining multiple cybersecurity risk factors into one cybersecurity risk factor for firms with more than one cybersecurity risk factor.

Therefore, I perform matching to identify cybersecurity risk factor disclosures from firms that were not affected by a cyber-attack incident. That is, each pair (pre and post) of cybersecurity risk factor disclosures for firms affected by a cyber-attack incident ("treatment firm") is matched with a pair (pre and post) of cybersecurity risk factor disclosures for firms seemingly unaffected by a cyber-attack incident ("control firm") because they did not disclose such attacks or did not discover attacks that occurred. The control group helps mitigate unobservable and uncorrelated factors (to a certain extent) that may affect cybersecurity risk factor disclosures. The net change may then be more reliably attributed to cyber-attack incidents.

My matching universe consists of the 2,729 Russell 3000 Index firms, minus the 180 firms affected by a cyber-attack incident(s) between Q1 2018 and Q1 2023. I exclude all 180 firms to ensure that the control firms were not affected by any type of cyber-attack incident. Following prior literature, I perform matching using propensity score.[18] Specifically, I match total assets in the fiscal year prior to the cyber-attack incident, and I match the fiscal year, the two-digit SIC Industry code, and the fiscal year-end exactly.[19] Table 6 summarizes my matching sample construction process and presents my matching results. My matched sample consisting of 121 pairs of cybersecurity risk factor disclosures permits me to perform a difference-in-differences (DD) analysis to identify the effect of cyber-attack incidents on cybersecurity risk factor disclosures.[20]

Results from analyses on cybersecurity risk factor disclosures following a cyber-attack incident may also be driven by (a) text describing the cyber-attack incident and/or (b) minor changes in sentence language choice. Therefore, I perform textual analyses on (1) the raw text of the cybersecurity risk factor disclosure; (2) text after removing content describing the cybersecurity incident; and (3) text after removing content describing the cybersecurity incident and identical or similar sentences. I label the text in (3) as unique as this section of the text is unique in the pre- or post-incident period. To conserve space, I only present and discuss results from (3), which better isolates the effect of cyber-attack incidents on cybersecurity risk factor disclosures. In the online appendix, I present the results from (1) and (2) and find evidence to reject hypothesis 2 and 2a.

I remove text describing the cybersecurity incident and identical or similar sentences in the following manner. I manually identify and remove part of the text that describes the cyber-attack incident from the cybersecurity risk factor of treatment firms in the post-cyber-attack incident period. The text of the cybersecurity risk factor of treatment firms in the pre-incident period is unaltered.[21] The text of the cybersecurity risk factor of control firms is also unaltered for both the pre-and post-cyber-attack incident periods. To identify unique text in the risk factors of treatment, I first convert all risk factors into individual sentences. Next, I remove identical

[18] See Shipman et al. (2017) for an overview of the use of PSM in accounting literature.
[19] The same fiscal year-end criterion helps ensure the pre- and post-filing dates of treatment and control firms are not far apart to permit a "learning effect". My results are qualitatively similar without imposing this matching criterion, as most firms share the same fiscal year-end of 31 December.
[20] In Appendix 5 I provide an example of pre-and-post cyber-attack incident cybersecurity risk factor disclosure for a treatment firm in my sample.
[21] I do not find any control firm in my sample discussing cyber-attack incidents that affected other firms.

sentences that are present both in the risk factors before and after the cyber-attack incident. This process removes 49% of the total sentences in cybersecurity risk factor disclosures.[22] Next, I remove sentences that are relatively similar using the Levenshtein ratio.[23] Specifically, I compare each sentence in the pre-period risk factor to each sentence in the post-period risk factor. I then remove sentences in pairs that have a Levenshtein ratio of 0.85. This process removes another 15% of the total sentences.[24] [25] I repeat the process to identify unique text in the risk factors for control firms.[26]

Table 7 presents my results. Table A suggests that following a cyber-attack incident, the net change in mean word count for treatment (control) firms is 103 (26). The mean difference of 77 words is statistically significant (p-value = 0.00).[27] The results are consistent with those that apply processed text for analysis, as illustrated in Panel B, and suggest that the net change in the unique text post-cyber-attack incident is greater for treatment firms than for control firms. Table 7 Panel C presents the results generated from calculating the similarity scores within the group. I calculate the similarity of cybersecurity risk factor disclosures within a group ("treatment firms" or "control firms") before and after a cyber-attack incident and expect the similarity score to be higher within the control group than within the treatment group. As expected, the mean similarity score for treatment (control) firms is 0.58 (0.8). The difference is statistically significant (p-value = 0.00). Panels D and E of Table 7 present the sentiment analysis results on the unique text present in cybersecurity risk factor disclosures.[28] I hone in on the proportion of text that falls into the negative sentiment category. I expect the ratio for proportions of text that falls into the negative category for firms (not) affected by cyber-attack incidents to increase (remain constant) . Panel D suggests that the mean ratio of words falling into the negative sentiment category decreases for treatment firms after a cyber-attack incident (p-value = 0.04). The ratio does not change for control

[22] I convert all letters in a sentence to lowercase and remove all punctuation before removing duplicate sentences, as capitalization and punctuation may lead to minor differences.
[23] I calculate similarity using the Levenshtein distance. The Levenshtein distance calculates the minimum number of insertions, deletions, and substitutions required to change one sequence into the other. I use a normalized similarity in the range [0,1] for a simpler interpretation. A ratio score of zero (one) represents completely different (identical) strings. (Documentation: https://maxbachmann.github.io/Levenshtein)
[24] I set the cut-off as 0.85 based on manual inspection of the strings and suggested setting the cut-off lower would remove sentences that have significant differences. I aim to identify unique sentences while maintaining the quality of the data.
[25] I acknowledge the possibility that some risk factors may not have any unique sentences. In these instances, I set the word count as zero, the similarity ratio as zero, and the negative sentiment ratio as zero. If the cybersecurity risk factor disclosures have zero unique sentences in both periods, then I set the word count as zero, the similarity ratio as one (i.e. completely identical), and the negative sentiment as zero.
[26] In the duplicate sentence removal stage, I remove 70% of the total sentences from the cybersecurity risk factor disclosures of control firms. In the similar sentence removal stage, I remove another 12% of the total sentences. I set the cut-off as 0.85 as in the treatment firm sample.
[27] In the online appendix, I show that the difference in raw text word count in the pre-incident period between treatment and control firms is statistically insignificant. That is, treatment firms and control firms' cybersecurity risk factor disclosure are of the same length before a cyber-attack incident occurs. This alleviates matching concerns, if any.
[28] I use the Valence Aware Dictionary and Sentiment Reasoner (VADER) analysis tool for my sentiment analysis. VADER is a lexicon and rule-based tool that calculates and returns ratios for proportions of text that fall in each of the three categories: positive, negative, and neutral. (Documentation: https://github.com/cjhutto/vaderSentiment#resources-and-dataset-descriptions)

firms (p-value = 0.14). The difference in change is statistically significant (p-value = 0.00). The results are largely consistent with using processed text as illustrated in Panel E.[29] The results from Panel D and E suggest the unique text present in the cybersecurity risk factor disclosures is less negative following a cyber-attack incident, which suggests firms remove text that is more negative in tone and add text that is less negative in tone. One possible explanation for this finding is treatment firms attempt to signal their confidence in minimizing the impact of current or future cyber-attacks.

I also examine the change in the number of cybersecurity-related keywords in the unique text of cybersecurity risk factor disclosures. I follow the approach of Chen et al. (2022) and count the number of keywords for treatment and matched-control firms before and after a cyber-attack incident occurs. Table 7 Panel F illustrates my results. Consistent with prior literature, I find that the number of keywords for treatment (control) firms increases from 3 (1) to 6 (2) following a cyber-attack, and the difference is statistically significant for both treatment and control firms (p-value = 0.00). Moreover, the difference in increase is also statistically significant (p-value = 0.00).[30] This finding supports the notion that the results of prior literature are robust when examining only the part of the text that is unique in the cybersecurity risk factor disclosures before and after a cyber-attack incident, as opposed to the entire risk factors section.

Lastly, I examine whether the unique text in cybersecurity risk factor disclosures becomes less standardized following a cyber-attack incident. I follow Cazier, McMullin, and Treu (2021) to generate a proxy *Standardized* for standardized text. I first generate trigrams using the entire Item 1a.[31] risk factor text for each two-digit SIC industry. While prior literature uses data from all years, I measure standardization using a three-year rolling window.[32] This approach better captures the time effect on the choice of language in risk factors. Next, I keep trigrams that appear in more than 10 percent of all risk factors, but less than 90 percent of all risk factors, as in Cazier et al. (2021). I label these fiscal-year and industry-specific trigrams as standard trigrams for that fiscal year and industry pair.

For each sentence in my cybersecurity risk factor disclosures unique text, I use the fiscal year and industry-specific standard trigrams to measure the level of standardization. I classify a sentence as a standard sentence if either the sentence consists of more than ten standard trigrams or if more than ten percent of trigrams in a sentence are standard. I then count the number of words in each standard sentence, which are then scaled by the total word count in a cybersecurity risk factor. Therefore, *Standardized* ranges from zero to one where zero (one) indicates the text is

[29] The only difference is the change in ratio, which is also statistically significant within the control group.
[30] I only perform the analysis on the raw text as the cybersecurity keywords are highly unlikely to be English-language stop words. The results are therefore by construction robust to processed text.
[31] I extract risk factors following Zafiryadis (2023). Ideally, I would have used only the cybersecurity risk factors from the extracted risk factors disclosures to identify standard trigrams across filings. However, the identification of cybersecurity risk factors from all risk factors using machine-readable methods would introduce additional noise in my constructs. Therefore, I use the entire text of all risk factors instead.
[32] For example, the boilerplate measure for the two-digit measure for industry *i* in year *t* is calculated using the risk factors from firms in industry *i* in the years *t*, *t*-1, *t*-2. I use 30 June as fiscal year cut-off to standardize fiscal year-end dates. For example, the risk factors in a Form 10-K filed for the period ending 30 June 2022 would be classified as risk factors that belong to the fiscal year 2021.

completely unstandardized (standardized).

The truncation introduced by the ten-word, or ten-percent cut-off may overclassify text as being standard. For example, a sentence with 50 trigrams only needs 6 trigrams to be classified as a standardized sentence. As a result, the *Standardized* variable may not correctly capture variation across firms. [33] I therefore construct another measure *Standardized_Relative*. *Standardized_Relative* is defined as the number of standard trigrams in a text scaled by the number of total trigrams in the same text.[34] Similar to *Standardized*, *Standardized_Relative* ranges from zero to one where zero (one) indicates the text is completely unstandardized (standardized).

Table 7 Panels G and H present my results. I set the value to be equal to zero for both measures (*Standardized and Standardized_Relative)* if a firm does not have any unique text. Using the *Standardized* Measure, I find that the text becomes less (more) standardized following a cyber-attack incident for treatment (control) firms. However, the difference is statistically insignificant for both treatment and control firms (with a p-value of 0.91 and 0.23 respectively). Using the *Standardized_Relative* measure, I find that the text becomes less standardized for both treatment firms (p-value = 0.00) and control firms (p-value = 0.09). The change observed for treatment firms is consistent with firms disclosing unique text that is less standardized (i.e. more idiosyncratic) to reflect the risk caused by the cyber-attack incident. The difference-in-differences is statistically insignificant (p-value = 0.18). I only perform the analysis on raw text as standard trigrams were identified using raw risk factor text.[35] Overall, I find some evidence that the unique text that is present in the cybersecurity risk factor disclosures of treatment firms becomes less standardized following a cyber-attack. Hence, I reject hypothesis 2b.

Taken together, I show that firms update their cybersecurity risk factor disclosures following a cyber-attack incident. I also show that this update is not merely due to (a) the description of the cyber-attack incident and (b) changes in wording. In addition, I show that firms include unique text (i.e. text that is not present in the pre-incident period) that is less standardized and more cybersecurity-focused following a cyber-attack incident.

5.3 Pre-Incident Risk Factors

The results from section 5.2 suggest that firms update their cybersecurity risk factor disclosures following a cyber-attack incident. This update to a certain extent shows that risk factors (at least cybersecurity risk factor disclosures) are not sticky disclosures and may reflect some level of idiosyncratic risk. Therefore, I examine if characteristics of cybersecurity risk factor disclosures from the pre-incident period are associated with differential stock returns when a firm encounters a cyber-attack incident. Specifically, I estimate the following cross-sectional model:

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[33] Imagine a scenario where both texts A and B have only one sentence, each with 50 trigrams. If text A has 6 standard trigrams and text B has 50 standard trigrams, then both text A and B are classified as standardized sentences. The *Standardized* measure for both texts A and B is 50/50 = 1. However, in this extreme example, text A has 44 non-standard trigrams while text B has none. This difference is not captured by the *Standardized* measure.

[34] *Standardized* and *Standardized_Relative* are highly correlated by construction. In my tests in Section 5.3, the two measures have a correlation of 0.49. The correlation is significant at the 0.01 level of significance.

[35] One could identify standard trigrams after processing the risk factors, and then repeat the analysis. However, this step is redundant as standard trigrams that contain English language stop words would appear or not appear simultaneously in the risk factors and my sample text. Therefore, I would observe similar if not identical results.

$$BHAR_i = \beta_0 + \beta_1 8\text{-}K_i + \beta_2 Ln(Pre\text{-}Incident\ Risk\ Factor\ Word\ Count) + \beta_3\ Pre\text{-}Incident\ Risk\ Factor\ Characteristic_i + \sum_{4}^{k} \beta_4 Control_{i,k} + \sum_{4+k}^{j} \beta_{4+k} Fixed\ Effect_{i,j} \quad (3)$$

with variables summarized in Appendix 4. The dependent variable is identical to that used to estimate equation (1). I include *Ln (Raw Word Count)* in all my specifications which captures the length of the pre-incident risk factor length. *Pre-Incident Risk Factor Characteristics* refer to characteristics of the raw cybersecurity risk factor text in the pre-incident period. The characteristics include *Sentiment,* which is the proportion of text with negative sentiment; *Keywords* is the number of cybersecurity-related keywords, and *Standardized* and *Standardized_Relative* are two measures for the portion of standardized text. I used the same control variables and fixed effects used to estimate equation (1).

Table 8 presents my results. As in Table 4, the coefficient for *8-K* is consistently negative and statistically significant. However, the coefficients for the characteristics are statistically insignificant. Hence, I fail to reject hypothesis 3 as I do not find any evidence that the pre-incident cyber security risk factor disclosure characteristics are associated with differential stock returns surrounding a cyber-attack incident disclosure.[36]

To summarize, I find some evidence that cyber-attack incident disclosure characteristics are associated with differential stock returns. Mainly, I find that cyber-attack incidents disclosed in Form 8-Ks are associated with more negative, abnormal stock returns compared with cyber-attack incidents disclosed in Form 10-Ks or Form 10-Qs. I also find evidence that firms affected by cyber-attack incidents updated their cybersecurity risk factor disclosures following a cyber-attack incident, and that this update is not merely attributable to (a) including text to describe the cyber-attack incident and (b) minor changes in sentences. Lastly, I fail to find evidence that pre-incident cybersecurity risk factor characteristics are associated with differential stock returns when a firm discloses a cyber-attack incident.

6. Robustness Check

I use the Fama-French Three Factor Model (FFTFM)to calculate the buy-and-hold abnormal return and cumulative abnormal return for my analyses in sections 5.1 and 5.3. This approach is consistent with prior literature that suggests firm-specific betas capture a firm's distinct systematic risk profile and thus may better adjust for risk. I also calculated abnormal returns using the Market Model (MM), which adjusts for a firm's risk using the Capital Asset Pricing Model (CAPM). Both FFTFM and MM require the calculation of firm-specific betas which could be noisy (Fama and French, 1996). Therefore, I also calculated abnormal returns

[36] In untabulated results, I remove the variable *8-K* from my regression specifications and find the same results. Hence, the lack of explanatory power of pre-incident cybersecurity risk factor characteristics is unlikely to be due to the correlation of the characteristic variables with the *8-K* variable.

using the Market-Adjusted Model (MAM). MAM directly uses the actual stock return over the same estimation window to adjust for risk related to the stocks. I find consistent results in all three instances. Overall, my results in sections 5.1 and 5.3 are not sensitive to the choice of risk-adjustment model in calculating abnormal returns.

7. Supplement Analysis

7.1 News Reports

Amir et al. (2018) suggest a firm is less likely to withhold a cyber-attack incident if the firm believes outside sources will discover the cyber-attack incident. This suggests that stakeholders can learn about a cyber-attack incident from sources other than a firm's SEC filing. I investigate one such source – News coverage. Prior studies document the relationship between the press and accounting information such as fraud, mispricing, and corporate taxes (see, Miller (2006); Drake, Guest, and Twedt (2014); Chen, Schuchard, and Stomberg (2019), among others).

Two hypotheses are in order. First, the anticipated negative stock market reaction surrounding cyber-attack incidents disclosed in irregular filings (i.e. Form 10-Ks and Form 10-Qs) may be clustered around the news instead, given that these irregular filings are less timely. That is, the negative stock market reaction related to the cyber-attack incident is clustered on the news date instead of the SEC filings date. Second, the number of news related to a cyber-attack incident may force a firm to file a timelier SEC filing (i.e. Form 8-K) as it becomes more costly for the firm to withhold information. Therefore, I expect the number of news preceding a cyber-attack incident in Form 8-K to be greater than those disclosed in regular filings.

I manually search for news related to the 164 cyber-attack incidents in my sample using Factiva. The starting date for my search is two months preceding the cyber-attack incident and the ending date is the first SEC filing date.[37] I search for all publications including web news. I fail to find any evidence for the two hypotheses stated above. First, 92 (56%) cyber-attack incidents in my sample have zero news coverage.[38] For the remaining 72 incidents, 36 (50%) only have at most two news articles mentioning the cyber-attack incident. Further, the first news coverage date for 44 (61%) of these incidents coincides with their SEC filing date. That is, the news coverage starts after the firm files with the SEC. Overall, I fail to find any evidence that stakeholders may learn about cyber-attack incidents from News coverage.

7.2 Repeated Disclosures

Prior studies examine repeated disclosure within filings (for example, Cazier and Pfeiffer (2017); Li (2019), among others). I examine repeated disclosures of cyber-attack incidents across time. Specifically, I examine if repeated disclosure of a cyber-attack incident is associated with differential stock returns surrounding the first-time disclosure. My initial sample consists of 134 cyber-attack incidents from section 5.1. Next, I remove cyber-attack incidents within my sample

[37] Fpr example, if a firm discloses a cyber-attack incident that occurred in March 2019, then my starting date for the search would be 1st January 2019.

[38] Firms such as X corporation (formally known as Twitter Inc.) and T-Mobile have more than 100 news articles covering the cyber-attack incident(s)

period that do not have a two-year window after the first disclosure. For example, the two-year window for a cyber-attack incident that occurred on 1 January 2020 (2022) ends on 31 December 2022 (2024). Hence, the second cyber-attack incident is removed from my sample. The consistent two-year window facilitates standardized comparison. This process generates 98 cyber-attack incidents that fall within my sample period with a two-year window post-first disclosure. Next, I search all Form 10-K, 10-Q, and 8-K filings for these 98 cyber-attack incidents and document the number of filings (other than the one containing the first-time disclosure) that mention the cyber-attack incident. I then test if the number of repeated disclosures leads to differential stock returns surrounding first-time disclosure by estimating a cross-sectional model similar to equation 1 in Section 5.1. I do not find any evidence that cyber-attack incidents with ex-post repeated disclosures have differential stock returns surrounding first-time disclosure of cyber-attack incidents.

7.3 Cryptocurrency

The rise in cryptocurrency's popularity may be associated with more cyber-attack incidents. One reason is cryptocurrency is valuable and is more difficult to track than traditional currencies, making it a popular currency choice for hackers or terrorists (Amiram et al. (2022)). I examine whether firms that hold or invest in cryptocurrency are associated with a higher risk of cyber-attacks. I use the matched sample from section 5.2 to conduct my analysis. I search for any mention of cryptocurrency in the entire Form 10-K filings from the pre-incident period, and then examine if the mention is related to either holding or investing in any type of cryptocurrency. In my matched sample, I fail to find any evidence to support the hypothesis that holding or investing in cryptocurrency is associated with a higher likelihood of cyber-attacks.

7.4 Loss of Data

One concern related to cyber-attack incidents is the loss of proprietary data. Proprietary data could either belong to the firm (e.g. clinical trial data of pharmaceutical firms) or clients of the firm (e.g. personal credentials of customers). While firms may be able to recover monetary costs related to a cyber-attack incident through the cybersecurity insurance they maintain, the loss of proprietary data is an additional cost that may not be recoverable. For example, MaxLinear Inc. suffered a cyber-attack incident in June 2020, where the attacker released certain proprietary information online. Given that attackers do sometimes release part of the data, I examine where and how.

BreachForums is a website that permits the sale or purchase of illegally obtained proprietary information. The website was created by a then-19-year-old named Conor Brian Fitzpatrick, who was known on the forum under the screen name "pompompurin". On 15 March 2023, Fitzpatrick was arrested by law enforcement and charged with conspiracy to commit access device fraud.[39] The website domain was later taken over by law enforcement agencies like the Federal Bureau of Investigation (See Appendix 6). According to the website thehackernews.com,

[39] See: https://www.justice.gov/usao-edva/united-states-v-conor-brian-fitzpatrick

the forum contained 888 databases consisting of 14 billion individual records. The forum had 333,000 members prior to its shutdown.[40]

Given the large amount of information available on the forum, I intend to examine if any of the firms in my sample had data leaked online to this forum. One way to examine this is by scraping the now-shutdown website using the Wayback Machine, which is an internet archive of websites.[41] However, I did not obtain approval from the ethics department in my institution to scrape the website.

8. Conclusion

Cybersecurity remains an important issue, as evident from the SEC's need for updating guidance, and for individual jurisdictions' need to update regulations continuously . As internet tools become more powerful and accessible, such as the recent developments in Artificial Intelligence (AI) powered tools like Chat GPT, the cybersecurity landscape will continue to evolve. As a result, firms are expected to spend more on cybersecurity to minimize potential losses.

I examine disclosures made by Russell 3000 constituent firms surrounding cyber-attack incidents. I find some evidence that cyber-attack incident disclosure characteristics are associated with differential stock returns. I find cyber-attack incident disclosures made in Form 8-Ks are associated with more negative, abnormal stock return surrounding the disclosure date when compared with incident disclosures made in Form 10-Ks or 10-Qs. Next. I find evidence using textual analysis that firms affected by cyber-attack incidents updated their cybersecurity risk factor disclosures following a cyber-attack incident, and this update is not merely attributable to (a) inserting text to describe the cyber-attack incident and (b) minor changes in sentences. This update shows that cybersecurity risk factor disclosures are not sticky disclosures and to a certain extent reflect idiosyncratic risk. However, I fail to find evidence that pre-incident cybersecurity risk factor characteristics are associated with differential stock returns when a firm discloses a cyber-attack incident.

My findings contribute to the literature related to cyber-attack disclosures by documenting the effect of disclosure characteristics or content on stock returns surrounding the disclosure date. My paper also contributes to the literature related to risk factors by providing evidence that cybersecurity risk factor disclosures are not sticky disclosures, but instead are updated following cyber-attack incidents and reflect firm-specific cybersecurity risk. My results may also be informative to regulators such as the SEC in their discussions regarding additional guidance and stricter disclosure requirements for cyber-attack incidents or cybersecurity risk. For example, the SEC recently introduced Item 1.05 on Form 8-Ks to facilitate firms to disclose material cyber-attack incidents.[42]

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[40] See: https://thehackernews.com/2023/07/owner-of-breachforums-pleads-guilty-to.html
[41] See: https://web.archive.org/
[42] On 26 July 2023, the SEC approved final rules requiring public companies to report cybersecurity incidents deemed material within four days of identifying them. Public companies must disclose the nature, scope, timing, and (estimated) material impact under Item 1.05 on Form 8-K.

My paper is not without limitations. One concern related to my study is the legacy effect. Firms in my sample may have encountered (disclosed or undisclosed) cyber-attacks before the start of my sample period and hence, their risk factor disclosure may have been affected. The legacy effect does not likely affect my inferences as I examine differences between pre-and post-cyber-attack. A related potential concern is that cyber-attack disclosures are voluntary. That is, firms may encounter cyber-attacks and choose not to disclose either because they deem the cyber-attack immaterial or they withhold bad news that is unlikely to be discovered by third parties. As a result, my results are not related to the effect of a cyber-attack *per se*, but the effect of encountering a cyber-attack and choosing not to withhold. I believe my analysis is still of interest as firm disclosures are an important channel through which shareholders gain information.

Future studies could expand the work on cyber-attack disclosures. First, future studies can examine disclosures made under Item 1.05 in Form 8-Ks which is intended for firms to disclose material cyber-attack incidents.[43] Second, future studies could examine whether firms update their risk factors in Form 10-Qs. Firms are permitted to update their risk factors in Form 10-Qs. Therefore, firms that disclose cyber-attack incidents using Form 8-Ks or Form 10-Qs may update their cybersecurity risk factor disclosures over time. It would be interesting to examine whether cybersecurity risk factor disclosures change gradually following a cyber-attack incident or are updated annually in Form 10-K. Second, future studies could examine cyber-attack disclosures in non-US markets. Even though the US stock exchanges remain the largest in terms of market cap, other stock exchanges are also of considerable size (e.g. Euronext or Tokyo Stock Exchange). Moreover, the disclosure requirements (in general and for cyber-attacks) differ across these markets. It would be interesting to understand how market participants react to cyber-attack disclosures.

[43] As of this draft, 8 firms have disclosed 8 cyber-attack incidents under Item 1.05.

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Table 1: Sample Selection Criteria

Table 1 presents my sample selection criteria. My initial sample consists of all Rusell 3000 constituents as of 2018. I then merge these firms with Compustat Annual and CRSP and retain the 2,729 firms that appear at least once in both databases between 2018 and 2023. I then search for cyber-attack incidents on EDGAR full-text search using a keyword list I construct with reference to Chen, Henry, and Jiang (2022) (see Appendix 1). I search for keywords in Form 8-K filings made between 1 January 2018 and 31 March 2023, and Form 10-K and 10-Q filings made between 1 April 2018 and 15 May 2023. I identify 233 cyber-attack incidents affecting 211 firms. I then remove cyber-attack incidents that did not occur between the first quarters of 2018 and 2023. The remaining 189 cyber-attack incidents affecting 180 firms consist of cyber-attack incidents that targeted third-party vendors. I focus on the subsample of 164 cyber-attack incidents affecting 157 firms in my analysis. Seven firms in my sample are affected by two separate cyber-attack incidents.

Criterion	Incidents	Firms
Full Sample	233	211
Less: Cyber-attacks not occurring between 2018 – 2023	-44	-31
Cyber-Attack Sample	189	180
Consisting of:		
Cyber-attacks targeting third-party vendors	25	23
Cyber-attacks targeting firm or a subsidiary of firm	**164**	**157**
Cyber-Attack Sample	189	180

Table 2: Descriptives Related to Cyber-Attack Disclosures

Table 2 presents simple descriptives related to cyber-attack disclosures. Table 2 Panel A displays the distribution of cyber-attack incidents across years for all three filing types – Forms 10-K, 10-Q, and 8-K. The sample size is the full 164 subsample of cyber-attack incidents that targeted the companies or their subsidiaries between 2018 Q1 and 2023 Q1. Table 2 Panel B illustrates the distribution of cyber-attack incidents across quarters for all three filing types. The sample size is 156 as eight cyber-attack incident disclosures do not specify in which month or quarter the firm was affected by a cyber-attack incident. Panel C presents the difference in disclosure characteristics between Form 8-K filings and non-Form 8-K filings (i.e. Form 10-K and Form 10-Q filings). The definition of the disclosure characteristics is summarized in Appendix 4. I test for differences across the two types of filings using the student's t-test and present the difference and corresponding p-value in the last column. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

Panel A: Distribution across years [N=164]

	Year						
Type	2018	2019	2020	2021	2022	2023	**All Years**
10-K	6	6	5	4	2	2	**25**
10-Q	3	5	15	10	11	3	**47**
8-K	9	12	24	19	15	13	**92**
All Filings	**18**	**23**	**44**	**33**	**28**	**18**	**164**

Panel B: Distribution across Quarters [N=156]

	Quarters				
Type	Q1	Q2	Q3	Q4	**All Quarters**
10-K	14	1	1	5	**21**
10-Q	11	13	17	3	**44**
8-K	16	29	29	17	**91**
All Filings	**46**	**42**	**43**	**25**	**156**

Panel C: Characteristics of cyber-attack disclosures [N=164]

Characteristic	8-K	Non-8-K	Diff	p-value
Separate Disclosure	0.84	0.25	0.59	**0.00*****
Immaterial Cyber-Attack	0.33	0.50	-0.17	**0.02****
Engage Cybersecurity Firm	0.78	0.44	0.34	**0.00*****
Maintain Insurance	0.20	0.21	-0.01	0.84
Discovery Date	0.54	0.19	0.35	**0.00*****
Wordcount – Raw	187.52	120.82	66.70	**0.00*****
Wordcount – Processed	107.50	66.57	40.93	**0.00*****

Table 3: Stock Returns Surrounding Disclosure Date (I)

Table 3 presents my results for stock returns surrounding the disclosure date. In both Panels A and B, I estimate stock returns using buy-and-hold abnormal return (BHAR) and cumulative abnormal return (CAR). I estimate BHAR and CAR using three estimation windows: [-1,3], [-1,1], and [-2,2] with the same event date defined as the disclosure date of the cyber-attack incident (i.e. the filing date). The [-1,3] estimation window calculates BHAR or CAR starting one day prior to the event date and ending three days after the event date. The [-1,1] ([-2,2]) estimation window estimates BHAR or CAR starting one (two) day(s) prior to the event date and ending one (two) day(s) after the event date. In both panels, I present the p-values for the null that the differential stock return is zero in parenthesis. Panel A presents the result for the entire sample. The sample size is 158. In Panel B, I separate disclosures into Form 8-K and Non-Form 8-K. In Panel B, the last two columns test the null that the difference between the two groups is zero. The p-values for the null are presented in parentheses. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

Panel A: Full Sample [N = 158]

Estimation Window	BHAR	CAR
[-1,3]	-0.007	-0.007
	(0.257)	(0.233)
[-1,1]	-0.008	-0.008
	(0.162)	(0.159)
[-2,2]	-0.006	-0.006
	(0.351)	(0.369)

Panel B: 8-K Disclosures vs. Non-8-K Disclosures

	8-K [N = 88]		Non-8-K [N = 70]		Difference	
Estimation Window	BHAR	CAR	BHAR	CAR	BHAR	CAR
[-1,3]	**-0.020*** **	**-0.020*** **	0.009	0.009	**-0.029** **	**-0.029** **
	(0.006)	**(0.006)**	(0.367)	(0.225)	**(0.017)**	**(0.021)**
[-1,1]	**-0.020*** **	**-0.020*** **	0.008	0.008	**-0.027** **	**-0.028** **
	(0.004)	**(0.007)**	(0.350)	(0.334)	**(0.010)**	**(0.011)**
[-2,2]	**-0.018*** **	**-0.018*** **	0.010	0.010	**-0.028** **	**-0.028** **
	(0.008)	**(0.008)**	(0.381)	(0.371)	**(0.025)**	**(0.025)**

Table 4: Stock Returns Surrounding Disclosure Date (II)

Table 4 presents my results for the regression estimate of stock returns. I estimate the following cross-sectional model to examine the effect (if any) of the cyber-attack incident disclosure characteristics on stock returns surrounding the disclosure date: $BHAR_i = \beta_0 + \beta_1 EightK_i + \beta_2 Disclosure\ Characteristic_i + \sum_3^k \beta_3 Control_{i,k} + \sum_{3+k}^{j} \beta_{3+k} Fixed\ Effects_{i,j}$. I provide a variable definition in Appendix 4. The sample size is 150 as eight cyber-attack incidents had missing information needed to estimate the model. The dependent variable is the buy and hold abnormal return (BHAR) with the disclosure date (i.e. filing date) as the event date. To conserve space, I only report the results using the [-1,3] estimation window. That is, I only estimate BHAR using the one day prior to and three days after the event date estimation window. My results are consistent with using [-1,1] and [-2,2] estimation windows. My results are also consistent with using the cumulative abnormal return (CAR). I separate the effect of Form 8-K and non-Form 8-K filings using *8-K* an indicator variable that takes the value of one (zero) if the cyber-attack incident was (not) disclosed in Form 8-K. *Disclosure Characteristics* are summarized in Appendix 4. I include several control variables to control for the pre-cyber-attack incident characteristics of the firms. I include year and industry fixed effects to remove the general trend across years and industries. I cluster standard errors by fiscal years. The standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

DV	(1) BHAR [-1,3]	(2) BHAR [-1,3]	(3) BHAR [-1,3]	(4) BHAR [-1,3]	(5) BHAR [-1,3]	(6) BHAR [-1,3]	(7) BHAR [-1,3]
8-K	**-0.03****	**-0.04*****	**-0.04*****	**-0.04****	**-0.04*****	**-0.04*****	**-0.04*****
	(0.01)	**(0.01)**	**(0.00)**	**(0.01)**	**(0.01)**	**(0.01)**	**(0.01)**
Immaterial Cyber-Attack			-0.01				-0.01
			(0.01)				(0.01)
Separate Disclosure				-0.00			-0.00
				(0.01)			(0.01)
Engage Cybersecurity Firm					0.02		0.02
					(0.01)		(0.02)
Maintain Insurance						-0.00	-0.00
						(0.02)	(0.02)
Constant	-0.07	-0.17**	-0.17***	-0.17***	-0.15**	-0.17**	-0.15**
	(0.07)	(0.05)	(0.04)	(0.04)	(0.05)	(0.05)	(0.04)
N	150	131	131	131	131	131	131
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.19	0.48	0.48	0.48	0.48	0.48	0.48
Within R2		0.28	0.28	0.28	0.29	0.28	0.29

Table 5: Stock Returns Surrounding Disclosure Date (III)

Table 5 presents my results for the regression estimate of the market reaction. I estimate the following cross-sectional model to examine the effect (if any) of cyber-attack incident disclosure characteristics on the market reaction surrounding the disclosure date: $BHAR_i = \beta_0 + \beta_1 EightK_i + \beta_2 Disclosure\ Characteristic_i + \beta_3 EightK_i \times Disclosure\ Characteristic_i + \sum_4^k \beta_4 Control_{i,k} + \sum_{4+k}^j \beta_{4+k} Fixed\ Effects_{i,j}$. I provide a variable definition summary in Appendix 4. The sample size is 150 as eight cyber-attack incidents had missing information needed to estimate the model. The dependent variable is the buy and hold abnormal return (BHAR) with the disclosure date (i.e. filing date) as the event date. To conserve space, I only report the results using the [-1,3] estimation window. That is, I only estimate BHAR using the one day prior to, and three days after, the event date estimation window. My results are consistent with [-1,1] and [-2,2] estimation windows. My results are also consistent with results from the application of the cumulative abnormal return (CAR). I separate the effect of Form 8-K and non-Form 8-K filings using *8-K* – an indicator variable that takes the value of one (zero) if the cyber-attack incident was (not) disclosed in Form 8-K. *Disclosure Characteristics* are summarized in Appendix 4. I include several control variables to control for the pre-cyber-attack incident characteristics of the firms. I include year and industry fixed effects to control for the general trend across years and industries. I cluster standard errors by fiscal years. The standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

DV	(1) BHAR [-1,3]	(2) BHAR [-1,3]	(3) BHAR [-1,3]	(4) BHAR [-1,3]	(5) BHAR [-1,3]	(6) BHAR [-1,3]
8-K	**-0.03****	**-0.04*****	**-0.02****	-0.06	-0.02	**-0.05*****
	(0.01)	**(0.01)**	**(0.01)**	(0.03)	(0.02)	**(0.01)**
Immaterial Cyber-Attack			0.02			
			(0.01)			
Immaterial Cyber-Attack x 8-K			**-0.06****			
			(0.02)			
Separate Disclosure				-0.01		
				(0.02)		
Separate Disclosure x 8-K				0.03		
				(0.04)		
Engage Cybersecurity Firm					0.04	
					(0.02)	
Engage Cybersecurity Firm x 8-K					-0.04	
					(0.03)	
Maintain Insurance						-0.02
						(0.03)
Maintain Insurance x 8-K						**0.06****
						(0.02)
Constant	-0.07	-0.17**	-0.18***	-0.16**	-0.15**	-0.17**
	(0.07)	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)
N	150	131	131	131	131	131
Controls	Yes	Yes	0.50	0.48	0.49	0.48
Fixed Effects	No	Yes	Yes	Yes	Yes	Yes
R2	0.19	0.48	0.50	0.48	0.49	0.48
Within R2		0.28	0.31	0.28	0.30	0.28
N	150	131	131	131	131	131

Table 6: Matching Sample Construction

Table 6 presents my matching sample construction. My treatment space initially consists of all 189 cyber-attack incidents that occurred between the first quarter of 2018 and 2023. I then exclude incidents that targeted third-party vendors used by firms. I also remove cyber-attack incidents with missing Form 10-K filings either before or after the cyber-attack incident. Two cyber-attack incidents in my sample share the same pre- and post-Form 10-K filings, as the firms were affected by two separate cyber-attack incidents within the same fiscal year. Therefore, I only retain one observation for each of these two firms. The observation I retain does not affect the results as either one would lead to the same Form 10-K filing. My control space initially consists of all 2,729 Rusell 3000 index constituents that appear in both Compustat Annual and CRSP at least once between 2018 and 2013. I exclude 180 firms that suffered from a cyber-attack incident during my sample period. The control space therefore consists of firms that did not incur a cyber-attack incident (either directly or indirectly) during my sample period. I then perform matching using propensity scores. Specially, I calculate propensity scores using total assets from the fiscal year before the cyber-attack incident and match exactly on two-digit SIC industry code, fiscal year, and fiscal year-end. I remove cyber-attack incidents without a matched control firm-year observation. I also remove cyber-attack incidents with missing pre or post Form 10-K filings for the matched control firm-year observation. My final matched sample consists of 121 cyber-attack incidents. That is, 121 pairs of cybersecurity risk factors in the pre- and post-incident periods, for both the treatment and control firms.

Criterion	Incidents	Firms
Cyber-attack sample	189	180
Less: Cyber-attacks targeting third-party vendors	-25	-23
Less: Incidents with missing pre or post cyber-attack 10-K Filings	-17	-16
Less: Incidents with same pre and post cyber-attack 10-K Filings	-2	0
Initial matching Sample	*145*	*141*
Less: Incidents without a matching control firm-year observation	-11	-11
Less: Control firm-year with missing pre or post 10-K Filings	-13	-13
Final matched sample used in Diff-in-Diff	**121**	**117**

Table 7: Textual Analysis of Cybersecurity Risk Factors

Table 7 presents the results from the textual analysis of cybersecurity risk factors after removing text describing the cyber-attack incident. I remove the text describing the cyber-attack incident from the post-cyber-attack cybersecurity risk factor of the treatment firms. I also remove sentences that are either identical or similar across pre- and post-incident cybersecurity risk factors. In all panels, the last column (row) presents the p-value for the null that the difference in the pre- and post-period (across treatment and control group) is zero unless otherwise specified. Panel A (B) presents the results of the word count analysis using the raw (processed) text. Panel C presents the results of the similarity analysis. I calculate similarity using cybersecurity risk factors within a group and use the Levenshtein ratio where a score of zero (one) suggests the two texts are completely different (identical). I calculate the similarity score using the raw and processed text of cybersecurity risk factor disclsoures. The last column presents the p-value for the null that the pre-and post-similarity score difference is zero. Panel D (E) presents the results of the sentiment analysis using the raw (processed) text. I calculate sentiment using the Valence Aware Dictionary and the Sentiment Reasoner (VADER). VADER returns the ratio of the proportion of words falling into the three categories: positive, negative, and neutral. I only focus on the proportion of words falling into the negative category in my analysis. Panel F presents the results of counting the number of cybersecurity related keywords following the approach as in Chen et al. (2022). Panels G and H present the results of classifying text into standardized vs. non-standardized text using two different measures. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

Panel A: Word Count - Raw [N=121]

	Pre	Post	Diff	p-value
Treatment	112	215	103	**0.00*** **
Control	50	76	26	**0.00*** **
Diff	62	139	77	**0.00*** **
p-value	**0.00*** **	**0.00*** **	**0.00*** **	

Panel B: Word Count - Processed [N=121]

	Pre	Post	Diff	p-value
Treatment	67	128	61	**0.00*** **
Control	30	45	15	**0.00*** **
Diff	37	83	46	**0.00*** **
p-value	**0.00*** **	**0.00*** **	**0.00*** **	

Panel C: Similarity – Within Group [N=121]

	Treatment	Control	Diff	p-value
Raw	0.58	0.80	0.22	**0.00*** **
Processed	0.58	0.80	0.22	**0.00*** **

Panel D: Negative Sentiment - Raw [N=121]

	Pre	Post	Diff	p-value
Treatment	0.11	0.10	-0.02	**0.04****
Control	0.05	0.06	0.01	0.14
Diff	0.06	0.04	-0.02	**0.00*****
p-value	**0.00*****	**0.00*****	**0.00*****	

Panel E: Negative Sentiment - Processed [N=121]

	Pre	Post	Diff	p-value
Treatment	0.17	0.15	-0.02	**0.10***
Control	0.08	0.09	0.01	**0.02*****
Diff	0.09	0.06	-0.03	**0.02*****
p-value	**0.00*****	**0.00*****	**0.02****	

Panel F: Keyword Count in Raw Text [N=121]

	Pre	Post	Diff	p-value
Treatment	3	6	3	**0.00*****
Control	1	2	1	**0.00*****
Diff	2	4	2	**0.00*****
p-value	**0.00*****	**0.00*****	**0.00*****	

Panel G: Standardized Text in Raw Text with Measure *Standardize* [N=121]

	Pre	Post	Diff	p-value
Treatment	0.67	0.66	-0.01	0.91
Control	0.29	0.32	0.03	0.23
Diff	0.38	0.34	-0.04	0.43
p-value	**0.00*****	**0.00*****	0.43	

Panel H: Standardized Text in Raw Text with Measure *Standardize Relative* [N=121]

	Pre	Post	Diff	p-value
Treatment	0.24	0.19	-0.05	**0.00*****
Control	0.11	0.09	-0.02	**0.09***
Diff	0.13	0.10	-0.03	0.18
p-value	**0.00*****	**0.00*****	0.18	

Table 8: Stock Returns and Pre-Incident Cybersecurity Risk Factors

Table 8 presents my results for the regression estimate of the stock returns. I estimate the following cross-sectional model to examine the effect (if any) of the pre-incident cybersecurity risk factor characteristics on the stock returns surrounding the disclosure date: $BHAR_i = \beta_0 + \beta_1 8\text{-}K_i + \beta_2 Ln(Pre\text{-}Incident\ Risk\ Factor\ Word\ Count) + \beta_3\ Pre\text{-}Incident\ Risk\ Factor\ Characteristic_i + \sum_4^k \beta_4 Control_{i,k} + \sum_{4+k}^{j} \beta_{4+k} Fixed\ Effect_{i,j}$. I provide a variable definition summary in Appendix 4. The sample size is 137 as 13 incidents from Table 5 do not have a pre-incident cybersecurity risk factor. The dependent variable is the buy and hold abnormal return (BHAR) with the disclosure date (i.e. filing date) as the event date. To conserve space, I only report the results using the [-1,3] estimation window. That is, I only estimate BHAR using the one day prior to and three days after the event date estimation window. My results are consistent with using [-1,1] and [-2,2] estimation windows. My results are also consistent with using the cumulative abnormal return (CAR). I separate the effect of Form 8-K and non-Form 8-K filings using *8-K* an indicator variable that takes the value of one (zero) if the cyber-attack incident was (not) disclosed in Form 8-K. I include several control variables to control for the pre-cyber-attack incident characteristics of the firms. I include year and industry fixed effects to remove the general trend across years and industries. I cluster standard errors by fiscal years. The standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 0.10, 0.05, and 0.01 levels respectively.

DV	(1) BHAR [-1,3]	(2) BHAR [-1,3]	(3) BHAR [-1,3]	(4) BHAR [-1,3]	(5) BHAR [-1,3]	(6) BHAR [-1,3]	(7) BHAR [-1,3]
8-K	**-0.04****	**-0.06*****	**-0.06*****	**-0.06*****	**-0.06*****	**-0.06*****	**-0.06*****
	(0.01)	**(0.01)**	**(0.01)**	**(0.01)**	**(0.01)**	**(0.01)**	**(0.01)**
Ln (Raw Word Count)	-0.01	-0.02	-0.02	-0.05	-0.02	-0.02	-0.05*
	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)
Sentiment			-0.00				-0.00
			(0.00)				(0.00)
Keywords				**0.04****			**0.04****
				(0.01)			**(0.01)**
Standardized					0.00		0.00
					(0.00)		(0.00)
Standardized_Relative						-0.00	0.00
						(0.00)	(0.00)
Constant	0.02	-0.08	-0.06	0.01	-0.11	-0.08	0.01
	(0.10)	(0.07)	(0.05)	(0.10)	(0.07)	(0.07)	(0.10)
N	137	120	120	120	120	120	120
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.19	0.48	0.48	0.51	0.48	0.48	0.51
Within R2		0.31	0.31	0.35	0.31	0.31	0.35

Appendix 1 – Word List

Cyber Attack

Cyberattack

Cybersecurity Incident

Data Breach

Data Security Incident

DDOS

Denial of Service

Malware

Ransomware

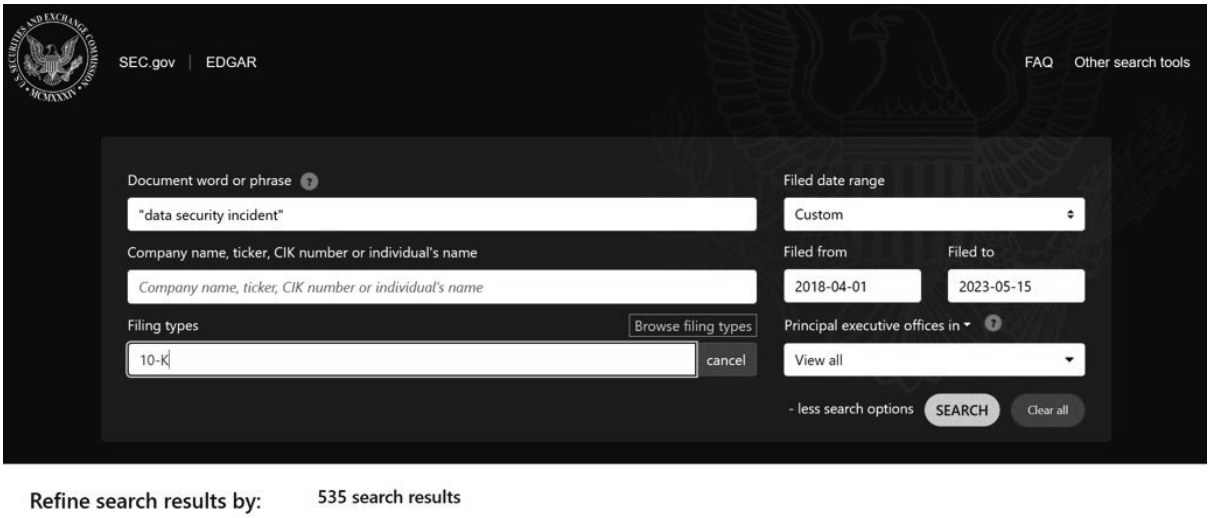
Security Breach

Unauthorized Access

The above word list is constructed with reference to the word list provided by Chen, Henry, and Jiang (2022). Note that the EDGAR Full Text Search is case insensitive and thus capitalization will not impact relevancy. All words in the word list are searched in quotation marks, for example, "unauthorized access" to ensure the string is searched as one single string. If not, EDGAR will search for the words "unauthorized" and "access" separately. See Appendix 2 for a snapshot of EDGAR Full Text Search.

Appendix 2 – Snapshot of EDGAR Full Text Search

I search for the keyword "data security incident" as an illustration. To search for 10-Ks filed for the period between 2018 Q1 and 2023 Q1, I restrict the date to be between "2018-04-01" and "2023-05-15". This process results in 535 potential 10-K filings. Note the actual number of 10-K filings may be less than 535 as the search includes Exhibits and Amendments, which I do not examine.



Source: EDGAR Full Text Search (https://www.sec.gov/edgar/search/)

Appendix 3 – Examples of Cyber Attack Disclosures

(1) Disclosure in Form 10-K

System security and data protection breaches, as well as cyber-attacks, could disrupt our operations, reduce our expected revenue and increase our expenses, which could adversely affect our stock price and damage our reputation.

Security breaches, computer malware, social-engineering attacks, denial-of-service attacks, software bugs, server malfunctions, software or hardware failures, loss of data or other information technology assets, and other cyber-attacks are increasingly sophisticated, making it more difficult to successfully detect, defend against them or implement adequate preventative measures.

For example, on February 23, 2022, we became aware of a security incident involving unauthorized access to our network by a group of independent criminal threat actors, not affiliated with any government or political cause. The threat actors obtained NVIDIA network credentials and through deception, obtained two-factor authentication capability and access to our network. The threat actors misappropriated certain NVIDIA proprietary information, including NVIDIA source code, and leaked some of that information online. Upon learning of the security incident, we engaged in remedial and preventative actions, rotated all NVIDIA network credentials to prevent further unauthorized access, hardened our network, analyzed the information that the threat actors exfiltrated, and notified law enforcement and other authorities.

Cyber-attacks, including ransomware attacks by organized criminal threat actors, nation-states, and nation-state-supported actors, may become more prevalent and severe. Our ability to recover from ransomware attacks may be limited if our backups have been affected by the attack, or if restoring from backups is delayed or not feasible.

Threat actors, sophisticated nation-states, and nation-state-supported actors now engage and are expected to continue to engage in cyber-attacks. Due to increasing geopolitical conflicts, we and the third parties upon which we rely may be vulnerable to a heightened risk of cyber-attacks. Furthermore, we rely on products and services provided by third party suppliers to operate certain critical business systems, including without limitation, cloud-based infrastructure, encryption and authentication technology, employee email, and other functions, which exposes us to supply-chain attacks or other business disruptions. We cannot guarantee that third parties and infrastructure in our supply chain or our partners' supply chains have not been compromised or that they do not contain exploitable defects or bugs that could result in a breach of or disruption to our information technology systems, including our products and services, or the third-party information technology systems that support our services. Our ability to monitor these third parties' information security practices is limited, and these may not have adequate information security measures in place. In addition, if one of our third-party suppliers suffers a security breach, our response may be limited or more difficult because we may not have direct access to their systems, logs and other information related to the security breach.

Source: Nvidia Corporation – Form 10-K filing for the fiscal year ended 30 January 2022

(2) Disclosure in Form 10-Q

CYBERSECURITY EVENT

On March 1, 2021, at approximately 02:00 hours Mexico City time, we experienced a Ransomware cyber-attack, which was operated by humans. Therefore, our antivirus software could not contain it. This cyber-attack encrypted a total of 479 servers, 367 of which were located in Mexico and 112 in the United States. It also encrypted 303 pieces of personal equipment, 257 of which were located in Mexico and 46 in the United States. However, due to the quick response of our IT team, our Enterprise Resource Planning software was not affected by the aforementioned attack.

After the attack we immediately began a remediation and recovery process, and as of the reporting date the affected servers have been completely restored. So far, the forensic investigation has not identified any concrete evidence of information stolen during the attack. We are implementing an information security strategy to ensure business continuity based on processes (controls and corporate governance framework), technology and human capital (organizational culture). The areas of compliance, internal control, information technology and internal audit are working together to integrate the reference frameworks, the risk management models and the necessary controls to implement the strategy and programs of information security.

As of March 31, 2021, we have recorded $0.1 million in costs related to this incident, but we expect to incur additional costs derived from the strategy and controls being implemented.

Source: Southern Copper Corp – Form 10-Q filing for the quarter ended 31 March 2021

(1) Disclosure in Form 8-K

Item 8.01 Other Events.

On August 15, 2020, Carnival Corporation and Carnival plc (together, the "Company," "we," "us," or "our") detected a ransomware attack that accessed and encrypted a portion of one brand's information technology systems. The unauthorized access also included the download of certain of our data files.

Promptly upon its detection of the security event, the Company launched an investigation and notified law enforcement, and engaged legal counsel and other incident response professionals. While the investigation of the incident is ongoing, the Company has implemented a series of containment and remediation measures to address this situation and reinforce the security of its information technology systems. The Company is working with industry-leading cybersecurity firms to immediately respond to the threat, defend the Company's information technology systems, and conduct remediation.

Based on its preliminary assessment and on the information currently known (in particular, that the incident occurred in a portion of a brand's information technology systems), the Company does not believe the incident will have a material impact on its business, operations or financial results. Nonetheless, we expect that the security event included unauthorized access to personal data of guests and employees, which may result in potential claims from guests, employees, shareholders, or regulatory agencies. Although we believe that no other information technology systems of the other Company's brands have been impacted by this incident based upon our investigation to date, there can be no assurance that other information technology systems of the other Company's brands will not be adversely affected.

Source: Carnival Plc – Form 8-K filing on 15 August 2020

Appendix 4 – Variable Definition

Cyber-attack disclosure characteristics		
Variable	Definition	Source
Separate Disclosure	An indicator variable that equals one if either the cyber-attack incident is the only disclosure or if the cyber-attack incident is (also) reported in a separate section. For example, under subsequent events in Form 10-Q or 10-K.	Hand-collected
Immaterial Cyber-attack	An indicator variable that equals one if the cyber-attack disclosure considers the cyber-attack incident to not have had a material effect on the firm, zero otherwise.	Hand-collected
Engage Cybersecurity Firm	An indicator variable that equals one if the cyber-attack disclosure mentions the firm engaging with a cybersecurity firm post-attack.	Hand-collected
Maintain Insurance	An indicator variable that equals one if the cyber-attack disclosure mentions the firm maintains insurance related to cybersecurity.	Hand-collected
Discovery Date	An indicator variable that equals one if the cyber-attack disclosure mentions a date (different from the filing date) on which the firm discovered or learned about the cyber-attack incident.	Hand-collected
Raw Word Count	Number of words in the cyber-attack disclosure.	Hand-collected
Processed Word Count	Number of words in the cyber-attack disclosure after processing the raw text. See footnote 12 for the processing technique.	Hand-collected
Stock Returns Tests		
Variable	Definition	
$BHAR_i$	The buy-and-hold abnormal return for cyber-attack incident *i*.	CRSP
CAR_i	The cumulative abnormal return for cyber-attack incident *i*.	CRSP
8-K	An indicator variable that takes the value of one (zero) if the cyber-attack incident disclosure was made in Form 8-K (Form 10-Q or Form 10-K).	Hand-collected
Size	Natural log of total assets. Total assets value is the annual figure from the fiscal year immediately before the cyber-attack incident.	Compustat
ROA	Net Income scaled by total assets and multiplied by 100. Net income and total assets are annual figures from the fiscal year immediately preceding the cyber-attack incident.	Compustat
Leverage	Total liabilities scaled by total assets and multiplied by 100. Total liabilities and total assets are annual figures from the fiscal year immediately preceding the cyber-attack incident.	Compustat

Cash	Cash and cash equivalents scaled by total assets and multiplied by 100. Cash and cash equivalents and total assets are annual figures from the fiscal year immediately preceding the cyber-attack incident.	Compustat
Loss	An indicator variable that takes the value of one (zero) if the net income annual figure from the fiscal year immediately preceding the cyber-attack incident was negative (positive).	Compustat
Bid-Ask	The 100-trading day average bid-ask spread percentage. The calculation starts 102 days preceding the cyber-attack incident and ends 2 days preceding the cyber-attack incident. The daily bid-ask spread is calculated as the difference between the bid-ask price, scaled by the closing price. The measure is then multiplied by 100.	CRSP
MTB	Market to book ratio. Market value is calculated as the annual closing price multiplied by the number of ordinary shares outstanding at the fiscal year end. Book value is calculated as the annual closing book value per share multiplied by the number of ordinary shares outstanding at the fiscal year end. The annual figures are from the fiscal year immediately preceding the cyber-attack incident.	CRSP
Ownership	Percentage of institutional ownership. The figure is for the fiscal year-end date immediately preceding the cyber-attack incident.	Capital IQ

Appendix 5 – Cybersecurity Risk Factor Disclosures Before and After a Cyber-Attack Incident

Pre-cyber-attack Incident

Risks Related to Cybersecurity and Business Disruptions

Unauthorized access to our, our customers' and/or our suppliers' information and systems could negatively impact our business.

We face certain security threats, including threats to the confidentiality, availability and integrity of our data and systems. We maintain an extensive network of technical security controls, policy enforcement mechanisms, monitoring systems and management oversight in order to address these threats. While these measures are designed to prevent, detect and respond to unauthorized activity in our systems, certain types of attacks, including cyber-attacks, could result in significant financial or information losses and/or reputational harm. In addition, we manage information and information technology systems for certain customers and/or suppliers. Many of these customers and/or suppliers face similar security threats. If we cannot prevent the unauthorized access, release and/or corruption of our customers' and/or suppliers' confidential, classified or personally identifiable information, our reputation could be damaged, and/or we could face financial losses.

Source: Boeing Co. – Form 10-K Filing for the fiscal year ended 31 December 2021

Post-cyber-attack Incident

Risks Related to Cybersecurity and Business Disruptions

Unauthorized access to our, our customers' and/or our suppliers' information and systems could negatively impact our business.

We rely extensively on information technology systems and networks to operate our company and meet our business objectives. As cyber threats increase in volume and sophistication, the risk to the security of these systems and networks – and to the confidentiality, integrity, and availability of the data they house – continues to evolve, requiring constant vigilance and concerted, company-wide risk management efforts.

A cyberattack or security breach, whether experienced directly or through our supply chain, could, among other serious consequences, result in loss of intellectual property; unauthorized access to various categories of sensitive, proprietary or customer data; disruption or degradation of business operations, or compromise of products or services. To address these risks, we maintain an extensive network of technical security controls, policy enforcement mechanisms, monitoring systems and management oversight. We also have established a Cybersecurity Governance Council to strengthen governance and coordination of cybersecurity activities. While these measures are designed to prevent, detect and respond to unauthorized activity, there is no guarantee that they will be sufficient to prevent or mitigate the risk of a cyberattack or the potentially serious reputational, operational, or financial impacts that may result. In November 2022, we discovered a cybersecurity incident that impacted certain systems of Jeppesen, a wholly owned Boeing subsidiary that provides flight planning and navigation services. We determined that the incident posed no risk to flight safety. We promptly notified law enforcement, regulatory authorities and customers, launched an investigation, and took additional steps to protect the integrity of our systems. While this incident has not had a material impact on us, future incidents like this one could have material impact on our business, operations, and reputation.

In addition, we manage information and information technology systems for certain customers and/or suppliers. Many of these customers and/or suppliers face similar security threats. If we were unable to protect against the unauthorized access, release and/or corruption of our customers' and/or suppliers' confidential, classified or personally identifiable information, our reputation could be damaged, and/or we could face financial or other losses.

Source: Boeing Co. – Form 10-K Filing for the fiscal year ended 31 December 2022

Appendix 6 – Breach Forums

(1) The seized domain

(2) Access to the seized domain in (1) using Wayback Machine

Chapter 2

The Effect of R&D as a Separate Income Statement Line Item on Financial Statement Users' Judgement*

Co-Authored with Jeppe Christoffersen and Thomas Plenborg

Abstract

Financial statement presentation formats may affect information availability. We conduct an experiment to investigate two different income statement presentation formats permitted under International Financial Accounting Standards. Specifically, we conduct an experiment to test the effect of the absence or presence of research and development (R&D) expenses as a separate line item on the income statement. We posit and find that financial statement users rate firms' innovativeness differently under the two formats, but we find no evidence of a difference in future profitability ratings. The results of this paper contribute to the ongoing debate surrounding financial statement presentation formats.

* We gratefully acknowledge comments and suggestions from Kirstin Becker, Jenny Chu, Bjørn N. Jørgensen, Lisa Koonce, and seminar participants at Copenhagen Business School, and the NHH Virtual Seminar Series. All errors are our own.

1. Introduction

Presentation formats of financial statements can affect information content. Under the International Financial Accounting Standards (IFRS), firms are permitted to report their income statement using two formats that differ in the classification of expenses – by function or by nature. Under by function format, expenses are grouped and aggregated based on their role in the firm. Common line items under by function format include selling, general, and administrative expenses (SG&A) and research and development (R&D) expenses. Under by nature format, expenses are aggregated based on their type. Common line items under by nature format include staff expenses and depreciation expenses. We test the effect of the absence or presence of R&D as a separate income statement line item on financial statement users' perception using an experiment.

The R&D setting is important for two reasons. First, R&D has a central role in economic growth and welfare improvement (Lev, 1999). R&D is essential for individual firms to develop new products or technologies, which improves society's overall well-being. One example to illustrate this point is the Industrial Revolution. Also, Lev (1999) notes that aggregate R&D expenditures in the U.S. increased from $26 million in 1970 to $206 billion in 1997. In 2019, aggregate R&D expenditures in the U.S. were estimated to be $2.4 trillion.[1] This illustrates the continuous importance of R&D.

Second, accounting regulations related to R&D are inadequate (Lev, 1999). Lev (1999) documents various accounting standards related to the treatment of R&D expenses across countries and argues that the practice in the U.S. is not effective since R&D expenses must be fully expensed and not capitalized.[2] However, prior literature suggests that capital markets value the capitalization amount (See, among others, Lev and Sougiannis (1996); Aboody and Lev (1998)). More recently, Koh and Reeb (2015) use patent data to illustrate that 10.5% of firms with zero R&D expenditure in financial statements file and receive patents, suggesting these firms do have R&D activities.[3] We illustrate another setting that can potentially affect the amount of information related to R&D in the financial statements – income statement presentation formats.

We conduct an experiment to investigate two different income statement presentation formats. Specifically, we investigate (1) by function presentation format where R&D is presented as a separate line item and (2) by nature presentation format where R&D is *not* presented as a separate line item. Experimentation affords us an important advantage compared to archival research to test our predictions. An experiment allows us to hold factors other than those of interest constant, thereby enabling causal inferences about the two presentation formats (Libby et al, 2002).

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[1] Source(s): NCSES, GSS, 2019

[2] IFRS (IAS 38), firms are required to separate between research and development costs. IAS 38 then provides a broad criterion where firms are required to either expense or capitalize internally generated R&D expenses. Under U.S. GAAP, R&D activities performed by an entity are required to be recognized as an expense as incurred (ASC 730-10-25). However, there are specific requirements for motion picture films, website development, and software development costs, where firms are permitted to capitalize R&D expenses partially.

[3] See Glaeser and Lang (2023) for a more recent review of accounting studies related to R&D and innovation.

Our main analysis relies on a 2 × 2 mixed design experiment. Our first manipulation (between-subjects manipulation) is how much a competitor of the focal firm is spending on R&D, hence manipulating if the focal firm has higher or lower R&D spending compared with the competitor. Our second manipulation (within-subjects manipulation) is the order of income statement shown (By function first and by nature second vs. by nature first and by function second). Participants are assigned the role of analysts and are tasked to evaluate the level of innovativeness and future profitability of the focal firm and its competitor.

We hypothesize and find a statistically significant difference between participants' ratings for the focal firm's innovativeness if the focal firm's R&D spending is disclosed in the income statement as a separate line item (i.e. by function format). However, the difference is statistically insignificant when participants observe the alternative presentation format where R&D spending is not disclosed (i.e. by nature format). Contrary to our prediction, we find no evidence of the presentation format affecting users' perception of future profitability.

Our study makes two contributions. First, our study informs standard setters by contributing to the ongoing debate related to financial statement presentation formats. At the time of this study, IASB still permits firms to report their income statements using by function or by nature format with minimal guidance. According to a 2017 staff letter prepared by the IASB staff for the board, IASB should (1) Provide a better explanation of by function and by nature classification; (2) Require firms to disclose the reason for choosing a certain presentation format and (3) Require by nature firms to additionally disclose by function classification in notes.[4] A more recent 2020 staff letter suggests the IASB is still concerned about presentation formats.[5] This paper contributes to this ongoing debate by shedding light on possible (unintended) consequences that arise due to the presentation formats' flexibility permitted under IAS 1.

Second, our study contributes to the literature on financial statement presentation format effects. We extend the literature by suggesting expense classification and presentation can affect financial statement users' perception, even if the bottom-line item (net income) is the same.

The rest of this paper is organized as follows. Section 2 provides background information on the two income statement presentation formats. Section 3 reviews related literature. Section 4 illustrates our theory and hypothesis. Section 5 describes our experiment and the results. Section 6 summarizes the paper.

2. Background

IFRS permits two formats for presenting the income statement. According to the International Accounting Standards 1 (IAS 1), the two formats differ in the classification of operating expenses: by function and by nature. Under by function format, expenses are aggregated based on their role in determining the operating income of a firm. Common line items under by function format include SG&A and R&D. Under by nature classification, expenses are aggregated

[4] Access to the 2017 staff letter:https://www.ifrs.org/content/dam/ifrs/meetings/2017/september/iasb/pfs/ap21b-primary-financial-statements.pdf

[5] Access to the 2020 staff letter: https://www.ifrs.org/content/dam/ifrs/meetings/2020/december/iasb/ap21f-pfs.pdf

directly according to their type. Common line items under by nature format include staff expenses and depreciation expenses.

We follow the approach of Berger and Hann (2003, 2007) to illustrate differences between by function and by nature formats. Firms usually disclose their previous fiscal year's figures along with their current fiscal year figures. Therefore, if a firm switches from by function format to by nature format (or vice versa), the previous year's figures will be presented under the newly chosen format. Hence, any difference in reported numbers is solely due to the change in presentation format, as the underlying transactions are held constant[6]. Figure 1 illustrates this point using income statement excerpts from the 2017 and 2018 annual reports of BioArctic AB, a Swedish publicly traded firm. As seen in Figure 1, Bio Arctic AB switched from reporting using by function format in 2017 to reporting using by nature format in 2018. Four observations are in order. First, "Costs of goods sold" and "Gross profit" are absent under by nature format.[7] Second, "other operating expenses" differ due to classification differences under the two presentation formats in the case of BioArctic AB. Third, the bottom-line item of the income statement, "net income", will always remain the same under both presentation formats. Fourth and most important, R&D is not a separate line item under the new presentation format.

IAS 1 permits firms to report their income statement using either by function or by nature format. IAS 1 requires firms reporting the income statement using by function format to additionally disclose by nature format classification of expenses in notes to financial statements, as by nature format classificationis useful for predicting future cash flows (IASB, 2018, Section 105). However, firms using by nature format to present their income statement have no additional disclosure requirements. Hence, IAS 1 creates an asymmetric disclosure requirement that can lead to expenses under by function to "disappear" as they are aggregated when firms choose by nature format. Notwithstanding, IAS 38.126 requires firms to disclose the aggregate amount of R&D expenses during the year but without specifying how and where to dislcose.

3. Literature Review

Prior literature shows the presentation format's effect on financial statement users' judgment. For example, Hirst and Hopkins (1998) examine whether the placement of comprehensive income on the income statement vs. the statement of changes in equity affects the judgment made by buy-side analysts. Similarly, Maines and McDaniel (2000) investigate if the placement of comprehensive income affects judgments made by nonprofessional investors. Hodder, Hopkins, and Wood (2008) examine how analysts' cash flow forecasts vary with the presentation of the operating activities section under the indirect approach. Bartov and Mohanram (2014) find that the stock market responds differently to gains or losses from early debt extinguishments depending on whether the gains or losses are reported above or below the line.

[6] This assumes that (1) No change in consolidation bases and (2) No M&A occurred during the year. One way to ensure the two years are comparable is to check if the amount of "Cash and Cash Equivalent" is the same for both years. See Berger and Hann (2003,2007)

[7] Note that some firms still present COGS and Gross profit as separate line items after switching formats. For these firms, gross profit would be different under the two formats. COGS is usually higher under by function format as more cost is aggregated into COGS under the by function format than under the by nature format.

Koonce, Leitter, and White (2019) test how the presentation of related balance sheet items affects the risk perception of information users and the lending decisions of potential lenders. We contribute to this stream of literature by examining a setting where a line item can "disappear" due to reporting format.

Another related literature documents the choice between by function and by nature presentation format. Ding, Stolowy and Tenenhaus (2003) investigate the format of income statements, balance sheets, and cash flow statements for 100 French public firms and document a shift from traditional French accounting practices towards international practices. Ding, Jeanjean and Stolowy (2008) investigate 199 French public firms and provide cross-sectional evidence consistent with a shift from reporting by nature to by function due to internationalization. More recently, Henry and Yang (2020) use SEC XBRL data to investigate if by function or by nature choice of US-cross-listed foreign firms' income statement format affects the quality of analyst forecasts.

Libby and Brown (2013) show that auditors require more correction to financial statement errors in disaggregated numbers (i.e., by nature format). The effect, however, is reduced if the disaggregation is in the notes as opposed to on the face of the income statement. Our paper is different from theirs for two reasons. First, we change expense line items presented on the face of the income statement (depending on presentation format choice), whereas they keep constant the expense line items. Second, they disaggregate by function format expense items (either on the face of the income statement or in the notes) into by nature format expense items, which is required under IAS 1. However, no such requirement exists for firms using by nature format. If R&D is not presented on the face of the income statement, IASB does not have a specific requirement of where and how R&D should be reported.

4. Theory and Hypothesis Development

Prior research illustrates that line-item placement matters (Hirst and Hopkins (1998); Maines and MacDaniel (2000); Bartov and Mohanram (2014); Koonce et al. (2019)). We examine a (more extreme) setting where the change in presentation format leads to the absence or presence of a line item due to a change in aggregation. We hypothesize participants would react more (less) significantly when presented with by function (by nature) format of the income statement, where R&D is (not) a separate line item. The direction of their reaction, however, is ex-ante unclear and may depend on the sequence of observing the income statement excerpts as well as the relative spending on R&D compared with a competitor.

For participants who observe an income statement in by nature format *first*, we hypothesize there should not be any change in the rating of innovativeness or future profitability for the focal firm, as no information related to R&D is presented. However, we cannot eliminate the possibility that participants rate innovativeness and future profitability downwards to penalize the lack of information related to the R&D of the focal firm.

Conversely, for participants who observe an income statement in by nature format *second*, we hypothesize there should also not be any change in the rating of innovativeness or future

profitability for the focal firm, as participants already observed the income statement in by function format where R&D is shown as a separate line item. However, participants may (incorrectly) react to the information due to confusion or information overload.[8] If true, the direction of their reaction is unclear.

When participants are presented with an income statement in by function format (regardless of the order), we hypothesize participants can react in two different ways, depending on their priors. On the one hand, participants may believe R&D spending is important for software firms. For these participants, R&D spending reflects the firms' desire to stay innovative, which will eventually translate into future profitability. On the other hand, participants may believe R&D spending is less important for software firms, especially firms that have existed for years (as in our case). Participants may also believe that spending too much on R&D (compared with a competitor) outweighs the benefit. For these participants, R&D spending does not necessarily reflect innovation or promise future profitability. For the first group of participants, investing more (less) than a competitor suggests the firm, relative to the competitor, is more (less) innovative and future profitability will be higher (lower). For the second group of participants, we have no clear prediction for the direction. Which prior belief prevails among participants is an experimental question. Our experiment also allows us to answer another important question – Does the order of presentation matter for the outcome? Since the total amount of information presented to participants is the same, the outcome should be independent of the order of presentation. That is participants who observe the same R&D spending should reach the same final rating, regardless of the order of presentation formats.

Figure 2 illustrates our hypothesis where more (less) R&D spending is perceived as being more (less) innovative and associated with higher (lower) future profitability.

5. Experiment

Our experiment is set within a software industry context. We choose this context for several reasons. First, R&D is important for software firms. By choosing an industry where participants can more easily relate the importance of R&D to the firm's success, we increase our chance to observe the effect of presentation formats, should one exist. Second, R&D in software firms is less dependent on approval by regulatory bodies. This allows us to eliminate possible perceptions participants may have towards R&D, such as in the pharmaceutical industry, where R&D success is highly dependent on the approval of drugs by government healthcare agencies such as the European Medicines Agency (EMA) or the Food and Drug Administration (FDA).

Participants

123 master students participated in the study. The experiment was carried out as a learning exercise for a master-level class taught by one of the authors. The author shared the experiment results as a learning activity at a later stage of the course.

[8] We do not remind participants of their ratings from the previous stage. This may also explain the change in ratings if participants try to (incorrectly) guess their ratings from the previous stage.

Design and manipulations

The experimental materials focus on two hypothetical European software firms – Digiware and Quantum. Quantum is the focal firm in our experiment setting, whereas Digiware acts as a benchmark. Participants are assigned the role of analysts and tasked to evaluate the two firms. Participants are also informed that the two firms are considered peer groups by analysts and that they are of similar size, operate in the same industry, serve similar clients, and have similar profitability. After receiving this information, participants receive additional information along with an excerpt of Quantum's annual income statement. The additional information and the annual income statement excerpt contain our two manipulations, as described below (See Appendix A for details).

Our experiment has a 2 × 2 mixed design. Our first manipulation (across subjects) is the level of R&D investment (High vs. Low, compared with the competitor). R&D expenses of Quantum remain constant across manipulations (5% of sales). Under the High (Low) relative investment scenario, Digiware's R&D expenses are equal to 8% of sales (2% of sales). Note that only participants presented with by function format can directly make this comparison since R&D only appears as a separate line item under by function format. Nevertheless, we are interested in whether relative R&D spending helps mitigate the effect of the absence or presence of R&D as a separate line item on the income statement.[9] Our second manipulation (within-subjects) is the order in which presentation formats are shown to participants (By function first and by nature second vs. by nature first and by function second). Therefore, all participants observe both formats.

As mentioned before and illustrated in Appendix A, other expense items and expense allocation also change as we manipulate the presentation format. However, sales and net profit remain constant across the two formats. This is an inevitable consequence of switching presentation formats, and it closely mimics reality (refer to the example in Figure 1). We base all our manipulations on analysis using financial statements of real-world EU software firms to mimic reality to the extent possible.

Procedure and dependent measures

The experiment is divided into three stages. In the pre-stage, participants first read a brief description of the two companies and evaluate the two firms' level of innovativeness (future profitability) on a 101-point scale, with 0 labeled "not innovative" ("not profitable") and 100 labeled "very innovative" ("very profitable"). After this initial valuation, participants enter stage 1 and are randomly assigned to one of the four conditions that vary by presentation format and relative level of R&D investment. Specifically, participants are randomly assigned to the following four groups: (1) Observe by function format *first* and by nature format *second*, and the level of R&D is *higher* than the competitor (labeled as FE); (2) Observe by function format *first* and by nature format *second*, and the level of R&D is *lower* than the competitor (labeled as FB); (3) Observe by nature format *first* and by function format *second*, and the level of R&D is *higher*

[9] As discussed in footnote 2, IFRS permits the capitalization of internally generated R&D. We clearly state to our participants that both Quantum and Digiware fully expense their R&D expenses.

than the competitor (labeled as NE) and (4) Observe by nature format *first* and by function format *second*, and the level of R&D is *lower* than the competitor (labeled as NB).

After reviewing the additional information and the annual income statement excerpt, participants again evaluate the two firms on the same 101-point scale described above. The pre-post difference in the evaluation of relative innovativeness and future profitability is one of our dependent variables. We compare the assessments across participants to understand the effect of R&D being present or absent from the income statement. In stage 2, participants are presented with an income statement in the alternative format. Again, participants evaluate the two firms on the same 101-point scale described above after reviewing the information. In stage 2, we compare the evaluations within subjects (evaluation in stage 2 minus evaluation in stage 1) to examine if participants change their evaluations upon receiving an income statement excerpt in the alternative format.

After stage 2, we ask participants about their views regarding R&D. These questions help us better understand our results. Participants then answer two check questions and some demographic-related questions. Finally, participants are debriefed.

Results

The experiment was conducted as an in-class learning activity in a master-level financial statement analysis course taught by one of the authors. Initially, we had 123 participants. We then removed 12 participants who failed to answer either of the two check questions.[10] Table 1 illustrates the distribution of the remaining 111 participants across our four treatment groups.

We first use one-way Analysis of Variance (ANOVA) to test for differences in mean ratings of the focal firm's innovativeness and future profitability among the four treatment groups for all three stages. Table 2 presents our findings. In the pre-stage, when participants in all four treatment groups receive identical information, we do not observe a difference in their mean rating of the focal firms' innovativeness ($F = 0.45$, $p = 0.72$) or future profitability ($F = 0.56$, $p = 0.56$). This helps ensure a reliable baseline for our experiment and helps address the concerns that participants may possess different priors related to R&D. This also lends credibility to random assignment in our experiment. In the first stage, when participants are assigned to a treatment group and are shown an income statement excerpt in the first format (either by function or by nature), we observe a difference in participants' rating of the focal firm's innovativeness ($F = 2.37$, $p < 0.1$), but not in the rating of future profitability ($F = 1.4$, $p = 0.25$). In the second stage, when participants are shown the income statement in the alternative format, we do not observe a difference in the rating of the focal firm's innovativeness ($F = 0.9$, $p = 0.44$) or future profitability ($F = 0.68$, $p = 0.57$). Overall, table 2 presents weak evidence of presentation formats' effect on the perception of financial statement users' judgment of a firm's innovativeness. However, we find no significant evidence related to future profitability.

Next, we test for differences in ratings within subjects. Specifically, we are interested in testing whether ratings change when participants are presented with alternative income statement

[10] We do not find clustering in the treatment group for deleted observations (untabluated).

presentation formats. One advantage of using a within-subjects design is that each participant acts as his/her own control. Table 3 illustrates our results. Table 3 Panel A presents the participants' rating of the focal firm's innovativeness. Columns 1 through 3 reveal the average rating of the focal firm's innovativeness across treatment groups in the pre-stage, first-stage, and second stage respectively. As discussed previously, differences in the average rating of innovativeness across treatment groups are present only in stage 1, when participants are first assigned to a treatment group randomly and are presented with an income statement excerpt for the first time. Columns 4, 5, and 6 reveal the difference in mean ratings between the first stage and the pre-stage, between the second stage and the first stage, and between the second stage and the pre-stage respectively (t-stats are presented in parenthesis).

We observe a downward (upward) adjustment in focal firms' innovativeness rating when the focal firm spends less (more) on R&D than the competitor for participants that are presented with the income statement in by function format excerpt first (i.e. treatment groups FE and FB). The direction of average reactions aligns with our hypothesis that participants perceive less (more) R&D as being less (more) innovative. However, the change in ratings (compared with the pre-stage) is statistically insignificant. When the same participants are presented with the income statement excerpt in the alternative format (i.e., by nature format), we hypothesize there should not be any adjustment in ratings as no additional information related to R&D is provided. However, we also acknowledge that participants may (incorrectly) react to the income statement excerpt in the alternative format due to confusion or information overload. Column 5 reveals this is indeed the case. For participants in the FE treatment group, the change is statistically significant (t-stat = 2.32).

We then examine the participants that receive the income statement excerpt in by nature format first (i.e. treatment groups NE and NB).We observe a statistically insignificant downward adjustment in ratings irrespective of the R&D level. This finding aligns with our hypothesis that there should not be any change in rating given that income statement in the by nature format does not contain information related to R&D. When the same participants are presented with an income statement excerpt in the alternative format (i.e. by function format), we observe a downward (upward) adjustment in the focal firm's innovativeness rating when the focal firm spends less (more) on R&D than the competitor. The direction of average reactions aligns with our hypothesis that participants perceive less (more) R&D as being less (more) innovative, and would change their rating once R&D information becomes available as they observe the income statement presented in the by function format. However, the change is only statistically significant for the downward adjustment (t-stat = 3.59).

Table 3 Panel B presents the participant's rating of the focal firms' future profitability. In stage 1, all participants adjust their future profitability rating downward, though the change is only statistically significant for participants in the treatment groups FB (t-stat = -2.09) and NE (t-stat = -3.03). The downward adjustment in treatment group FB, that is, participants that receive the income statement excerpt in by function format first and where R&D spending is less than the competitor, aligns with our hypothesis that there will be a downward (upward) adjustment in rating if participants perceive less (more) R&D spending translates into smaller (greater) future

profitability. In stage 2, we observe a statistically upward adjustment in treatment group FB (t-stat = 1.93) and a statistically downward adjustment in treatment groups FE (t-stat = 4.72) and NB (t-stat = -3.14). The significant change in the NB treatment group, that is participants who first receive the income statement in by nature format and where R&D spending is less than the competitor, aligns with our hypothesis that participants will adjust their rating upon receiving the income statement in the alternative format (i.e. by function format) where R&D is a separate line item. The downward adjustment also aligns with our hypothesis that participants believe less (more) R&D spending translates to less (greater) future profitability.

Overall, table 3 provides some evidence that participant perception of the focal firm's innovativeness is affected by the presentation format of the income statement excerpt. We also find some evidence that the income statement presentation format affects the perception of future profitability, but the evidence is weak and contradictory.

We then test whether ratings differ across subjects. Specifically, we are interested in testing if ratings differ across the two presentation formats (R&D spending level) while holding the R&D spending level (presentation format) constant. Table 4 illustrates our results. Table 4 panel A presents the ratings for the two presentation formats when the focal firm's R&D spending is *greater* than that of its competitor. In the pre-stage, we do not observe a significant difference in the rating of the innovativeness and future profitability of the focal firm. In stage 1, participants who receive the income statement excerpt in by function (by nature) format have a mean rating of 60.26 (51.87) for the focal firm's innovativeness. The mean difference is statistically significant (t-stat = 1.90). For the same participants, the mean rating for future profitability is 58.96 (50.93) but the difference is statistically insignificant (t-stat = 1.56). The direction of difference in ratings for the focal firm's innovativeness and future profitability are both aligned with our hypothesis that participants perceive more (less) R&D spending associated with being more (less) innovative and greater (less) future profitability. In stage 2, the difference in innovativeness and future profitability ratings becomes statistically insignificant.

Table 4 Panel B illustrates the ratings for the two presentation formats when the focal firm's R&D is *less* than that of its competitor. In the pre-stage, the difference in the rating of innovativeness and future profitability of the focal firm is insignificant. In stage 1, participants who receive the income statement excerpt in by function (by nature) format have a mean rating of 48.68 (56.79) for the focal firm's innovativeness. The mean difference is statistically significant (t-stat = -1.68). For the same participants, the mean rating for future profitability is 48.96 (54.86) but the difference is statistically insignificant (t-stat = -1.13). Once again, the reaction direction for both the rating of the focal firm's innovativeness and future profitability aligns with our hypothesis that participants perceive more (less) R&D spending associated with being more (less) innovative and greater (less) future profitability. In stage 2, the difference in innovativeness and future profitability ratings becomes statistically insignificant.

Table 4 panel C (D) illustrates the results when we hold constant the presentation format of the income statement excerpt as by function (by nature). In panel C, we do not observe a statistical difference in the pre-stage or stage 2. In stage 1, participants who observe the focal firm's R&D spending to be less (greater) than the competitor have a mean rating of 48.68 (60.26)

for the focal firm's innovativeness and 48.96 (58.96) for the focal firm's future profitability. Both differences are statistically significant (t-stat = -2.62 and -1.75). This observation once again aligns with our hypothesis that participants associate participants perceive more (less) R&D spending associated with being more (less) innovative and greater (less) future profitability. In panel D, we do not observe a statistically significant difference in any of the three stages.

Overall, table 4 provides some evidence that the presentation format affects the financial statement users' perception of innovativeness and future profitability. However, the overall evidence is weak. For example, in table 4 panel C, the difference between the two presentation formats should persist even in stage 2 since no new information related to R&D is provided in the alternative format (i.e. by nature format). One possible explanation is participants are confused by the new information (i.e. information overload) and (incorrectly) adjust their rating.[11] Also, in Table 4 panel D, the difference should be statistically significant in stage 2 since new information related to R&D is presented in the alternative format (i.e. by function format).

Our experiment also permits us to study if the order in which participants receive the income statement excerpts (i.e. by function (by nature) format in stage 1 and by nature (by function) format in stage 2) affects their perceived information content, given that we have a two-stage experiment where each participant observes the income statement excerpt in both formats. Specifically, we test if the change in rating is different between participants who first observe the income statement excerpt in by function (by nature) format and by nature (by function) format second, holding the focal firm's relative R&D spending constant.

Table 5 illustrates our results. In Panel A (B), we hold constant that the R&D spending is greater (less) than the competitor. In Panel A and B, column 1 (4) reveals the change in ratings when compared with the previous round for participants that are presented with by function format of the income statement excerpt first (i.e. treatment group "Function (F)"). Similarly, column 2 (5) presents the change in ratings when compared with the previous round for participants that are presented with by nature format of the income statement excerpt first (i.e. treatment group "Nature (N)"). Columns 3 and 6 reveal the difference in change in ratings between the two treatment groups. Panel A suggests the difference in change in ratings is statistically insignificant. For example, the change in ratings between stage 1 and the pre-stage for observing by function format is 1.59 (2.77) for participants in the treatment group "Function (F)" ("Nature (N)"). The difference of -1.17 is statistically insignificant (t-stat = -0.31). Panel B suggests similar results except for rating of future profitability when participants are presented with by nature format of the income statement excerpt. Participants in the "Function (F)" ("Nature (N)") treatment group changed their rating for future profitability by 4.72 (-5.93). The difference of 10.65 is statistically significant (t-stat = 2.38). Overall, Table 5 suggests that the order of presentation does not affect the perceived information content of financial statement users.

To summarize, we find some evidence that the presentation format affects financial statement users' perception of innovation. However, the evidence for the perception of future

[11] We do not remind the participants their previous ratings, which may lead them to incorrectly guessing their previous ratings.

profitability is weak and contradictory. We illustrate our results visually for innovativeness (future profitability) in Figure 3 (Figure 4).

Prior Related to R&D

We were concerned that participants may have different prior perceptions of R&D. For example, participants may have different priors of the importance of R&D or the time it takes for R&D spending to generate profit. The difference in perception should be eliminated through the randomization process when we randomly assigned participants into four different groups.

Our result above where no difference in ratings is present in the pre-stage provides preliminary evidence that the randomization process was successful. We asked three additional questions related to R&D perception at the end of our experiment to better understand if a difference in priors exists and the magnitude of the difference.. Table 6 illustrates our results. We find no statistically significant differences in the priors among participants in different treatment groups using a one-way ANOVA.

6. Conclusion

IFRS permits firms to report income statements in either by function or by nature format. In this paper, we use an experiment to test whether the absence or presence of R&D as a separate line item on the income statement affects financial statement users' perception of a firm's innovation and future profitability. Our results show some evidence that financial statement users' evaluation of a firm's innovation is affected by the presentation format. However, we do not find any results of the evaluation of future profitability.

The results of this paper contribute to the ongoing debate related to financial statement presentation formats. One recurring discussion that standard setters such as the IASB engage in relates to financial statement presentation formats. Our results suggest the presence of some (unintended) consequences that may be informative to financial statement users or preparers. In addition, the results of this paper contribute to the presentation format literature, and literature related to R&D.

Our study has some limitations. First, expense line items and allocation differ across by function and by nature format. The line items on the income statement differ under each format (e.g., staff expenses are by nature expenses and distribution expenses are by function expenses). Hence, expenses allocated to common expense items across the two formats, such as other operating expenses, would also differ under the two formats, while sales and net profit would remain constant. As such, the focal firm presented to the participants differs not just concerning the absence or presence of R&D as a line item. This may add noise to our measure. However, we believe this noise biases us against finding results.

Second, in our experiment, participants provide their ratings for each stage individually and they are not permitted to adjust their previous ratings. Further, we also do not remind them of their previous ratings. As a result, participants may be forced to guess their previous ratings. This may explain some of the results we observe.

Lastly, we focused on one feature related to the two income statement presentation formats. Other features related to by function and by nature presentation format may also be of interest. For example, gross profit is (usually) only present under the by function presentation format. One related research question could be "Does the presence of gross profit help mitigate the fixation on net income?". We leave this question for future researchers to answer.

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Appendix A

A1 – Pre-Stage Information

Please read the following scenario and answer all the questions below.

You have recently joined an investment bank as an analyst. As part of your on-boarding training, your supervisor has asked you to evaluate two software firms described below.

Quantum and Digiware are two different European software firms specializing in cybersecurity. Both Quantum and Digiware were incorporated 10 years ago. The client bases for the two firms are similar, as both Quantum's and Digiware's main clients are financial institutions, such as banks and brokerage houses. Quantum and Digiware are also similar in terms of size. Since the two firms operate in the same industry and serve similar clients, each firm considers the other firm to be its main competitor, and analysts consider the two firms to be in the same peer group.

The European Union has strict requirements of internet security for firms operating in the financial industry. As a result, both Quantum and Digiware have been profitable since their incorporation.

A2 – Scenario with R&D Expense Greater than Competitor

Please read the following scenario and answer all the questions below.

Both Quantum and Digiware have their own research and development (R&D) department that focuses on improving current and developing new algorithm used in the firms' products. The R&D department is also responsible for fixing any issues with software and ensures all software are updated in time. Given the importance of the R&D department, both firms have substantial R&D expenses, which they fully expense. For the fiscal year ended 2021, **Digiware**'s R&D expense equaled to 2% of total sales.

To better evaluate the two software firms, as a first step, your supervisor has provided you the following income statement excerpt for **Quantum** for the fiscal year ended 2021.

A3 – Scenario with R&D Expense Less than Competitor

Please read the following scenario and answer all the questions below.

Both Quantum and Digiware have their own research and development (R&D) department that focuses on improving current and developing new algorithm used in the firms' products. The R&D department is also responsible for fixing any issues with software and ensures all software are updated in time. Given the importance of the R&D department, both firms have substantial R&D expenses, which they fully expense. For the fiscal year ended 2021, **Digiware**'s R&D expense equaled to 8% of total sales.

To better evaluate the two software firms, as a first step, your supervisor has provided you the following income statement excerpt for **Quantum** for the fiscal year ended 2021.

A4 – Income Statement Excerpt in *By Function* Format

Quantum - ***In EUR thousands***	2021	
	(€)	(%)
Sales	**1000**	**100.00%**
Cost of Sales	730	73.00%
Gross Profit	**270**	**27.00%**
Selling, General, and Administration Costs	198	19.80%
Research and Development Costs	48	4.80%
Other Operating Revenue	-16	-1.60%
Net Income	**40**	**4.00%**

A5 – Income Statement Excerpt in *By Nature* Format

Quantum - ***In EUR thousands***	2021	
	(€)	(%)
Sales	**1000**	**100%**
Cost of Sales	480	48.00%
Gross Profit	**520**	**52.00%**
Staff Expenses	280	28.00%
Depreciation of PPE	38	3.80%
Other Operating Expenses	162	16.20%
Net Income	**40**	**4.00%**

Figure 1: Comparison of By Function and By Nature Format

By Function

Consolidated income statement

AMOUNTS IN KSEK	NOTE	2017	2016
Net sales	5	140,706	105,613
Cost of goods sold	7	-266	-238
Gross profit		**140,441**	**105,375**
Other operating income	6,11	19,044	39,073
Marketing expenses	7,8,9,11	-1,397	-1,370
Administrative expenses	7,8,9,10,11	-31,522	-14,544
Research and development costs	7,8,9,11	-101,583	-53,665
Other operating expenses	12	-5,689	-238
Operating profit		**19,294**	**74,631**
Financial income	13	1,043	8
Financial expenses	13	-647	-503
Profit before tax		**19,690**	**74,136**
Income tax	14	-4,534	-16,556
PROFIT FOR THE YEAR		**15,157**	**57,580**
Profit for the year attributable to owners of the parent company		15,157	57,580
Earnings per share			
Earnings per share, SEK	15	0,22	0,91

By Nature

Consolidated income statement [1)]

Amounts in kSEK	Note	2018	2017
Net revenues	6	713,970	140,706
Other operating income	7	16,259	19,044
Total operating income		**730,229**	**159,750**
Project expenses		-145,357	-63,641
Other external expenses	9, 10	-31,949	-36,197
Personnel expenses	8	-57,039	-32,936
Depreciations of tangible assets	15	-2,059	-1,993
Other operating expenses	11	-5,031	-5,689
Operating profit		**488,794**	**19,294**
Financial income	12	2,171	1,043
Financial expenses	12	-1,371	-647
Profit before tax		**489,593**	**19,690**
Income tax	13	-107,991	-4,534
Profit for the year		**381,602**	**15,157**
Profit for the year attributable to owners of the parent company		381,602	15,157
Earnings per share			
Earnings per share, SEK	14	4.33	0.22

Source: Bio Arctic AB Annual Reports 2017 & 2018

Figure 2: Hypothesis Illustration

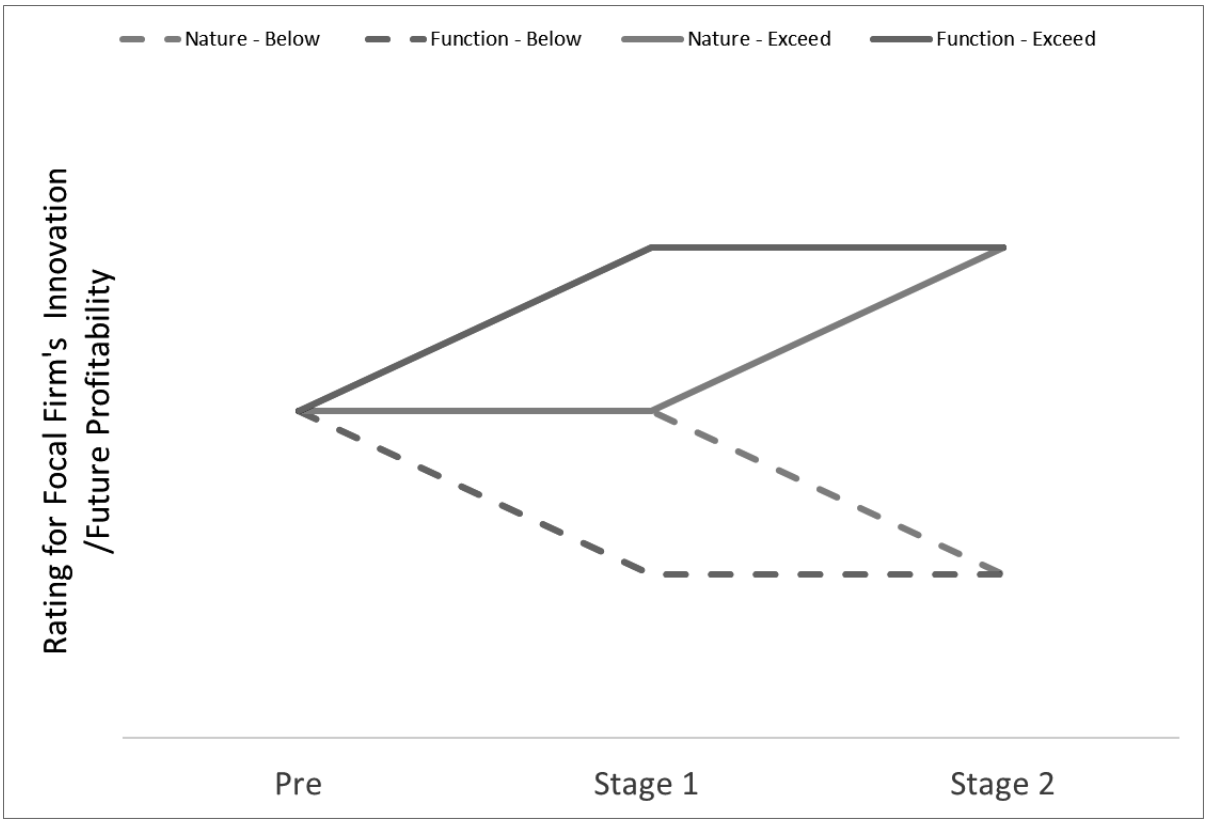

Figure 3: Mean Ratings for Innovativeness

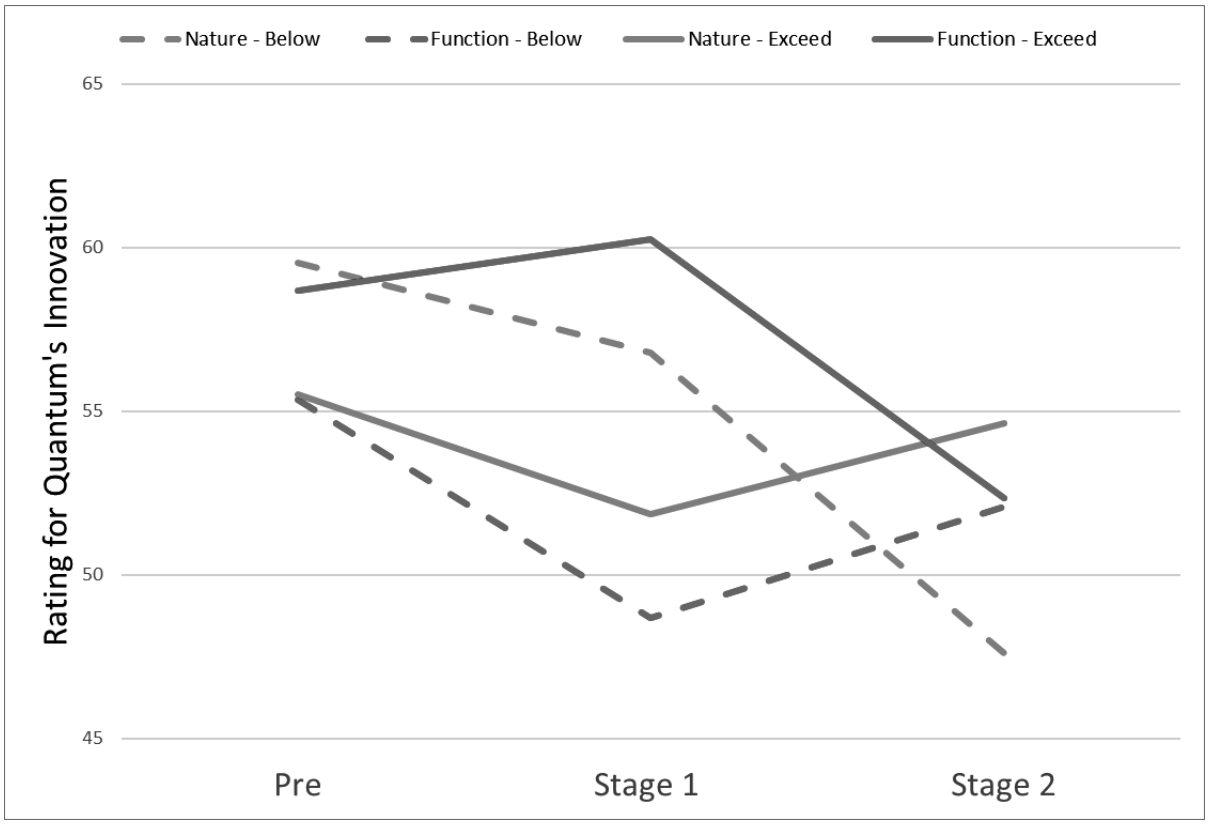

Figure 4: Mean Ratings for Future Profitability

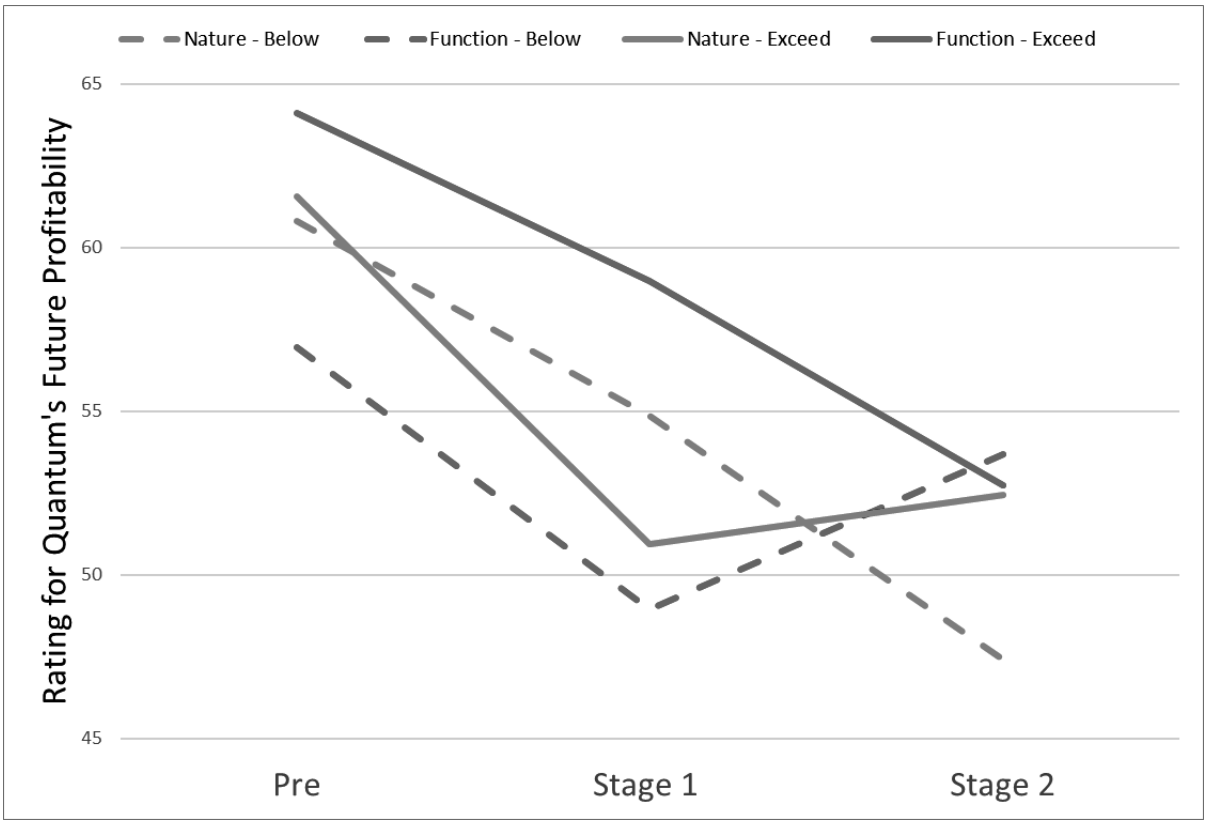

Table 1: Treatment Group Distribution

Table 1 illustrates the distribution of 111 (out of 123) participants who answered both of our check questions correctly across our four treatment groups. Participants are assigned to the Function (F) (Nature (N)) group if they are first presented with the income statement excerpt in the by function (by nature) format. Participants are assigned to the Exceed (E) (Below (B)) group if the focal firm invests more (less) in R&D compared with the competitor. As a result, we have four different treatment groups – FE, FB, NE, and NB.

Group	N
Function – Exceed (FE)	27
Function – Below (FB)	25
Nature – Exceed (NE)	30
Nature – Below (NB)	29
Total	111

Table 2: One-Way ANOVA

Table 2 illustrates the results from a one-way analysis of variance (ANOVA) for the participants' mean rating for the focal firm's innovativeness and future profitability. Participants rate the focal firm's innovativeness (future profitability) for the first time before they are assigned to any treatment group, and the mean ratings are recorded under the columns "Pre-Stage". Participants are then randomly assigned to one of the four treatment groups (see Table 1) where they observe the income statement excerpt in the first format (i.e. either by function or by nature), and the mean ratings are recorded under the columns "Stage 1". Finally, participants are shown the income statement excerpt in the alternative format (e.g. if participants observed by function format first, they are presented with by nature format), and the mean ratings are recorded under the columns "Stage 2". In all stages, innovativeness (future profitability) is rated on a scale from 1 – 100, where we label 1 as "Not Innovative" ("Not Profitable") and 100 as "Very Innovative" ("Very Profitable").

	Innovativeness			Future Profitability		
Group	Pre-Stage	Stage 1	Stage 2	Pre-Stage	Stage 1	Stage 2
FE	58.67	60.26	52.33	64.11	58.96	52.74
FB	55.36	48.68	52.08	56.96	48.96	53.68
NE	55.53	51.87	54.63	61.57	50.93	52.43
NB	59.52	56.79	47.62	60.79	54.86	47.41
F	0.45	**2.37**	0.9	0.69	1.4	0.68
p-value	0.72	**0.07**	0.44	0.56	0.25	0.57

Table 3: Within-Subject Differences

Table 3 illustrates the results of testing within-subject differences for our four treatment groups (See Table 1). In Panel A (B), columns 1 through 3 summarize the participants' mean ratings for the focal firm's innovativeness (future profitability) in the Pre-Stage, Stage 1, and Stage 2 respectively. In both Panels A and B, column 4 presents the difference in participants' mean ratings between Stage 1 and Pre-Stage. Column 5 reveals the difference in participants' mean ratings between Stage 2 and Stage 1 and lastly, Column 6 reveals the difference in participants' mean ratings between Stage 2 and Pre-Stage. The t-statistic for the null hypothesis that the difference in mean ratings is zero is presented in parentheses.

Panel A: Mean Ratings for Focal Firm's Innovativeness

	Mean Ratings			Difference		
Group	Pre-Stage	Stage 1	Stage 2	Stage 1	Stage 2	Pre-Stage
FE	58.67	60.26	52.33	1.59	-7.93	-6.34
				(0.59)	**(-2.32)**	**(-2.23)**
FB	55.36	48.68	52.08	-6.68	3.4	-3.28
				(-1.36)	(1.10)	(-0.80)
NE	55.53	51.87	54.63	-3.66	2.76	-0.9
				(-1.46)	(1.01)	(-0.28)
NB	59.52	56.79	47.62	-2.73	-9.17	-11.9
				(-0.79)	**(-3.59)**	**(-3.02)**

Panel B: Mean Ratings for Focal Firm's Future Profitability

	Mean Ratings			Difference		
Group	Pre-Stage	Stage 1	Stage 2	Stage 1	Stage 2	Pre-Stage
FE	64.11	58.96	52.74	-5.15	**-6.22**	**-11.37**
				(-1.34)	**(-2.14)**	**(-3.8)**
FB	56.96	48.96	53.68	**-8**	**4.72**	-3.28
				(-2.09)	**(1.93)**	(-0.79)
NE	61.57	50.93	52.43	**-10.64**	1.5	**-9.14**
				(-3.03)	(0.77)	**(-2.75)**
NB	60.79	54.86	47.41	-5.93	**-7.45**	**-13.38**
				(-1.56)	**(-3.14)**	**(-3.68)**

Table 4: Across-Subjects Differences

Table 4 illustrates the results of testing across-subject differences. In Panel A (B), we hold constant the R&D spending of the focal firm to be greater (less) than the competitor such that we only examine the mean ratings of participants in the "Exceed (E)" ("Below (B)") treatment group. In Panel A and B, Column 1 (4) presents the "Function (F)" treatment group participants 'mean rating for the focal firm's innovativeness (future profitability). Column 2 (5) presents the "Nature (N)" treatment group participants 'mean rating for the focal firm's innovativeness (future profitability). Column 3 (6) reveals the difference in mean ratings for the focal firm's innovativeness (future profitability). The t-statistic for the null hypothesis that the difference in mean ratings is zero is presented in parenthesis. In Panel C (D), we hold constant the presentation format of the first income statement excerpt that participants observe to be by function (by nature) such that we only examine mean ratings of participants in the "Function (F)" ("Nature (N)") treatment group. In Panel C and D, Column 1 (4) presents the "Below (B)" treatment group participants 'mean rating for the focal firm's innovativeness (future profitability). Column 2 (5) illustrates the "Exceed (E)" treatment group participants 'mean rating for the focal firm's innovativeness (future profitability). Column 3 (6) reveals the difference in mean ratings for the focal firm's innovativeness (future profitability). The t-statistic for the null hypothesis that the difference in mean ratings is zero is presented in parenthesis.

Panel A: Mean ratings across presentation formats (R&D expense is greater than competitor)

	Innovativeness			Future Profitability		
Stage	Function	Nature	Difference	Function	Nature	Difference
Pre-Stage	58.67	55.53	3.14	64.11	61.57	2.54
			(0.78)			(0.55)
Stage 1	60.26	51.87	**8.39**	58.96	50.93	8.03
			(1.90)			(1.56)
Stage 2	52.33	54.63	-2.30	52.74	52.43	0.31
			(-0.58)			(0.07)

Panel B: Mean ratings across presentation formats (R&D expense is less than competitor)

	Innovativeness			Future Profitability		
Stage	Function	Nature	Difference	Function	Nature	Difference
Pre-Stage	55.36	59.52	-4.16	56.96	60.79	-3.83
			(-0.84)			(-0.76)
Stage 1	48.68	56.79	**-8.11**	48.96	54.86	-5.90
			(-1.68)			(-1.13)
Stage 2	52.08	47.62	4.46	53.68	47.41	6.27
			(0.89)			(1.15)

Panel C: Mean ratings across R&D spending (presentation format is by function)

	Innovativeness			Future Profitability		
Stage	Below	Exceed	Difference	Below	Exceed	Difference
Pre-Stage	55.36	58.67	-3.31	56.96	64.11	-7.15
			(-0.67)			(-1.38)
Stage 1	48.68	60.26	**-11.58**	48.96	58.96	**-10.00**
			(-2.62)			**(-1.75)**
Stage 2	52.08	52.33	-0.25	53.68	52.74	0.94
			(-0.06)			(0.17)

Panel D: Mean ratings across R&D spending (presentation format is by nature)

	Innovativeness			Future Profitability		
Stage	Below	Exceed	Difference	Below	Exceed	Difference
Pre-Stage	59.52	55.53	3.98	60.79	61.57	-0.77
			(0.97)			(-0.17)
Stage 1	56.79	51.87	4.93	54.86	50.93	3.93
			(1.04)			(0.83)
Stage 2	47.62	54.63	-7.01	47.41	52.43	-5.02
			(-1.55)			(-1.19)

Table 5: Difference in Change in Ratings

Table 5 illustrates the results of testing differences in change in ratings. Specifically, we test the change in ratings compared with the previous round. In Panel A (B), we hold constant the R&D spending of the focal firm to be greater (less) than the competitor such that we only examine the mean ratings of participants in the "Exceed (E)" ("Below (B)") treatment groups. In both Panels A and B, the row "Stage 1" ("Stage 2") presents the change in ratings between Stage 1 and the Pre-Stage ("Stage 2 and Stage 1"). In Panel A and B, column 1 (4) presents the change in rating for the focal firm's innovativeness (future profitability) of participants that observe the income statement excerpt in by function format first and by nature format second (i.e. treatment group "Function(F)"). Similarly, column 2 (5) presents the change in rating for the focal firm's innovativeness (future profitability) of participants that observe the income statement excerpt in by nature format first and by function format second (i.e. treatment group "Function(F)"). Columns 3 and 6 reveal the difference in change in ratings between the two treatment groups. The t-statistic for the null hypothesis that the difference in change in ratings is zero is presented in parenthesis.

Panel A: R&D expense is greater than the competitor

	Innovativeness			Future Profitability		
	Function	Nature	Difference	Function	Nature	Difference
Stage 1	1.59	2.77	-1.17 (-0.31)	-5.15	1.50	-6.65 (-1.59)
Stage 2	-7.93	-3.67	-4.26 (-1.02)	-6.22	-10.63	4.41 (0.96)

Panel B: R&D expense is less than the competitor

	Innovativeness			Future Profitability		
	Function	Nature	Difference	Function	Nature	Difference
Stage 1	-6.68	-9.17	2.49 (0.47)	-8.00	-7.45	-0.55 (-0.13)
Stage 2	3.40	-2.72	6.12 (1.30)	4.72	-5.93	**10.65** **(2.38)**

Table 6: Perception of R&D

Table 6 illustrates the results from a one-way analysis of variance (ANOVA) for the three additional questions related to R&D we ask our participants after the experiment to better understand their priors related to R&D. "R&D Q1" is "How does R&D affect a software firm's current profitability?"; "R&D Q2" is "How does R&D affect a software firm's future profitability?" and "R&D Q3" is "How long (number of years) do you think it takes R&D expense to translate into profitability for a software firm?". "R&D Q1" and "R&D Q2" are rated on a scale from 1 – 9, where we label 1 (9) as "Negatively affect profitability" ("Positively affect profitability"). We also label 5 as "No Effect". Therefore, for "R&D Q1" and "R&D Q2", a score above (below) 5 means participants perceive a positive (negative) relationship. The unit for "R&D Q3" is the number of years.

Group	R&D Q1	R&D Q2	R&D Q3
FE	4.15	7.56	4.15
FB	3.32	7.88	4.76
NE	3.97	7.77	4.53
NB	4.48	7.31	4.03
Mean	4.00	7.62	4.36
F	1.19	2.01	0.93
p-value	0.32	0.12	0.43

Chapter 3

How Similar are CAMs and KAMs? Evidence from Twin Audit Matters*

Co-Authored with Brian Burnett and Bjørn N. Jørgensen

Abstract

We investigate the similarity of key audit matters (KAMs) and critical audit matters (CAMs) holding fixed underlying transactions. Specifically, we study U.S.-listed firms that are domiciled in the European Union (EU) and therefore must report KAMs to their home-country securities regulator and CAMs to the U.S. Securities and Exchange Commission (SEC). While the EU requires that these firms report consolidated financial statements using International Financial Reporting Standards (IFRS), some of them report two separate annual reports each fiscal year, one with KAMs based on IFRS and the other with CAMs based on U.S. Generally Accepted Accounting Principles (U.S. GAAP). For firms reporting only under IFRS, we find more extensive KAM than CAM disclosure, differences in the word count, and similarity scores between 60% and 82%. For firms reporting under both IFRS and U.S. GAAP, we find even more extensive differences consistent with accounting standards' influence on audit matter disclosures. For example, similarity scores are between 40% and 70%. Our empirical-archival evidence is consistent with experimental evidence that the level of precision of an accounting standard influences audit matter disclosure.

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1. Introduction

For the past 50 years, the U. S. Securities and Exchange Commission (SEC) has grappled with the appropriate disclosure requirements for foreign issuers cross-listed in the U.S. Its approach aims to encourage foreign firms to access U.S. capital markets while protecting U.S. investors. Towards this end, the SEC permits exemptions from some disclosure and governance requirements and permits foreign private issuers to follow their home country requirements (SEC 1979). The main justification for the exemptions is that the disclosure and governance requirements are of sufficient quality to protect investors.[1] Using similar reasoning, in 2007 the SEC eliminated the U.S. GAAP reconciliation requirement for foreign private issuers reporting using IFRS, stating that IFRS and U.S. GAAP are of comparable quality. Our paper provides evidence about the SEC's approach regarding a relatively new disclosure – audit matters. The SEC currently requires auditors of foreign issuers to report critical audit matters (CAMs) even though the auditors of most of these firms already report key audit matters (KAMs) in their home country disclosures.

The SEC's approach assumes that KAMs and CAMs are substantially different and do not provide comparable insights into the most difficult aspects of the audit or the auditor's response to these issues. Given the recency and substantial nature of the disclosure, the SEC's approach makes sense and is similar to its initial requirement that firms adopting IFRS in 2005 (and earlier) continue to reconcile to U.S. GAAP. We aim to provide evidence about whether KAMs and CAMs are substantially similar and whether the SEC could consider accepting KAMs in lieu of CAMs. Audit matters may differ across firms and between countries for multiple reasons including accounting standards, audit standards, enforcement, and litigation risk.

To analyze the similarity of KAMs and CAMs, we identify and compare two samples of EU-domiciled firms that disclose both KAMs and CAMs for the *same* underlying economic transactions.[2] First, we identify a set of EU-domiciled firms that publicly disclose two sets of financial statements in the same fiscal year. These firms file consolidated financial statements prepared in accordance with U.S. Generally Accepted Accounting Principles (U.S. GAAP) with the SEC and also file consolidated financial statements prepared in accordance with International Financial Reporting Standards (IFRS) and IFRS Interpretations Committee (IFRIC) as adopted by the European Union (EU). The KAMs are based on IFRS and the CAMs are based on U.S. GAAP, holding fixed the underlying economic transactions.[3] The audit matters in this sample differ in terms of audit standards, enforcement, litigation risk, and most notably accounting standards. We label these as "IFRS-USGAAP" firms. Second, we identify a set of EU-domiciled firms that file IFRS financial statements both in the EU and the U.S. Therefore, these EU firms are required to

[1] For example, in 1991, the U.S. and Canada adopted the Multi-Jurisdictional Disclosure System (MJDS) where each country could access the other country's capital markets using their home country disclosures on the premise that the disclosures in both countries were substantially comparable.

[2] We follow Christensen, Hail and Leuz (2013) and consider firms from European countries that are members of the European Union, adding Iceland and Norway which have similar regulations. We verify that our firms are domiciled in these countries based on their annual report disclosures.

[3] We verify that these firms have the same cash and cash equivalents balance across the two sets of financial statements, which suggests the underlying consolidated entity is the same.

disclose KAMs in the EU and CAMs in the U.S. Each pair of audit matters in this sample differ

In an influential econometrics book, Angrist and Pischke (2009) argue persuasively in favor of using matched samples in research.[4] Our research design is inspired by disciplines that achieve matching by using twins as subjects, including medicine, where this is the gold standard for research design. The reason is that identical twins allow the researcher to control individual characteristics with much fewer observations needed to achieve statistical power to make causal inferences. Although empirical research in other disciplines also uses twin observations, the use of twins is limited in social sciences (Froot and Dabora 1999). A notable exception is Ashenfelter and Krueger (1994) who use twins to illustrate that omitted ability variables do not bias estimated returns to schooling upward, but that measurement error likely results in downward bias. As a result, they estimate a higher return to schooling than documented in prior studies. Accounting often permits a research design that is similar in spirit to "twins" because different accounting disclosures/treatments for the same underlying transactions can occur. For example, Berger and Hann (2003, 2007) cleverly exploit that some accounting standards in their adoption year require restatement of the prior year "as if" the new standard had been applied to the previous year. Because the previous year used the replaced accounting standard, this setting allows comparisons in the year prior to adoption while holding fixed the underlying transactions for the entity that is being measured.[5]

We observe "twin" audit matters for the firms in our two samples. That is, we observe the KAMs and CAMs holding fixed the underlying economic transactions. Hrubec and Robinette (1984) classify medical twin studies into two categories: those that examine genetic contributions to disease and those aimed at assessing environmental contributions while controlling for genetic variation. In spirit, our study falls into the latter category where holding the underlying economic transactions fixed is akin to holding the genetic variation fixed allowing us to assess the environmental contributions to audit matters. For our sample of firms that report under both IFRS and U.S. GAAP (IFRS-USGAAP sample), we also observe "twin" financial statements in addition to "twin" audit matters.

Our research question is whether KAMs are substantially similar to CAMs for foreign issuers in the U.S. To analyze the similarity of the audit matters, we compare the number and topics of the audit matters. We then perform textual analysis to examine the similarity of KAMs and CAMs when the audit matters topics are the same. We find material differences for the IFRS-USGAAP sample of firms. The auditors disclose 43% more KAMs than CAMs. Further examination reveals that KAMs are much more likely to cover non-accounting audit matters (e.g., Brexit and COVID-19) with 21% of firm-years listing a non-accounting KAM while auditors never disclose a non-

[4] For example, they state (page 69): "Matching estimators are appealingly simple: at bottom, matching amounts to covariate-specific treatment-control comparisons, weighted together to produce a single overall average treatment effect," and "an attractive feature of matching strategies is that they are typically accompanied by an explicit statement of the conditional independence assumption required to give matching estimates a causal estimation."

[5] Berger and Hann (2003) exclude firms with large changes in the entity in the year prior to adoption due to acquisitions or divestitures, among other reasons.

accounting CAM. Auditors disclose 28% more accounting-related audit matters as KAMs than CAMs consistent with accounting standards potentially playing a significant role in the differences.

Our textual analysis reveals significant differences consistent with the differences between IFRS and U.S. GAAP, even when auditors disclose the same audit matters as KAMs and CAMs. Each audit matter must provide a description section (the identification of the audit matter) and a response section (the procedures taken by the auditor to address that audit matter). The rules-based nature of U.S. GAAP suggests that the auditor's description of the audit matter will be more detailed under U.S. GAAP than IFRS. The rules-based nature of U.S. GAAP, however, is likely to make auditing U.S. GAAP financial statements more straightforward than IFRS, where auditors will likely exercise more judgment in applying IFRS to transactions and determining appropriate audit tests. Consistent with this expectation, we find the description section uses 9-10% fewer words for KAMs than CAMs while the response section uses 12-13% more words for KAMs than CAMS. Our semantic analysis of the similarity of the description and response sections finds that auditors' disclosures of audit matters as KAMs and CAMs are significantly different. The similarity ratios of the description and response sections are 0.69-0.70, which suggests that even though the audit matters between the KAMs and CAMs are the same the disclosures contain only 69-70% of common vocabulary. As an additional test of similarity, we identify the top five keywords in the KAM and CAM. Our analysis finds that on average only two keywords among the top five are the same between KAMs and CAMs, which suggests a similarity of 40%. Thus, for the twin audit matter firms that report under different standards, we find major differences between KAMs and CAMs, even when the audit matters are the same.

We next analyze twin audit matter firms that report in the U.S. and the EU using the same accounting standard, IFRS (IFRS-IFRS sample). Because experimental literature such as Kachelmeier, Rimkus, Schmidt, and Valentine (2020) suggests the nature of accounting standards, in particular measurement uncertainty, affects the disclosure of audit matters, we use propensity score matching (PSM) to match firms with twin audit matters that report under IFRS and U.S. GAAP (IFRS-USGAAP sample) to firms with twin audit matters that report only under IFRS (IFRS-IFRS sample). This matched sample enables us to perform a difference-in-differences (DD) analysis that isolates the effects of accounting standards on audit matters.[6] For these PSM-matched twin audit matter firms that report only under IFRS, we find that KAMs and CAMs exhibit differences. Auditors disclose 16% more KAMs than CAMs, mainly due to differences in accounting-related topics. Further, the differences in this sample are entirely due to more extensive KAM disclosures (that is, every CAM is also disclosed as a KAM). Our textual analysis when the audit matters are the same between KAMs and CAMs reveals that on average the description section contains 10% fewer words in the KAM than the CAM while the response section contains 5-8% more words in the KAM than the CAM. In our semantic tests, we find a similarity ratio of 0.76 in the description section and a ratio of 0.81 in the response section. Additionally, we find

[6] Propensity score matching has been used extensively in auditing and accounting research in recent years, see surveys by DeFond and Zhang (2014) and Shipman, Swanquist, and Whited (2017), respectively. Lawrence, Minutti-Meza, and Zhang (2011) and DeFond, Erkens, and Zhang (2017) employ the technique to investigate whether client characteristics explain differences in audit quality between Big Four and other audit firms. In our difference-in-differences analysis, we rely on propensity score matching to match IFRS-USGAAP firms with IFRS-IFRS firms.

that on average three keywords of the top five keywords are the same, which is 60% similarity (40% difference). Thus, even when firms report under the same accounting standard other factors such as audit standards, the definition of KAMs and CAMs, enforcement, and litigation risk affect auditors' audit matters disclosures. This is consistent with prior literature documenting these institutional differences affecting disclosures and earnings quality (e.g., Ball, Kothari, and Robin 2000; Guenther and Young 2000; Bushman, Piotroski, and Smith 2004; among many others).

Lastly, we perform a difference-in-differences analysis between twin audit matter firms that report under different accounting standards in the U.S. and the EU (IFRS-USGAAP sample) to those that report under the same standard (IFRS-IFRS sample). Because both sets of twin audit matter firms are subject to the same factors influencing auditors' audit matter disclosures except for accounting standards, this analysis should primarily isolate the influence of accounting standards on audit matter disclosures. We find the number of differences between KAMs and CAMs is greater for firms in the IFRS-USGAAP sample. When the audit matters are the same, we find that the word count difference in the response section is greater for firms reporting under different standards with approximately 63% of the difference being attributable to accounting standards. The text similarity and keyword differences for both the description and response sections are statistically significantly different with firms reporting under different standards having 20-30% lower similarity than firms that report only under IFRS.

We contribute to the understanding of the difference between KAMs and CAMs in practice. Studies have focused on either KAMs or CAMs. In contrast, we consider a setting where the same firm discloses both KAMs and CAMs separately for the same fiscal year and exploits variation in the accounting standard. A concern about the new audit matter disclosures is that they could become boilerplate (e.g., Brasel, Doxey, Grenier, and Reffett 2016). Our results suggest auditors put unique effort and thought into their disclosures. Even when the audit matter topic and the accounting standard are the same, we find disclosures under KAMs and CAMs are 10-40% different depending on the similarity measure. This is not consistent with boilerplate disclosures by auditors.

Our study should be of interest to the U.S. SEC. In 2007, it decided to accept financial statements prepared under IFRS without reconciliation to U.S. GAAP from foreign private issuers cross-listed in the U.S. capital markets. Thus, a natural question is whether the SEC should accept KAM disclosures that auditors make in foreign issuers' home countries. Our results suggest there are differences between KAMs and CAMs for firms reporting under IFRS to both the SEC and their home country regulator (IFRS-IFRS sample), but that the KAM reporting is more extensive and would be unlikely to harm U.S. investors. In contrast, for our European firms reporting under U.S. GAAP to the SEC and IFRS to their home country regulator (IFRS-USGAAP sample), the differences between CAMs and KAMs are more substantive and reflect the differences between U.S. GAAP and IFRS. More principles-based standards that require more managerial discretion influence the amount of audit matters and their reporting. This suggests the U.S. SEC should likely continue to require these firms to report both CAMs and KAMs. We believe that standard setters and regulators can be informed by the implementation of similar standards, rules, and regulations in different jurisdictions. We also offer a methodological contribution to researchers in accounting and auditing by identifying a sample of firms with twin audit matters where ceteris paribus

empirical analyses are arguably more compelling than the more common empirical archival analyses using regressions.

2. Background of KAMs and CAMs

Key audit matters were developed by the International Audit and Assurance Standards Board (IAASB) and became required for audits of financial statements for periods ending on or after December 15, 2016.[7] According to the IAASB, KAMs are defined as "those matters that, in the auditor's professional judgment, were of most significance in the audit of the financial statements of the current period. Key audit matters are selected from matters communicated with those charged with governance" (IAASB 2015).

CAMs were developed by the Public Company Accounting Oversight Board (PCAOB) and became required for audits of financial statements for periods ending on or after June 30, 2019.[8] According to the PCAOB, CAMs are defined as "any matter arising from the audit of the financial statements that was communicated or required to be communicated to the audit committee and that: (1) relates to accounts or disclosures that are material to the financial statements and (2) involved especially challenging, subjective, or complex auditor judgement" (PCAOB 2017).

While both KAMs and CAMs were developed with the common goal of improving the transparency and informativeness of audit reports, the definitions of audit matters suggest differences arise in terms of identifying audit matters. Specifically, KAMs are audit matters that are "of most significance," whereas CAMs are audit matters that are "material." The benefit of our difference-in-differences analysis comparing IFRS-USGAAP firms to IFRS-IFRS firms is that we can isolate the effect of *accounting standards* separate from the *auditing standards* (i.e., the slight difference between KAM and CAM definitions).[9]

3. Literature Review and Hypotheses Development

The purpose of the introduction of CAM and KAM reporting was to make the auditor's report more relevant, useful, and informative to investors (Schilder 2015; Doty 2017). Auditors expend considerable effort and resources to gather evidence and form an opinion on whether their clients' financial statements materially comply with the applicable accounting standard. Many felt that the binary pass/fail audit opinion with standardized language did not convey enough information from the auditor to investors about the quality of clients' financial reporting. They argued that investor confidence in auditing could be enhanced by an auditor report that communicated more information about the judgements made by auditor during the audit.

[7] Some countries, such as the United Kingdom and the Netherlands, introduced key audit matters before IAASB's disclosure requirement became mandated.

[8] The exact disclosure requirement date depends on the public float of the firms. Disclosure of CAMs became required for large accelerate filers for fiscal years ending on or after June 30, 2019. For all other firms to which the disclosure requirement applies, CAMs disclosure became required for fiscal years ending on or after December 15, 2020. Some firms, such as growth companies, are permitted but not required to disclose CAMs. See AS 3101 for details.

[9] Appendix 1 illustrates KAMs and CAMs for an IFRS-IFRS firm that reports using IFRS to the U.S. SEC.

Experimental studies explore the role of the nature of accounting standards on auditor liability for CAM disclosures and investors' perceptions of the level of assurance provided by these disclosures. Gimbar, Hansen, and Ozlanski (2016) hypothesize that a CAM related to a litigated accounting treatment will highlight judgments and estimates related to the application of the standard. This could increase assessments of the auditor's responsibility for CAM-related accounting. They argue that this will be true even for precise accounting standards that are typically perceived to constrain auditors' influence over the financial statements. Using an experiment of lease classification as an operating or capital lease (a standard with precise rules for determination), Gimbar et al. (2016) find CAM disclosure increases the extent to which participants find the auditor to be responsible for the misclassified lease.

In contrast, Brasel et al. (2016) posit that, under certain conditions, investors interpret CAM disclosures as a form of risk disclosure, where auditors report factors that increase the risk of failing to detect a material misstatement and making it less likely the auditor will be held accountable for the material misstatement. Their experimental evidence supports this theory, and they express concern that CAM disclosures may become boilerplate and lose their intended impact.

To the extent that audit matter disclosures become boilerplate, we would expect audit matters disclosed as KAMs and CAMs to be substantially the same, particularly when the audit matter topic is the same. A substantial literature examining disclosures and earnings quality, however, finds that differences in factors such as public enforcement, private enforcement, strength of the legal system, auditing standards, and accounting standards between the U.S. and other countries influence financial reporting outcomes (Ball et al. 2000; Guenther and Young 2000; Bushman et al. 2004). This leads to our first hypothesis in null form:

H1: *Ceteris paribus, audit matters will not be different for KAMs and CAMs.*

In the experimental literature, a significant focus is placed on the influence of the nature of accounting on audit matters. Kachelmeier et al. (2020) reconcile the seemingly contradictory results of Gimbar et al. (2020) and Brasel et al. (2016) by focusing on the nature of accounting. They find that CAM disclosures involving greater measurement uncertainty (less precision) reduce auditor culpability and investor confidence in the financial statement area disclosed in a CAM. They find the opposite for CAM disclosures involving categorical determinations (more precision).

Our study continues this line of inquiry but uses our unique setting to investigate whether accounting standards influence the disclosure of KAM or CAM and the nature of those disclosures. IFRS is more principles-based, while U.S. GAAP is more rules-based (i.e., more bright-line thresholds, scope exceptions, implementation guidance, and details).[10] Thus broad agreement exists that IFRS permits more discretion than U.S. GAAP (Hail, Leuz, and Wysocki 2010). Therefore reporting under IFRS requires more judgment and estimates, which in turn

[10] See Table 1 Panel B on p. 1257 of Donelson, McInnis, and Mergenthaler (2012) for a detailed comparison of the principles-based versus rules-based nature of IFRS and U.S. GAAP.

should require auditors to make more judgments than under U.S. GAAP. This leads to our second hypothesis in alternative form.

H2: *Ceteris paribus, auditors will report more audit matters for IFRS than U.S. GAAP.*

We hypothesize that audit matters may differ for firms that report under different accounting standards. For example, IFRS permits capitalization of internal R&D more broadly than U.S. GAAP. The choice of whether to capitalize R&D or expense it as incurred involves discretion. Nevertheless, we expect that auditing is easier when R&D is expensed as incurred, since this accounting treatment likely involves less discretion once chosen. Similarly, contingencies are treated differently when probable. IFRS defines probable to mean more likely than not, implying a 50% probability threshold. In contrast, probable has a higher implied probability threshold in U.S. GAAP. As a result, more contingencies may be recognized rather than disclosed under IFRS relative to U.S. GAAP. Ceteris paribus, auditors would therefore have different accruals to consider when doing the audit, depending on the choice of accounting standard. We test this hypothesis in a unique setting where we can hold fixed all underlying transactions.

Audit matter reporting requires a description of the audit matter as well as the auditor's response detailing the auditors' actions to address the audit matter. The rules-based nature of U.S. GAAP (more detailed and precise standards) suggests that the auditor's description of the audit matter will be more detailed under U.S. GAAP than IFRS. The rules-based nature of U.S. GAAP, however, is likely to make auditing U.S. GAAP financial statements more straightforward than IFRS where auditors will likely need to apply more judgment in applying IFRS to the underlying transactions and determining appropriate audit tests for accounting standards that are less precise. This leads to our third hypotheses in alternative forms.

H3a: *Ceteris paribus, the audit matter description will be more detailed for U.S. GAAP than IFRS.*

H3b: *Ceteris paribus, the audit matter response will be more detailed for IFRS than U.S. GAAP.*

4. Sample and Research Design

Our initial sample focuses on twin audit matter firms that report using IFRS in the EU and U.S. GAAP in the U.S. (IFRS-USGAAP firms). To identify this sample, we start with all EU-domiciled firms that filed annual reports with the SEC at least once from 2019 through 2022. We focus on this period because CAM disclosures became required for large accelerated filers and accelerated filers. KAM disclosures became required in the EU for fiscal years ending December 15, 2016, and onward. We require that firms in our sample disclose both KAMs and CAMs for the same fiscal year, and our sample period therefore starts in 2019. We then manually verify the basis of preparation for these firms and keep in our sample those that file financial statements prepared in accordance with U.S. GAAP. Next, we search for financial statements prepared in

accordance with IFRS for the same firms, which they report to their European securities regulator.[11] We exclude firms from two regulated industries, banking and utilities.

To ensure that the consolidated entity remains unchanged across the two accounting standards, we check for differences in cash and cash equivalent balance under IFRS and U.S. GAAP.[12] We remove firms with unequal balances across accounting standards. Our final sample of twin audit matter firms reporting under different standards consists of 85 firm-year observations from 31 firms. The 85 firm-year observations consist of 171 KAMs and 120 CAMs (See Table 3). Table 1 summarizes our sample selection criteria. Note that the number of firms and firm-year observations are identical under U.S. GAAP and IFRS since we collect data on firms that each year simultaneously disclose under both accounting standards.

For this sample, we hand collect all variables related to KAMs and CAMs as well as all accounting variables from IFRS filings. We use Compustat North America to obtain accounting variables for U.S. GAAP filings, which we supplement with hand collection when missing. To ensure any observed difference between IFRS and U.S. GAAP is not caused by a data errors, we verify the financial accounting data from Compustat with SEC filings.

Table 2 presents the descriptive statistics for audit matters, along with accounting variables. Two observations are in order. First, the number of audit matters under IFRS (KAMs) is on average 43% higher than the number of audit matters under U.S. GAAP (CAMs) within a firm-year and the difference is statistically significant ($Z = 5.58$, p-value = 0.00).[13] This supports rejecting the null hypothesis in H1. Second, the difference in the cash balance under IFRS and U.S. GAAP within a firm-year is statistically insignificant ($Z = -0.62$, p-value = 0.44). Theoretically, we should not be able to calculate the sign rank test statistic for cash balance given that firms in the IFRS-USGAAP sample were required to have the same cash balance within each firm-year observation. However, we can compute the statistic because 71 firm-year observations have the same cash balance, while the remaining firm-year observations have a small difference in cash balance due to currency conversion.[14] This in turn affects the calculation of the test

[11] First, we inspected the audit report in the financial statements filed with the SEC to verify that all firms in our sample report using U.S. GAAP. Second, we require that our sample firms be domiciled in the EU, file a separate annual report to an EU securities regulator where its audit report confirms that the consolidated financial statements are prepared using IFRS. In this paper, IFRS refers to IFRS as endorsed by the EU, with the exception that, post-Brexit, UK firms instead use the label "international accounting standards" or "endorsed IFRS."

[12] Cash and cash equivalent balance does not have any accrual component and therefore is largely unaffected by accounting standard choice. However, the balance for cash and cash equivalent must be the same provided the underlying consolidated entity is the same across accounting standards. Further, we include firms with cash equivalents and restricted cash if these items are of the same magnitude but merely classified differently under IFRS and U.S. GAAP.

[13] We use the Wilcoxon signed rank test, which is a nonparametric statistical hypothesis test and does not require any assumptions about the distribution of the data. Moreover, the Wilcoxon test is more powerful in small samples, where the asymptotic normality assumption may not hold. Nevertheless, our results are qualitatively similar when we use the paired Student's t-test. The Wilcoxon signed rank is used in all our tests for differences across paired observations unless otherwise specified.

[14] We add error with our currency conversion required because presentation currency may vary with the accounting standard.

statistic. Nevertheless, the underlying consolidated entity across the two accounting standards is the same within each firm-year by construction.[15]

5. Empirical Results

5.1 IFRS-USGAAP Sample: Comparison of the number of audit matters

Table 3 Panel A presents the number of KAMs and CAMs for our 85 firm-year observations from the IFRS-USGAAP sample. Consistent with the result in Table 2, we observe that the number of KAMs exceeds the number of CAMs. The number of KAMs is dramatically higher than the number of CAMs; the number of KAMs is 171, which is 43% higher than the number of CAMs at 120. This supports the rejection of the null in H1.

Panel B of Table 3 presents a comparison of the number of KAMs versus the number of CAMs for the same firm year.[16] The diagonal reveals that 43 firm-year observations, 51%, have the same number of audit matters across IFRS and U.S. GAAP filings, while the remaining 42 firm-year observations (i.e., 49%) report a different number of audit matters.[17] The number of CAMs exceeds the number of KAMs (observations above the diagonal) only three times, whereas the number of KAMs exceeds the number of CAMs (observations below the diagonal) 39 times (93% of differences). Panel B supports the rejection of the null in H1.

5.2 IFRS-USGAAP Sample: Comparison of the audit matter topics

Table 4 presents the audit matter subject classifications. We manually classify our audit matters into different topics following Burke et al. (2023). The classification with the most audit matters across IFRS and U.S. GAAP filings is revenue from customer contracts (KAMs 37, CAMs 22) with significantly more KAMs than CAMs. Goodwill is an audit matter for 20 firm-years for KAMs and 23 firm-years for CAMs. The number of KAMs related to accounting topics is 153, while the number of CAMs related to accounting topics is 22% lower at 120. This again supports the rejection of the null in H1. Another stark difference between KAMs and CAMs is that 18 KAMs relate to non-accounting topics in contrast to zero CAMs. Table 4 Panel B presents the frequency with which a KAM topic in the IFRS filing coincides with a CAM topic in the U.S. GAAP filing for the same firm-year observation. That is, an audit matter is classified as coinciding when both KAM and CAM identify the same audit issue in the same firm-year observation (e.g., goodwill is identified both as KAM and as CAM). Seventy-four firm-year observations have either one or two coinciding audit matter topics. In total, 107 (62%) audit matters coincide between KAMs and CAMs, while 64 (38%) differ.

[15] Within each firm-year observation, the audit firms are the same for 82 out of 85 firm-year observations. All results are robust to eliminating these three firm-year observations. Further, the audit office and audit engagement partner are the same for 20 out of 85 firm-year observations. Again we find qualitatively similar results for this subsample. Our ability to reject null hypotheses for surprisingly low sample sizes (20) arises from our research design choice of studying twin audit matter firms.

[16] The topics mentioned in their audit matters may differ, which we examine in Panel C of Table 4.

[17] Same number of KAMs and CAMs within each firm year observation does not imply the topic of the audit matters are the same across KAMs and CAMs. See Table 4 Panel B for details.

Panel C of Table 4 focuses on the latter group and reveals the audit matter classification for those 64 audit matter topics that appear as either a KAM or CAM but not both. Revenue-related differences stand out as the main difference with 16 of the 64 differences (25%) exhibiting a KAM related to revenues under IFRS that is not reported as a CAM under U.S. GAAP. The difference in deferred and capitalized costs is the second largest difference related to an accounting topic with nine of the 61 differences (14%). Of the 64 differences in audit matters between KAMs and CAMs, 46 (72%) relate to accounting topics, while 18 (38%) do not. Of the 46 related to accounting topics, 31 (86%) are reported as a KAM but not as a CAM. This supports H2 that accounting standards influence audit matter reporting and is consistent with increased measurement uncertainty under IFRS requiring more auditor judgment.

5.3 IFRS-USGAAP Sample: Comparison of the characteristics of the audit matter disclosures

The 107 coinciding audit matter pairs presented in Table 4 Panel B permit us to test for differences in the characteristics of the information disclosed in KAMs and CAMs while holding the audit matter and the underlying transactions constant. We analyze the actual text of these audit matters.[18] Specifically, we examine the description and response sections by (i) counting the number of words, (ii) comparing the semantic similarity of the KAM and CAM texts, and (iii) extracting keywords from KAMs and CAMs.[19] The word count proxies for the level of detail, while the semantic similarity test and keyword extraction proxies for similarity between KAMs and CAMs. In all analyses, we apply common preprocessing techniques to convert raw text to processed text.[20]

[18] See Bochkay, Brown, Leone, and Tucker (2023) for a recent survey.

[19] We use Python's natural language toolKit (NLTK) library in our textual analysis, which is a popular open-source natural language processing package (documentation: https://www.nltk.org/). We calculate the similarity between texts of KAMs and CAMs using the Levenshtein library in Python (documentation: https://maxbachmann.github.io/Levenshtein/levenshtein.html). The Levenshtein distance calculates the minimum number of insertions, deletions, and substitutions required to change one sequence into the other according to Levenshtein with custom costs for insertion, deletion, and substitution. We calculate similarity using the ratio which returns the normalized between the range [0,1] where one (zero) indicates the two pieces of text are completely identical (different). We extract keywords from the texts using the Yet Another Keyword Extractor (YAKE) library in Python (documentation: https://github.com/LIAAD/yake). YAKE is a lightweight unsupervised keyword extraction method that relies on text statistical features extracted from single documents to identify the most important keywords of a text. YAKE does not need to be trained on a particular set of documents and is not dependent on dictionaries. We first extract five keywords from KAMs and CAMs. Next, we calculate the number of identical keywords between the two audit matters. The maximum (minimum) possible number of identical keywords is five (zero). The text of the audit matters is more (less) similar if they have a higher (lower) identical keyword count. Since we are applying the same analysis to both KAMs and CAMS within each firm for each year, our results are insensitive to the choice of analysis tool.

[20] We perform the following procedures to process the raw text:

(1) Tokenization breaks raw text into separate words (e.g., the sentence "I am an accountant" would be broken into "I," "am," "an," and "accountant").

(2) Removal of "stop words," which refer to words that may be essential in human communication but do not contribute to computerized language processing (e.g., "a", "an", and "the"; we use NLTK's English stop word list, as all our audit matters are in English, https://pythonspot.com/nltk-stop-words/).

(3) Normalization, specifically the lemmatization technique, instead of stemming, as the former retains more information (lemmatization reduces a word to its root form, also known as a lemma. For example, the verb "check" may appear as "check," "checking," or "checked").

(4) We join the processed text back into a sentence. Note that we manually coded audit matters as they are presented in the auditor's report, along with the correct punctuation marks to indicate the continuation or end of a sentence. However, our textual analysis is insensitive to punctuation marks.

Table 5 presents the results from our textual analysis of the IFRS-USGAAP firm sample. Panel A reports the results of word count analysis. For the description section of the audit matters, the word count is 8% lower for KAMs than CAMs in the raw texts (Z = -1.94, p-value = 0.05) and 10% lower for processed texts (Z = - 2.32, p-value = 0.02), consistent with U.S. GAAP being more detailed. For the response section of audit matters, the word count is 13% greater for KAMs than CAMs in the raw texts (Z = 3.46, p-value = 0.00) and 12% greater for processed texts (Z = 3.18, p-value = 0.00), consistent with auditors exercising more judgments in applying IFRS standards and designing appropriate audit tests of less precise standards. Taken together, the results from Table 5 Panel A support H3a and H3b and suggest that, for the same audit matter, holding underlying transactions constant, CAMs are more detailed (in terms of word count) in the description section, while KAMs are more detailed in the response section.

Table 5 Panel B reveals the results of text similarity analysis. We use the Levenshtein ratio to calculate the similarity between the texts of KAMs and CAMs. A ratio of one (zero) indicates that the two pieces of text are completely identical (different). The similarity ratio is calculated using texts of both KAM and CAM and hence we cannot compare differences. Instead, we test if the similarity score equals one (i.e. completely identical texts). We find that the Levenshtein ratio equals 0.70 (0.69) for raw (processed) text of the description section. The Levenshtein ratio equals 0.70 for both the raw and processed text of the response section. In all four scenarios, the Levenshtein ratio is statistically significantly different than one.

Table 5 Panel C reveals the results of keyword extraction analysis. We extract five keywords from both the description and response section of KAMs and CAMs. We then calculate the number of identical keywords between KAMs and CAMS. The maximum (minimum) possible number of identical keywords is five (zero). The text of the audit matters is more (less) similar if they have a higher (lower) identical keyword count. The number of identical keywords is calculated using texts of both KAM and CAM and hence we cannot compare differences. Instead, we test if the number of identical keywords score equals five (i.e. completely identical texts). We find that the number of identical keywords is two for both raw and processed texts of the description and response section, suggesting a 40% similarity. We also find that the number of identical keywords is statistically significantly different from five for both raw and processed texts of the description and response section.

In summary, our analysis of twin audit matter firms reporting under *different* accounting standards, U.S. GAAP and IFRS, exhibit substantial differences in the number of audit matters, audit matter topics, and textual characteristics. This provides convincing evidence in favor of rejecting the null of H1. The evidence is also consistent with accounting standards influencing audit matters where more precision under U.S. GAAP leads to more detailed descriptions of audit matters and more uncertainty under IFRS leads to more thorough response sections. However, the differences in KAMs and CAMs for this sample are the joint outcome of accounting standards and other factors, and further analysis using a difference-in-differences research design is necessary to better assess the influence of accounting standards on audit matters.

5.4 Twin audit matter firms reporting under the same accounting standard

To identify a matched sample of EU firms reporting under the *same* accounting standard (IFRS-IFRS sample), we start with all EU-domiciled firms that filed with the SEC using IFRS from 2019 to 2022. Since most EU-domiciled firms also have to report KAMs in the EU, there exists firms that report both KAMs for IFRS and CAMs for IFRS for the same underlying transactions in the same fiscal year.[21] Next, we obtain industry classification and total assets from Compustat North America. We then manually search for the IFRS filing to the EU securities regulator for the remaining firms to obtain auditor reports with KAMs for the same fiscal year. We also verify that financial statements in the SEC and EU filings are the same. We exclude firms with non-English auditor reports and financial statements with IFRS carve-outs. We use the remaining observations to match our twin audit matter firm-years with different accounting standards (IFRS-USGAAP sample) to twin audit matter firm-years reporting only under IFRS (IFRS-IFRS sample) using propensity scores.[22] Table 6 summarizes our sample selection criteria for the sensitivity analysis. Our sample of firms filing KAMs in the EU and CAMs in the U.S. while reporting using IFRS consists of 75 firm-year observations from 32 firms. The 75 firm-year observations consist of 163 KAMs and 141 CAMs (See Table 7). Any differences in audit matters in this sample arise from audit standards and other factors that may affect KAMs and CAMs, but *not* accounting standards.

5.4.1 IFRS-IFRS Sample: Comparison of the number of audit matters

Table 7 Panel A presents the number of KAMs and CAMs for the 75 firm-year observations where the accounting standard is held constant as IFRS. The number of KAMs exceeds the number of CAMs by 16%. This supports rejecting the null of H1. Differences in auditing standards, enforcement, litigation risk, and other factors affect the audit matter disclosures. Panel B of Table 7 again presents the number of KAMs and CAMs. The diagonal suggests that 58 firm-year observations (i.e., 77%) have an equal number of KAMs and CAMs, while 17 firm-year observations (i.e., 23%) have a different number of KAMs and CAMs. The number of KAMs exceeds CAMs (observations below the diagonal) in all these 17 firm-year observations. That is, all of the differences between KAMs and CAMs are from more extensive KAM disclosure.

[21] For example, Nobes and Stadler (2023) note that EU 4th directive exempts firms listed on a non-EU regulated stock exchange from applying IFRS for their consolidated financial statements. Therefore these firms may not have KAMs in their auditor report.

[22] We use one-to-one propensity score matching. We restrict our matches to those that match exactly on fiscal year and two-digit GIC industry classification. We do not match exactly based on country following the recommendation of Ecker, Francis, Olson, and Schipper (2013). The propensity scores are calculated based on total assets (in US dollars). Since our IFRS-IFRS firms prepare their consolidated financial statements in accordance with IFRS, we use the value of total assets (in US dollars) from the IFRS filings of our twin firms to ensure consistency. We use one nearest neighbor matching *without* replacement. To ensure the matching is as close as possible, we also restrict the range of observations that are treated as potential matches to be within the common range of propensity scores.

5.4.2 IFRS-IFRS Sample: Comparison of the audit matter topics

Table 8 Panel A presents the audit matter topics. The two most frequent audit matters for both KAMs and CAMs are revenue from customer contracts and goodwill. Table 8 Panel B reveals that all 141 CAMs coincide with a KAM. That is, all CAMs are also reported as KAMs. Not surprisingly then, Panel C of Table 8 reveals that the 23 audit matters that do not coincide are all KAMs that are not reported as CAMs.

5.4.3 IFRS-IFRS Sample: Comparison of the characteristics of the audit matter disclosures

The twin audit matter sample reporting under the same accounting standard provides us with 140 pairs of coinciding audit matters that we can analyze, holding fixed all underlying transactions and the accounting standards (IFRS).[23] As with our IFRS-USGAAP sample, we analyze the actual text of the audit matters. If auditors engage in boilerplate-type disclosures, a strong expectation would be that the audit matter disclosures would be nearly identical.

Table 9 presents the results from our textual analysis of the IFRS-IFRS sample. Panel A reveals the results of word count analysis. For the description section of the audit matters, the word count is 10% lower for KAMs than CAMs in the raw texts ($Z = -2.19$, p-value = 0.03) and 11% lower for processed text ($Z = -2.57$, p-value = 0.01). For the response section, the word count is 8% greater for KAMs than CAMs in the raw ($Z = 3.36$, p-value = 0.00) and 5% for the processed text ($Z = 2.72$, p-value = 0.01). Taken together, the results suggest that CAMs are more detailed in the description section, whereas KAMs are more detailed in the response section.

Table 9 Panel B reveals our results of text similarity analysis. We use the Levenshtein ratio to calculate the similarity between the texts of KAMs and CAMs. A ratio of one (zero) indicates that the two pieces of text are completely identical (different). The similarity ratio is calculated using texts of both KAM and CAM and hence we cannot compare differences. Instead, we test if the similarity score equals one (i.e. completely identical texts). The Levenshtein ratio equals 0.76 for both raw and processed text of the description sections of KAMs and CAMs. The Levenshtein ratio equals 0.81 for both raw and processed text of the response sections of KAMs and CAMs. We also find that all Levenshtein ratios are statistically significantly different from one.

Table 9 Panel C reveals the results of keyword extraction analysis. We extract five keywords from both KAMs and CAMs. We then calculate the number of identical keywords between KAMs and CAMS. The maximum (minimum) possible number of identical keywords is five (zero). The text of the audit matters is more (less) similar if they have a higher (lower) identical keyword count. The number of identical keywords is calculated using texts of both KAM and CAM and hence we cannot compare differences. Instead, we test if the number of identical keywords score equals five (i.e. completely identical texts). The number of identical keywords equals three for both the raw and processed text of the description sections of KAMs and CAMs. The number of identical keywords equals three for both raw and processed text of the response

[23] For our textual analysis, 140 pairs of audit matters (not 141) are available for analysis from 75 firm-year observations because the KAM does not provide a description or a response section for one firm-year observation.

sections of KAMs and CAMs, suggesting a 60% similarity. We find that all numbers of identical keywords are statistically significantly different five.

Collectively, the analysis of twin audit matter firms in Tables 7–9, where the accounting standard (IFRS) is held constant while the auditing standard (and other factors) varies, provides evidence consistent with auditing standards (and other factors) affecting the number, topic, and textual characteristics of audit matters. Auditors do not merely copy the audit matter disclosures even when the audit matter topic is the same. This is inconsistent with auditors engaging in boilerplate-type disclosure and overall supports rejecting the null of H1. This also raises the possibility that the differences documented for our twin audit matter firms that report under different standards (IFRS-USGAAP sample) are not due to accounting standards. To address this concern, we perform a difference-in-differences analysis to isolate the effect of accounting standards on audit matters.

5.5 Difference-in-differences analysis

The primary difference between the two sets of audit matter twin firms is that one reports under two accounting standards and the other does not, which permits us to do a difference-in-differences analysis to better isolate the effects of accounting standards on audit matter disclosures.

Table 10 presents the difference-in-differences results for the average number of audit matters. The IFRS-USGAAP (IFRS-IFRS) sample has on average two (two) KAMs. The difference in the average number of KAMs is statistically insignificant (Z = -0.81, p-value = 0.43). The IFRS-USGAAP (IFRS-IFRS) firm sample has on average one (two) CAMs. The difference in the average number of CAMs is statistically significant (Z = -3.40, p-value = 0.00). The last row captures the difference in the differences in the number of KAMs and CAMs. We test and find that the difference-in-differences is statistically significant (Z = 2.26, p-value = 0.02).[24] This provides evidence in support of H2.

Table 11 presents the difference-in-differences results from textual analysis. The total number of observations is 69 (instead of 75) because two (three) firm-year observations from the IFRS-USGAAP (IFRS-IFRS) firm sample have zero pairs of coinciding audit matters and one firm-year observation from the Same firm sample has no description and response sections for KAMs.

Table 11 Panel A reveals the results from word count analysis. The average word count difference is calculated as the average word count of KAMs minus the average word count of CAMs for each pair of coinciding audit matters within a firm-year observation. For the description

[24] Alternatively, we find that the IFRS-USGAAP firm sample has on average 2.56 pairs of coinciding audit matter topics, while the IFRS-IFRS firm sample has 3.72 pairs of coinciding audit matter topics. The difference in the average number of coinciding audit matter topics is statistically significant (Z = -4.07, p-value = 0.00). As a measure of the frequency of non-coinciding audit matters, we test and find that the difference between (i) the highest number of audit matters (i.e., the maximum number of KAMs and CAMs for each firm-year) and (ii) the number of coinciding audit matters is statistically significantly greater for IFRS-USGAAP firms than for IFRS-IFRS firms (Z = 3.32, p-value = 0.00).

section, the word count in KAMs is less than in CAMs for both the IFRS-USGAAP firm sample and the IFRS-IFRS firm sample. However, we fail to find a statistically significant difference-in-differences and fail to find support for H3a. For the response section, the word count in KAMs is greater than in CAMs for both the IFRS-USGAAP firm sample and the IFRS-IFRS sample. The difference-in-differences is statistically significant only for processed text (Z = 1.78, p-value = 0.08).

Table 11 Panel B presents the results of the text similarity analysis. We use the Levenshtein ratio to calculate the similarity between the texts of KAMs and CAMs. A ratio of one (zero) indicates that the two pieces of text are completely identical (different). For the description section of the audit matters, the Levenshtein ratio is lower for IFRS-USGAAP sample firms than IFRS-IFRS sample firms in the raw texts (Z = -2.48, p-value = 0.01) and processed text (Z = -2.54, p-value = 0.01). For the response section of the audit matters, the Levenshtein ratio is also lower for IFRS-USGAAP sample firms than IFRS-IFRS sample firms in the raw texts (Z = -3.69, p-value = 0.00) and the processed text (Z = -3.77, p-value = 0.00). With a ratio of 1.0 indicating perfect similarly, the differences in similarity suggest that the audit matter disclosures in the IFRS-USGAAP sample are approximately 50% more *dissimilar* than the audit matter disclosures in the IFRS-IFRS sample.

Table 11 Panel C reveals the results from keyword extraction analysis. We extract five keywords from both KAMs and CAMs. We then calculate the number of identical keywords between KAMs and CAMS. The maximum (minimum) possible number of identical keywords is five (zero). The text of the audit matters is more (less) similar if they have a higher (lower) identical keyword count. For the description section of the audit matters, the number of identical keywords is lower for IFRS-USGAAP sample firms than IFRS-IFRS sample firms in the raw texts (Z = -3.15, p-value = 0.00) and processed text (Z = - 2.85, p-value = 0.00). For the response section of the audit matters, the number of identical keywords is also lower for IFRS-USGAAP sample firms than IFRS-IFRS sample firms in the raw texts (Z = 3.26, p-value = 0.00) and the processed text (Z = -3.57, p-value = 0.00). The IFRS-USGAAP sample firms exhibit 40% similarity in keywords compared to IFRS-IFRS sample firms which exhibit 60% similarity in keywords.

Taken together, Table 11 suggests that the length (a proxy for detail) of audit matters does not differ between the IFRS-USGAAP firm sample and the IFRS-IFRS firm sample. However, the text (for both sections of the audit matters, and both raw and processed text) of KAMs and CAMs are more similar for the IFRS-IFRS firm sample compared with the IFRS-USGAAP firm sample. This magnitude of the differences suggests a strong influence of accounting standards on audit matters disclosures consistent with the experimental evidence from Kachelmeier et al. (2020).

6. Conclusion

We identify a novel sample of European twin audit matter firms that prepare and publicly disclose two separate audit matter disclosures (KAMs and CAMs) for the same fiscal year. Some of these firms report under two different accounting standards, IFRS for KAMs and U.S. GAAP for CAMs, while others report only under IFRS. For both sets of firms, we compare and contrast the KAMs and CAMs reported for the same fiscal year. For firms reporting under different accounting standards, we find that the number of KAMs under IFRS exceeds the number of CAMs under U.S. GAAP. Further, we classify the audit matter topics under both IFRS and U.S. GAAP and document that they differ. Even when the audit matter is the same, textual analysis reveals differences consistent with the uncertainty and lack of precision of in IFRS relative to U.S. GAAP influencing the audit matter disclosures. Collectively, these results support the idea that accounting standards affect audit matter disclosures after controlling for the underlying transactions. For firms reporting under the same accounting standard, IFRS, we find that KAMs and CAMs differ in the number of audit matters, the topics, and exhibit textual differences. Importantly, the number of KAMs exceeds the number of CAMs, and all CAMs are also always reported as KAMs.

To better isolate the influence of accounting standards on audit matter disclosure, we perform a difference-in-differences analysis comparing the two sets of firms. We document differences in audit matter topics (comparing KAMs and CAMs) between twin audit matter firms with two financial statements reporting under different accounting standards (IFRS and U.S. GAAP) and twin audit matter firms that exclusively file IFRS.[25] This supports the idea that accounting standards impact audit matter disclosures in our twin audit matter firms.

Future research could investigate the effect of audit matter disclosures on audit fees. First, one could investigate whether audit fees increase from 2018 to 2019 for twin audit matter firms that disclosed two financial statements (IFRS and U.S. GAAP) but only KAMs in 2018 and then began disclosing CAMs the following year in 2019. As a benchmark, one could use the change in audit fees from 2017 to 2018 or from 2019 to 2020. Relative to this benchmark, increased audit fee changes are therefore likely attributable to the introduction of CAMs. Second, future research could compare the difference in audit fees between firms that report under IFRS and U.S. GAAP to firms that report only under IFRS as a measure of the differential effect of two audit matters from (i) reporting financial statements based on two accounting standards compared to (ii) reporting exclusively under IFRS.

[25] An alternative benchmark might be EU-domiciled firms that report a single set of financial statements using U.S. GAAP but with two separate audit reports with KAMs in EU filings and CAMs in the US SEC filings. See James Hardie plc in 2021 as an example. We acknowledge our benchmark firms may be biased in their reporting of KAMs and CAMs because they exclusively report using IFRS. For example, KAMs under IFRS might allow auditors to more easily present the underlying risks of material misstatement due to their experience.

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Table 1: IFRS-USGAAP Firm Sample Selection Criteria

Table 1 presents our sample selection criteria for our sample of firms that report under both accounting standards – IFRS and U.S. GAAP. Our initial sample consists of EU-domiciled firms in industries that publish twin consolidated financial statements for the fiscal year at least once between 2019 and 2022 and omit firms from two regulated industries, banks and utilities. That is, our initial sample consists of firms that file with the SEC using U.S. GAAP while they file consolidated financial statements using IFRS to their European securities regulator. Next, we exclude observations without both KAM and CAM auditor report available, which occurs for the fiscal year 2019 as accelerated filers were not required to disclose CAMs until fiscal year 2020. We then check the balance sheet for cash and cash equivalents differences under IFRS and U.S. GAAP. We exclude firms with unequal balances across accounting standards (after correcting for differences in reporting currency) as these firms do not have the same underlying consolidated entity in their IFRS and U.S. GAAP filings. We present the number of firms and firm-year observations for both accounting standards. Note that the number of observations are the same by construction since we have a sample each IFRS filing must have a corresponding U.S. GAAP filing for the same fiscal year. The 85 firm-year observations consist of 171 KAMs and 120 CAMs (See Table 3).

	IFRS		U.S. GAAP	
Criteria	Firm	Firm-Year	Firm	Firm-Year
Non-regulated firms that published twin consolidated financial statements for fiscal years between 2019 and 2022	41	113	41	113
Less: Firms without both KAM and CAM auditor report available	-8	-12	-8	-12
Less: Firms without matching balances of cash and cash equivalents across accounting standards	-2	-16	-2	-16
IFRS-USGAAP firm sample	**31**	**85**	**31**	**85**

Table 2: Descriptive Statistics for the IFRS-USGAAP Firm Sample

Table 2 presents the descriptive statistics for audit matters, along with accounting variables for our sample of firms that report under both IFRS and U.S. GAAP. The "IFRS" and "U.S. GAAP" columns present the statistics for IFRS and U.S. GAAP information, respectively. Therefore, "Audit Matters" under the "IFRS" and "U.S. GAAP" columns refer to Key Audit Matters (KAMs) and Critical Audit Matters (CAMs), respectively. We test for differences across the two accounting standards using the Wilcoxon signed-rank test and present Z-scores and their corresponding p-values in the last two columns.

	IFRS				U.S. GAAP				Signed-rank test	
Variables	Obs.	Mean	Median	SD	Obs.	Mean	Median	SD	Z	p-value
Audit Matters	85	2.0	2.0	1.1	85	1.4	1.0	0.7	5.58	**0.00**
Cash	85	1,424	590	2,141	85	1,425	590	2,141	-0.62	0.44
PPE (Net)	85	1,478	195	2,380	85	1,487	350	2,398	-1.48	0.14
Total Assets	85	11,494	5,264	14,696	85	10,858	5,236	13,918	4.36	**0.00**
Total Liabilities	85	7,393	2,801	10,559	85	7,289	2,252	10,534	5.76	**0.00**
Total Shareholders' Equity	85	4,058	1,607	5,479	85	3,805	1,618	5,081	1.65	0.10
Revenue	85	5,078	2,212	6,591	85	5,046	2,212	6,390	1.46	0.15
Net Income	85	721	17	2,432	85	702	14	2,331	-0.41	0.69
Operating Cash Flow	85	1,271	439	2,237	85	1,133	352	2,071	6.57	**0.00**

Table 3: Audit Matter Distribution for the IFRS-USGAAP Firm Sample

Table 3 presents the distribution of audit matters for our sample of firms that report under both IFRS and U.S. GAAP. For each firm-year observation, we document the number of KAMs and CAMs. Panel A reveals the number of audit matters in IFRS filings and U.S. GAAP filings. Panel B elaborates on the number of audit matters, where the diagonal represents the number of observations with an equal number of KAMs and CAMs. Note an equal number of audit matters does not necessarily correspond to coinciding audit matter topics.

Panel A: Comparison of the Number of Audit Matters between IFRS and U.S. GAAP

	IFRS		U.S. GAAP	
Number of Audit Matters	Firm-Year Obs.	KAMs	Firm-Year Obs.	CAMs
0	0	0	2	0
1	37	37	54	54
2	23	46	21	42
3	14	42	8	24
4	9	36	0	0
5	2	10	0	0
Total	**85**	**171**	**85**	**120**

Panel B: Comparison of the Number of Audit Matters within Each Firm-Year

		Number of CAMs						
		0	1	2	3	4	5	**Total KAMs**
Number of KAMs	0	***0***	0	0	0	0	0	**0**
	1	2	***33***	2	0	0	0	**37**
	2	0	14	***8***	1	0	0	**23**
	3	0	3	9	***2***	0	0	**14**
	4	0	4	2	3	***0***	0	**9**
	5	0	0	0	2	0	***0***	**2**
	Total CAMs	**2**	**54**	**21**	**8**	**0**	**0**	**85**

Table 4: Audit Matter Topics of IFRS-USGAAP Firm Sample

Table 4 presents the audit matter topics in our sample of firms that report under both IFRS and U.S. GAAP. Panel A presents the distribution of topics for both KAMs and CAMs. We follow Burke et al. (2023) and classify audit matters into topics. We supplement their list of topics by creating a topic for audit matters that appear several times but could not be included in any existing category (e.g. COVID-19). Panel B presents the distribution of audit matters that coincide across IFRS filings and U.S. GAAP filings. An audit matter pair is classified as coinciding if KAM and CAM have the same topic within a firm-year observation. The 96 coinciding audit matters permit us to conduct textual analysis of the actual text of the audit matters. Panel C presents the distribution of topics for those audit matters that did not have a coinciding audit matter within a firm-year observation. The topic classification is the same as in Panel A.

Panel A: Audit Matter Topics

	KAMs		CAMs	
Topic	Obs.	%	Obs.	%
Accounting Topics				
Business combinations	4	2%	4	3%
Other contingent liabilities	2	1%	3	3%
Deferred and capitalized costs	16	9%	7	6%
Goodwill	***20***	***12%***	***23***	***19%***
Other intangible assets	9	5%	9	8%
Other income taxes	4	2%	1	1%
Deferred income taxes	9	5%	9	8%
Uncertain tax positions	13	8%	12	10%
Other revenue	4	2%	0	0%
Property, plant, and equipment	3	2%	2	2%
Revenue from customer contracts	***37***	***22%***	***22***	***18%***
Sales return and allowances	6	4%	6	5%
Equity investments and joint ventures	3	2%	2	2%
Leases	2	1%	1	1%
Long-lived assets	0	0%	4	3%
Others	21	2%	15	3%
Accounting Topics	153	77%	120	100%
Non-Accounting Topics				
Brexit	1	1%	0	0%
COVID - 19	10	6%	0	0%
U.S. GAAP to IFRS Conversion	4	2%	0	0%
Going Concern	3	2%	0	0%
Non-Accounting Topics	18	23%	0	0%
All Topics	**171**	**100%**	**120**	**100%**

Panel B: Number of Coinciding Audit Matters

	IFRS		USGAAP	
Coinciding Pairs of Audit Matters	Obs.	KAMs	Obs.	CAMs
0	6	0	6	0
1	56	56	56	56
2	18	36	18	36
3	5	15	5	15
Total	**85**	**107**	**85**	**107**

Panel C: Non-coinciding Audit Matter Topics

	KAMs		CAMs	
Topic	Obs.	%	Obs.	%
Accounting Topics				
Other contingent liabilities	1	2%	2	15%
Deferred and capitalized costs	***9***	***14%***	***0***	***0%***
Goodwill	0	0%	3	23%
Other income taxes	3	5%	0	0%
Uncertain tax positions	1	2%	0	0%
Other revenue	4	6%	0	0%
Property, plant and equipment	1	2%	0	0%
Revenue from customer contracts	***16***	***25%***	***1***	***8%***
Equity investments and joint ventures	1	2%	0	0%
Leases	1	2%	0	0%
Long-lived assets	0	0%	4	31%
Others	9	14%	3	23%
Non-Accounting Topics				
Brexit	1	2%	0	0%
COVID – 19	***10***	***16%***	***0***	***0%***
U.S. GAAP to IFRS Conversion	4	6%	0	0%
Going Concern	3	5%	0	0%
All Topics	**64**	**100%**	**13**	**100%**

Table 5: Textual Analysis of IFRS-USGAAP Firm Sample

Table 5 presents the results from the textual analysis for our sample of firms that report under both IFRS and U.S. GAAP. Our sample is the 107 coinciding audit matters presented in Panel B of Table 4. We perform textual analysis on the description and on the response section of each audit matter. For both sections of the audit matters, we perform analysis using the raw text as well as the processed text, which we obtain after applying common textual analysis preprocessing techniques. Panel A illustrates the results from our word count analysis. We count the number of words in both the description and the response section of each audit matter. The "Word Count" columns present the average word count for KAMs and CAMs. We then test differences in average word count across the two audit matters using the Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns. Panel B illustrates the results from our text similarity analysis. We calculate the similarity between KAMs and CAMs using the Levenshtein ratio, where a ratio of one (zero) indicates the two pieces of text are completely identical (different). The "Ratio" column presents the average Levenshtein ratio. We test if the Levenshtein ratio equals one (i.e. completely identical) using the single-sample Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns. Panel C illustrates the results from our keyword extraction analysis. We first extract keywords from the text of the audit matters using YAKE. We set the maximum number of keywords to five. Next, for each pair of coinciding matters, we tabulate the number of identical keywords. The minimum (maximum) number of identical keywords is zero (five). The "Keywords" column presents the average number of identical keywords. We test if the number of identical keywords equals five (i.e. all keywords are identical) using the single-sample Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns.

Panel A: Word Count Analysis

		Word Count		Signed-rank test	
	Obs.	KAMs	CAMs	Z	p-value
Description - Raw	107	166	181	-1.94	**0.05**
Description - Processed	107	99	110	-2.32	**0.02**
Response - Raw	107	208	184	3.46	**0.00**
Response - Processed	107	125	112	3.18	**0.00**

Panel B: Text Similarity Analysis

			Signed-rank test	
	Obs.	Ratio	Z	p-value
Description - Raw	107	0.70	-8.98	**0.00**
Description - Processed	107	0.69	-8.98	**0.00**
Response - Raw	107	0.70	-8.98	**0.00**
Response - Processed	107	0.70	-8.98	**0.00**

Panel C: Keyword Extraction Analysis

			Signed-rank test	
	Obs.	Keywords	Z	p-value
Description - Raw	107	2	-8.99	**0.00**
Description - Processed	107	2	-8.96	**0.00**
Response - Raw	107	2	-9.03	**0.00**
Response - Processed	107	2	-8.99	**0.00**

Table 6: IFRS-IFRS Firm Sample Selection Criteria

Table 6 presents our sample selection criteria for our sample of firms that report under IFRS to both the EU and the U.S. SEC. Our initial sample consists of EU-domiciled firms that filed using IFRS with the U.S. SEC at least once for the fiscal year between 2019 and 2022. We then exclude firms without two separate auditor reports with KAMs and CAMs for their IFRS filings. Next, we exclude firms with non-English auditor reports to ensure consistency in our sample and we exclude firms that adopt IFRS with carve out(s). We then remove firm-year observations from regulated industries such as banks. We then obtain for the remaining firms the two-digit GIC industry classification and total assets using Compustat North America. We exclude firms with missing information on Compustat. Finally, we match (one-to-one without replacement) the remaining firm with our twin audit matter sample firms that reports under IFRS and U.S. GAAP using propensity scores. We present the number of firms and firm-year observations. Note that for each of the remaining 75 IFRS-IFRS firm-year observations, we can observe both KAMs and CAMs for the same fiscal year, while holding fixed all underlying transactions and accounting standard constant as IFRS. The 75 firm-year observations consist of 163 KAMs and 141 CAMs (See Table 7).

	Obs.	
Criteria	Firm	Firm-Year
EU-domiciled firms that filed with the U.S. SEC for fiscal years between 2019 through 2022	115	357
Less: Firms without both KAM and CAM auditor reports available	-29	-79
Less: Observations with non-English auditor reports	-2	-6
Less: Observations with IFRS carve out(s)	0	-2
Less: Observations from regulated industries	-6	-25
Less: Observations with missing industry classification or total assets on Compustat North America	-8	-15
Number of observations available for propensity score matching (PSM)	70	230
Less: Observations without a suitable match	-38	-155
IFRS-IFRS firm sample	**32**	**75**

Table 7: Audit Matter Distribution for the IFRS-IFRS Firm Sample

Table 7 presents the distribution of audit matters for our sample of firms that report under IFRS to both the EU and the U.S. SEC. For each IFRS-IFRS firm-year observation, we document the number of KAMs and CAMs. Panel A reveals the number of audit matters in auditor reports with KAMs and auditor reports with CAMs. Panel B elaborates on the number of audit matters, where the diagonal represents the number of observations with an equal number of KAMs and CAMs. Note an equal number of audit matters does not necessarily correspond to coinciding audit matter topics.

Panel A: Comparison of the Number of Audit Matters

	Auditor Report with KAMs		Auditor Report with CAMs	
Number of Audit Matters	Firm-Year	Obs.	Firm-Year	Obs.
1	26	26	30	30
2	26	52	31	62
3	12	36	8	24
4	9	36	5	20
5	0	0	1	5
6	1	6	0	0
7	1	7	0	0
Total	**75**	**163**	**75**	**141**

Panel B: Comparison of the Number of Audit Matters within Each Firm-Year

		Number of CAMs							
		1	2	3	4	5	6	7	**Total KAMs**
Number of KAMs	1	***26***	0	0	0	0	0	0	**26**
	2	3	***23***	0	0	0	0	0	**26**
	3	0	7	***5***	0	0	0	0	**12**
	4	1	1	3	***4***	0	0	0	**9**
	5	0	0	0	0	***0***	0	0	**0**
	6	0	0	0	1	0	***0***	0	**1**
	7	0	0	0	0	1	0	***0***	**1**
	Total CAMs	**30**	**31**	**8**	**5**	**1**	**0**	**0**	**75**

Table 8: Audit Matter Topics of IFRS-IFRS Firm Sample

Table 8 presents the audit matter topics in our sample of firms that report under IFRS to both the EU and the U.S. SEC. Panel A presents the distribution of topics for both KAMs and CAMs. We follow Burke et al. (2023) and classify audit matters into topics. We supplement their list of topics by creating a topic for audit matters that appear several times but could not be included in any existing category (e.g. COVID-19). Panel B reveals the distribution of audit matters that coincide across auditor reports with KAMs and auditor report reports with CAMs. An audit matter pair is classified as coinciding if KAM and CAM have the same topic within a IFRS-IFRS firm-year observation. 118 out of 119 coinciding audit matters permit us to conduct textual analysis of the actual text of the audit matters. The difference is due to one IFRS-IFRS firm year observation with no description and response section of KAM. Panel C presents the distribution of topics for those audit matters that did not have a coinciding audit matter within a IFRS-IFRS firm-year observation. The topic classification is the same as in Panel A.

Panel A: Audit Matter Topics

	KAMs		CAMs	
Topic	Obs.	%	Obs.	%
Accounting Topics				
Accounts/loans receivable	1	1%	1	1%
Business combinations	9	6%	8	6%
Other contingent liabilities	4	2%	4	3%
Depreciation and amortization	4	2%	4	3%
Goodwill	18	11%	17	12%
Goodwill and intangible assets	2	1%	2	1%
Other intangible assets	11	7%	11	8%
Deferred income taxes	4	2%	4	3%
Uncertain tax positions	13	8%	12	9%
Warranty liabilities	4	2%	4	3%
Other revenue	3	2%	0	0%
Property, plant, and equipment	7	4%	7	5%
Revenue from customer contracts	40	25%	31	22%
Sales return and allowances	6	4%	6	4%
Allowance for credit losses	4	2%	4	3%
Equity investments and joint ventures	3	2%	3	2%
Leases	1	1%	1	1%
Long-lived assets	5	3%	5	4%
Others	21	13%	15	11%
Accounting Topics	160	98%	139	99%
Non-Accounting Topics				
COVID – 19	1	1%	0	0%
Going Concern	2	1%	2	1%
Non-Accounting Topics	3	2%	2	1%
All Topics	**163**	**100%**	**141**	**100%**
All Topics	**163**	**100%**	**141**	**100%**

Hereof:				
Coinciding audit matter pairs (Panel B)	**141**	**87%**	**141**	**100%**
Audit matters that did not have a coinciding audit matter within a IFRS-USGAAP firm-year observation (Panel C)	**22**	**13%**	**0**	**0%**

Panel B: Coinciding Audit Matter Topics

	Auditor Reports with KAMs		Auditor Reports with CAMs	
Coinciding Pairs of Audit Matters	Obs.	KAMs	Obs.	CAMs
1	30	30	30	30
2	31	62	31	62
3	8	24	8	24
4	5	20	5	20
5	1	5	1	5
Total	**75**	**141**	**75**	**141**

Panel C: Non-coinciding Audit Matter Topics

	KAMs		CAMs	
Topic	Obs.	%	Obs.	%
Accounting Topics				
Business Combinations	1	5%	0	0%
Goodwill	1	5%	0	0%
Uncertain tax positions	1	5%	0	0%
Other revenue	3	14%	0	0%
Revenue from customer contracts	***9***	***41%***	***0***	***0%***
Others	6	27%	0	0%
Non-Accounting Topics				
COVID – 19	1	5%	0	0%
All Topics	**22**	**100%**	**0**	**0%**

Table 9: Textual Analysis of IFRS-IFRS Firm Sample

Table 9 presents the results from the textual analysis for our sample of firms that report under IFRS to both the EU and the U.S. SEC. Our sample is the 140 coinciding audit matters presented in Panel B of Table 9. We perform textual analysis on both the description and the response section of each audit matter. For both sections of the audit matters, we perform analysis using the raw text as well as the processed text, which we obtain after applying common textual analysis preprocessing techniques. Panel A illustrates the results from our word count analysis. We count the number of words in both the description and the response section of each audit matter. The "Word Count" columns present the average word count for KAMs and CAMs. We then test differences in average word count across the two audit matters using the Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns. Panel B illustrates the results from our text similarity analysis. We calculate the similarity between KAMs and CAMs using the Levenshtein ratio, where a ratio of one (zero) indicates the two pieces of text are completely identical (different). The "Ratio" column presents the average Levenshtein ratio. We test if the Levenshtein ratio equals one (i.e. completely identical) using the single-sample Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns. Panel C illustrates the results from our keyword extraction analysis. We first extract keywords from the text of the audit matters using YAKE. We set the maximum number of keywords to five. Next, for each pair of coinciding matters, we tabulate the number of identical keywords. The minimum (maximum) number of identical keywords is zero (five). The "Keywords" column presents the average number of identical keywords. We test if the number of identical keywords equals five (i.e. all keywords are identical) using the single-sample Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last two columns.

Panel A: Word Count Analysis

		Word Count		Signed-rank test	
	Obs.	KAMs	CAMs	Z	p-value
Description - Raw	140	187	208	-2.19	**0.03**
Description - Processed	140	111	124	-2.57	**0.01**
Response - Raw	140	199	184	3.36	**0.00**
Response - Processed	140	116	110	2.72	**0.01**

Panel B: Text Similarity Analysis

			Signed-rank test	
	Obs.	Ratio	Z	p-value
Description - Raw	140	0.76	-10.26	**0.00**
Description - Processed	104	0.76	-10.25	**0.00**
Response - Raw	140	0.81	-10.26	**0.00**
Response - Processed	140	0.81	-10.21	**0.00**

Panel C: Keyword Extraction Analysis

			Signed-rank test	
	Obs.	Keywords	Z	p-value
Description - Raw	140	3	-9.69	**0.00**
Description - Processed	140	3	-9.62	**0.00**
Response - Raw	140	3	-9.79	**0.00**
Response - Processed	140	3	-9.29	**0.00**

Table 10: Comparison of IFRS-USGAAP and IFRS-IFRS Sample Firms – Audit Matters

Table 10 presents the results from comparing differences in the number of coinciding audit matters for propensity score-matched (PSM) firm-year pairs of twin audit matter firms reporting under different accounting standards (IFRS-USGAAP sample) to those reporting under the same standard (IFRS-IFRS sample). Our sample is the 75 pairs of differences in coinciding audit matters based on Tables 7. The "Average" column presents the average number of the variable mentioned in the left column. We test for differences-in-differences (DD) in number of audit matters, that is, we compare IFRS-USGAAP and IFRS-IFRS sample firms' differences between KAMs and CAMs in (i) the highest number of audit matters (i.e., the maximum of the number of KAMs and CAMs for each firm-year) and (ii) the number of coinciding audit matters using Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last column. The last row represents the difference between (i) and (ii).

		Average		Signed-rank test	
	Obs.	IFRS-USGAAP	IFRS-IFRS	Z	p-value
Number of KAMs	75	2	2	-0.81	0.43
Number of CAMs	75	1	2	3.40	**0.00**
Difference between (i) and (ii)	75	1	0	2.26	**0.02**

Table 11: Comparison of IFRS-USGAAP and IFRS-IFRS Sample Firms – Textual Analysis

Table 11 presents the results from comparing differences in the textual analysis properties for propensity score-matched (PSM) firm-year pairs of twin audit matter firms reporting under different accounting standards (IFRS-USGAAP sample) to those reporting under the same standard (IFRS-IFRS sample). Our sample is the 69 pairs of differences in coinciding audit matters based on Panel B of Tables 4 and 9. We compare the differences in textual analysis properties of both the description and the response section of each audit matter. For both sections of the audit matters, we compare differences in textual properties of the raw text as well as the processed text, which we obtain after applying common textual analysis preprocessing techniques. Panel A illustrates our results for comparison of word count differences. The "Word count difference" column presents the difference in the average word count for KAMs and CAMs. We test for differences-in-differences (DD) in word count, that is, we compare IFRS-USGAAP and IFRS-IFRS sample firms' differences in the averages across their two audit matters using the Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last column. Panel B illustrates our results for comparison of textual analysis. We calculate the similarity between KAMs and CAMs using the Levenshtein ratio, where a ratio of one (zero) indicates the two pieces of text are completely identical (different). The "Similarity" column presents the average Levenshtein ratio for the IFRS-USGAAP and IFRS-IFRS sample firms. We then test for differences in the Levenshtein ratio across the two samples using the Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last column. We first extract keywords from the text of the audit matters using YAKE. We set the maximum number of keywords to five. Next, for each pair of coinciding matters, we tabulate the number of identical keywords. The minimum (maximum) number of identical keywords is zero (five). The "Keywords" column presents the average number of identical keywords for the IFRS-USGAAP and IFRS-IFRS sample firms.. We then test for differences in the average number of identical keywords across the two samples using the Wilcoxon signed-rank test and present the Z-scores and their corresponding p-values in the last column.

Panel A: Differences in Word Count

		Word count difference		Signed-rank test	
	Obs.	IFRS-USGAAP	IFRS-IFRS	Z	p-value
Description – Raw	69	-14	-14	-0.24	0.81
Description - Processed	69	-10	-10	-0.28	0.78
Response – Raw	69	33	16	1.44	0.15
Response - Processed	69	19	7	1.78	**0.08**

Panel B: Differences in Text Similarity

		Similarity		Signed-rank test	
	Obs.	IFRS-USGAAP	IFRS-IFRS	Z	p-value
Description – Raw	69	0.70	0.79	-2.48	**0.01**
Description - Processed	69	0.70	0.79	-2.54	**0.01**
Response – Raw	69	0.70	0.81	-3.69	**0.00**
Response - Processed	69	0.70	0.82	-3.77	**0.00**

Panel C: Differences in Keyword Extraction

		Keywords		Signed-rank test	
	Obs.	IFRS-USGAAP	IFRS-IFRS	Z	p-value
Description – Raw	69	2	3	-3.15	**0.00**
Description - Processed	69	2	3	-2.85	**0.00**
Response – Raw	69	2	3	-3.26	**0.00**
Response - Processed	69	2	3	-3.57	**0.00**

Appendix 1 – Illustration of KAM and CAM

We illustrate the difference (similarity) between KAMs and CAMs using Nokia Oyj (NYSE: NOK) as an example. Nokia Oyj is a renowned European telecommunications corporation with its headquarters and incorporation in Finland. Nokia Oyj is listed on NASDAQ Nordic and the New York Stock Exchange. As a result, Nokia Oyj files a form 20-F in accordance with IFRS to the U.S. SEC. Nokia Oyj is also required to file to its home country's securities regulator using IFRS, as NASDAQ Nordic is an EU-regulated stock exchange. Therefore, we observe both KAMs and CAMs for Nokia Oyj for the same fiscal year, holding accounting standards constant as IFRS.

In the 2021 EU filing, Nokia Oyj discloses one KAM – "Revenue Recognition – Accounting for significant and complex contracts". The KAM is separated into two parts. The first part describes and justifies the audit matter. The second part describes procedures taken by the auditor to address the audit matter.[44] In 2021 Form 20-F, Nokia Oyj discloses one CAM – "Revenue Recognition – Accounting for significant and complex contracts". The CAM is separated into two parts. The first part describes and justifies the audit matter. The second part describes procedures taken by the auditor to address the audit matter.

Two observations are in order. First, we would classify Nokia Oyj in 2021 as having one coinciding audit matter as the KAM and CAM are related to the same audit matter. Second, the actual texts of the KAMs and CAMs are uncannily similar.

[44] Some firms may have an additional part of KAM known as "Key Observations". This additional part describes the key observations the auditor made related to the audit matter. Some firms may include key observations in the response section of key audit matters instead. For CAMs, the key observation is seldom disclosed separately. Our results in word count are not sensitive to key observations of KAMs being disclosed separately as most KAMs do not have a separate key observation section. Moreover, the key observations section is usually no longer than one sentence.

Key audit matter	How our audit addressed the key audit matter
Revenue recognition – Accounting for significant and complex contracts *Refer to Notes 2 and 6 to the financial statements* The Company recognises revenue in accordance with International Financial Reporting Standard 15 *Revenue from Contracts with Customers* from contracts. A number of the contracts that the Company enters into are particularly significant in value, and contain highly complex terms and conditions which impact revenue recognition. Such complexities included the assessment of whether to combine two contracts entered into at similar times, accounting for modifications to existing contracts and accounting for contractual discounts. Given the level of complexity and management judgement involved in the accounting for significant and complex contracts, performing audit procedures to evaluate the reasonableness of these accounting judgements required a high degree of auditor judgement, and there was a significant audit effort in obtaining sufficient audit evidence. This matter is a significant risk of material misstatement referred to in EU Regulation No 537/2014, point (c) of Article 10(2).	Our audit procedures related to the determination of the appropriateness of the accounting for significant and complex contracts included the following, among others: ■ We assessed management's accounting policy in relation to the areas of complexity identified in all significant and complex contracts to determine compliance of the policy with IFRS 15; ■ We tested the operating effectiveness of controls over revenue recognition of significant and complex contracts, specifically focusing on controls relating to the areas of accounting complexity; ■ We utilised data analytics to identify those contracts with higher levels of risk based on size and complexity; ■ We analysed the terms and conditions of significant and complex contracts, and obtained and read the Company's accounting paper setting out management's accounting conclusions; ■ We met with senior management in the finance and operations teams relevant to the significant and complex contracts to make inquiries regarding commercial and financial considerations relating to those contracts; ■ We consulted with our revenue recognition accounting experts to assess the accounting for certain complex elements within these contracts; and ■ We assessed whether management's conclusions were in accordance with the terms and conditions of the contract and compliant with IFRS 15.

There are no significant risks of material misstatement referred to in EU regulation No 537/2014, point (c) of Article 10(2) relating to the parent company's financial statements.

Source: Nokia Oyj 2021 IFRS Filing in EU

Link to filing: https://www.nokia.com/system/files/2022-03/nokia-ar21-en.pdf

Revenue recognition - Accounting for significant and complex contracts — Refer to Notes 2 and 6 to the financial statements

Critical Audit Matter Description

The Company recognises revenue in accordance with International Financial Reporting Standard 15 *Revenue from Contracts with Customers from contracts.*

A number of the contracts that the Company enters into are particularly significant in value, and contain highly complex terms and conditions which impact revenue recognition.

Such complexities included the assessment of whether to combine two contracts entered into at similar times, accounting for modifications to existing contracts and accounting for contractual discounts.

Given the level of complexity and management judgement involved in the accounting for significant and complex contracts, performing audit procedures to evaluate the reasonableness of these accounting judgements required a high degree of auditor judgement, and there was a significant audit effort in obtaining sufficient audit evidence.

How the Critical Audit Matter Was Addressed in the Audit

Our audit procedures related to the determination of the appropriateness of the accounting for significant and complex contracts included the following, among others:

- We assessed management's accounting policy in relation to the areas of complexity identified in all significant and complex contracts to determine compliance of the policy with IFRS 15;

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- We tested the operating effectiveness of controls over revenue recognition of significant and complex contracts, specifically focusing on controls relating to the areas of accounting complexity;
- We utilised data analytics to identify those contracts with higher levels of risk based on size and complexity;
- We analysed the terms and conditions of significant and complex contracts, and obtained and read the Company's accounting paper setting out management's accounting conclusions;
- We met with senior management in the finance and operations teams relevant to the significant and complex contracts to make inquiries regarding commercial and financial considerations relating to those contracts;
- We consulted with our revenue recognition accounting experts to assess the accounting for certain complex elements within these contracts; and
- We assessed whether management's conclusions were in accordance with the terms and conditions of the contract and compliant with IFRS 15.

Source: Nokia Ojy 2021 IFRS Filing in Form 20-F

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