

ASSURING SUSTAINABILITY: THE ASSOCIATION BETWEEN INDEPENDENT
SUSTAINABILITY REPORTING ASSURANCE AND ENVIRONMENTAL
PERFORMANCE

by

JACQUELINE LI NING TAN

(Under the Direction of Frank L. Heflin)

ABSTRACT

Assurance of sustainability reports is increasingly common, and the Securities and Exchange Commission (SEC) will require assurance of certain sustainability disclosures in the next five years. I study the association between sustainability reporting assurance and future environmental outcomes. I find that, for higher-environmental-impact companies, sustainability reporting assurance is associated with lower future carbon emissions and fewer future environmental regulation violations. However, the association between sustainability reporting assurance and future environmental regulation violations is somewhat mixed, as I find higher future violations for lower-environmental-impact companies. I also examine sustainability reporting assurance by accounting firms (e.g., traditional audit firms) versus non-accounting firms. I find that assurance by accounting firms is associated with lower future carbon emissions for higher-environmental-impact companies. However, I find that accounting firm assurance is associated with fewer future environmental regulation violations only for lower-environmental-impact companies. Overall, my results are consistent with either assurance helping higher-environmental-impact companies improve environmental performance or higher-environmental-

impact companies using sustainability reporting assurance as part of a strategy to convey to stakeholders their efforts to improve environmental performance, particularly for future carbon emissions. My results are also weakly consistent with the assurance process provided by accounting firms differing from assurance provided by non-accounting firms, although the results are mixed.

INDEX WORDS: ESG; sustainability; corporate social responsibility; misconduct; carbon emissions; external assurance

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DEDICATION

To my family who have always believed in me and been in my corner through it all. To my friends who saw me through the ups-and-downs and for their unwavering moral support. To my dogs for their unconditional love. And to my younger self – you did it, kid!

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CHAPTER 1

INTRODUCTION

Companies increasingly choose to voluntarily disclose their sustainability information (Center for Audit Quality, 2024; Gipper et al., 2024; Rouen et al., 2024).¹ However, the voluntary nature of sustainability reporting in the U.S. raises concerns about the credibility of this type of information, especially in the absence of uniform reporting standards or mandatory disclosure requirements. While prior research has addressed various determinants and consequences of issuing and assuring sustainability reports (Ballou et al., 2018; Birkey et al., 2016; Casey & Grenier, 2015; Cho et al., 2014; Clarkson et al., 2019; Datt et al., 2019; Luo et al., 2023; Michelin et al., 2019; Peters & Romi, 2015; Simnett et al., 2009; Zhou et al., 2016), little research addresses whether sustainability reporting assurance is associated with improvements in future sustainability performance, particularly environmental performance.

I examine whether independently assuring sustainability reports is associated with future improvements in environmental performance. Studying the association between independent assurance and future environmental performance is important, in part, because of the growing regulatory focus on sustainability reporting assurance in the U.S. On March 6, 2024, the SEC adopted new rules (The Enhancement and Standardization of Climate-Related Disclosures for Investors, 2024) that require publicly registered companies to disclose material climate-related metrics and risks in their 10-K filings, starting in 2026. Large accelerated filers (i.e., companies

¹ The number of U.S.-based companies obtaining independent assurance for their sustainability reports has increased between 2010 and 2020, but this number still remains below the majority of U.S. companies and trails behind non-U.S.-based companies (Bakarich et al., 2023; Gipper et al., 2024).

with public float exceeding \$700 million) must also begin assuring certain disclosures by 2029, with the level of assurance increasing to reasonable assurance (i.e., to the same level of assurance as a financial statement audit) by 2033. I focus on environmental performance because of its growing importance as a regulatory issue, and its importance to various stakeholder groups, including equity investors.²

Independent assurance can be associated with better future environmental performance for at least two reasons: (1) companies may use assurance as a mechanism to more credibly signal their commitment to improve environmental performance, and (2) assurance may help companies improve environmental performance. Regarding credibility about environmental performance efforts, companies can use assurance to differentiate themselves from their peers and signal their commitment to sustainability-related activities (Bagnoli & Watts, 2017; Du & Wu, 2019; Gipper et al., 2024). Thus, companies that assure their sustainability reports could have better sustainability initiatives in place that predispose them to having better future environmental performance. Regarding help with improving environmental performance, assurance providers can identify areas for improvement in sustainability processes (Edgley et al., 2010; O'Dwyer, 2011; O'Dwyer & Owen, 2007, 2005). If companies leverage independent assurers' expertise and implement their assurance providers' suggestions for improvement, companies can improve their sustainability initiatives that then lead to better environmental performance.

Conversely, it is possible that independent assurance is not associated with future environmental performance because the sustainability reporting assurance process is still developing and assurance providers may not produce assurance reports that help companies

² Research suggests that environmental performance can signal desirable but otherwise unobservable company attributes that improve a company's market value (Kim et al., 2021), and equity investors indicate that they consider environmental factors in their investment decisions to reduce portfolio volatility and risk (Larcker et al., 2024).

improve environmental performance (Talbot & Boiral, 2018). Additionally, companies may use sustainability reporting assurance to boost public perception without real sustainability performance gains (Boiral et al., 2019; Gillet, 2012; Michelon et al., 2015; Talbot & Boiral, 2013).

I examine future environmental performance along two dimensions: (1) future carbon emissions, and (2) future environmental regulation violations. I examine future carbon emissions in light of recent U.S. legislation that mandates carbon emissions disclosures. Carbon emissions disclosures will be a critical tool in climate change mitigation and holding companies accountable in their emissions-reduction efforts (Aiuto et al., 2024) as the U.S. seeks to meet its aggressive emissions reduction targets (The White House Briefing Room, 2021). I examine environmental regulation violations because the monetary penalties associated with these violations reduce companies' market value (Karpoff et al., 2005) and can serve as an important regulatory tool.

I use a sample of publicly traded U.S. companies that issue at least one sustainability report between January 1, 2000, and December 31, 2023. I obtain data on sustainability reporting assurance from LSEG Refinitiv ("Refinitiv"). Refinitiv provides a comprehensive source of sustainability information by compiling data on companies worldwide from publicly available reports, disclosures, and proprietary sources. Refinitiv intends for its sustainability data to integrate with a company's financial statement data to allow platform users (e.g., investors, analysts, etc.) to incorporate sustainability metrics into financial analysis.

I consider the current environmental impact of a company's operations when examining the association between sustainability reporting assurance and future environmental performance. Companies whose operations have a higher environmental impact are more likely to assure their sustainability reports to increase report credibility (Cho et al., 2014; Simnett et al., 2009). Hence, higher-environmental-impact companies have different motivations from lower-environmental-

impact companies for obtaining independent assurance that may influence the association between sustainability reporting assurance and future environmental performance.

I find that sustainability reporting assurance is associated with lower future carbon emissions. This result is concentrated among higher-environmental-impact companies. Moreover, I find that sustainability reporting assurance is associated with fewer future environmental regulation violations, but only for higher-environmental-impact companies. These results are generally consistent with: (1) companies using sustainability reporting assurance to increase the credibility of their commitment to improving future environmental performance, or (2) assurance improving future environmental performance.

For lower-environmental-impact companies, I find a *positive* relation between sustainability reporting assurance and future environmental regulation violations. Lower-environmental-impact companies are less concerned with the credibility of their sustainability reports than their higher-environmental-impact counterparts (Cho et al., 2014; Simnett et al., 2009). Therefore, they may be less concerned about violations, particularly if the violations are minor. Additionally, it is possible that lower-environmental-impact companies have more recently developed an interest in better sustainability performance (perhaps due to a change in stakeholder demand) that motivates them to voluntarily initiate sustainability reporting assurance. To provide some evidence regarding this conjecture, I examine the length of assurance, defined as the number of years since a company first assures its sustainability report. I find that lower-environmental-impact companies have a shorter time since first obtaining assurance than their higher-environmental-impact counterparts. This evidence is at least consistent with lower-environmental-impact companies more recently devoting attention to environmental issues.

I also examine whether sustainability reporting assurance provided by accounting firms (e.g., traditional audit firms) versus non-accounting firms (e.g., engineering firms, environmental consulting firms) matters for future environmental performance. Accounting and non-accounting firms have different characteristics and adopt different approaches to sustainability reporting assurance. Accounting firms possess assurance expertise (Huggins et al., 2011; Wallage, 2000) and a thorough understanding of independence requirements (Pflugrath et al., 2011; Simnett et al., 2009). Thus, accounting firms' approach to sustainability reporting assurance resembles that of a financial statement audit and focuses on the accuracy and consistency of sustainability disclosures (O'Dwyer & Owen, 2007, 2005). Conversely, non-accounting firms have subject matter expertise in sustainability (Huggins et al., 2011) that helps them address the breadth and complexity of information in sustainability reports (O'Dwyer, 2011; O'Dwyer et al., 2011). Thus, non-accounting firms have the potential to offer more recommendations to improve clients' sustainability efforts (O'Dwyer & Owen, 2007, 2005). Whether accounting firm versus non-accounting firm assurance matters for future environmental performance is important because, while the market for sustainability reporting assurance in the U.S. is currently dominated by non-accounting firms (Bakarich et al., 2023; Gipper et al., 2024), accounting firms are expected to grow their market share, especially in light of the SEC adopting new rules that require certain companies to disclose and independently assure material climate-related metrics and risks in their 10-K filings (Gipper et al., 2024).

I find mixed results regarding the association between assurance provider type and environmental performance. When I measure environmental performance using future carbon emissions, I find some evidence of a negative association between a company's choice of an accounting firm to assure its sustainability report and future carbon emissions, and this association

is concentrated in higher-environmental-impact companies. However, when I measure environmental performance using future environmental regulation violations, I find a negative association between a company's choice of an accounting firm to assure its sustainability report and future environmental regulation violations only for lower-environmental-impact companies. The contrast in these results possibly stem from the stark differences between my two measures of environmental performance – where carbon emissions are a more specific and quantifiable sustainability metric, environmental regulation violations are a multi-faceted metric influenced by numerous factors. Thus, assurance providers' different approaches towards sustainability reporting assurance have different associations with future environmental performance depending on how this performance is measured.

My paper makes the following contributions. I provide new evidence on the association between sustainability reporting assurance and future environmental performance. The two studies most closely related to my paper are Christensen (2016) and Du and Wu (2019). Christensen (2016) studies sustainability reporting assurance in the U.S. market and uses lawsuits reported in international business news sources to measure future sustainability performance. Christensen (2016) does not find an association between sustainability reporting assurance and future sustainability-related lawsuits. Du and Wu (2019) study the Taiwanese market and use negative media mentions in major Taiwanese business media outlets to measure future sustainability performance. They find that sustainability reporting assurance is associated with fewer negative sustainability-related media mentions in the future.

My paper differs from Christensen (2016) and Du and Wu (2019) on two key fronts. First, I focus on future environmental performance while Christensen (2016) and Du and Wu (2019) include negative social and governance issues in their measures of future sustainability

performance. Hence, my paper’s analysis aligns environment-related outcome measures (e.g., carbon emissions and environmental regulation violations) with an environment-centric assurance process because companies assure environment-related metrics more frequently than non-environment-related metrics (Center for Audit Quality, 2024; Gipper et al., 2024). In contrast, prior research does not distinguish between environment- and non-environment-related issues in their measures of future sustainability performance and utilizes samples dominated by non-environment-related outcome measures. For example, environment-related lawsuits only account for 5.9 percent of Christensen’s (2016) sample, while negative media mentions on “Environmental Protection and Safety” only account for 47.8 percent of Du and Wu’s (2019) sample.

Second, my paper’s two measures of environment-specific dimensions of sustainability performance (i.e., future carbon emissions and future environmental regulation violations) are more objective and quantifiable measures of sustainability performance than prior research’s use of news media mentions to identify misconduct cases. News media is highly susceptible to bias because media outlets prioritize stories with broad appeal and advertising potential (Elejalde et al., 2019; Prat & Strömberg, 2013) and cover socially responsible companies more favorably (Cahan et al., 2015). Thus, using news media mentions to identify instances of misconduct could cause prior research to overlook certain misconduct cases, especially if the misconduct is less severe, involves a less prominent company, or is associated with a company with a strong sustainability reputation.

My paper’s consideration of the environmental impact of a company’s operations when examining the association between sustainability reporting assurance and future environmental performance also extends prior research. It highlights that companies face different sustainability-

related risks which can influence both their motivations to independently assure their sustainability reports and their response to the assurance process.

Finally, my paper is helpful as U.S. regulators consider new regulation that would require companies to separately assure their climate-related disclosures in 10-K filings. My findings that voluntary sustainability reporting assurance is associated with lower carbon emissions and fewer environmental regulation violations in the future, especially for higher-environmental-impact companies, suggest that voluntary assurance is informative of a company's environmental performance. Hence, mandating sustainability reporting assurance could provide investors and other stakeholders better insight into a company's operations.

CHAPTER 2

BACKGROUND

The need for sustainability reporting assurance

A company's external and internal stakeholders utilize sustainability information for decision-making. Prior research finds that companies benefit from a lower cost of capital, increased analyst coverage, and improved forecast accuracy (Dhaliwal et al., 2011, 2012, 2014; Plumlee et al., 2015), as well as higher share prices and greater profitability (Clarkson et al., 2011; Hughes, 2000; Matsumura et al., 2014), when they issue sustainability disclosures. These results are consistent with voluntary sustainability disclosures reducing information asymmetry between companies and external investors. Moreover, a company's management can use sustainability information to allocate resources efficiently and manage enterprise risk effectively (Casey & Grenier, 2015).

However, the voluntary nature of sustainability reporting in the U.S. raises concerns about the credibility of a company's sustainability information (Cho et al., 2012; Smith et al., 2011). Unlike financial reporting, sustainability reporting is voluntary and is not governed by a uniform standard. Therefore, companies have discretion over the content, method, and format of their sustainability disclosures. Moreover, even when companies voluntarily adhere to sustainability reporting guidelines issued by various non-profit organizations, companies have significant discretion in selecting which guidelines to adopt and how strictly to adhere to these guidelines.³

³ Non-profit organizations that issue sustainability reporting guidelines include the Global Reporting Initiative (GRI), International Sustainability Standards Board (ISSB), and Task Force on Climate-related Financial Disclosures (TCFD).

Independently verifying and assuring sustainability disclosures can alleviate concerns about the credibility of a company's sustainability information in the current voluntary disclosure climate (Birkey et al., 2016; Nugent & Simnett, 2007; O'Dwyer, 2011; Simnett et al., 2009). Prior research finds that companies are more likely to assure their sustainability reports when they face higher environmental and social risks (Simnett et al., 2009) or when they have higher sustainability strengths (Casey & Grenier, 2015) to enhance the credibility of their sustainability reports and to mitigate investors' concerns about companies' sustainability efforts. Several experimental studies also find that stakeholders perceive assured sustainability disclosures as being more credible (Brown-Liburd & Zamora, 2015; Cheng et al., 2015; Hodge et al., 2009).

Sustainability reporting assurance in the U.S.

In terms of the level of assurance, U.S.-based companies are similar to their international counterparts and favor limited assurance for their sustainability reports wherein independent assurers conduct a limited set of review procedures and provide a lower level of assurance as opposed to reasonable assurance (Bakarich et al., 2023; Gipper et al., 2024).⁴

However, unlike their international counterparts, U.S.-based companies prefer to engage non-accounting firms (e.g., engineering firms, environmental consulting firms) rather than accounting firms (e.g., traditional audit firms) to assure their sustainability reports (Bakarich et al., 2023; Gipper et al., 2024). While accounting firms' market share of the U.S. market for sustainability reporting assurance has remained stable in recent years, this share is expected to increase as sustainability reporting expands for two key reasons (Gipper et al., 2024). First, a

⁴ Reasonable assurance engagements (or examinations) affirm that the reported information is free from material misstatements and involves a more extensive and stringent examination of reported information that includes corroborating disclosures to source information to ensure accuracy. Conversely, limited assurance engagements (or reviews) only state that the assurance provider is unaware of any material misstatements with the reviewee's claims and involve fewer procedures and less verification of disclosures against source information as compared to reasonable assurance engagements (BDO, 2023).

company's financial reporting function is likely to be involved in sustainability reporting given the SEC's recent adoption of 89 FR 21668.⁵ A company's financial reporting function is more likely to engage accounting firms for sustainability reporting assurance because they work closely with accounting firms for financial statement audits and are more aware of an accounting firm's ability to conduct assurance engagements consistent with regulatory requirements. Second, non-accounting firms primarily assure environmental metrics while accounting firms can assure both environmental and social metrics. As the U.S. expands its sustainability reporting requirements and pays closer attention to social metrics, accounting firms are likely to be relied upon more for sustainability reporting assurance.

Prior research

Determinants and consequences of sustainability reporting assurance

Prior research has examined various characteristics that influence a company's decision to independently assure its sustainability report and the type of assurance provider to provide this assurance. Larger companies (Casey & Grenier, 2015; Datt et al., 2019; Simnett et al., 2009), companies with stronger sustainability performance (Clarkson et al., 2019), companies that staff their environmental committees with members with greater environmental expertise (Peters & Romi, 2015), and companies based in code law countries that are more stakeholder-oriented (Simnett et al., 2009; Zhou et al., 2016) are more likely to independently assure their sustainability reports. These companies are also more likely to engage accounting firms to assure their sustainability reports (Clarkson et al., 2019; Peters & Romi, 2015; Simnett et al., 2009; Wong et

⁵ This legislation was adopted on March 6, 2024, and requires publicly registered companies to disclose material climate-related risks and metrics in their 10-K filings starting in 2026. Large accelerated filers and accelerated filers must begin obtaining limited assurance for carbon emissions disclosures by 2029 and 2031, respectively. Large accelerated filers must also increase this level of assurance to reasonable assurance (i.e., to the same level of assurance as a financial statement audit) by 2033 (The Enhancement and Standardization of Climate-Related Disclosures for Investors, 2024).

al., 2016; Zhou et al., 2016). Companies that operate in industries with greater environmental and social impact are more likely to independently assure their sustainability reports (Cho et al., 2014; Simnett et al., 2009), although the degree of environmental and social impact does not influence a company's choice of assurance provider (Casey & Grenier, 2015; Simnett et al., 2009). Companies with higher leverage are less likely to independently assure their sustainability reports (Casey & Grenier, 2015; Datt et al., 2019) and are less likely to engage accounting firms for sustainability reporting assurance (Casey & Grenier, 2015; Simnett et al., 2009).

Prior research has also examined the economic consequences of sustainability reporting assurance. Companies with independently assured sustainability reports have better third-party sustainability reporting ratings (Luo et al., 2023) and higher rates of restatement of sustainability-related disclosures which indicate improved sustainability reporting quality because the assurance process identifies errors in prior sustainability reports and updates methodologies of calculating sustainability metrics for better comparability (Ballou et al., 2018; Michelon et al., 2019). Ballou et al. (2018) also find that companies restate more sustainability-related disclosures when they engage an accounting firm for sustainability reporting assurance, which suggests that accounting firms improve sustainability reporting quality more effectively than non-accounting firms. Clarkson et al. (2019) find that companies with independently assured sustainability reports enjoy a higher market value, especially if their sustainability reports are assured by a Big 4 accounting firm. Casey and Grenier (2015) also find that companies with independently assured sustainability reports are associated with a lower cost of capital and lower analyst forecast dispersion, especially if the company engages an accounting firm for sustainability reporting assurance.

Proposed contributions to the literature

A developing area within the literature explores the non-economic consequences of sustainability reporting assurance. For example, Birkey et al. (2016) find that companies with independently assured sustainability reports have a better environmental reputation, regardless of the company's choice of assurance provider.

Two studies within this literature also examine the association between sustainability reporting assurance and a company's sustainability performance. Christensen (2016) examines sustainability reporting assurance in the U.S. market between 1999 and 2010 and uses lawsuits reported in reputable international business news sources like the *Wall Street Journal*, *Financial Times*, *Dow Jones Newswires*, and *Reuters* to measure a company's sustainability performance. Christensen (2016) does not find an association between sustainability reporting assurance and the likelihood of future sustainability-related lawsuits, which he attributes to a low number of companies obtaining sustainability reporting assurance within his sample. Du and Wu (2019) examine sustainability reporting assurance in the Taiwanese market between 2005 and 2013 and use negative media mentions in major Taiwanese business media outlets to measure a company's sustainability performance. They find that sustainability reporting assurance is associated with fewer negative sustainability-related media mentions in the future.

My paper differs from these two studies. First, I focus on future environmental performance, while Christensen (2016) and Du and Wu (2019) include social and governance issues in their respective measures of future sustainability performance. Companies assure environment-related metrics more frequently than non-environment-related metrics (Center for Audit Quality, 2024; Gipper et al., 2024). Thus, my paper's focus on future environmental performance aligns environment-related outcome measures (e.g., carbon emissions and

environmental regulation violations) with an environment-centric assurance process. In contrast, prior research does not distinguish between environment- and non-environment-related issues in their respective measures of future sustainability performance. As a result, their measures of future sustainability performance focus heavily on non-environment-related issues. 5.9 percent of Christensen's (2016) sample of sustainability-related lawsuits are environment-related, while the remaining 94.1 percent pertain to social issues (e.g., labor, human rights, etc.). Similarly, only 47.8 percent of Du and Wu's (2019) sample of negative media mentions falls under the category of "Environmental Protection and Safety", although the actual percentage of environment-related negative media mentions is likely lower because this category includes media mentions related to food safety, sanitation, and flight security issues which are not environment-related. The remainder of Du and Wu's (2019) sample consists of negative media mentions related to social (e.g., labor law violations, workplace safety violations, etc.) and governance issues (e.g., financial misstatements, financial statement fraud, money laundering, etc.).

Second, my paper utilizes objective and quantifiable measures of future environmental performance that are subject to strict regulation and oversight. The SEC's recent adoption of *89 FR 2166* requires certain companies to disclose and independently assure material carbon emissions in their 10-K filings. This recent legislation adds to existing reporting requirements under the U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program that tracks U.S. emissions and requires U.S.-based manufacturing facilities to report emissions to the EPA if these emissions exceed specific thresholds each year.

Environmental regulation violations are disciplined via enforcement actions levied against companies by a government agency. Government agencies publicly announce these enforcement actions and assess monetary penalties on companies to remedy these violations. Monetary

penalties have a disciplining effect on companies, accounting for the bulk of the decrease in a company's market value when violations are initially announced (Karpoff et al., 2005).

In contrast, Christensen (2016) relies on news media to identify sustainability-related lawsuits and Du and Wu (2019) use negative news media mentions as their respective measures of sustainability performance. News media is highly susceptible to bias because media outlets prioritize stories with broad appeal and advertising potential (Elejalde et al., 2019; Prat & Strömberg, 2013) and cover socially responsible companies more favorably (Cahan et al., 2015). Thus, prior research could overlook lawsuits and negative news media mentions if these measures are related to sustainability misconduct that is less severe, involves a less prominent company, or is associated with a company with a strong sustainability reputation.

Third, I consider the environmental impact of a company's operations when I examine the association between sustainability reporting assurance and future environmental performance. Companies whose operations have a higher environmental impact are more likely to assure their sustainability reports, which suggests that these companies have stronger incentives to enhance the credibility of their sustainability reports compared to lower-environmental-impact companies (Cho et al., 2014; Simnett et al., 2009). Thus, higher- and lower-environmental-impact companies have different motivations for independently assuring their sustainability reports, and these motivations could influence the association between sustainability reporting assurance and future environmental performance.

Finally, I consider whether the type of assurance provider that a company engages for sustainability reporting assurance is associated with future environmental performance. The U.S. sustainability reporting assurance market is divided among accounting and non-accounting firms, with non-accounting firms dominating the market (Bakarich et al., 2023; Gipper et al., 2024). Both

types of assurance providers have different attributes and different approaches to sustainability reporting assurance (Huggins et al., 2011; O'Dwyer & Owen, 2007, 2005; Pflugrath et al., 2011; Simnett et al., 2009; Wallage, 2000) that are better suited to address different aspects of sustainability reporting assurance. Understanding how these different attributes and different approaches to sustainability reporting assurance can influence future environmental performance is important as the U.S. expands its sustainability reporting and assurance requirements, thus offering accounting and non-accounting firms an opportunity to expand their share of the sustainability reporting assurance market.

CHAPTER 3

HYPOTHESIS DEVELOPMENT

Independent assurance and future environmental performance

Prior research suggests competing forces regarding sustainability reporting assurance and future environmental performance. Sustainability reporting assurance can be associated with better future environmental performance through two mechanisms: (1) assurance could serve as a credibility-enhancing signal of a company's intentions and/or efforts to improve environmental performance, and (2) assurance could improve future environmental performance. However, there are at least two reasons why sustainability reporting assurance might not be associated with better future environmental performance: (1) the assurance process might not be effective at either helping companies improve or in credibly signaling better environmental performance in the future, and (2) companies could use assurance as a legitimization tool (i.e., greenwashing).

Regarding signaling improvements in environmental performance, companies can independently assure their sustainability reports to differentiate themselves and signal stronger sustainability initiatives to stakeholders (Bagnoli & Watts, 2017; Du & Wu, 2019; Gipper et al., 2024). Thus, companies that voluntarily assure their sustainability reports may have more developed environmental initiatives than their peers and these environmental initiatives can lead to better environmental performance in the future. For instance, companies that voluntarily assure their sustainability reports may have more robust carbon management policies and emissions reduction initiatives leading to lower future carbon emissions. Similarly, companies that

voluntarily assure their sustainability reports may be better at managing environmental risks than their peers, which could lead to fewer occurrences of future environmental regulation violations.

Regarding improving future environmental performance, assurance providers verify disclosures and offer recommendations to improve sustainability reporting processes and initiatives during the assurance process (Edgley et al., 2010; O'Dwyer, 2011; O'Dwyer & Owen, 2007, 2005). Companies can apply the insights gained from the assurance process to improve their environmental practices and become more environmentally friendly over time. For instance, in the context of carbon emissions as a measure of environmental performance, assurance providers can suggest better carbon management policies and emissions reduction initiatives that companies can implement to lower future carbon emissions. Similarly, assurance providers can identify areas of concern that could lead to environmental regulation violations, giving companies the opportunity to address these concerns and reduce the occurrence of these incidents.

However, shortcomings in the assurance process may limit the effectiveness of sustainability reporting assurance on future environmental performance. Talbot and Boiral (2018) examine a sample of assured sustainability reports and find that assurance providers often failed to highlight instances where information in reports was incomplete and unreliable, despite the reports claiming to be compliant with Global Reporting Initiative (GRI) standards.

Moreover, companies may use sustainability reporting assurance for symbolic reasons. Various studies find that companies use sustainability reporting to legitimize themselves to stakeholders (Boiral et al., 2019; Gillet, 2012; Talbot & Boiral, 2013), but do not find an association between the quality and quantity of sustainability disclosures and sustainability reporting assurance (Michelon et al., 2015). Thus, companies may independently assure their sustainability reports to satisfy stakeholders and boost public perception (Maroun, 2020) without

implementing significant initiatives to lower future carbon emissions or reduce future environmental regulation violations.

Given the arguments in both directions, I state my first hypothesis in the null form:

H1a: Independently assuring a sustainability report is not associated with future carbon emissions.

H1b: Independently assuring a sustainability report is not associated with the occurrence of future environmental regulation violations.

Assurer-type and future environmental performance

Accounting and non-accounting firms adopt different approaches to sustainability reporting assurance that can have different effects on future environmental performance.

An accounting firm's experience with financial statement audits influences its approach to sustainability reporting assurance. First, accounting firms are proficient in appropriately responding to the assessed risk of material misstatement because their experience with financial statement audits gives rise to assurance competencies that are easily applicable to assurance engagements in non-financial reporting domains (Huggins et al., 2011). For example, accounting firms know when and how to engage subject matter experts for sustainability reporting assurance due to their experience working with these experts to obtain sufficient evidence in fields outside of accounting during financial statement audits (Huggins et al., 2011; Wallage, 2000). Second, accounting professionals must adhere to a strict professional code of ethics and independence requirements and maintain objectivity and independence throughout the sustainability reporting assurance process (Pflugrath et al., 2011; Simnett et al., 2009). Hence, sustainability reporting assurance provided by an accounting firm resembles that of a financial statement audit and focuses on the accuracy and consistency of sustainability disclosures (O'Dwyer & Owen, 2007, 2005).

Accordingly, accounting firms may be better suited than non-accounting firms at helping companies lower future carbon emissions and reduce future environmental regulation violations.

Conversely, non-accounting firms have industry-centric knowledge and subject matter expertise in the sustainability space (Huggins et al., 2011) that accounting firms may not have. These traits can help non-accounting firms address the breadth and complexity of information contained within sustainability reports (O'Dwyer, 2011; O'Dwyer et al., 2011). Thus, sustainability reporting assurance provided by a non-accounting firm may offer more recommendations to improve clients' sustainability reporting and performance processes (O'Dwyer & Owen, 2007, 2005). Accordingly, non-accounting firms may be more effective at helping companies lower future carbon emissions and reduce future environmental regulation violations than accounting firms.

Given the opposing arguments, I state my second hypothesis in the null form:

H2a: The type of assurer that assures a sustainability report is not associated with future carbon emissions.

H2b: The type of assurer that assures a sustainability report is not associated with the occurrence of future environmental regulation violations.

CHAPTER 4

RESEARCH DESIGN AND DATA

Research design

Dependent variables

I examine a company's future environmental performance along two dimensions: (1) future carbon emissions, and (2) future environmental regulation violations.

My first dependent variable that measures future carbon emissions, GHG_{t+n} , is the natural logarithm of one plus total carbon emissions that a company discloses in a publicly available source. I obtain this information from Refinitiv's metric titled 'Total CO2 Equivalent Emissions'. Refinitiv first examines publicly available sources (e.g., sustainability report, ESG website, etc.) for a company-disclosed value of emissions. If a company-disclosed value is unavailable, Refinitiv has proprietary methods to estimate a company's carbon emissions. For the purposes of my analyses, I do not include estimated carbon emissions in my sample. Refinitiv's metric titled 'Total CO2 Equivalent Emissions' is the sum of a company's Scope 1 and Scope 2 emissions. Scope 1 emissions are direct emissions generated from sources controlled or owned by a company, while Scope 2 emissions are indirect emissions associated with the purchase of electricity, steam, heat, or cooling (US EPA, 2024).

My second dependent variable that measures future environmental regulation violations, $VIOL_{t+n}$, is the natural logarithm of one plus the total number of enforcement actions related to environmental regulation violations that are brought against a company by various local, state, and federal government agencies in the U.S. I obtain this information from the Violations Tracker

maintained by Good Jobs First, a non-profit agency that scrapes the websites of governmental agencies to compile a database tracking corporate misconduct and its related penalty amounts.⁶ The Violations Tracker includes violations announced after January 1, 2000, with a minimum associated penalty of 5,000 USD. Because the tracker only records violations when they are announced against a company, I assume that a company does not have a violation for fiscal years where it does not appear in the Violations Tracker. For example, if a company is listed in the Violations Tracker in 2010 and 2013, I assume that the count of environmental regulation violations for this company is zero for 2011 and 2012.

The subscript, $t+n$, in each of the dependent variables in Equations (1) and (2) denotes the leading observation window over which I aggregate each measure. I aggregate my measures of carbon emissions and environmental regulation violations for the following two ($t+2$) and three fiscal years ($t+3$). For example, if the current fiscal year is 2010 (t), then GHG_{t+2} is the natural logarithm of one plus the sum of carbon emissions in 2011 ($t+1$) and 2012 ($t+2$). Similarly, $VIOL_{t+3}$ is the natural logarithm of one plus the sum of enforcement actions related to environmental regulation violations in 2011 ($t+1$), 2012 ($t+2$), and 2013 ($t+3$).

Independent variables and models

My analyses consider the various decisions a company makes regarding sustainability reporting assurance. My first variable of interest, $ASSURE_t$, is an indicator variable equal to one if a company assures its sustainability report in the current fiscal year, and zero otherwise. My second variable of interest, $ACCOUNT_t$, is an indicator variable equal to one if a company chooses an accounting firm to assure its sustainability report in the current fiscal year, and zero otherwise. I obtain the data for these variables from Refinitiv, which provides a comprehensive source of

⁶ The complete list of sources is available at <https://violationtracker.goodjobsfirst.org/pages/violation-tracker-data-sources>.

sustainability information by compiling data on companies worldwide from publicly available reports, disclosures, and proprietary sources.

I utilize Equation (1) to test Hypothesis 1a and 2a:

$$GHG_{i,t+n} = \alpha_0 + \alpha_1 \left\{ \begin{matrix} ASSURE_{i,t} \\ ACCOUNT_{i,t} \end{matrix} \right\} + Controls_{i,t} + Year\ FE + \varepsilon_{i,t} \quad (1)$$

I utilize Equation (2) to test Hypothesis 1b and 2b:

$$VIOL_{i,t+n} = \beta_0 + \beta_1 \left\{ \begin{matrix} ASSURE_{i,t} \\ ACCOUNT_{i,t} \end{matrix} \right\} + Controls_{i,t} + Year\ FE + \varepsilon_{i,t} \quad (2)$$

I use modified control function regression models, as introduced in Klein and Vella (2010) and Armstrong et al. (2022), to address potential endogeneity arising from unobserved correlated omitted variables in my analyses. Prior research on sustainability reporting assurance utilizes propensity score matching, instrumental variables, and a Heckman two-stage model to address endogeneity concerns (Christensen, 2016; Du & Wu, 2019). However, as discussed in Armstrong et al. (2022), Klein and Vella's (2010) model is advantageous over these methods because: (1) it does not rely on the conditional independence assumption required by OLS; (2) it does not depend on a valid exclusion restriction required by instrumental variable estimation; and (3) it does not rely on the normality of error terms required by a Heckman two-stage model.

To address endogeneity concerns, the modified control function regression model includes a factor calculated from the standard deviation of residuals to control for correlated omitted variables that contribute to endogeneity. To obtain this variable, I first regress the independent variable on all control variables and calculate the standard deviation of these first-stage residuals. Next, I regress the dependent variable on the independent variable and all controls variables and calculate the standard deviation of the second-stage residuals. I then compute the ratio of the

second-stage to first-stage residual standard deviations and multiply this ratio by first-stage residuals to obtain the control function variable (*KVFUNCTION*).

Control variables

Equation (1) follows prior research to select controls that may impact a company's carbon emissions. Following Qian and Schaltegger (2017), I control for a company's size (*SIZE*), financial performance (*ROA*), financial risk (*FINRISK*), liquidity (*LIQ*), sales growth (*SALEGROWTH*), asset age (*ASSETAGE*), capital intensity (*CAPINT*), and R&D intensity (*RDINT*). Additionally, I include key variables from Gipper et al.'s (2023) model for carbon emissions and control for a company's prior year carbon emissions (GHG_{t-1}), fixed asset tangibility (*TANG*), number of employees (*EMP*), inventory levels (*INV*), and net property, plant, and equipment (*PPE*).

Equation (2) follows prior research to select controls for factors that may affect the occurrence of environmental regulation violations. Following Christensen (2016) and Du and Wu (2019), I control for a company's organization complexity (*BUSSEG* and *GEOSEG*), resource constraints (*FINSTRENGTH*), institutional ownership (*IOR*), litigation risk (*LITRISK*), growth opportunities (*TOBINQ*), industry market competition (*MKTCOMP*), prior year violations ($VIOL_{t-1}$), financial performance (*ROA*), and size (*SIZE*). I also control for the change in the likelihood of misconduct across industries over time, calculated as the percentage of companies with violations within an industry-year.

I obtain control variables from Compustat and provide detailed definitions of these variables in the Appendix. I measure all control variables in the current fiscal year, except for GHG_{t-1} and $VIOL_{t-1}$, which I measure in the prior fiscal year. I winsorize continuous control variables at the 1st and 99th percentiles.

To address concerns about influential observations, I calculate studentized residuals and only include company-year observations with absolute studentized residual values below 2.5 in the final regression samples.⁷ I include year fixed effects in both equations to control for time-varying factors common to all companies. I cluster standard errors for t -statistics by company.⁸

Sample

I present the sample construction for Equation (1) and Equation (2) in Panel A and Panel B of Table 1, respectively. For both samples, I start with publicly traded U.S. companies that issue at least one sustainability report between January 1, 2000, and December 31, 2023, resulting in 42,346 company-year observations. I then remove observations without sustainability reporting coverage in Refinitiv and exclude cases where Refinitiv incorrectly captures sustainability reporting assurance information.⁹ Next, I remove observations with missing control variables in Compustat.¹⁰ Finally, I restrict my analysis to company-year observations that issue a sustainability report and that have coverage in Refinitiv on their decision to assure their sustainability report. My final sample for my analysis using Equation (1) and Equation (2) consists of 2,807 and 3,695 company-year observations, respectively.

Descriptive statistics

I present summary statistics for the sample used in Equation (1) in Panel A of Table 2. The mean of 14.35 (14.85) for GHG_{t+2} (GHG_{t+3}) indicates that, on average, a company in this sample emits 1.71 (2.81) million metric tons of carbon dioxide equivalents in the following two (three)

⁷ My results and inferences remain unchanged when I use a cutoff of 3.0 for studentized residuals.

⁸ Following Petersen (2009), I address correlation arising from a firm and time effect in my panel data by including year fixed effects in my regression model and clustering standard errors by company. My inferences remain unchanged when I cluster standard errors by fiscal year.

⁹ Specifically, there are 24 company-year observations where Refinitiv lists an assurer for the company's sustainability report while simultaneously denoting that the company did not issue a sustainability report. This error rate is less than 1 percent of the initial sample of 42,346 company-year observations.

¹⁰ Per Table 1, I lose 13,575 and 4,242 company-year observations due to missing controls when constructing my sample for Equation (1) and Equation (2), respectively. The number of company-year observations removed in this step differs because Equations (1) and (2) each use a different set of control variables.

fiscal years.¹¹ Within this sample, 52 percent of companies independently assure their sustainability reports, and 22 percent of companies that issue and independently assure their sustainability reports engage an accounting firm for sustainability reporting assurance.

I present summary statistics for the sample used in Equation (2) in Panel B of Table 2. The mean of 0.51 (0.67) for $VIOL_{t+2}$ ($VIOL_{t+3}$) indicates that, on average, a company in this sample has 0.665 (0.954) environmental regulation violations in the following two (three) fiscal years.¹² Within this sample, 45 percent of companies independently assure their sustainability reports, and 23 percent of companies that issue and independently assure their sustainability reports engage an accounting firm for sustainability reporting assurance.

¹¹ Because GHG_{t+n} is a logged variable, I convert the mean value back to metric tons of carbon dioxide equivalents by taking the exponent of the mean minus one. Thus, $e^{14.35} - 1 = 1,706,576$ and $e^{14.85} - 1 = 2,813,668$ metric tons of carbon dioxide equivalents.

¹² Because $VIOL_{t+n}$ is a logged variable, I exponentiate the mean and subtract one to convert the mean value to the number of environmental regulation violations. Specifically, $e^{0.51} - 1 = 0.665$ and $e^{0.67} - 1 = 0.954$ environmental regulation violations.

CHAPTER 5

RESULTS

Independent assurance and future environmental performance

Independent assurance and future carbon emissions

I examine the association between a company's decision to assure its sustainability report and future carbon emissions by estimating Equation (1) with $ASSURE_t$ as the independent variable. I present the results of this analysis in Table 3. I find a significantly negative coefficient for $ASSURE_t$ in both Columns (1) and (2), indicating that a company's decision to assure its sustainability report is associated with 3.82 (5.73) percent less carbon emitted over the next two (three) fiscal years.¹³ These results suggest that assuring a sustainability report is associated with a company's improved environmental performance.

Companies whose operations have a higher environmental impact are more likely to assure their sustainability reports to enhance their credibility (Cho et al., 2014; Simnett et al., 2009). Therefore, companies may have different motivations for assuring their sustainability reports, which could influence the association between sustainability reporting assurance and environmental performance. I re-estimate Equation (1) using two sub-samples obtained from splitting my full sample based on a company's environmental impact. Following prior research (Cho et al., 2014; Cho & Patten, 2007; Patten, 2002), I classify companies as higher-

¹³ Because GHG_{t+n} is a logged variable, economic significance is calculated by taking the exponent of the coefficient on $ASSURE_t$ minus one. Thus, $e^{-0.039} - 1 = -3.82\%$ for GHG_{t+2} and $e^{-0.059} - 1 = -5.73\%$ for GHG_{t+3} .

environmental-impact if they operate in an environmentally sensitive industry defined by SIC codes 10xx, 13xx, 26xx, 28xx, 29xx, 33xx, or 49xx.¹⁴

I estimate Equation (1) with $ASSURE_t$ as the independent variable for higher- and lower-environmental-impact companies and present results in Table 4. I find a significantly negative coefficient for $ASSURE_t$ among higher-environmental-impact companies in Columns (1) and (3), but I do not find a significant coefficient for $ASSURE_t$ among lower-environmental-impact companies in Columns (2) and (4). These results indicate that the negative association between a company's decision to assure its sustainability report and carbon emissions two to three fiscal years in the future is concentrated among higher-environmental-impact companies. In terms of economic significance, the coefficient on $ASSURE_t$ indicates that a company's decision to assure its sustainability report is associated with 2.18 (1.69) percent less carbon emitted over the next two (three) fiscal years for higher-environmental-impact companies. These results suggest that companies whose operations have a greater environmental impact either have stronger sustainability initiatives that lower carbon emissions and use sustainability reporting assurance to signal these initiatives to stakeholders; or these companies are more responsive to public scrutiny surrounding their environmental impact and are more likely to implement assurance providers' recommendations for improving sustainability processes.

Independent assurance and future environmental regulation violations

I examine the association between a company's decision to assure its sustainability report and future environmental regulation violations by estimating Equation (2) with $ASSURE_t$ as the independent variable. I present the results of this analysis in Table 5. I do not find a significant coefficient for $ASSURE_t$ in both Columns (1) and (2). However, when I split the sample into

¹⁴ Industries considered environmentally sensitive are mining (10xx), oil and gas extraction (13xx), paper (26xx), chemical and allied products (28xx), petroleum refining (29xx), metals (33xx), and utilities (49xx).

higher- and lower-environmental-impact companies and re-estimate Equation (2) with $ASSURE_t$ as the independent variable, results presented in Table 6 indicate that the two sub-samples result in significant and oppositely signed coefficients on $ASSURE_t$ that contribute to the lack of evidence of an association between a company's decision to assure its sustainability report and the occurrence of future environmental regulation violations in the full sample.

I find a significantly negative coefficient for $ASSURE_t$ among higher-environmental-impact companies in Columns (1) and (3) of Table 6, indicating that a company's decision to assure its sustainability report is associated with 7.60 (9.70) percent fewer environmental regulation violations over the next two (three) fiscal years for higher-environmental-impact companies.¹⁵ These results suggest that companies whose operations have a greater environmental impact either have stronger sustainability initiatives that reduce future environmental regulation violations and use sustainability reporting assurance to signal these initiatives to stakeholders; or these companies are more responsive to public scrutiny surrounding their environmental impact and are more likely to implement assurance providers' recommendations for improving sustainability processes.

I find a significantly positive coefficient for $ASSURE_t$ among lower-environmental-impact companies in Columns (2) and (4), indicating that a company's decision to assure its sustainability report is associated with 5.13 (6.08) percent more environmental regulation violations over the next two (three) fiscal years for lower-environmental-impact companies.¹⁶ One possible explanation for this result is that lower-environmental-impact companies are less concerned with the credibility of their sustainability reports compared to higher-environmental-impact companies

¹⁵ Because $VIOL_{t+n}$ is a logged variable, economic significance is calculated by taking the exponent of the coefficient on $ASSURE_t$ minus one. Thus, $e^{-0.079} - 1 = -7.60\%$ for $VIOL_{t+2}$ and $e^{-0.102} - 1 = -9.70\%$ for $VIOL_{t+3}$.

¹⁶ Because $VIOL_{t+n}$ is a logged variable, economic significance is calculated by taking the exponent of the coefficient on $ASSURE_t$ minus one. Thus, $e^{0.050} - 1 = 5.13\%$ for $VIOL_{t+2}$ and $e^{0.059} - 1 = 6.08\%$ for $VIOL_{t+3}$.

(Cho et al., 2014; Simnett et al., 2009). Thus, lower-environmental-impact companies may be less concerned about environmental regulation violations, especially if these violations are less severe. It is also possible that lower-environmental-impact companies have recently developed an interest in better sustainability performance (perhaps due to a change in stakeholder demand) that motivates them to voluntarily initiate sustainability reporting assurance.

To test this explanation, I examine the length of assurance (i.e., the number of years since a company first assures its sustainability report) for higher- and lower-environmental-impact companies. Higher- (lower-) environmental-impact companies have independently assured their sustainability reports for an average length of 4.270 (3.659) or 4.309 (3.548) years when the dependent variable is aggregated over the following two or three fiscal years. A *t-test* of these averages indicates that lower-environmental-impact companies have a significantly shorter average length of assurance than higher-environmental-impact companies. These results suggest that lower-environmental-impact companies are much newer to the sustainability reporting assurance process than higher-environmental-impact companies.¹⁷ As a result, lower-environmental-impact companies may still be in the early stages of learning through the sustainability reporting assurance process and require more time to enact policy changes that reduce the occurrence of future environmental regulation violations.

Assurer-type and future environmental performance

Assurer-type and future carbon emissions

I examine the association between the type of assurer a company engages to assure its sustainability report and future carbon emissions by estimating Equation (1) with $ACCOUNT_t$ as

¹⁷ I assume that a company does not revert its decision to independently assure its sustainability report in the following years when calculating length of assurance. However, my inferences remain unchanged if I account for changes in a company's decision to obtain independent assurance for its sustainability report when calculating length of assurance.

the independent variable. I present the results of this analysis in Table 7. While I do not find a significant coefficient for $ACCOUNT_t$ in Column (1), I find a significantly negative coefficient for $ACCOUNT_t$ in Column (2) which indicates a weakly negative association between a company's decision to have an accounting firm assure its sustainability report and carbon emissions three fiscal years in the future.

However, when I consider the environmental impact of a company's operations in this analysis, I find a significantly negative coefficient for $ACCOUNT_t$ among higher-environmental-impact companies in Columns (1) and (3) of Table 8, but I do not find a significant coefficient for $ACCOUNT_t$ among lower-environmental-impact companies in Columns (2) and (4). In terms of economic significance, the coefficient on $ACCOUNT_t$ indicates that a company's decision to have an accounting firm assure its sustainability report is associated with 7.60 (11.75) percent less carbon emitted over the next two (three) fiscal years for higher-environmental-impact companies. These results suggest that accounting firms' approach to sustainability reporting assurance is more effective at improving a company's environmental performance than non-accounting firms' approach when companies' operations have a greater environmental impact and these companies have a greater need to increase the credibility of their sustainability reports (Cho et al., 2014; Simnett et al., 2009).

Assurer-type and future environmental regulation violations

I examine the association between the type of assurer a company engages for sustainability reporting assurance and the occurrence of future environmental regulation violations by estimating Equation (2) with $ACCOUNT_t$ as the independent variable. I present the results of this analysis in Table 9. I do not find a significant coefficient for $ACCOUNT_t$ in both Columns (1) and (2). However, when I consider the environmental impact of a company's operations, I find a

significantly negative coefficient for $ACCOUNT_t$ among lower-environmental-impact companies in Columns (2) and (4) in Table 10, but I do not find a significant coefficient for $ACCOUNT_t$ among higher-environmental-impact companies in Columns (1) and (3). In terms of economic significance, the coefficient on $ACCOUNT_t$ indicates that a company's decision to have an accounting firm assure its sustainability report is associated with 7.87 (11.93) percent fewer environmental regulation violations over the next two (three) fiscal years for lower-environmental-impact companies. These results suggest that accounting firms' approach to sustainability reporting assurance is more effective at improving a company's environmental performance than non-accounting firms' approach when companies' operations have a smaller environmental impact.

This result contrasts with evidence presented in Table 8 which suggest that accounting firms' approach to sustainability reporting assurance is more effective at improving a company's environmental performance than non-accounting firms' approach when companies' operations have a *greater* environmental impact. The contrast in results could stem from carbon emissions and environmental regulation violations being two vastly different metrics of environmental performance. For example, where carbon emissions measures greenhouse gas emissions, environmental regulation violations include violations pertaining to emissions, water pollution, and toxic gas releases. Additionally, carbon emissions amounts are a company-reported sustainability metric that have some existing reporting requirements (e.g., the Greenhouse Gas Reporting Program requires U.S.-based manufacturing facilities to report emissions data to the EPA if these emissions exceed threshold amounts each year), while environmental regulation violations are a more complex metric because multiple factors can influence whether a government agency issues an enforcement action against a company.

Hence, one type of assurance provider is not definitively better at improving a company's future environmental performance over the other. Instead, both types of assurance providers take different approaches to sustainability reporting assurance that have varying effects on environmental performance based on how this performance is measured. Companies should consider which environmental performance metrics stakeholders are concerned with and tailor their choice of assurance provider accordingly.

CHAPTER 6

CONCLUSION

I examine whether sustainability reporting assurance is associated with improvements in a company's environmental performance by examining the association between a company's decision to assure its sustainability report and its choice of assurance provider, and future carbon emissions and the occurrence of future environmental regulation violations.

I find that sustainability reporting assurance is associated with improved environmental performance, especially if a company's operations have a higher environmental impact. While I also find some evidence that sustainability reporting assurance is associated with poorer environmental performance, this association is limited to lower-environmental-impact companies and I only draw this inference when I measure environmental performance using the occurrence of future environmental regulation violations, not future carbon emissions. One explanation for this conclusion is that lower-environmental-impact companies have only been incentivized recently to obtain sustainability reporting assurance. I find that lower-environmental-impact companies have started obtaining sustainability reporting assurance more recently than higher-environmental-impact companies, which suggests that lower-environmental-impact companies are still new to the assurance process. Their efforts to improve their environmental impact could take time, hence sustainability reporting assurance is initially accompanied by an increase in future environmental regulation violations.

I also find that accounting firms' approach to sustainability reporting assurance is associated with improved environmental performance for higher-environmental-impact (lower-

environmental-impact) companies when environmental performance is measured using future carbon emissions (future environmental regulation violations). One probable reason for the contrast in results is that future carbon emissions and future environmental regulation violations capture different aspects of environmental performance. Thus, these results highlight that the different approaches that assurance providers take towards sustainability reporting assurance can have differing associations with environmental performance based on how this performance is measured.

My findings are relevant to the evolving regulatory landscape as U.S. regulators consider mandating assurance on climate-related disclosures in 10-K filings. Whether companies use sustainability reporting assurance to signal their commitment to or to drive actual improvements to their environmental performance, my findings in the current voluntary assurance setting suggest that, at a minimum, sustainability reporting assurance is informative about a company's future environmental performance. Thus, requiring companies to independently assure their sustainability reports could provide investors and other stakeholders with better insight into a company's operations.

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APPENDIX

Variable Definitions

Variable	Definition
<u>Independent Variables</u>	
<i>ASSURE</i>	Indicator equal to one if a company assures its sustainability report per LSEG Refinitiv, and zero otherwise.
<i>ACCOUNT</i>	Indicator equal to one if a company chooses an accounting firm to assure its sustainability report per LSEG Refinitiv, and zero otherwise.
<u>Dependent Variables</u>	
<i>GHG</i>	Natural logarithm of one plus company-reported Total CO2 Equivalent Emissions per LSEG Refinitiv. Total CO2E Emissions = Scope 1 (Direct) + Scope 2 (Indirect) Emissions. GHG_{t+2} aggregates this value for the following two fiscal years, and GHG_{t+3} aggregates this value for the following three fiscal years. GHG_{t-1} captures this value for the prior fiscal year.
<i>VIOL</i>	Natural logarithm of one plus the number of environmental regulation violations in which the company is listed as the ultimate parent company per the Violations Tracker maintained by Good Jobs First. $VIOL_{t+2}$ aggregates this value for the following two fiscal years, and $VIOL_{t+3}$ aggregates this value for the following three fiscal years. $VIOL_{t-1}$ captures this value for the prior fiscal year.
<u>Control Variables</u>	
<i>ASSETAGE</i>	Net property, plant, and equipment (PPE) divided by gross PPE per Compustat.
<i>BUSSEG</i>	Number of business segments per Compustat.
<i>CAPINT</i>	Capital expenditure divided by sales revenue per Compustat.
<i>EMP</i>	Natural logarithm of one plus the number of employees per Compustat.
<i>FINRISK</i>	Total debt divided by total assets per Compustat.
<i>FINSTRENGTH</i>	Decile rank of a company's Z-score at the SIC-2-digit industry-year level. $Z\text{-Score} = (3.3 \times \text{Pre-Tax Income}) + (1.0 \times \text{Sales Revenue}) + (1.4 \times \text{Retained Earnings}) + (1.2 \times \frac{\text{Current Assets} - \text{Current Liabilities}}{\text{Total Assets}})$
<i>GEOSEG</i>	Number of geographic segments per Compustat.
<i>INV</i>	Natural logarithm of one plus total inventory per Compustat. INV_t captures this value in the current fiscal year. INV_{t-1} captures this value in the prior fiscal year.
<i>IOR</i>	Percentage of institutional ownership averaged over the fiscal year per Thomson Reuters.
<i>KVFUNCTION</i>	This measure is utilized in a modified control function regression method to control for unobserved correlated omitted variables responsible for an endogenous relation following Klein and Vella (2010) and Armstrong et al. (2022). I calculate this measure by multiplying the ratio between the standard deviation of first-stage residuals and the standard deviation of second-stage residuals by first-stage residuals. First-stage residuals are obtained by regressing the independent variable on controls. Second-stage residuals are obtained by regressing the dependent variable on the independent variable and controls.
<i>LIQ</i>	Net cash flow from operations divided by total assets per Compustat.

<i>LITRISK</i>	Indicator equal to one if a company's pre-tax or after-tax settlement amounts for litigation and/or insurance per Compustat is negative, and zero otherwise.
<i>MKTCOMP</i>	Herfindahl–Hirschman Index is calculated at the SIC-2-digit industry-year level using market value. Market value is calculated by multiplying the total number of shares of common equity outstanding at fiscal year-end by the closing price per share at fiscal year-end per Compustat.
<i>PPE</i>	Natural logarithm of one plus net PPE per Compustat. PPE_t captures this value in the current fiscal year. PPE_{t-1} captures this value in the prior fiscal year.
<i>RDINT</i>	Total R&D expenditure divided by sales revenue per Compustat. Consistent with Christensen (2016) and Du and Wu (2019), I assume that R&D equals 0 if the data is missing in Compustat.
<i>ROA</i>	Return-on-Assets, calculated as net income divided by total assets per Compustat.
<i>SALE</i>	Sales revenue per Compustat. Following Barth and Kallapur (1996), I include this variable as an alternative to scaling Total CO2 Equivalent Emissions obtained from LSEG Refinitiv when calculating <i>GHG</i> .
<i>SALEGROWTH</i>	Percentage change in sales revenue from the prior fiscal year per Compustat.
<i>SIZE</i>	Natural logarithm of one plus total assets per Compustat.
<i>TANG</i>	Net PPE divided by total assets per Compustat.
<i>TOBINQ</i>	Tobin's Q, calculated as the sum of market value of common equity, book value of preferred stock, book value of long-term debt, and current liabilities, divided by book value of total assets per Compustat.

Table 1: Sample construction**Panel A: Sample construction for analysis of assurance and future carbon emissions**

Company-year observations between Jan 1, 2000, and Dec 31, 2023, per Refinitiv	42,346
Less:	
Company-year observations with missing sustainability reporting coverage in Refinitiv	(22,954)
Company-year observations with incorrect assurance data in Refinitiv	(24)
Company-year observations with missing Compustat and control variable data	(13,575)
Company-year observations where company does not issue a sustainability report	(733)
Company-year observations with missing assurance information in Refinitiv	(2,253)
Final number of company-year observations	2,807

	<u>Full</u>	<u>Higher</u> <u>Env.</u> <u>Impact</u>	<u>Lower</u> <u>Env.</u> <u>Impact</u>
Number of company-year observations	2,807	834	1,973
Unassured sustainability report	1,359	339	1,020
Assured sustainability report	1,448	495	953
Assured by accounting firm	322	115	207
Assured by non-accounting firm	1,126	380	746

Panel B: Sample construction for analysis of assurance and future violations

Company-year observations between Jan 1, 2000, and Dec 31, 2023, per Refinitiv	42,346
Less:	
Company-year observations with missing sustainability reporting coverage in Refinitiv	(22,954)
Company-year observations with incorrect assurance data in Refinitiv	(24)
Company-year observations with missing Compustat and control variable data	(4,242)
Company-year observations where company does not issue a sustainability report	(7,239)
Company-year observations with missing assurance information in Refinitiv	(4,192)
Final number of company-year observations	3,695

	<u>Full</u>	<u>Higher</u> <u>Env.</u> <u>Impact</u>	<u>Lower</u> <u>Env.</u> <u>Impact</u>
Number of company-year observations	3,695	1,296	2,399
Unassured sustainability report	2,023	667	1,356
Assured sustainability report	1,672	629	1,043
Assured by accounting firm	384	147	237
Assured by non-accounting firm	1,288	482	806

Note: This table presents sample construction for the samples that I use in various analyses. Panel A presents sample construction calculations for the analysis of sustainability reporting assurance and future carbon emissions using Equation (1). Panel B presents sample construction calculations for the analysis of sustainability reporting assurance and future environmental regulation violations using Equation (2).

Table 2: Descriptive statistics

Panel A: For sample used in analysis of assurance and future carbon emissions

Variable	Full Sample						Higher Environmental Impact						Lower Environmental Impact					
	N	Mean	SD	p25	p50	p75	N	Mean	SD	p25	p50	p75	N	Mean	SD	p25	p50	p75
GHG_{t+2}	2,085	14.35	1.99	12.92	14.30	15.90	651	15.50	1.80	14.27	15.62	16.73	1,434	13.83	1.85	12.51	13.79	15.10
GHG_{t+3}	1,779	14.85	1.94	13.47	14.76	16.38	568	15.96	1.78	14.70	16.09	17.15	1,211	14.34	1.80	13.04	14.31	15.55
GHG_{t-1}	2,807	13.47	2.11	12.01	13.53	15.00	834	14.75	1.83	13.50	14.88	16.01	1,973	12.93	1.99	11.60	12.90	14.29
$ASSURE_t$	2,807	0.52	0.50	0.00	1.00	1.00	834	0.59	0.49	0.00	1.00	1.00	1,973	0.48	0.50	0.00	0.00	1.00
$ACCOUNT_t$	1,448	0.22	0.42	0.00	0.00	0.00	495	0.23	0.42	0.00	0.00	0.00	953	0.22	0.41	0.00	0.00	0.00
$ASSETAGE_t$	2,807	0.51	0.14	0.41	0.49	0.60	834	0.52	0.13	0.43	0.50	0.60	1,973	0.50	0.14	0.40	0.48	0.59
$CAPINT_t$	2,807	0.07	0.09	0.02	0.04	0.07	834	0.11	0.12	0.04	0.06	0.13	1,973	0.05	0.07	0.02	0.03	0.06
EMP_t	2,807	3.43	1.22	2.63	3.44	4.33	834	2.89	1.16	2.08	2.91	3.84	1,973	3.66	1.16	2.85	3.61	4.51
$FINRISK_t$	2,807	0.30	0.16	0.18	0.28	0.40	834	0.29	0.14	0.19	0.27	0.39	1,973	0.30	0.17	0.17	0.28	0.40
INV_t	2,807	6.13	2.68	5.66	6.91	7.77	834	6.94	1.65	6.23	7.19	7.99	1,973	5.79	2.95	5.22	6.76	7.67
INV_{t-1}	2,807	6.08	2.66	5.62	6.85	7.71	834	6.90	1.64	6.17	7.13	7.95	1,973	5.74	2.92	5.19	6.70	7.58
LIQ_t	2,807	0.12	0.07	0.07	0.11	0.15	834	0.12	0.06	0.08	0.12	0.16	1,973	0.11	0.07	0.07	0.10	0.15
PPE_t	2,807	8.17	1.54	7.03	8.13	9.23	834	8.88	1.31	8.08	8.93	9.71	1,973	7.87	1.54	6.75	7.80	8.81
$RDINT_t$	2,807	0.04	0.07	0.00	0.01	0.05	834	0.04	0.08	0.00	0.01	0.03	1,973	0.04	0.07	0.00	0.01	0.05
ROA_t	2,807	0.07	0.07	0.03	0.06	0.11	834	0.06	0.07	0.03	0.07	0.11	1,973	0.07	0.07	0.03	0.06	0.10
$SALEGROWTH_t$	2,807	0.07	0.20	-0.02	0.05	0.14	834	0.08	0.24	-0.03	0.05	0.15	1,973	0.07	0.18	(0.01)	0.05	0.13
$SALE_t$	2,807	27,707	41,879	5,603	12,466	27,746	834	27,113	43,025	5,761	12,353	24,556	1,973	27,959	41,394	5,522	12,501	29,061
$SIZE_t$	2,807	9.77	1.23	8.95	9.75	10.58	834	9.97	1.21	9.16	9.95	10.71	1,973	9.69	1.24	8.89	9.65	10.48
$TANG_t$	2,807	0.29	0.23	0.10	0.20	0.42	834	0.41	0.23	0.19	0.41	0.60	1,973	0.23	0.21	0.09	0.16	0.30

Panel B: For sample used in analysis of assurance and future environmental regulation violations

Variable	Full Sample						<i>Higher Environmental Impact</i>						<i>Lower Environmental Impact</i>					
	N	Mean	SD	p25	p50	p75	N	Mean	SD	p25	p50	p75	N	Mean	SD	p25	p50	p75
$VIOL_{t+2}$	3,338	0.51	0.77	0.00	0.00	0.69	1,189	0.92	0.96	0.00	0.69	1.39	2,149	0.28	0.52	0.00	0.00	0.69
$VIOL_{t+3}$	2,964	0.67	0.90	0.00	0.00	1.10	1,070	1.16	1.07	0.00	1.10	1.79	1,894	0.38	0.63	0.00	0.00	0.69
$VIOL_{t-1}$	3,695	0.31	0.59	0.00	0.00	0.69	1,296	0.60	0.78	0.00	0.00	1.10	2,399	0.16	0.37	0.00	0.00	0.00
$ASSURE_t$	3,695	0.45	0.50	0.00	0.00	1.00	1,296	0.49	0.50	0.00	0.00	1.00	2,399	0.44	0.50	0.00	0.00	1.00
$ACCOUNT_t$	1,672	0.23	0.42	0.00	0.00	0.00	629	0.23	0.42	0.00	0.00	0.00	1,043	0.23	0.42	0.00	0.00	0.00
$BUSSEG_t$	3,695	3.23	1.86	2.00	3.00	4.00	1,296	3.60	1.88	2.00	4.00	5.00	2,399	3.04	1.82	1.00	3.00	4.00
$GEOSEG_t$	3,695	3.49	2.61	2.00	3.00	5.00	1,296	3.54	3.17	1.00	3.00	4.00	2,399	3.46	2.25	2.00	3.00	5.00
$FINSTRENGTH_t$	3,695	8.76	2.12	8.00	10.00	10.00	1,296	8.71	2.20	8.00	10.00	10.00	2,399	8.78	2.07	8.00	10.00	10.00
IOR_t	3,695	0.58	0.37	0.00	0.73	0.85	1,296	0.65	0.29	0.62	0.75	0.83	2,399	0.53	0.40	0.00	0.72	0.86
$LITRISK_t$	3,695	0.14	0.35	0.00	0.00	0.00	1,296	0.16	0.36	0.00	0.00	0.00	2,399	0.13	0.34	0.00	0.00	0.00
$TOBINQ_t$	3,695	2.05	1.51	1.11	1.54	2.41	1,296	1.62	1.01	0.97	1.25	1.96	2,399	2.29	1.68	1.22	1.72	2.69
$MKTCOMP_t$	3,695	0.11	0.11	0.04	0.07	0.13	1,296	0.05	0.05	0.03	0.03	0.06	2,399	0.14	0.12	0.06	0.08	0.18
ROA_t	3,695	0.06	0.08	0.03	0.06	0.10	1,296	0.05	0.08	0.02	0.05	0.09	2,399	0.06	0.08	0.03	0.06	0.10
$SIZE_t$	3,695	9.73	1.24	8.91	9.74	10.58	1,296	10.00	1.14	9.30	10.04	10.75	2,399	9.58	1.26	8.77	9.57	10.43

Table 3: Assurance and future emissions

	GHG_{t+2} (1)	GHG_{t+3} (2)
$ASSURE_t$	-0.039*** (-3.91)	-0.059*** (-5.27)
$SIZE_t$	-0.017 (-0.86)	-0.029 (-1.24)
ROA_t	-0.469*** (-5.44)	-0.736*** (-7.56)
$FINRISK_t$	-0.167*** (-4.08)	-0.189*** (-3.93)
LIQ_t	0.429*** (3.92)	0.884*** (6.60)
$SALEGROWTH_t$	0.534*** (15.04)	0.606*** (16.50)
$ASSETAGE_t$	0.284*** (4.56)	0.510*** (6.55)
$CAPINT_t$	-0.077 (-0.70)	-0.097 (-0.65)
$RDINT_t$	0.303*** (2.79)	0.137 (1.04)
GHG_{t-1}	0.956*** (109.59)	0.937*** (83.41)
$TANG_t$	0.020 (0.24)	-0.094 (-0.93)
EMP_t	-0.005 (-0.61)	0.002 (0.18)
INV_t	0.058*** (3.97)	0.056*** (3.80)
INV_{t-1}	-0.061*** (-4.22)	-0.063*** (-4.32)
PPE_t	0.061** (2.52)	0.086*** (2.86)
$SALE_t$	0.000 (0.80)	0.000 (0.79)
$KVFUNCTION_t$	0.445*** (15.26)	0.502*** (18.32)
<i>Constant</i>	0.822*** (8.87)	1.317*** (11.37)
Observations	2,030	1,730
Adjusted R-squared	0.993	0.993

Note: This table presents results when estimating Equation (1) with $ASSURE_t$ as the variable of interest to examine the association between a company's decision to independently assure its sustainability report and future carbon emissions. All variables are defined in the Appendix. All regressions include year fixed effects and standard error clustering by company. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 4: Assurance and future emissions across companies by environmental impact

	GHG_{t+2}		GHG_{t+3}	
	(1)	(2)	(3)	(4)
	<u>Higher</u>	<u>Lower</u>	<u>Higher</u>	<u>Lower</u>
$ASSURE_t$	-0.022*** (-3.09)	-0.013 (-0.85)	-0.017* (-1.97)	-0.031 (-1.30)
$SIZE_t$	-0.101*** (-6.39)	-0.034 (-1.18)	-0.101*** (-6.42)	-0.042 (-1.03)
ROA_t	0.260*** (3.62)	-0.538** (-2.60)	0.169** (2.09)	-0.570* (-1.91)
$FINRISK_t$	0.146*** (3.88)	-0.176** (-2.56)	0.220*** (5.99)	-0.126 (-1.35)
LIQ_t	0.060 (0.84)	0.359* (1.78)	0.359*** (6.41)	0.636** (2.06)
$SALEGROWTH_t$	0.278*** (12.14)	0.543*** (8.74)	0.141*** (6.19)	0.703*** (6.58)
$ASSETAGE_t$	0.476*** (13.27)	0.273** (2.54)	0.602*** (13.69)	0.498*** (3.32)
$CAPINT_t$	0.330*** (3.51)	-0.447** (-2.28)	0.372*** (3.19)	-0.730* (-1.83)
$RDINT_t$	-0.303*** (-6.73)	0.811*** (4.25)	-0.420*** (-8.25)	0.913*** (3.29)
GHG_{t-1}	0.969*** (220.62)	0.947*** (64.88)	0.955*** (202.30)	0.923*** (41.08)
$TANG_t$	-0.139* (-1.82)	-0.023 (-0.21)	-0.188** (-2.15)	-0.088 (-0.55)
EMP_t	0.041*** (4.53)	-0.007 (-0.54)	0.039*** (3.76)	0.002 (0.13)
INV_t	0.213*** (15.33)	0.039** (2.37)	0.263*** (19.47)	0.025 (0.91)
INV_{t-1}	-0.211*** (-16.10)	-0.041** (-2.56)	-0.267*** (-22.56)	-0.027 (-1.03)
PPE_t	0.110*** (5.47)	0.091** (2.58)	0.124*** (5.90)	0.118** (2.31)
$SALE_t$	0.000 (0.04)	0.000 (0.74)	0.000 (0.96)	0.000 (0.41)
$KVFUNCTION_t$	0.592*** (52.22)	0.261*** (4.14)	0.625*** (48.39)	0.042* (1.72)
<i>Constant</i>	0.716*** (11.08)	0.894*** (6.21)	1.152*** (15.38)	1.336*** (6.24)
Observations	634	1,386	555	1,169
Adjusted R-squared	0.999	0.985	0.999	0.974

Note: This table presents results when estimating Equation (1) with $ASSURE_t$ as the variable of interest and considering the environmental impact of a company's operations. Following prior research (Cho et al., 2014; Cho & Patten, 2007; Patten, 2002), a company's operations have a higher environmental impact if it operates in an industry with the following SIC codes: 10xx, 13xx, 26xx, 28xx, 29xx, 33xx, or 49xx. All variables are defined in the Appendix. All regressions include year fixed effects and standard error clustering by company. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 5: Assurance and future violations

	$VIOL_{t+2}$ (1)	$VIOL_{t+3}$ (2)
$ASSURE_t$	-0.024 (-1.42)	-0.021 (-0.95)
$BUSSEG_t$	0.039*** (6.88)	0.048*** (7.48)
$GEOSEG_t$	0.014*** (3.09)	0.015*** (2.70)
$FINSTRENGTH_t$	0.010** (2.54)	0.015*** (2.59)
IOR_t	0.087*** (3.68)	0.151*** (4.75)
$LITRISK_t$	0.055*** (2.73)	0.048 (1.56)
$TOBINQ_t$	-0.021*** (-4.51)	-0.031*** (-4.37)
$MKTCOMP_t$	0.088 (0.94)	0.021 (0.17)
$VIOL_{t-1}$	0.747*** (26.43)	0.849*** (29.06)
ROA_t	0.054 (0.50)	0.112 (0.84)
$SIZE_t$	0.051*** (6.36)	0.065*** (6.30)
$KVFUNCTION_t$	0.395*** (7.75)	0.440*** (5.51)
<i>Constant</i>	-0.724*** (-7.95)	-0.896*** (-7.96)
Observations	3,262	2,896
Adjusted R-squared	0.767	0.782

Note: This table presents results when estimating Equation (2) with $ASSURE_t$ as the variable of interest to examine the association between a company's decision to independently assure its sustainability report and the occurrence of future environmental regulation violations. All variables are defined in the Appendix. All regressions include year fixed effects, standard error clustering by company, and an industry-year trend to control for the change in the likelihood of environmental regulation violations across industries over time. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 6: Assurance and future violations across companies by environmental impact

	$VIOL_{t+2}$		$VIOL_{t+3}$	
	(1)	(2)	(3)	(4)
	<i>Higher</i>	<i>Lower</i>	<i>Higher</i>	<i>Lower</i>
$ASSURE_t$	-0.079*** (-5.11)	0.050** (2.20)	-0.102*** (-5.46)	0.059* (1.91)
$BUSSEG_t$	0.050*** (8.11)	0.019*** (3.01)	0.066*** (10.35)	0.026*** (2.83)
$GEOSEG_t$	0.025*** (7.78)	0.007 (1.34)	0.023*** (6.40)	0.010 (1.27)
$FINSTRENGTH_t$	0.022*** (4.51)	0.009** (2.02)	0.024*** (4.31)	0.015** (2.21)
IOR_t	0.132*** (4.02)	0.049* (1.79)	0.250*** (5.65)	0.092** (2.15)
$LITRISK_t$	0.113*** (8.58)	-0.010 (-0.43)	0.143*** (8.81)	-0.023 (-0.69)
$TOBINQ_t$	-0.039*** (-6.03)	0.000 (0.09)	-0.068*** (-9.57)	0.001 (0.18)
$MKTCOMP_t$	0.179 (1.03)	0.052 (0.51)	0.093 (0.49)	0.024 (0.17)
$VIOL_{t-1}$	0.760*** (63.17)	0.572*** (15.10)	0.857*** (65.05)	0.726*** (14.83)
ROA_t	0.355*** (5.26)	-0.288*** (-2.79)	0.367*** (4.53)	-0.404** (-2.58)
$SIZE_t$	0.054*** (7.95)	0.043*** (4.58)	0.053*** (7.37)	0.057*** (3.86)
$KVFUNCTION_t$	1.326*** (35.77)	0.053** (2.00)	1.414*** (30.12)	0.061* (1.81)
<i>Constant</i>	-1.080*** (-13.52)	-0.563*** (-6.14)	-1.015*** (-9.85)	-0.749*** (-4.97)
Observations	1,167	2,069	1,054	1,838
Adjusted R-squared	0.974	0.527	0.973	0.542
Mean Length of Assurance (years)	4.270	3.659	4.309	3.548
<i>t-stat (Higher vs. Lower)</i>	2.867***		3.404***	

Note: This table presents results when estimating Equation (2) with $ASSURE_t$ as the variable of interest and considering the environmental impact of a company's operations. Following prior research (Cho et al., 2014; Cho & Patten, 2007; Patten, 2002), a company's operations have a higher environmental impact if it operates in an industry with the following SIC codes: 10xx, 13xx, 26xx, 28xx, 29xx, 33xx, or 49xx. All variables are defined in the Appendix. All regressions include year fixed effects, standard error clustering by company, and an industry-year trend to control for the change in the likelihood of environmental regulation violations across industries over time. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 7: Assurer-type and future emissions

	GHG_{t+2} (1)	GHG_{t+3} (2)
$ACCOUNT_t$	-0.021 (-0.76)	-0.057* (-1.80)
$SIZE_t$	-0.070** (-2.07)	-0.109** (-2.47)
ROA_t	-0.020 (-0.13)	-0.149 (-0.79)
$FINRISK_t$	-0.140* (-1.73)	-0.182* (-1.93)
LIQ_t	0.434* (1.90)	0.798*** (2.75)
$SALEGROWTH_t$	0.427*** (6.65)	0.528*** (5.77)
$ASSETAGE_t$	0.192* (1.72)	0.267* (1.94)
$CAPINT_t$	0.224 (1.38)	0.233 (0.98)
$RDINT_t$	0.125 (0.56)	-0.168 (-0.64)
GHG_{t-1}	0.991*** (71.22)	0.972*** (53.65)
$TANG_t$	-0.198 (-1.27)	-0.373** (-1.98)
EMP_t	0.010 (0.68)	0.011 (0.63)
INV_t	0.012 (0.44)	0.008 (0.27)
INV_{t-1}	-0.008 (-0.30)	-0.007 (-0.27)
PPE_t	0.068 (1.58)	0.120** (2.11)
$SALE_t$	0.000 (0.52)	0.000 (0.24)
$KVFUNCTION_t$	0.034*** (3.01)	0.073*** (3.36)
<i>Constant</i>	0.734*** (4.82)	1.379*** (6.38)
Observations	908	734
Adjusted R-squared	0.986	0.985

Note: This table presents results when estimating Equation (1) with $ACCOUNT_t$ as the variable of interest to examine the association between the type of sustainability reporting assurance provider and future carbon emissions. All variables are defined in the Appendix. All regressions include year fixed effects and standard error clustering by company. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 8: Assurer-type and future emissions across companies by environmental impact

	GHG_{t+2}		GHG_{t+3}	
	(1)	(2)	(3)	(4)
	<u>Higher</u>	<u>Lower</u>	<u>Higher</u>	<u>Lower</u>
$ACCOUNT_t$	-0.079** (-2.56)	-0.035 (-0.99)	-0.125*** (-3.20)	-0.031 (-0.79)
$SIZE_t$	0.019 (0.37)	-0.116** (-2.44)	0.064 (1.16)	-0.148** (-2.53)
ROA_t	0.216 (1.26)	-0.305 (-1.54)	0.123 (0.63)	-0.166 (-0.63)
$FINRISK_t$	0.043 (0.39)	-0.243** (-2.23)	-0.049 (-0.38)	-0.318** (-2.44)
LIQ_t	0.279 (1.21)	0.255 (0.97)	0.420* (1.85)	0.630* (1.83)
$SALEGROWTH_t$	0.329*** (5.72)	0.523*** (3.57)	0.294*** (5.10)	0.786*** (4.14)
$ASSETAGE_t$	0.359*** (2.70)	0.080 (0.45)	0.379** (2.21)	0.155 (0.76)
$CAPINT_t$	-0.064 (-0.35)	-0.335 (-1.36)	-0.171 (-0.82)	-0.872** (-2.32)
$RDINT_t$	-0.237 (-1.21)	0.654** (2.14)	-0.382* (-1.94)	0.657** (2.00)
GHG_{t-1}	0.986*** (54.69)	0.975*** (45.46)	0.977*** (44.01)	0.968*** (38.19)
$TANG_t$	0.424* (1.86)	-0.343* (-1.82)	0.582** (2.03)	-0.346 (-1.49)
EMP_t	0.074*** (3.37)	-0.001 (-0.05)	0.077*** (3.44)	-0.008 (-0.36)
INV_t	0.026 (0.60)	-0.022 (-0.56)	0.036 (0.87)	-0.004 (-0.11)
INV_{t-1}	-0.052 (-1.13)	0.018 (0.47)	-0.077* (-1.69)	0.002 (0.08)
PPE_t	-0.051 (-0.80)	0.173*** (2.83)	-0.091 (-1.27)	0.205*** (2.71)
$SALE_t$	-0.000 (-0.32)	-0.000 (-0.42)	-0.000 (-0.28)	-0.000 (-0.15)
$KVFUNCTION_t$	0.178*** (3.20)	0.055*** (2.90)	0.248*** (4.08)	0.143*** (2.68)
<i>Constant</i>	0.697*** (3.02)	0.846*** (3.61)	1.182*** (4.07)	1.347*** (4.45)
Observations	343	569	285	449
Adjusted R-squared	0.995	0.979	0.994	0.977

Note: This table presents results when estimating Equation (1) with $ACCOUNT_t$ as the variable of interest and considering the environmental impact of a company's operations. Following prior research (Cho et al., 2014; Cho & Patten, 2007; Patten, 2002), a company's operations have a higher environmental impact if it operates in an industry with the following SIC codes: 10xx, 13xx, 26xx, 28xx, 29xx, 33xx, or 49xx. All variables are defined in the Appendix. All regressions include year fixed effects and standard error clustering by company. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 9: Assurer-type and future violations

	$VIOL_{t+2}$ (1)	$VIOL_{t+3}$ (2)
$ACCOUNT_t$	-0.033 (-0.93)	-0.069 (-1.47)
$BUSSEG_t$	0.039*** (3.95)	0.043*** (3.35)
$GEOSEG_t$	0.011 (1.30)	0.004 (0.33)
$FINSTRENGTH_t$	0.003 (0.45)	0.012 (1.14)
IOR_t	0.037 (0.82)	0.093 (1.45)
$LITRISK_t$	0.075* (1.96)	0.107** (2.16)
$TOBINQ_t$	-0.019** (-2.37)	-0.025** (-2.12)
$MKTCOMP_t$	0.154 (0.94)	0.448* (1.94)
$VIOL_{t-1}$	0.699*** (15.59)	0.797*** (15.93)
ROA_t	0.161 (0.85)	-0.029 (-0.11)
$SIZE_t$	0.045*** (3.04)	0.058*** (2.96)
$KVFUNCTION_t$	0.060*** (2.60)	0.125*** (3.07)
<i>Constant</i>	-0.593*** (-3.42)	-0.758*** (-3.23)
Observations	1,350	1,105
Adjusted R-squared	0.654	0.687

Note: This table presents results when estimating Equation (2) with $ACCOUNT_t$ as the variable of interest to examine the association between the type of sustainability reporting assurance provider and the occurrence of future environmental regulation violations. All variables are defined in the Appendix. All regressions include year fixed effects, standard error clustering by company, and an industry-year trend to control for the change in the likelihood of environmental regulation violations across industries over time. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.

Table 10: Assurer-type and future violations across companies by environmental impact

	$VIOL_{t+2}$		$VIOL_{t+3}$	
	(1)	(2)	(3)	(4)
	<u>Higher</u>	<u>Lower</u>	<u>Higher</u>	<u>Lower</u>
$ACCOUNT_t$	0.057 (0.78)	-0.082** (-2.46)	0.081 (0.71)	-0.127** (-2.50)
$BUSSEG_t$	0.077*** (3.85)	0.006 (0.63)	0.093*** (3.49)	0.009 (0.69)
$GEOSEG_t$	0.008 (0.74)	0.012 (1.32)	-0.008 (-0.50)	0.014 (1.06)
$FINSTRENGTH_t$	0.005 (0.37)	0.010 (1.15)	0.001 (0.05)	0.022 (1.52)
IOR_t	0.121 (0.92)	0.007 (0.14)	0.216 (1.04)	0.067 (0.90)
$LITRISK_t$	0.144** (2.07)	0.005 (0.13)	0.236*** (2.70)	-0.022 (-0.40)
$TOBINQ_t$	-0.052** (-2.19)	-0.005 (-0.75)	-0.086** (-2.58)	0.004 (0.35)
$MKTCOMP_t$	-0.761 (-1.47)	0.275 (1.64)	-0.497 (-0.52)	0.435* (1.84)
$VIOL_{t-1}$	0.743*** (12.90)	0.486*** (9.56)	0.840*** (11.92)	0.592*** (8.80)
ROA_t	0.267 (0.84)	-0.083 (-0.44)	0.595 (1.33)	-0.301 (-0.91)
$SIZE_t$	0.060** (2.22)	0.044*** (3.17)	0.058 (1.49)	0.068*** (3.27)
$KVFUNCTION_t$	0.106*** (3.28)	0.028*** (3.70)	0.094** (2.26)	0.034*** (3.43)
<i>Constant</i>	-0.820*** (-2.86)	-0.522*** (-3.27)	-0.693 (-1.64)	-0.862*** (-3.52)
Observations	523	823	443	664
Adjusted R-squared	0.695	0.517	0.713	0.538

Note: This table presents results when estimating Equation (2) with $ACCOUNT_t$ as the variable of interest and considering the environmental impact of a company's operations. Following prior research (Cho et al., 2014; Cho & Patten, 2007; Patten, 2002), a company's operations have a higher environmental impact if it operates in an industry with the following SIC codes: 10xx, 13xx, 26xx, 28xx, 29xx, 33xx, or 49xx. All variables are defined in the Appendix. All regressions include year fixed effects, standard error clustering by company, and an industry-year trend to control for the change in the likelihood of environmental regulation violations across industries over time. Robust t-statistics are in parentheses. *, **, and *** represent significance levels of 10 percent, 5 percent, and 1 percent, respectively.