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RESEARCH ARTICLE OPEN ACCESS

Audit Quality and Materiality Disclosure Quality in Integrated Reporting: The Moderating Effect of Carbon Assurance Quality

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Correspondence: Patrick Velte (patrick.velte@leuphana.de)**Received:** 19 October 2024 | **Revised:** 2 January 2025 | **Accepted:** 29 January 2025**Keywords:** audit fees | audit quality | big four audit firm | carbon assurance | integrated reporting | materiality

ABSTRACT

This study concentrates on the link between audit quality and materiality disclosure quality in integrated reporting and the moderating effect of carbon assurance quality. The cross-country study consists of 612 firm-year observations from European and South African listed firms between 2017 and 2022. Regression analyses indicate that audit fees and big four audit firms are positively and significantly related to integrated reporting quality, whereas audit firms as carbon assurers, reasonable assurance level, and reference to international sustainability assurance standards strengthen this link. These findings are robust to several endogeneity and additional analyses. The study mainly contributes to the increasing research on the influence of financial audits on sustainability issues. To the best of our knowledge, this is the first empirical study on the relationship between audit quality and integrated reporting quality, based on materiality disclosure. Moreover, the moderator effect of carbon assurance quality is included as an innovative complementary monitoring factor.

1 | Introduction

Financial statements by public interest entities (PIEs) have been criticized by many stakeholders due to their low-quality information content (Tan et al. 2023). As a reaction, stand-alone sustainability reports, e.g., based on the Global Reporting Initiative (GRI) standards, become a “best practice” since the financial crisis of 2008-09 (KPMG 2022). However, we stress the limited reliability of sustainability reports due to greenwashing and information overload (de Villiers et al. 2014). Integrated reporting should decrease these risks as the major aim is to connect material financial, environmental, social, and governance (ESG) information in one document (Gerwanski et al. 2019). Integrated reports should lead to an increased information value of business reporting by PIEs, and they reduce greenwashing and information overload (Hichri 2023).

Except for South Africa, integrated reporting is still voluntary in most regimes (Gerwanski et al. 2019). However, the former International Integrated Reporting Council (IIRC) was consolidated into the new global International Sustainability Standards Board (ISSB). The ISSB has already published two global reporting standards with a focus on climate disclosure. It is expected that the ISSB will be the “gold standard” for listed firms on national stock exchanges, stressing the link between climate and financial risks (Velte 2023). As shareholders and other stakeholders demand clear connectivity between financial and ESG information and better quantification of ESG aspects, we stress an urgent need to rely on research on integrated reporting quality.

In view of voluntary publication in most regimes, a focus on the materiality principle in integrated reports and the “integrated

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thinking” approach is crucial (Gerwanski et al. 2019). The integrated reporting framework by the IIRC (IIRC 2021) is principle-based, whereas materiality is the dominant principle in this framework. Stakeholders demand a precise reference in the integrated reporting about the operationalization of the materiality principle within the integrated reporting process (Velte 2022). As a major part of materiality disclosure, stakeholder integration in the materiality assessment must be recognized. We assume that the reliance on the materiality principle impacts sustainability management significantly (IIRC 2013a; Higgins et al. 2014). The IIRC framework (IIRC 2013b) stresses that material information is of “such relevance and importance that it could substantively influence the assessments of providers of financial capital with regard to the organization’s ability to create value over the short, medium and long term”.

Due to the major connections between financial statements, sustainability reports, and integrated reporting, we address the roles of financial audit, sustainability assurance, and integrated reports in this study. While many studies have analyzed the impact of earnings quality on sustainability outputs (Velte 2024) or of sustainability outputs on integrated reporting (e.g., Gerwanski et al. 2019), we know very little about the link between financial audits and integrated reporting quality. We only note four studies on that topic. Chouaibi and Hichri (2021) found a positive impact of auditor industry specialization and inclusion of the code of ethics of audit firms and integrated reporting quality, while the big four audit firms did not have any significant impact in a European sample. Hichri (2023) documented a positive impact of audit fees and environmental assurance on integrated reporting quality, whereas Rivera-Arrubla et al. (2017) did not stress any significant impact of big four audit firms on integrated reporting. Finally, Appiagyei et al. (2023) found a positive impact of big four audit firms and no impact of auditor switch on integrated reporting quality in South Africa.

In the context of these heterogeneous results, researchers did not focus on materiality disclosure quality in integrated reporting (MRQ). Few analyses have been conducted on the link between earnings management (e.g., Velte 2023), corporate governance (Velte 2022; Gerwanski et al. 2019) and MRQ. Most studies have relied on the impact of audit quality on sustainability performance and reporting (e.g., Al Ani et al. 2024; Blanco et al. 2024). The contribution of the financial auditor on MRQ has not been analyzed yet. Financial auditors should fulfill a major monitoring function to increase both financial reporting quality and MRQ (DeAngelo 1981). Moreover, as integrated reports link financial and sustainability reports, we include carbon assurance quality as a possible moderator of this link. Climate outputs represent the most important sustainability factor in research and business practice nowadays (Alfi et al. 2023), thus a focus on this dimension seems to be justified.

In our study, we refer to an international sample of 612 firm-year observations between 2017 and 2022 and analyze the impact of audit quality, based on audit fees and big four audit firms, on MRQ. In this context, we include South Africa as a mandatory regime for integrated reporting and the European capital

market as a voluntary setting (Gerwanski et al. 2019). The increased sustainability reporting regulations and the Green Deal project within the European Union justify this focus (see also Velte 2022; Chouaibi and Hichri 2021). Moreover, carbon assurance quality, based on the selection of audit firms as carbon assurers, reasonable carbon assurance level, and reliance on global assurance standards, will be included as a moderator.

We contribute to the prior literature in many ways. First, audit and assurance-related determinants of MRQ have been neglected in former studies (e.g., Gerwanski et al. 2019; Fasan and Mio 2017). Moreover, the connectivity between financial audits, carbon assurance, and integrated reporting was not recognized yet, while the integrated thinking process should be monitored by financial auditors and sustainability assurers. This leads to the following research questions:

1. Does audit quality influence MRQ and
2. Does carbon assurance quality moderate the link between audit quality and MRQ?

Based on stakeholder agency theory and prior research, we assume a positive relationship between the variables. Regression analyses indicate a positive influence of both proxies of audit quality (audit fees and big four audit firms) on MRQ in line with our basic assumptions. We are aware that the two audit quality proxies included in the study have some limitations. First, audit fees may be related to audit efficiency instead of audit quality (DeFond and Zhang 2014). Second, big four audit firms may also fail, as the former Wirecard scandal in Germany stresses. Agency conflicts may also be present in these audit firms (DeFond and Zhang 2014; Chen et al. 2016). Moreover, in line with our assumptions, carbon assurance quality strengthens this link. Our results are robust to endogeneity checks and additional analyses.

The structure of the paper is as follows. First, we start with a stakeholder theoretical foundation, a literature review, and our hypotheses. Then, we present the sample selection, an overview of included variables, and the regression models. The next chapter includes the results of empirical analyses (descriptive statistics, correlations, regression, robustness, and endogeneity analyses). We discuss the results, include a summary, and present an outlook.

2 | Theory, Literature Review, and Hypotheses Development

2.1 | Stakeholder Agency Theory

Previous studies on audit quality and integrated reporting have relied on different theories (e.g., resource dependence theory, institutional theory, agency theory) (e.g., Hichri 2023), while stakeholder theory (Freeman 1984) and principal-agent theory (Jensen and Meckling 1976; Ross 1973) are most popular in this context (Velte and Stawinoga 2017). In this study, we used stakeholder agency theory (Hill and Jones 1992) as a combination of the principal agent and stakeholder theories for the following reasons: in line with principal-agent theory (Jensen and Meckling 1976), financial audit and carbon assurance with an

adequate quality should decrease agency conflicts (information asymmetries between management and shareholders and conflicts of interest). While the traditional focus of financial auditors was on financial reporting, financial auditors were also responsible for checking the reliability of integrated reports. As financial auditors may also be engaged as sustainability assurers, the connectivity between financial and sustainability information is highlighted.

Integrated reports represent a broad stakeholder tool (IIRC 2013a; Flower 2015). Thus, an extension of the principal-agent theory to other nonshareholding stakeholders is justified (Gerwanski et al. 2019). We assume that shareholders and other stakeholders demand that financial and sustainability information, combined in an integrated report, should be reliable. In line with stakeholder theory, top managers engage with “those groups who can affect or are affected by the achievement of an organization’s purpose” (Freeman 1984, 49). Thus, executive directors should balance conflicting interests between stakeholders, which should lead to a proper integration of financial and sustainability information. The key assumption of integrated reporting is that “an organization’s ability to create value over time depends on (...) the quality of its relationships with, and assessments by, its stakeholders” (IIRC 2013b, 1). Integrated reporting should satisfy various stakeholder interests, leading to a holistic presentation of six (non)-financial capitals. These capitals must relate to the materiality principle and a precise disclosure of the operationalization of this principle based on stakeholder demands (Velte 2023). However, integrated reports lack objectivity and comparability due to an increased level of management discretion. This also relates to the consolidation of the former IIRC on the ISSB and the publication of the first two ISSB standards. Integrated reports may be used for either symbolic or substantive CSR activities (Chouaibi and Hichri 2021). Information overload and greenwashing may also be related to integrated reports in line with stand-alone CSR reports (Flower 2015). Thus, information asymmetries between management and external stakeholders may not significantly be reduced. Strong corporate governance tools as monitoring instruments represent a useful way to overcome these limitations (Velte and Stawinoga 2017).

2.2 | Hypothesis 1: The Financial Auditor’s Role in Integrated Reporting Quality

As a major part of the corporate governance system, the financial auditor is a monitoring mechanism with a major impact on the integrated reporting process of firms (Appiagyei et al. 2023). The major goal of the financial auditor is to verify the compliance of the financial statements with the relevant regulations and norms (DeAngelo 1981). The auditor reports an opinion to the stakeholders to stress the reliability of financial statements, referring to the famous “gatekeeper” or “public watchdog” function. A proper gatekeeper function of financial auditors should reduce agency conflicts between management and stakeholders (Hill and Jones 1992). Thus, stakeholders are dependent on the publication of the audit opinion with the main audit results. Stakeholder agency theory (Hill and Jones 1992) assumes that reliable financial data included in integrated reports is

most important for their decision-making. An annual audit of financial reports should increase the incentives of top managers to realize an adequate quality of integrated reports (Rivera-Arrubla et al. 2017). Financial auditors may discover material errors in the financial statements, leading to a greater risk of a modified opinion. As managers like to receive a clean opinion, they should recognize appropriate resources to establish an integrated report with adequate quality.

Audit quality can be measured by various input and output factors (e.g., DeFond and Zhang 2014). We focus on input-related auditor characteristics and auditor-client contracting features in this study, as they are more directly linked to auditors’ resources and skills in comparison to output measures, e.g., financial reporting quality or market reactions (DeFond and Zhang 2014). The existence of big four audit firms is a dominant proxy in empirical audit research and a useful audit quality measure because large auditors are expected to have stronger incentives and greater competencies to provide high audit quality (DeAngelo 1981; DeFond and Zhang 2014). A major strength of this variable is its relatively high construct validity (DeFond and Zhang 2014). In line with the big four audit firms, audit fees are very popular in prior research as a proxy of audit quality because audit fees are expected to measure the auditors’ effort levels, which are inputs to the audit process that is related to audit quality (DeFond and Zhang 2014). One major advantage of audit fees as an audit quality measure is that the variable is continuous and thus captures subtle variations in quality (DeFond and Zhang 2014). However, audit fees also capture risk premia and improve audit efficiency in contrast to audit efforts (DeFond and Zhang 2014). In this context, we stress the risk that financial auditors may react as opportunistic agents in line with the management. When financial auditors are not independent from their clients, audit quality will be lower, and this contrasts with stakeholders’ information needs.

Table 1 summarizes the prior studies on the impact of audit quality on sustainability and integrated reporting. Nine studies have stressed the role of financial auditors in improving the quality of sustainability and integrated reporting in line with stakeholder agency theory (e.g., Chouaibi and Hichri 2021). Thus, they significantly contribute to decreased agency conflicts between management stakeholders. Financial auditors are not only reliable in the audit of financial statements, but they also review integrated reports as “other information”. Moreover, financial auditors may be additionally selected as sustainability assurers, stressing the link between financial audit and sustainability assurance.

As indicated in Table 1, most studies have focused on stand-alone sustainability reporting as outputs, while integrated reporting is of low relevance yet. Based on a sample of listed firms in South Africa, Appiagyei et al. (2023) found a positive impact of the big four audit firms on integrated reporting quality. Chouaibi and Hichri (2021) addressed European firms and documented the positive impact of auditor industry specialization and the implementation of a code of ethics in audit firms on integrated reporting quality. However, big four audit firms do not change integrated reporting quality. Based on international samples, audit fees increase integrated reporting quality (Hichri 2023), while big four audit firms and integrated reporting quality are

TABLE 1 | Studies on the impact of audit quality on sustainability and integrated reporting.

Year of publication	Author(s)	Journal	Audit quality as independent variable(s)	Sustainability or integrated reporting as dependent variable(s)	Significant results
2016	Chen et al.	<i>Journal of Management Accounting Research</i>	<ul style="list-style-type: none"> • State • Sample • Years • Method • Theory <ul style="list-style-type: none"> • USA • 2000-08 • 12,429 firm-year observations • OLS; 2SLS/IV; Heckman 2 stage • N.A. 	CSR reporting (dummy)	+
2017	Rivera-Arribla et al.	<i>Social Responsibility Journal</i>	<ul style="list-style-type: none"> • International • 91 firms • 2011 • OLS • Institutional theory 	Integrated reporting quality (self-created score)	±
2018	Fernandez-Feijoo et al.	<i>Corporate Social Responsibility and Environmental Management</i>	<ul style="list-style-type: none"> • International • 2011-13 • 2751 and 1415 firm-year observations • Panel • Legitimacy theory 	CSR reporting quality (GRI score) CSR assurance (dummy) Big four assurance firm (dummy)	+ + +
2019	Pucheta-Martinez et al.	<i>Corporate Social Responsibility and Environmental Management</i>	<ul style="list-style-type: none"> • Spain • 2004-14 • 1312 firm-year observations • Tobit • Agency theory 	CSR reporting quality (self-created score) CSR reporting quality (self-created score)	+ + +
2020	Hammami and Zadeh	<i>International Journal of Accounting & Information Management</i>	<ul style="list-style-type: none"> • Canada • 2008-17 • 1142 firm-year observations • OLS • Legitimacy theory; institutional theory 	CSR reporting (Bloomberg database) CSR reporting (Bloomberg database)	+

(Continues)

TABLE 1 | (Continued)

Year of publication	Author(s)	Journal	<ul style="list-style-type: none"> • State • Sample • Years • Method • Theory 	Audit quality as independent variable(s)	Sustainability or integrated reporting as dependent variable(s)	Significant results
2021	Chouaibi and Hichri	<i>International Journal of Law and Management</i>	<ul style="list-style-type: none"> • International (Europe) • 130 firms • 2017 • OLS • Moral-development theory; legitimacy theory 	<ul style="list-style-type: none"> Big four audit firm Auditor industry specialization Code of ethics of audit firm Development of behavioral skills in audit firm Moderator: polluting active industry 	Integrated reporting quality (Refinitiv score)	± + + ± Mod.: + (behavior)
2022	Handayati et al.	<i>Journal of Corporate Accounting & Finance</i>	<ul style="list-style-type: none"> • Indonesia • 394 firm-year observations • 2016–20 • OLS • Stakeholder theory 	<ul style="list-style-type: none"> Big four audit firm Moderator: board meeting frequency 	CSR reporting quality (GRI; self-creating score)	+ Mod.: more pronounced
2023	Appiagyei et al.	<i>Meditari Accountancy Research</i>	<ul style="list-style-type: none"> • South Africa • 2011–16 • 420 firm-year observations • Panel • Stakeholder theory 	<ul style="list-style-type: none"> Big four audit firm Joint audit Auditor switch 	<ul style="list-style-type: none"> Integrated reporting quality (score; EY Ranking) Sustainability performance (Bloomberg) 	+ ±
2023	Hichri	<i>European Business Review</i>	<ul style="list-style-type: none"> • International • 2010–19 • 300 firms • OLS • Stakeholder theory 	<ul style="list-style-type: none"> Audit fees Environmental assurance (dummy) 	Integrated reporting (Refinitiv score)	+ +

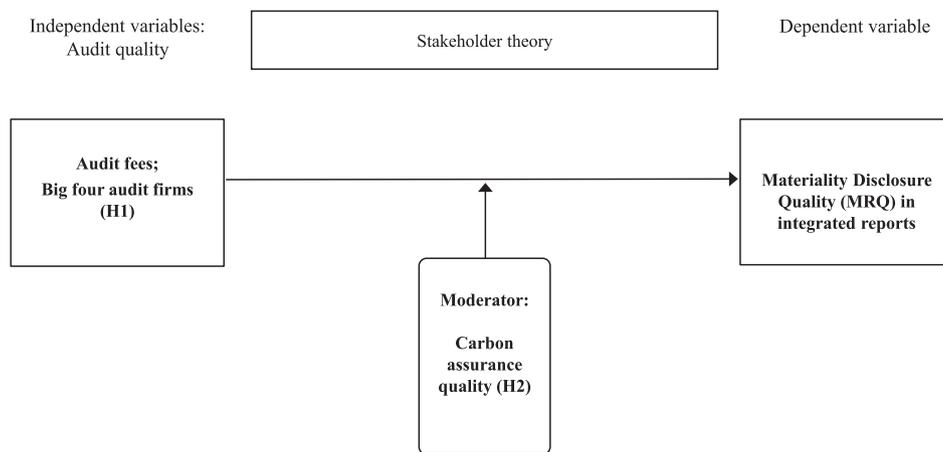


FIGURE 1 | Research framework.

found to be unrelated (Rivera-Arrubla et al. 2017). Table 1 also highlights that some researchers stressed the positive impact of audit fees (Chen et al. 2016; Hammami and Zadeh 2020; Pucheta-Martinez et al. 2019) and big four audit firms (Fernandez-Feijoo et al. 2018; Handayati et al. 2022; Pucheta-Martinez et al. 2019) on stand-alone sustainability reporting.

In line with previous research results (e.g., Hichri 2023) and stakeholder agency theory (Hill and Jones 1992), we assume that the selection of big four audit firms and higher audit fees for financial audits lead to an increased MRQ. Thus, our first hypothesis (H1) is as follows:

H1. *Audit quality, measured by big four audit firms and audit fees, improves MRQ.*

In the following, we formulate our second hypothesis on the moderating impact of carbon assurance quality regarding the impact of audit quality on integrated reporting.

2.3 | Hypothesis 2: The Moderating Effect of Carbon Assurance Quality

As integrated reports connect financial and sustainability reporting, we also include sustainability assurance with a focus on climate issues in our study. Stakeholders do not only demand high-quality financial statements but also reliable carbon reporting (Mahoney et al. 2013). In contrast to mandatory financial audits, carbon assurance is still voluntary in most countries. In line with stakeholder agency theory (Hill and Jones 1992), carbon assurance enhances the quality of sustainability reports and stakeholder attraction (Velte and Stawinoga 2017). Climate information as a major part of integrated reports can be linked with greenwashing and information overload (Mahoney et al. 2013). Stakeholders demand reliable climate reports, leading to the request for annual climate assurance. This strategy should reduce agency conflicts between management and stakeholders, and it should improve the quality of carbon information (Hill and Jones 1992). Due to the voluntary character of carbon assurance, firms can choose between audit firms and other assurance providers (Velte and Stawinoga 2017; Velte 2022). Prior research assumes that the selection of big four audit firms as

assurance providers leads to increased assurance quality, as these audit firms have more experience, resources, and knowledge of financial and sustainability figures in comparison to other assurance providers (Velte and Stawinoga 2017). Big four audit firms should decrease information asymmetries and conflicts of interest between management and stakeholders, as stakeholder agency theory assumes (Hill and Jones 1992). Thus, we expect that big four audit firms as assurance providers will positively influence MRQ due to their increased monitoring activities.

Regarding the scope of sustainability assurance, firms can choose between reasonable and limited assurance. While limited assurance is dominant in business practice due to cost savings (Velte and Stawinoga 2017; Hichri 2023), a reasonable assurance level leads to an increased assurance quality and should be positively related to MRQ. Moreover, firms may opt to engage assurance providers who include the International Standard on Assurance Engagement (ISAE) 3000 as the “best practice” for sustainability reporting. Including the ISAE 3000 should lead to increased assurance quality and to increased MRQ.

As integrated reporting covers a range of sustainability information, climate issues represent a dominant category in comparison to other environmental aspects or social dimensions (Velte 2022). Most environmental research has been focused on climate reporting (Alfi et al. 2023) and recent regulatory initiatives, such as the reporting standards of the ISSB, include a “climate first approach” (Velte 2022). One possible reason for this climate focus is the higher degree of operationalization of climate outputs (e.g., emissions) and the increased connectivity between climate risks and financial performance (Gerwanski et al. 2019).

Referring to prior research results on that topic, Sierra-García et al. (2015) found that managers who engage a third party to ensure their stand-alone sustainability reports might likewise be willing to spend money on integrated reporting and to be more focused on the quality of integrated reporting. While Sierra-García et al. (2015) found a positive effect of sustainability assurance on the implementation of integrated reporting, the choice of CSR assesor (audit firm) did not make a difference. However, Hichri (2023) documented that the existence

of environmental assurance leads to increased quality of integrated reporting.

Based on stakeholder agency theory (Hill and Jones 1992) and previous research results (e.g., Hichri 2023), we state hypothesis 2 (H2) as follows:

H2. *The positive influence of audit quality on MRQ will be strengthened by carbon assurance quality.*

Figure 1 highlights our research framework.

We present the research design in the next section with the sample selection process, variable descriptions, and regression models.

3 | Research Design

3.1 | Sample and Data

Regarding sample selection, we rely on European and South African companies and justify this choice as follows: First, integrated reporting is most important in both regimes (e.g., Sierra-García et al. 2015; Gerwanski et al. 2019; Velte 2022) in view of the regulatory pressure. South African firms listed on the Johannesburg Stock Exchange must publish integrated reports based on the King code ('apply or explain'; Dumay et al. 2016; Sierra-García et al. 2015). European regulations on sustainability reporting and corporate governance also lead to the increased relevance of integrated reporting in recent years (Velte 2022). The EU Directive 2014/95 (Nonfinancial Reporting Directive 2014) refers to the duty of specific big PIEs to prepare a nonfinancial declaration. The first year of mandatory publication of nonfinancial information was 2017, thus we started our data selection in this business year. 2022 was the most recent business year with proper coverage of integrated reports. In contrast to this, the new EU Corporate Sustainability Reporting Directive (CSRD 2022) requests a full sustainability report for a broader range of companies, whereas these must report on the financial consequences of environmental risks and chances. Moreover, business environments in South Africa and Europe are quite similar, e.g., investor protection rules and cultural aspects, which have a massive influence on integrated reporting (Gerwanski et al. 2019).

The initial sample relates to 2472 firm-year observations of 412 firms included in the Integrated Reporting Examples Database with headquarters in a European country or South Africa between 2017 and 2022. Carbon assurance variables were selected from the CDP database, whereas other variables were selected from Refinitiv. Around two-thirds of all companies included in the database referred to Europe and South Africa. This stresses the central role of these regimes for integrated reporting. Eighteen firms were deleted with a double-listing, 132 nonpublicly listed firms lacked Refinitiv and CDP coverage, and 56 firms from financial services were dropped. We delete financial services because firms in this industry have a specific asset structure and financial leverage, differ in accounting standards and practice, and sector-specific reporting rules compared to real economy firms (Gerwanski et al. 2019; Velte 2022). Firms

without a strong reference to the IIRC's framework are excluded (IIRC 2013a, 2021). The focus on the IIRC framework increases the comparability within our included firms. Furthermore, the IIRC framework explicitly stresses the need for materiality disclosure as a main component of integrated reporting. Integrated reports are manually checked, and 45 firms are excluded without a precise reference to the IIRC framework. Thus, the Integrated Reporting Examples Database includes some firms without strict connectivity with the IIRC framework in contrast with their goals. A potential reason for this result may be a decreased monitoring level of the database. Finally, after deleting 354 firm-year observations due to missing data, we note a final sample of 612 firm-year observations (102 firms) between 2017 and 2022. Table 2 gives an overview of the sample selection process.

3.2 | Variable Measurement

3.2.1 | Dependent Variables

In line with previous studies on integrated reporting (Fasan and Mio 2017; Gerwanski et al. 2019), we build a self-created integrated reporting quality score in line with stakeholder agency theory (Hill and Jones 1992) and major content elements that focus on materiality disclosure in integrated reporting, which are included in the IIRC framework (2013a, 2013b, 2021). In line with Gerwanski et al. (2019), we use the following seven elements for MRQ: (1) materiality section, (2) identification process, (3) description of material aspects, (4) time horizon, (5) materiality matrix, (6) risks and opportunities, and (7) mitigation actions. The score ranges from zero to 12 (Gerwanski et al. 2019).

Table 3 summarizes the components of the integrated reporting score.

As additional analyses, we measure the influence of audit quality on financial reporting quality. We include two proxies of earnings management, which are dominantly used in prior archival research on related topics. First, to address accruals-based earnings management (AEM), we used the accruals model by Kothari et al. (2005). Second, to include real earnings management (REM), we focus on three basic factors

TABLE 2 | Sample selection and composition.

Sample selection	Firms	Firm-years
Firms listed on the IIRC Examples Database	412	2472
Double-listed firms	(18)	(108)
No Refinitiv and CDP coverage	(132)	(792)
Financial services firms	(56)	(336)
Missing reference to the IIRC framework	(45)	(270)
Missing data	(59)	(354)
= Final sample	102	612

TABLE 3 | Content elements of MRQ (see also Gerwanski et al. 2019).

MRQ score			
Item #	Scoring element	Point range	Reference
1	<i>Materiality section:</i> An individual materiality section highlights the relevance of the materiality concept as a major element of an integrated report and the readability for a broad range of stakeholders.	0–2 0: No materiality section 1: A materiality section is existent 2: A materiality section is listed in the table of contents	IIRC 2013b: 8, 35
2	<i>Identification process:</i> The evaluation of the potential impact on the value-creation process is highly relevant for stakeholders. Proper stakeholder relations are demanded to include value factors.	0–2 0: No information 1: Reference to the identification process 2: Identification process is mentioned with a clear stakeholder interaction	IIRC 2013a: 3.18, 3.21–30; IIRC 2013b: 10–34, 39–40; Eccles and Krzus (2015)
3	<i>Description of material aspects:</i> Firms should describe their material sustainability aspects as a major part of the integrated report.	0–2 Reliance of the material issues was analyzed between 0 and 2 in line with detail, conciseness, and usefulness of the data.	IIRC 2013a: 3.17, 3.28, 3.30–32; IIRC 2013b: 36; Eccles and Krzus (2015)
4	<i>Time horizon:</i> Time horizon of material issues is extremely relevant for strategic decisions and future developments.	0–2 0: Time reference is missing 1: No precise information 2: Categorization and description due to the short-, medium-, and long-term impact	IIRC 2013a: 3.17, 3.23; IIRC 2013b: 8
5	<i>Materiality matrix:</i> A materiality matrix is important to illustrate the mapping process for stakeholders.	0–1 0: A materiality matrix is missing 1: A materiality matrix is included	Eccles and Krzus (2015)
6	<i>Risks and opportunities:</i> A balanced inclusion of material risks and opportunities is necessary for reliable integrated reporting	0–1 0: Firms do not refer to risks and opportunities as material issues 1: Firms refer to risks and opportunities as material issues	IIRC 2013a: 3.19, 3.30, 3.34–35, 3.39, 4.23–26; Eccles and Krzus (2015)
7	<i>Mitigation actions:</i> Descriptions of mitigation actions be detailed and include qualitative and quantitative information	0–2 0: Information is missing 1: Vague qualitative description of actions 2: Detailed qualitative and quantitative information	IIRC 2013a: 2.27, 3.23, 4.25; Eccles and Krzus (2015)
Σ		0–12	

(Roychowdhury 2006), which are also recognized: as abnormal levels of operating cash flows, abnormal production costs, and abnormal discretionary expenses.

3.2.2 | Independent Variables

In line with previous studies (e.g., Al Ani et al. 2024; Carey et al. 2017; Du et al. 2020), we rely on the natural logarithm of audit fees (FEE) paid to the financial auditor as a major proxy of audit quality. Moreover, we choose a dummy variable coded 1 if the firm is audited by a big four audit firm (Deloitte, EY, KPMG, or PwC) (BIG). These independent variables represent

audit quality indicators which should lead to an increased level of MRQ.

3.2.3 | Moderator and Control Variables

Based on the CDP database, carbon assurance quality as our moderator variable includes three different proxies. First, ASSUQ1 is a dummy variable that equals 1 if a firm has carbon emissions assured by an audit firm and 0 otherwise. This is a common measure in the accounting and management literature (e.g., Datt et al. 2020). Second, ASSUQ2 is a dummy variable that equals 1 if a firm has carbon emissions assured

with a reasonable level and 0 otherwise (e.g., a limited assurance level). Previous research has also included this proxy based on overall sustainability assurance (e.g., Garcia-Sanchez et al. 2023). Third, ASSUQ3 is a dummy variable that equals 1 if a firm has carbon emissions assured using ISAE3000 as the global “best practice” assurance standard for sustainability reporting. Previous literature has also distinguished between these standards (e.g., Garcia-Sanchez et al. 2023). The three variables are summarized in the carbon assurance score (ASSUQ) coded 3 if ASSUQ1, ASSUQ2, and ASSUQ3 are fulfilled.

We include some firm- and governance-specific variables as control variables in line with prior studies (e.g., Gerwanski et al. 2019). Regarding firm-level controls, firm size (SIZE) is the natural logarithm of total assets at the end of the financial year. Financial performance is recognized by the return on equity (ROE), and market-based performance by Tobin’s Q (TOBIN). Leverage (LEV) is the long-term debt scaled by total assets. The combined environmental and social performance score (ES) controls for the link between sustainability performance and integrated reporting. A positive influence of these firm-related control variables on MRQ was assumed except for leverage.

Regarding governance factors, we include board gender diversity (GEND) as the “Blau index” of female directors on the board as a motivator of integrated reporting. Board size (BOARDS) refers to the number of board members (Fasan and Mio 2017). Voluntary implementation of sustainability board committees (CSRSC) is also recognized to push for increased sustainability actions. Board Independence (BOARDIN) is the ratio of independent board directors and should be related to increased monitoring of integrated reporting. To recognize the potential influence of the industry on integrated reporting (Fasan and Mio 2017), the indicator variable ENVSEN includes if the company belongs to environmentally sensitive industries (two-digit SIC codes 08, 10–14, 26, 28, 33–34, 49). The variable INST addresses whether a voluntary integrated reporting setting (European countries: 1) is existent or not (South Africa: 0).

All variables are summarized in Table 4.

3.3 | Model Specifications

The following linear regression models, based on FEE and BIG, are recognized to analyze hypothesis 1:

1. $MRQ_{i,t} = \beta_0 + \beta_1 FEE_{i,t} + \beta_2 ASSUQ_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 ROE_{i,t} + \beta_5 TOBIN_{i,t} + \beta_6 LEV_{i,t} + \beta_7 ES_{i,t} + \beta_8 GEND_{i,t} + \beta_9 CSRSC_{i,t} + \beta_{10} BOARDIN_{i,t} + \beta_{11} ENVSEN_{i,t} + \beta_{12} INST_{i,t} + u_i + e_{i,t}$
2. $MRQ_{i,t} = \beta_0 + \beta_1 BIG_{i,t} + \beta_2 ASSUQ_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 ROE_{i,t} + \beta_5 TOBIN_{i,t} + \beta_6 LEV_{i,t} + \beta_7 ES_{i,t} + \beta_8 GEND_{i,t} + \beta_9 CSRSC_{i,t} + \beta_{10} BOARDIN_{i,t} + \beta_{11} ENVSEN_{i,t} + \beta_{12} INST_{i,t} + u_i + e_{i,t}$

We then analyze the moderation effect of ASSUQ on the impact of FEE and BIG on MRQ in line with hypothesis 2:

TABLE 4 | Overview of variables.

Variables	Variable definition
Dependent variable	
MRQ	Materiality disclosure score in integrated reporting, based on seven scoring components: (1) materiality section, (2) identification process, (3) description of material aspects, (4) materiality matrix, (5) time horizon, (6) mitigation actions and (7) risks and opportunities
Additional analyses	
AEM	Absolute value of discretionary accruals (signed discretionary accruals), where discretionary accruals are computed using the Kothari et al. (2005) model including lagged ROA as a regressor; AEM is multiplied with (–1) in regression models to address earnings quality
REM	Sum of REM proxies, measured as $AB_CFO - AB_PROD + AB_EXP$ (AB_CFO: level of abnormal cash flows from operations; AB_PROD: Level of abnormal production costs, where production costs are defined as the sum of the cost of goods sold and the change in inventories; AB_EXP: Level of abnormal discretionary expenses, where discretionary expenses are the sum of R&D expenses, advertising expenses, and SG&A expenses); REM is multiplied with (–1) in regression models in order to address earnings quality
Independent variables	
FEE	The natural logarithm of audit fees paid to the financial auditor
BIG	A dummy independent variable coded 1 if the firm is audited by Deloitte, EY, KPMG, or PwC, and is 0 otherwise
Moderator variables	
ASSUQ	Assurance quality score coded 3 if ASSUQ1, ASSUQ2, and ASSUQ3 are fulfilled and is 2, 1, or 0 otherwise
(ASSUQ1)	A dummy dependent variable coded 1 if a firm has Scope 1 carbon emissions assured by an audit firm and is 0 otherwise

(Continues)

TABLE 4 | (Continued)

Variables	Variable definition
(ASSUQ2)	A dummy dependent variable coded 1 if a firm has Scope 1 carbon emissions assured with a reasonable assurance level and is 0 otherwise
(ASSUQ3)	A dummy dependent variable coded 1 if a firm has Scope 1 carbon emissions assured with high-quality assurance standards (ISAE3000) and is 0 otherwise
Control variables	
SIZE	Natural logarithm of total assets
ROE	Return on equity
TOBIN	Measure for a firm's investment growth opportunities by year-end
LEV	Leverage as long-term debt scaled by total assets
ES	Equally weighted environmental and social score
GEND	Blau index of board gender diversity amount of directors on the board
CSRSC	A dummy variable coded 1 if the firm has established a sustainability board committee and is 0 otherwise
BOARDIN	Ratio of independent board members compared to the total number of directors
ENVSEN	Indicator variable takes the value 1 if the firm is operating in an environmentally sensitive industry (SIC codes: 08, 10–14, 26, 28, 33–34, 49), and 0 otherwise
INST	Indicator variable takes the value 1 if the disclosure of an integrated report is voluntary in the corresponding setting (Europe), and 0 otherwise (South Africa)

$$3. MRQ_{i,t} = \beta_0 + \beta_1 FEE_{i,t} + \beta_2 ASSUQ_{i,t} + \beta_3 FEE * ASSUQ_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 ROE_{i,t} + \beta_6 TOBIN_{i,t} + \beta_7 LEV_{i,t} + \beta_8 ES_{i,t} + \beta_9 GEND_{i,t} + \beta_{10} CSRSC_{i,t} + \beta_{11} BOARDIN_{i,t} + \beta_{12} ENVSEN_{i,t} + \beta_{13} INST_{i,t} + u_i + e_{i,t}$$

$$4. MRQ_{i,t} = \beta_0 + \beta_1 BIG_{i,t} + \beta_2 ASSUQ_{i,t} + \beta_3 BIG * ASSUQ_{i,t} + \beta_4 SIZE_{i,t} + \beta_5 ROE_{i,t} + \beta_6 TOBIN_{i,t} + \beta_7 LEV_{i,t} + \beta_8 ES_{i,t} + \beta_9 GEND_{i,t} + \beta_{10} CSRSC_{i,t} + \beta_{11} BOARDIN_{i,t} + \beta_{12} ENVSEN_{i,t} + \beta_{13} INST_{i,t} + u_i + e_{i,t}$$

We included time-, industry-, and country-fixed effects and a panel data structure in line with prior research (Gerwanski et al. 2019). A Generalized Least Squares (GLS) random effects (RE) estimator with firm-clustered standard errors

(Huber-White sandwich estimator) was recognized due to potential within-cluster correlations, (Bell and Jones 2015; Gerwanski et al. 2019). Variance inflation factors (VIF) (mean VIF = 2.12; highest VIF = 2.89) do not show tendencies of multicollinearity. We decided to use the random intercept model because higher-level processes in the data, which are not captured by removing higher-level variance through within transformation, are important in this context (Bell and Jones 2015). The choice of a RE estimator also relates to the results of the Hausman test (p -value = 0.2156). Instead of explicitly measuring the influence of environmentally sensitive industries (ENVSEN) on integrated reporting, Model 2 recognizes industry division-level fixed effects, which refers to time-invariant influences of industry affiliations on MRQ (Holder-Webb et al. 2009). Model 3 includes time-fixed effects due to potential learning effects. Model 4 refers to country-fixed effects to reflect the influence of legal and socio-economic environments on integrated reporting.

In the following, we present the empirical results of our study, separating between descriptive statistics, correlation, and regression results as well as endogeneity tests and additional analyses.

4 | Empirical Results

4.1 | Descriptive Statistics

Table 5 includes the descriptive statistics. MRQ as the dependent variable has an average of 7.097 and a standard deviation of 3.278. The quality of materiality disclosure in integrated reporting was quite satisfying on average. FEE as our independent variable has a mean of 4.565 and a standard deviation of 0.565. Interestingly, most included firms engaged a big four audit firm (BIG) (mean: 0.613; SD: 0.231). We also stress that carbon assurance quality (ASSUQ) as our moderator variable was relatively low on average (mean: 1.312; SD: 1.42).

Table 6 separates between the different components of MRQ.

4.2 | Correlation Analyses

Table 7 includes the Pearson correlation matrix for the dependent, independent, moderator, and control variables. In correspondence with our assumptions, MRQ is positively and significantly correlated with FEE (0.354**), BIG (0.369**), and ASSUQ (0.226**), indicating a possible positive influence on audit quality and carbon assurance quality.

4.3 | Regression Analyses

The results of the regression analyses are shown in Tables 8 and 9. In line with hypothesis 1, FEE (models 1–4) and BIG (models 5–8) are positively and significantly related to MRQ (Table 8). This corresponds to the stakeholder agency theory (Hill and Jones 1992) Stakeholder agency theory assumes that a proper financial audit reduces the agency conflicts between management and stakeholders (Hill and Jones 1992; DeFond and Zhang 2014).

TABLE 5 | Descriptive statistics.

Variables	N	Mean	SD	Min	Median	Max
MRQ	612	7.097	3.278	0	6.000	12.000
FEE	612	4.565	0.565	2.343	4.652	6.765
BIG	612	0.613	0.231	0	1	1
ASSUQ	612	1.312	1.42	0	1	3
SIZE	612	12.431	1.232	9.312	12.323	17.542
ROE	612	10.432	20.323	-12.098	11.212	87.323
TOBIN	612	1.332	1.343	0.045	0.729	9.232
LEV	612	0.332	0.212	0.132	0.265	0.565
ES	612	74.545	15.443	11.324	75.656	87.878
GEND	612	0.389	0.178	0	0.390	0.666
CSRC	612	0.565	0.332	0	1	1
BOARDIN	612	0.323	18.221	0	0.542	0.875
ENVSEN	612	0.365	0.412	0	0	1
INST	612	0.321	0.398	0	0	1
AEM	612	0.034	0.323	-0.212	0.055	1.344
REM	612	0.022	0.298	-0.243	0.019	0.928

TABLE 6 | Summary statistics of MRQ elements.

MRQ elements	N	Mean	SD	Min	Median	Max
Materiality section	612	1.476	0.767	0	2	3
Identification process	612	1.465	0.653	0	1	3
Description	612	1.587	0.787	0	1	2
Time horizon	612	0.389	0.403	0	0	3
Materiality matrix	612	0.446	0.378	0	0	2
Risks and opportunities	612	0.378	0.432	0	0	2
Mitigation actions	612	1.356	0.878	0	2	3

As integrated reports are related to the risks of greenwashing and information overload, higher audit fees and big four audits represent an increased level of audit quality. An intensive monitoring function of financial auditors should lead to an increased level of MRQ because financial statements are a major part of integrated reports. Financial auditors should pressure top managers to be more sensible in MRQ. Our research results are also in line with prior research (Appiagyei et al. 2023; Chouaibi and Hichri 2021; Hichri 2023; Rivera-Arrubla et al. 2017). Former studies for South African firms (Appiagyei et al. 2023) also found that big four audit firms and integrated reporting quality are positively related. Moreover, audit fees positively impact integrated reporting quality in an international sample of firms (Hichri 2023).

In line with hypothesis 2, we stress a positive moderator effect of ASSUQ on the link between FEE and MRQ (models 9–12) and

BIG and MRQ (models 13–16). The variables ASSUQ*FEE and ASSUQ*BIG have a strong positive significance with MRQ on a 1% level. This is in line with the stakeholder agency theory (Hill and Jones 1992) and prior research (Hichri 2023). Financial audit and carbon assurance can be classified as complementary monitoring functions to promote integrated reporting quality. Carbon information represents a major content element of an integrated report, especially based on the new ISSB standards. Agency conflicts can be linked to climate reports due to increased management discretion (Hill and Jones 1992). Stakeholders need reliable carbon information, leading to the request for annual assurance of this information (Velte 2022). Carbon assurance may overcome information asymmetries and conflicts of interest between management and stakeholders. Thus, stakeholders' information demands for reliable financial and sustainability information should lead to a moderator effect of carbon assurance on the positive impact of audit quality on integrated reporting.

TABLE 7 | Pearson correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) MRQ	1.000															
(2) FEE	0.354**	1.000														
(3) BIG	0.369**	0.245**	1.000													
(4) ASSUQ	0.226**	0.331**	0.356**	1.000												
(5) SIZE	0.365**	0.366**	0.423**	0.343**	1.000											
(6) ROE	0.123**	0.156*	0.232*	0.143*	0.432**	1.000										
(7) TOBIN	0.343**	0.242**	0.323**	0.147**	0.223**	0.121*	1.000									
(8) LEV	-0.232**	0.343**	0.144**	-0.132**	-0.442**	-0.143**	-0.154*	1.000								
(9) ES	0.225**	0.234*	0.243**	0.212**	0.054	0.021	0.132*	0.212*	1.000							
(10) GEND	0.421**	0.321*	0.153*	0.112***	0.121	0.245	0.141	0.144*	0.223*	1.000						
(11) CSRC	0.312**	0.243**	0.232**	0.155*	0.243***	0.432**	0.132**	-0.211	0.113*	0.063	1.000					
(12) BOARDIN	0.231*	0.154**	0.242	0.113	0.097	0.132	0.087	0.232	0.113	0.234	0.133	1.000				
(13) ENVSEN	0.112**	0.134**	0.124**	0.015	0.124**	0.221	0.135	0.142*	0.232*	0.121*	0.012	0.142*	1.000			
(14) INST	0.153**	0.211*	0.321	0.231***	0.131*	0.022	0.187*	0.221*	0.012***	0.072	0.142	0.212	0.125*	1.000		
(15) AEM	-0.312*	0.142**	0.144**	-0.243*	0.218*	0.079**	0.121**	0.244*	0.198	0.253*	0.334	0.245*	0.121*	0.121*	1.000	
(16) REM	-0.231*	0.243**	0.321**	-0.121**	0.423**	0.132**	0.164**	-0.14*	0.132*	0.211**	0.014	0.211	0.190	0.212*	0.131	1.000

*, ** and *** denote significance at the 10%, 5% and 1% level.

TABLE 8 | Regression analyses (hypothesis 1; influence of FEE and BIG on MRQ).

Variables	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)	Model (8)
FEE	0.243**	0.264**	0.242**	0.253**	—	—	—	—
BIG	—	—	—	—	0.343**	0.354**	0.321**	0.334**
ASSUQ	0.201**	0.232**	0.212**	0.221**	0.221**	0.212**	0.232**	0.221**
SIZE	0.245**	0.267**	0.265**	0.254**	0.266**	0.223**	0.245**	0.232**
ROE	0.176**	0.185**	0.158*	0.168*	0.198**	0.154**	0.142**	0.121**
TOBIN	0.154*	0.165*	0.198*	0.165*	0.165*	0.167*	0.154*	0.153*
LEV	-0.232*	-0.225*	-0.243*	-0.231*	-0.243*	-0.223*	-0.212*	-0.234*
ES	0.154**	0.135**	0.134**	0.143**	0.143*	0.154*	0.159*	0.145*
GEND	2.545**	2.565**	2.776**	2.254**	2.434**	2.543**	2.534**	2.432**
BOARDIN	1.435**	1.543**	1.676**	1.355**	1.545**	1.445**	1.542**	1.454**
ENVSEN	0.154	—	—	—	0.153	—	—	—
INST	0.211	0.264	0.324	—	0.242	0.214	0.254	—
Constant	16.232***	15.676***	15.465***	16.334***	15.424***	15.767***	15.212***	15.334***
Industry-fixed	NO	YES	YES	YES	NO	YES	YES	YES
Time-fixed	NO	NO	YES	YES	NO	NO	YES	YES
Country-fixed	NO	NO	NO	YES	NO	NO	NO	YES
Observations	612	612	612	612	612	612	612	612
R ²	23.56%	21.78%	21.34%	23.55%	22.54%	22.32%	22.21%	22.76%

*significance at the 10% level; **significance at the 5% level; ***significance at the 1% level.

TABLE 9 | Regression analyses (hypothesis 2; moderator effect of ASSUQ on the link between FEE, BIG, and MRQ).

Variables	Model (9)	Model (10)	Model (11)	Model (12)	Model (13)	Model (14)	Model (15)	Model (16)
FEE	0.329**	0.334**	0.341**	0.338**	—	—	—	—
BIG	—	—	—	—	0.365**	0.365**	0.376**	0.378**
ASSUQ	0.254**	0.254**	0.243**	0.246**	0.243**	0.265**	0.259**	0.254**
ASSUQ*FEE	0.343***	0.323***	0.312***	0.321***	—	—	—	—
ASSUQ*BIG	—	—	—	—	0.343***	0.354***	0.335***	0.344***
SIZE	0.234**	0.278**	0.256**	0.242**	0.233**	0.216**	0.254**	0.209**
ROE	0.156**	0.167**	0.167*	0.179*	0.166**	0.134**	0.156**	0.127**
TOBIN	0.176*	0.134*	0.212*	0.187*	0.126*	0.246*	0.178*	0.144*
LEV	-0.221*	-0.223*	-0.266*	-0.204*	-0.276*	-0.189*	-0.235*	-0.205*
ES	0.133**	0.154**	0.126**	0.123**	0.147*	0.157*	0.167*	0.175*
GEND	2.243**	2.334**	2.732**	2.278**	2.498**	2.443**	2.578**	2.337**
BOARDIN	1.324**	1.454**	1.542**	1.332**	1.675**	1.643**	1.586**	1.454**
ENVSEN	0.122	—	—	—	0.166	—	—	—
INST	0.205	0.257	0.243	—	0.221	0.227	0.246	—
Constant	16.211***	15.623***	15.211***	16.086***	15.534***	15.767***	15.209***	15.398***
Industry-fixed	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Time-fixed	No	No	Yes	Yes	No	No	Yes	Yes
Country-fixed	No	No	No	Yes	No	No	No	Yes
Observations	612	612	612	612	612	612	612	612
R ²	23.98%	21.54%	22.21%	24.32%	23.21%	23.65%	23.78%	23.94%

*significance at the 10% level; **significance at the 5% level; ***significance at the 1% level.

4.4 | Endogeneity Tests

Empirical research on the influence of audit quality on integrated reporting is confronted with endogeneity concerns (e.g., Velte 2022). Self-selection bias and reverse causality are the two major endogeneity concerns in this context (Wintoki et al. 2012). We already stressed in the literature review section, that the link between audit quality and integrated reporting quality may be bi-directional. As financial auditor selection and carbon assurance are voluntary management decisions, we address potential self-selection bias as follows. We checked for endogeneity concerns using the Propensity Score Matching (PSM) approach in this study. PSM partials out selection bias by creating a control group. Using a set of firm characteristics in a probit regression, this technique pairs every firm in the treatment group with a statistical twin firm from a large set of nonparticipant firms to form the control group. These statistical twins can be used for comparison to examine the treatment effects. Table 10 presents the results of the PSM regressions, based on FEE (models 17 and 19) and BIG (models 18 and 20). The results are in line with our baseline results that audit quality has a positive impact on integrated reporting quality and that carbon assurance quality strengthens this relationship as a moderator effect.

In line with sample selection bias, two-stage least squares (2SLS)/instrumental variables (IV) and difference-in-difference approaches are key endogeneity checks for reverse causality issues (Wintoki et al. 2012). As our time frame is rather short, we are not able to conduct a proper difference-in-difference design. Instead, we include 2SLS/IV regressions. As a first step, we regress the endogenous variable on all chosen instruments, which have previously undergone relevance and exogeneity checks, and obtain the residual for the endogenous variable. As a second step, we replace the endogenous variable with the corresponding residual and regress the dependent variable (MRQ) on it. We decided to use the

industry-year averages of our dependent variable (MRQ_mean) as an instrumental variable in line with prior research (Blanco et al. 2024). Post-estimation analyses confirmed the strength and relevance of our instrument. The results of the second stage are shown in Table 10 for FEE (models 21 and 23) and BIG (models 22 and 24) are in line with our main regressions. The second-stage coefficients for FEE and BIG were positively and statistically significant to MRQ as well as the moderating effect.

4.5 | Additional Analyses

As a variation of our basic models, we measure the impact of audit quality on financial reporting quality instead of MRQ. We already stated that integrated reporting includes financial and ESG information due to the integrated thinking process. Financial reporting quality can be classified as a major component of integrated reporting quality. Audit quality should be negatively related to earnings management as an inverse measure of financial reporting, as stricter financial audit should motivate top managers to reduce accounting policies in line with stakeholder preferences (DeFond and Zhang 2014). Table 11 presents the regression results for FEE (models 25 and 27) and BIG (models 26 and 28), referring to AEM and REM. In line with stakeholder agency theory (Hill and Jones 1992) and prior research (e.g., DeFond and Zhang 2014), audit quality reduces the extent of earnings management and thus increases financial reporting quality.

Against the background of different legal settings regarding integrated reporting, we conduct country-specific analyses. As additional analyses, we measure the impact of audit quality on MRQ for the two subsamples of South African firms (mandatory settings) and European firms (voluntary settings). We assume that the impact of audit quality on integrated reporting is stronger for South African firms due to greater awareness and learning effects of mandatory integrated reporting. Regression results (not

TABLE 10 | Endogeneity checks (PSM and 2SLS/IV, second stage).

Variables	Model (17)	Model (18)	Model (19)	Model (20)	Model (21)	Model (22)	Model (23)	Model (24)
	PSM	PSM	PSM	PSM	2SLS/IV	2SLS/IV	2SLS/IV	2SLS/IV
FEE	0.186**	—	0.198**	—	0.176**	—	0.232**	—
BIG	—	0.254**	—	0.267**	—	0.265**	—	0.278**
ASSUQ	0.154**	0.225**	0.224**	0.234**	0.165**	0.243**	0.243**	0.232**
ASSUQ*FEE	—	—	0.267***	—	—	—	0.277***	—
ASSUQ*BIG	—	—	—	0.278***	—	—	—	0.274***
CONTROLS	Yes							
Constant	15.254***	15.058***	15.453**	15.478**	15.676**	15.324**	15.454**	15.323**
Industry-fixed	Yes							
Time-fixed	Yes							
Country-fixed	Yes							
Observations	612	612	612	612	612	612	612	612
R ²	22.32%	22.54%	22.79%	23.24%	22.15%	22.14%	22.23%	22.32%

*significance at the 10% level; **significance at the 5% level; ***significance at the 1% level.

TABLE 11 | Additional analyses (impact of FEE and BIG on earnings management (ACC and REM) and the moderator effect of ASSUQ).

Variables	Model (25)	Model (26)	Model (27)	Model (28)
	ACC	ACC	REM	REM
FEE	0.165**	—	0.189**	—
BIG	—	0.276**	—	0.298**
ASSUQ	0.178**	0.232**	0.189**	0.265**
ASSUQ*FEE	—	—	0.254***	—
ASSUQ*BIG	—	—	—	0.256***
CONTROLS	YES	YES	YES	YES
Constant	15.967***	15.218***	15.735**	15.898**
Industry-fixed	YES	YES	YES	YES
Time-fixed	YES	YES	YES	YES
Country-fixed	YES	YES	YES	YES
Observations	612	612	612	612
R ²	24.32%	23.94%	23.68%	24.67%

Note: ACC and REM are multiplied by (−1) as an inverse measure of financial reporting quality.
*significance at the 10% level; **significance at the 5% level; ***significance at the 1% level.

tabulated) indicate a significant positive impact of both measures of audit quality on MRQ in both sub-samples. Thus, in contrast to our assumptions, country effects (mandatory versus voluntary regimes) do not have a significant effect on this relationship.

5 | Discussion and Conclusion

5.1 | Summary

As an innovative contribution to previous research, this study focused on the influence of audit quality on integrated reporting quality and the moderating impact of carbon assurance quality on this link. For the first time, we connected audit fees (FEE) and big four audit firms (BIG) as important proxies for audit quality and materiality disclosure in integrated reporting (MRQ), based on a self-created score and manual content analyses. We included 612 firm-year observations (102 firms) covering the business years 2017–2022 from an international sample of South African and European listed firms. Based on stakeholder agency theory (Hill and Jones 1992), integrated reporting was framed as a stakeholder information tool, stressing the need for major connectivity between financial and sustainability information. Stakeholders demand careful materiality analysis and disclosure, which are explicitly linked to stakeholder materiality (Flower 2015). However, Integrated reporting can be connected with major agency conflicts, as information asymmetries and conflicts of interest between management and stakeholders can be present. Explicit disclosure on the operationalization of the materiality principle within integrated reports limits information overload and greenwashing risks (Gerwanski et al. 2019; Velte 2022). Strong corporate governance mechanisms represent an effective instrument to decrease these agency conflicts. In this study, we include two well-known measures of audit quality (audit fees and big four audit firms) as a major driver for increased MRQ, because an increased quality of financial reporting supports the

quality of integrated reporting. Moreover, as a major content element of integrated reports, climate information lacks objectivity and comparability. Stakeholders demand a voluntary assurance on climate information as a significant quality driver. Thus, financial audit and climate assurance with high quality can be classified as complementary monitoring instruments, leading to lower agency conflicts (Hill and Jones 1992). In view of the major interrelations between financial audit, sustainability assurance, and MRQ, we assumed and found a positive significant influence of audit quality on integrated reporting quality, whereas carbon assurance quality as a moderator strengthens this relationship. Our results are robust to endogeneity checks (PSM and 2SLS/IV) and accruals-based and REM as variations of the dependent variable. Our research results are in line with stakeholder agency theory (Hill and Jones 1992) and prior research on that topic (e.g., Appiagyei et al. 2023; Hichri 2023).

5.2 | Limitations

Our study has some limitations. As we conducted content analyses of integrated reports to present the dependent variable, manual scores of integrated reporting quality relate to subjectivity, although we explained in detail the content elements of the materiality score (see also Gerwanski et al. 2019; Velte 2022). Other principles than the materiality principle were neglected in this study. Moreover, integrated reporting lacks comparability in business practice due to the principle-based approach of the IIRC framework (Flower 2015). We cannot clearly extract whether the included firms have really implemented a properly integrated thinking approach in line with the framework. Furthermore, we only relied on carbon assurance quality and the CDP database instead of other sustainability assurance aspects. Moreover, as already noted, audit fees and big four audit firms are surrogates of audit quality, leading to some restrictions (e.g., audit efficiency).

5.3 | Managerial Implications

In the following, we stress some implications for regulators and business practices to promote the positive influence of financial audits and carbon assurance on integrated reporting quality. Referring to managerial implications, boards of directors and stakeholders should pressure top managers to implement solid integrated reporting processes with a focus on the materiality principle. Otherwise, stakeholders cannot analyze the degree of integrated thinking and the degree of stakeholder integration (Flower 2015; Velte and Stawinoga 2017). Moreover, boards should increase the quality of financial audits and carbon assurance, because integrated reporting has many interrelations with financial statements and sustainability reports (Hichri 2023; Rivera-Arrubla et al. 2017). As climate risks refer to financial risks, an integrated thinking process can significantly reduce information overload and greenwashing, which increases the information demands of stakeholders. Boards of directors should promote their financial, industry, and sustainability skills to realize a better leadership and monitoring function (Chen et al. 2016). Sustainability expertise is also a crucial factor for audit firms and assurance providers, which should be increased in the following years. As the classical function of auditors relates to financial audits, they also feel responsible for sustainability assurance in recent years (Velte and Stawinoga 2017).

5.4 | Regulatory Implications

While the EU standard setter has published stricter regulations on sustainability reporting for PIEs and stressed the connectivity between financial and ESG data (e.g., the CSRD), an integrated report is not mandatory for European firms in contrast to South Africa. However, the IIRC was consolidated by the ISSB. We propose that the new sustainability reporting standards of the ISSB will be the future “gold standard” for listed firms as a major global language in line with IFRS reports (de Villiers et al. 2024). They follow an integrated reporting approach of the IIRC framework. Integrated reporting is extremely useful for capital market providers, as they analyze connected information of the financial and ESG areas. The differences between European and global reporting standards should be decreased to achieve better comparability (de Villiers et al. 2024). Moreover, future regulations on ESG-related internal control and risk management systems are useful to increase the awareness of integrated thinking and for a strategic positioning of ESG aspects. The new Corporate Sustainability Due Diligence Directive (CSDDD) stipulates sustainability-related risk and compliance management systems for specific environmental and human rights standards for the whole value chain of the firm, e.g., climate transition plans.

5.5 | Research Implications

Future researchers are invited to analyze the influence of other audit quality characteristics (e.g., audit report lag, going concern opinions, auditor industry expertise) on MRQ and the moderating effect of other sustainability assurance

factors (e.g., quality of assurance statements, joint provision of financial audits and sustainability assurance) on that link. Automated text analyses by artificial intelligence software (e.g., python) are attractive in this context to build innovative proxies of integrated reporting quality (e.g., the tone, readability, and similarity of integrated reports) (Velte 2022). We assume an increased research activity on that topic, as regulators have finalized stricter sustainability reporting and assurance duties for PIEs in recent years and stress the connectivity with financial statements.

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