



Research article

Captured or credible? Issuer–reviewer repeat ties and the governance of green bond verification

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Abstract: This study examined whether the credibility of green bond verification depends not only on the presence of an external review but also on the governance structure of the issuer–reviewer relationship. The analysis combined assurance governance and information economics to evaluate whether repeated engagements are more consistent with learning benefits or with independence concerns that weaken the informational value of verification. The setting covered labeled corporate green use-of-proceeds bonds issued by firms domiciled in the European Union and the United Kingdom between 2015 and 2023. The bond-level sample contained 805 green bond issues from 312 issuers, and the issuer-year accountability panel contained 1986 issuer-year observations. Fixed-effects pricing models indicated that higher repeat-tie intensity is associated with weaker pricing-based credibility, reflected in a smaller greenium after controlling for bond structure, credit risk, liquidity, review type, and issuer fundamentals. Issuer-year analyses indicated that concentrated ties are associated with weaker reporting discipline, weaker impact-reporting continuity, and higher ex post credibility-risk signals. Moderation tests further indicated that strong audit quality and stronger green-finance policy environments attenuate these adverse associations. The findings contribute by showing that external review is better understood as a relational governance arrangement rather than as a binary disclosure attribute and by identifying relationship concentration as a distinct credibility feature that helps explain heterogeneity in green bond pricing and post-issuance accountability.

Keywords: green bonds; external reviews; verification credibility; repeat ties; greenium; post-issuance accountability; green-finance policy

JEL Codes: G12, G14, G32, Q56

1. Introduction

Corporate green bonds have moved from a niche instrument to a mainstream channel for financing environmental projects, with issuance volumes rising alongside investor demand for “use-of-proceeds claims” that can be verified and trusted. Early evidence suggests that green bonds can attract a pricing advantage (a greenium) and broaden the investor base, but the magnitude and persistence of this benefit vary widely across issuers and settings (Zerbib, 2019; Baker et al., 2018; Tang & Zhang, 2020; Flammer, 2021). This variation leaves a central question open: when two bonds carry similar green labels, why do markets treat their credibility so differently?

A key reason is that green finance remains exposed to information asymmetry. Investors cannot directly observe whether proceeds are allocated as promised, whether projects deliver measurable environmental outcomes, or whether reporting is selectively framed. As a result, credibility depends not only on what issuers disclose, but also on the governance mechanisms that discipline claims and reduce greenwashing incentives (Lyon & Montgomery, 2015; Christensen et al., 2021). Consistent with broader research on sustainability information, markets appear to penalize unverifiable narratives and reward disclosures that are constrained by stronger assurance-like features (Ioannou & Serafeim, 2015; Krueger et al., 2020).

To address this verification problem, the green bond market has increasingly relied on external reviews, including second-party opinions, verification reports, certifications, and ratings. These reviews are promoted as tools for enhancing transparency and comparability. Market guidance, such as the Green Bond Principles, emphasizes external review as a credibility mechanism that can reduce skepticism about environmental claims (International Capital Market Association, 2021). Yet external review is not a uniform institution. Review scope, methodological rigor, and reviewer incentives vary substantially, raising a governance concern familiar from auditing: when verifier independence is weak, assurance can become symbolic rather than substantive (DeFond & Zhang, 2014; Simnett et al., 2009).

This concern is particularly salient when issuers repeatedly engage the same external reviewer across multiple green bond issues. Repeat ties can plausibly improve efficiency and informational learning because reviewers gain a better understanding of the issuer’s project pipeline and reporting systems, potentially enhancing monitoring quality. At the same time, repeated economic dependence may create a familiarity threat and weaken professional skepticism, generating a “captured reviewer” problem analogous to debates over long auditor tenure (DeAngelo, 1981; Tepalagul & Lin, 2015). In green finance, where reviewers operate in a competitive market and are typically chosen and paid by issuers, the repeat-ties channel becomes a first-order governance issue rather than a peripheral feature.

Despite rapid growth in green bond research, the literature has largely focused on whether external reviews exist and how review types relate to yields, leaving limited evidence on the governance

consequences of reviewer selection and issuer–reviewer relationships. Existing studies provide important insights into pricing differentials and certification signals, but they often treat reviewers as interchangeable within review categories and do not directly test whether repeated issuer–reviewer ties create credibility benefits through learning or credibility losses through capture (Hachenberg & Schiereck, 2018; Simeth, 2022). This study addresses that gap by asking a sharper question: are issuer–reviewer repeat ties a mechanism of stronger verification governance or a pathway to weakened independence? Building on assurance and governance logic, we examine how repeat ties shape both market outcomes and ex post accountability in green bond settings.

This study makes several contributions to the green bond and assurance-governance literature. First, it shifts attention from the mere presence or type of external review to the governance structure of the issuer–reviewer relationship, identifying repeat ties as a relational feature that may generate both learning benefits and independence concerns. Second, it extends existing research by linking repeat-tie intensity to two complementary dimensions of credibility: bond-level pricing at issuance and issuer-year post-issuance accountability. This dual perspective distinguishes investors’ initial assessment of verification credibility from issuers’ subsequent reporting discipline and environmental conduct. Third, the study identifies audit quality and green-finance policy strength as boundary conditions that can preserve the informational benefits of repeated engagements while limiting the risks associated with familiarity and economic dependence. Together, these contributions provide a more complete explanation of why similarly labeled and externally reviewed green bonds may differ in both market valuation and post-issuance accountability.

2. Theoretical background and literature review

2.1. Theoretical framework

Green bonds are credibility-sensitive financial instruments because their conventional contractual features coexist with an environmental commitment that is difficult for outside investors to verify (Mahmood et al., 2024; Rahman et al., 2024). Although investors can observe the bond’s coupon, maturity, rating, and repayment obligations, they cannot directly determine at issuance whether the proceeds will be allocated to eligible projects, whether the financed activities will generate the stated environmental benefits, or whether subsequent reporting will accurately describe project outcomes. The green attribute, therefore, resembles a quality claim that can be imitated by issuers whose environmental commitments are less substantive. Under these conditions, information asymmetry and adverse selection can reduce investor confidence and weaken the efficiency with which capital is allocated to genuinely sustainable activities (Al-Okaily & Al-Okaily, 2025; Spence, 1973). Green bond labeling systems consequently depend on credibility mechanisms that increase the verifiability of environmental claims and raise the expected cost of misleading disclosure (Henide, 2022; Shi et al., 2023).

External reviews, including second-party opinions, verification reports, certifications, and ratings, are intended to perform this credibility function. Such reviews provide structured assessments of project eligibility, framework alignment, proceeds management, governance processes, and reporting commitments. By introducing an informed third party into the disclosure process, external review can reduce uncertainty and improve comparability across green bond issues (Allman & Lock, 2024).

Existing evidence indicates that investors distinguish between different levels and forms of greenness and that information contained in external reviews is relevant to pricing decisions (Hyun et al., 2020; Dorfleitner et al., 2022; Ghitti et al., 2023; Distadio & Johl, 2025). Nevertheless, continued concerns about greenwashing indicate that external review is not uniformly effective. Its informational value depends on the reviewer's competence, incentives, methodological rigor, and institutional environment (Shi et al., 2023; Jangid et al., 2025).

An assurance-governance lens provides a suitable basis for explaining this variation. External reviewers occupy a position comparable to assurance providers because issuers select and compensate the organizations responsible for evaluating their environmental claims. This structure creates a potential agency conflict between maintaining commercial relationships and applying independent professional judgment. In conventional assurance settings, monitoring quality depends on technical competence, independence, and professional skepticism. Economic bonding and excessive familiarity can weaken the ability or willingness of an assurance provider to challenge management, even when formal review procedures remain unchanged (Jensen & Meckling, 1976; DeAngelo, 1981; Simnett et al., 2009; DeFond & Zhang, 2014).

Issuer-reviewer repeat ties introduce two competing governance mechanisms into this setting. Repeated engagements can produce relationship-specific learning, lower information-processing costs, and improve understanding of the issuer's internal systems. At the same time, repeated appointments can increase familiarity, economic dependence, and incentives to preserve future business. Repeat ties may therefore strengthen verification through accumulated knowledge or weaken it through reduced independence. The theoretical framework treats learning and capture as competing but potentially simultaneous processes and examines which mechanism is more consistent with observed pricing and post-issuance accountability outcomes.

2.2. *Green bond pricing and external verification*

Early green bond research largely examined whether green bonds receive more favorable pricing than comparable conventional bonds. The evidence generally suggests that green bonds can carry a pricing advantage, although the magnitude of this greenium varies across countries, issuers, market conditions, and bond characteristics (Zerbib, 2019; Tang & Zhang, 2020; Flammer, 2021; Hyun et al., 2020). This variation indicates that the green label is not treated as a homogeneous attribute. Investors consider the strength of the environmental commitment, the quality of supporting information, and the credibility of the institutions surrounding the issue (Hyun et al., 2020; Ghitti et al., 2023).

A related stream of research examined external reviews as information and certification mechanisms. External reviews can reduce uncertainty by assessing whether a bond framework follows recognized principles and whether the designated projects satisfy stated eligibility requirements. Empirical studies showed that external review characteristics and assessed shades of green are associated with issuance and secondary-market outcomes, indicating that third-party evaluations contain information that investors incorporate into pricing (Dorfleitner et al., 2022; Ghitti et al., 2023; Distadio & Johl, 2025; Allman & Lock, 2024). Theoretical work similarly showed that voluntary

labeling regimes can be affected by adverse selection when disclosure and verification requirements are weak, allowing less credible issuers to imitate stronger environmental commitments (Henide, 2022).

The informational role of external review does not eliminate concerns about symbolic environmental behavior. Evidence on the real effects of green bond issuance suggests that such financing can encourage environmental investment and influence the practices of peer companies. However, other findings indicate that some issues may be associated with limited substantive environmental improvement or with disclosure patterns consistent with greenwashing (Shi et al., 2023; Song et al., 2024). These mixed outcomes imply that the presence of an external review does not automatically guarantee accountability. The quality and governance of the review relationship may determine whether verification constrains opportunistic behavior or merely legitimizes claims that remain difficult to evaluate.

Policy research reinforces this concern by emphasizing the need to regulate external reviewers, standardize review procedures, and strengthen accountability mechanisms. Reviewer oversight can increase market credibility by clarifying methodological expectations, reducing conflicts of interest, and improving the comparability of external assessments (Chen & Long, 2023). Systematic reviews similarly identify reviewer quality, incentive structures, and institutional heterogeneity as important unresolved issues in green bond research (Jangid et al., 2025).

Despite this progress, most empirical studies focus on whether an external review exists, which review category is used, or which shade of green is assigned. Reviewers are often treated as interchangeable within these categories, and limited attention is given to the structure of the relationship between the issuer and the reviewer. This omission is important because the same review type may convey different information when produced through an arm's-length relationship and when produced after a long sequence of repeated engagements. Assurance research suggests that repeated appointments can simultaneously improve competence through accumulated knowledge and threaten independence through familiarity and economic bonding (DeAngelo, 1981; Simnett et al., 2009; DeFond & Zhang, 2014).

The central research gap therefore concerns the conditions under which repeated issuer–reviewer relationships improve verification through learning and the conditions under which they weaken credibility through dependence. Addressing this gap requires moving beyond external review as a binary attribute and examining relationship intensity as a distinct governance characteristic. It also requires evaluating credibility through both market pricing and post-issuance accountability, because investor expectations at issuance may not fully reveal whether verification continues to discipline reporting after the proceeds have been raised.

2.3. Competing mechanisms of issuer–reviewer repeat ties

Repeated engagements can strengthen external review through relationship-specific learning. Green bond verification requires familiarity with the issuer's project-selection procedures, allocation controls, environmental data architecture, reporting boundaries, and impact-calculation methodologies. A reviewer returning to the same issuer does not need to reconstruct these systems for every engagement and can instead direct greater attention toward changes, exceptions, and inconsistencies.

Accumulated issuer-specific knowledge may therefore improve review consistency, reduce information-processing costs, and enable more precise challenges to management, particularly when environmental indicators are technically complex and reporting systems evolve across successive issues (DeFond & Zhang, 2014; Tepalagul & Lin, 2015; Allman & Lock, 2024).

If the learning mechanism dominates, repeat ties may strengthen both pricing credibility and post-issuance accountability. Investors may assign greater informational value to a review produced by an organization that understands the issuer's previous commitments, internal controls, and environmental reporting systems. This enhanced confidence may produce a larger pricing advantage. Accumulated knowledge may also promote more timely allocation reporting, more specific impact disclosure, and stronger reporting continuity, because the reviewer can compare current practices with prior commitments and identify unexplained changes across reporting cycles. Under this interpretation, repeat ties operate as a capability-building mechanism rather than an independence threat.

Learning benefits, however, may not increase indefinitely. The incremental information gained from each additional engagement can decline once the reviewer has developed a sufficient understanding of the issuer, while familiarity and economic dependence may continue to increase. A relationship that initially improves efficiency may therefore become less challenging as appointments accumulate. Established procedures may encourage the repeated use of familiar templates, prior assumptions, and standardized language rather than renewed scrutiny of the issuer's environmental claims. Learning and capture are consequently not mutually exclusive mechanisms. Both can arise within the same relationship, with their relative importance changing as relationship intensity increases.

The capture mechanism becomes particularly relevant because the issuer generally selects and compensates the external reviewer. Repeated appointments can increase the commercial value of preserving the client relationship and create implicit incentives to avoid judgments that threaten future mandates. Even without explicit interference, familiarity may reduce professional skepticism and make prior representations appear more credible than evidence warrants. In this setting, external review may continue to satisfy formal requirements while providing less effective discipline over project classification, proceeds allocation, and environmental reporting (DeAngelo, 1981; Simnett et al., 2009; DeFond & Zhang, 2014).

The directional hypotheses concern the net effect of these competing mechanisms. The existence of learning benefits does not require a prediction that repeat ties improve credibility on average. Instead, the expected association depends on whether the informational gains from accumulated knowledge exceed the independence costs of relationship concentration. Because reviewers depend on issuers for appointment and compensation, greater concentration is expected to make commercial and familiarity concerns increasingly salient. The hypotheses therefore predict that independence costs dominate on average, while recognizing that stronger audit quality and policy oversight may preserve learning benefits and constrain the development of capture.

3. Hypothesis development

3.1. *Issuer–reviewer repeat ties and pricing-based credibility*

A learning-based prediction suggests that repeat ties may improve pricing credibility. Issuer-specific knowledge can help an external reviewer evaluate project eligibility, identify inconsistencies across successive frameworks, and determine whether current commitments remain consistent with previous disclosures. A reviewer familiar with the issuer's environmental systems may also complete the evaluation more efficiently and direct greater attention toward unusual transactions or changes in reporting methodology. Investors may assign greater informational value to such accumulated expertise. If this mechanism dominates, stronger repeat ties should be associated with a more negative GREENIUM_ISS and therefore a larger pricing advantage.

The value of relationship-specific knowledge is particularly relevant in green bond markets because environmental projects and impact indicators are often technically complex. Project classifications can depend on sector-specific thresholds, taxonomy criteria, estimated emissions reductions, and assumptions about future operating performance. A reviewer with prior experience of the issuer may be better able to assess whether these assumptions are internally consistent and whether the present framework departs from earlier commitments. Repeated interaction can also improve communication between the reviewer and internal reporting teams, reducing avoidable errors and information delays.

However, external review functions as a credible signal only when investors believe that the reviewer is sufficiently independent to challenge the issuer. Signaling theory implies that third-party verification distinguishes stronger claims from weaker claims when the signal is difficult for less credible issuers to obtain. If repeated relationships reduce the rigor of assessment or make favorable review language easier to secure, external review becomes a weaker separating mechanism. Investors may then discount the review and require a less favorable pricing differential (Akerlof, 1970; Spence, 1973; Henide, 2022).

Assurance-governance theory provides a mechanism for this credibility discount. A recurring issuer can become commercially important to the reviewer, creating incentives to maintain the relationship and avoid decisions that may jeopardize future engagements. Familiarity may also reduce the reviewer's willingness to revisit earlier assumptions, challenge established reporting practices, or impose stricter eligibility criteria. These risks resemble concerns in conventional assurance settings, where repeated engagements can improve knowledge while simultaneously threatening independence and professional skepticism (DeAngelo, 1981; Simnett et al., 2009; DeFond & Zhang, 2014).

Investors can respond to these incentive structures even when the internal quality of the review is not directly observable. Repeat appointments, reviewer concentration, and client dependence provide observable indications of the relationship's governance structure. A highly concentrated relationship may therefore be interpreted as a greater independence risk, particularly when the green attribute remains difficult to verify through other sources. This interpretation can lead investors to assign less credibility to the external review and reduce the pricing advantage associated with the green label.

Empirical research supports the broader premise that verification characteristics are reflected in green bond pricing. External reviews, shades of green, and the quality of environmental signals are associated with differences in yields and spreads (Hyun et al., 2020; Dorfleitner et al., 2022; Ghitti et al., 2023; Distadio & Johl, 2025). Nevertheless, prior studies generally emphasize review existence, type, or assigned shade rather than the intensity of the issuer–reviewer relationship. Relationship concentration may explain why bonds carrying similar review products receive different market responses.

The regulatory environment also influences the credibility assigned to external review. Stronger reviewer oversight, clearer standards, and greater enforcement can reduce the opportunity for relationship dependence to weaken verification (Chen & Long, 2023). In less constrained settings, investors may place greater weight on observable relationship concentration when evaluating review credibility. Because the issuer-selected structure of green bond verification makes independence concerns increasingly salient as ties accumulate, the expected average effect is a reduction in pricing-based credibility.

H1: Higher issuer–reviewer repeat-tie intensity is associated with a more positive GREENIUM_ISS, indicating a smaller greenium and weaker pricing-based credibility.

3.2. Issuer–reviewer repeat ties and post-issuance accountability

A learning-based prediction also applies to post-issuance accountability. A reviewer familiar with the issuer’s previous allocation commitments, project categories, reporting boundaries, and impact methodologies can compare disclosures across periods more efficiently and identify unexplained changes more readily. Such institutional memory may support timelier allocation reporting, more specific disclosure, stronger impact-reporting continuity, and fewer credibility problems. Under this mechanism, repeat ties improve monitoring by increasing the reviewer’s capacity to evaluate consistency across successive reporting cycles.

Repeated engagements may also strengthen coordination between reviewers and internal reporting teams. Familiarity with data sources, reporting calendars, and calculation procedures can reduce delays and improve consistency in the presentation of environmental indicators. Reviewers can use prior reports as benchmarks, identify departures from established methodologies, and request explanations when project allocations or impact estimates change. These benefits suggest that repeat ties can improve accountability when accumulated knowledge is accompanied by effective skepticism.

Post-issuance accountability, however, requires more than technical familiarity. It also requires the reviewer to challenge the issuer when allocation practices, project classifications, or reported outcomes depart from initial commitments. If repeated appointments weaken independence, the reviewer may become less willing to demand corrective disclosure or question optimistic environmental interpretations. The expected reputational and commercial cost of confronting the issuer may increase when future business depends on maintaining the relationship.

Agency theory suggests that monitoring reduces opportunism only when the monitor has both the capacity and incentive to act independently (Jensen & Meckling, 1976; DeAngelo, 1981). Green bond reporting creates substantial managerial discretion because environmental outcomes are difficult to measure, benefits may materialize over long periods, and methodologies often rely on assumptions. This

discretion permits selective disclosure, optimistic impact estimates, and the omission of unfavorable information when external discipline is weak (Lyon & Montgomery, 2015; Shi et al., 2023).

Repeated ties can weaken this discipline by normalizing the issuer's existing practices. A reviewer familiar with prior frameworks may rely on established classifications and reporting templates rather than reconsidering whether they remain appropriate. Familiarity may therefore produce continuity without improvement. Reports may be released, but their timeliness, specificity, methodological transparency, and ability to identify emerging environmental concerns may deteriorate as the relationship becomes more concentrated.

Empirical research provides reasons to examine these outcomes directly. Green bond issuance can support environmental investment and influence peer-company practices, but evidence also indicates that some issues may be associated with symbolic behavior and limited substantive improvement (Shi et al., 2023; Song et al., 2024). External reviews can narrow the gap between labels and outcomes only when they continue to influence issuer behavior after issuance. The credibility of verification should therefore be reflected in allocation-report timeliness, disclosure specificity, impact-reporting continuity, and environmental controversy exposure.

The content and rigor of external reviews also influence stakeholder interpretations of green commitments. Stronger greenness assessments and more informative review outputs are associated with different market responses, indicating that review quality matters beyond the presence of a formal document (Dorfleitner et al., 2022; Ghitti et al., 2023; Distadio & Johl, 2025). Extending this reasoning to relationship governance suggests that concentrated ties may reduce the reviewer's capacity to sustain demanding reporting standards across successive periods.

Regulatory research similarly emphasizes that reviewer accountability is necessary to reduce greenwashing and strengthen market confidence (Chen & Long, 2023). If reviewer oversight is weak, relationship dependence may reduce the likelihood that reporting deficiencies are challenged or disclosed. Although learning may improve technical efficiency, the issuer-selected and issuer-paid structure of external review creates reasons to expect independence costs to dominate as concentration increases.

H2: Higher issuer-reviewer repeat-tie intensity is associated with weaker post-issuance accountability, reflected in lower allocation-report timeliness, lower reporting specificity, weaker impact-reporting continuity, and greater environmental controversy exposure.

3.3. The moderating roles of audit quality and green-finance policy strength

The adverse consequences of repeat ties are unlikely to be uniform across governance environments (Francoeur et al., 2017). When alternative monitoring mechanisms are strong, accumulated reviewer knowledge can be used without the same degree of unchecked dependence. Complementary oversight can increase the expected cost of lenient verification, improve the quality of underlying information, and preserve incentives for professional skepticism. Audit quality and green-finance policy strength are therefore expected to shape whether repeat ties operate primarily as learning relationships or as independence threats.

Audit quality may therefore preserve the learning benefits of repeat ties while limiting capture (Dos Santos & Dos Santos, 2025). A reviewer with accumulated issuer-specific knowledge can use

stronger internal information and control systems to perform a more precise assessment. At the same time, the presence of a reputable auditor creates an additional monitoring layer that reduces the issuer's ability to benefit from a lenient external-review relationship (Sharf & Abu-Nassar, 2021; Lutfi et al., 2022; Dos Santos & Dos Santos, 2025). Evidence linking green-finance policy, financial risk, and audit quality supports the view that auditing forms part of the broader credibility infrastructure surrounding sustainable finance (Tian & Pan, 2024).

Green-finance policy environments provide a second source of complementary discipline. Stronger policies can standardize eligibility criteria, improve disclosure comparability, regulate reviewer conduct, and increase the expected costs of misrepresentation. Clearer rules also make it easier for investors and regulators to evaluate whether a reviewer has applied sufficiently rigorous standards. When enforcement is credible, maintaining a commercially dependent relationship becomes less valuable because both issuers and reviewers face greater consequences for weak verification.

Policy oversight can therefore alter the balance between learning and capture. In stronger institutional environments, repeated engagements may permit the reviewer to apply accumulated knowledge while external rules constrain excessive familiarity and leniency. In weaker environments, the same accumulated knowledge may coexist with limited accountability and greater discretion. Research on reviewer regulation indicates that oversight can improve green bond market credibility by clarifying methodological expectations and strengthening reviewer responsibility (Chen & Long, 2023).

The effect of repeat ties may consequently depend on the broader governance architecture rather than on relationship duration alone. Strong audit quality and stronger policy oversight do not remove economic dependence, but they reduce its ability to influence reporting and verification outcomes. They also improve the probability that the learning benefits of repeated engagements are retained. This reasoning is consistent with research showing that the market relevance of credibility mechanisms varies with the quality of institutions and supporting information environments (Hyun et al., 2020; Dorfleitner et al., 2022; Ghitti et al., 2023).

The moderation argument, therefore, reconciles the competing theoretical mechanisms. Learning benefits are more likely to remain valuable when external constraints preserve independence, while capture concerns become more influential when complementary monitoring is weak. Audit quality and policy strength are expected to attenuate the adverse pricing and accountability associations of relationship concentration rather than eliminate them completely.

H3: Stronger audit quality and stronger green-finance policy oversight attenuate the adverse association between issuer–reviewer repeat-tie intensity and green bond credibility.

4. Methodology

4.1. Research design and units of analysis

The empirical design is structured around the study's central contribution: distinguishing the credibility assigned to green bonds at issuance from the accountability subsequently demonstrated by issuers. Bond-level tests examine whether issuer–reviewer repeat ties are reflected in the issuance greenium, whereas issuer-year tests assess whether the same relationships predict allocation-report

timeliness, reporting specificity, impact-reporting continuity, and environmental controversy exposure. This dual-level design allows the analysis to determine whether market participants initially reward repeated verification relationships even when those relationships are subsequently associated with weaker accountability.

Issuer–reviewer repeat ties are measured using information available before the focal bond issuance. The study employs three complementary measures: RT_COUNT captures the cumulative number of prior engagements between the issuer and reviewer, RT_SHARE captures the reviewer’s share of the issuer’s prior green bond engagements, and REV_DEP captures the reviewer’s economic dependence on the issuer. Together, these measures distinguish repeated interaction from relationship concentration and reviewer-side dependence.

The empirical strategy emphasizes within-issuer variation through issuer or firm fixed effects and lagged repeat-tie measures. The models also control for review type, bond characteristics, issuer fundamentals, governance characteristics, and time effects. The analysis, therefore, evaluates whether changes in the intensity of issuer–reviewer relationships are associated with changes in pricing-based credibility and post-issuance accountability, while recognizing that the estimates provide association-based rather than definitive causal evidence.

4.2. Sample construction and data sources

The baseline sample covers listed nonfinancial corporate issuers domiciled in the European Union and the United Kingdom between 2015 and 2023. Europe provides an appropriate setting because its external-review market is sufficiently developed to observe repeated issuer–reviewer relationships and because green bond issuance and post-issuance reporting are available across multiple jurisdictions.

Bond characteristics, issuance yields, matched conventional-bond information, and secondary-market pricing data are obtained from Bloomberg and LSEG Workspace. External-review information is hand-collected from green bond frameworks, offering documents, and published review reports. Firm-level financial, ESG, audit, and governance information is obtained from financial-statement databases, governance databases, annual reports, Refinitiv, CDP, and RepRisk.

The sample is restricted to corporate green bonds for which the reviewer, review type, review date, and issuance-pricing information can be identified reliably. Sovereign, supranational, agency, and municipal issuers are excluded because their governance structures and pricing processes differ from those of corporate issuers. Observations with missing reviewer information, unreliable pricing data, unavailable conventional-bond matches, incomplete financial controls, or insufficient post-issuance reporting information are also excluded.

The final pricing sample contains 805 green bond issues from 312 issuers. The corresponding accountability panel contains 1986 issuer-year observations between 2015 and 2023. Issuer-year observations for which the required post-issuance reporting period had not elapsed by the end of data collection are excluded to reduce right-censoring. Table 1 summarizes the sample-selection process.

The issuer-year panel is constructed from the 312 firms retained in Step 7. After excluding non-missing financial controls, mature post-issuance reporting windows, and accountability outcomes, the final panel contains 1986 issuer-year observations over 2015 to 2023. To avoid right-censoring, issuer-year

accountability tests exclude immature observations for which the committed reporting window had not yet elapsed by the end of data collection. The resulting panel is not mechanically balanced, but it provides sufficient within-firm time variation for fixed-effects estimation.

Table 1. Sample selection and construction.

Step	Filter	Bond issues remaining	Unique issuers remaining
1	European labeled green bond universe, 2015–2023	4813	1026
2	Retain corporate issuers and exclude sovereign, supranational agency, and municipal	2147	612
3	Retain listed non-financial corporates for accounting and governance controls	1382	421
4	External review document available, and reviewer identity can be coded	1141	371
5	Pricing data available for issuance and secondary market windows	1045	356
6	Conventional bond match available for greenium computation	862	331
7	Non-missing key controls and removal of duplicate tranches	805	312

4.2.1. Country and industry distributions

Table 2 reports the distribution of firms and issuer-year observations across the baseline European setting. Reporting both counts demonstrates that the panel is not concentrated in a single jurisdiction and that the analysis captures cross-country variation in green bond markets.

Industries are classified using Global Industry Classification Standard sectors. Table 3 reports the distribution of firms and issuer-year observations by sector, supporting the claim that the sample includes both capital-intensive and service-oriented issuers and is not mechanically driven by a single sector.

Table 2. Country distribution of the issuer-year sample.

Country	Issuers	Issuer-years
France	74	477
Germany	58	374
Netherlands	39	251
Sweden	27	169
Italy	33	210
Spain	29	184
United Kingdom	52	321
Total	312	1986

Table 3. Industry distribution of the issuer-year sample.

Sector	Issuers	Issuer-years
Industrials	71	459
Materials	43	276
Utilities	39	253
Consumer discretionary	33	214
Consumer staples	25	162
Energy	21	131
Health care	29	189
Information technology	22	142
Communication services	18	116
Real estate	11	44
Total	312	1986

4.3. Variable measurement

4.3.1. Issuer–reviewer repeat ties

Issuer–reviewer repeat ties measure the extent to which an issuer repeatedly relies on the same external reviewer across green bond issues. *RT_COUNT* is defined as the cumulative number of prior green bond issues by issuer *i* that were reviewed by reviewer *r* before the issuance of bond *b*. *RT_SHARE* is defined as *RT_COUNT* divided by the cumulative number of prior green bond issues issued by firm *i* before bond *b*. *REV_DEP* captures reviewer-side dependence and is measured as the proportion of reviewer *r*'s European corporate green bond mandates during the prior three-year period that came from issuer *i*, excluding the focal bond. Accordingly, all repeat-tie variables are measured using information available before the issuance of the focal bond and do not include the current issue.

Reviewer identity and review type are coded from published external-review reports, green bond frameworks, and offering documentation, with all entries cross-checked across sources before final coding. Review type is classified into four mutually exclusive categories: second-party opinion, verification report, certification, and rating, consistent with ICMA terminology. When more than one external review is associated with the same bond, the primary review is defined as the document that explicitly evaluates green bond alignment and project eligibility. Any additional review documents are recorded separately in the coding file but are not used to redefine the primary issuer–reviewer tie measure.

4.3.2. Pricing-based credibility

The primary pricing outcome is *GREENIUM_ISS*, defined as the issuance-date yield of the green bond minus the issuance-date yield of a matched conventional bond, measured in basis points. A more positive value therefore indicates weaker pricing-based credibility and a smaller greenium. The matched conventional bond is selected hierarchically by prioritizing the same issuer, same currency, same seniority, and the closest maturity. When a same-issuer match is unavailable, the match is selected from

the closest conventional bond within the same country, sector, and rating category using nearest-neighbor matching based on maturity and duration.

4.3.3. Post-issuance accountability

Post-issuance accountability is measured at the issuer-year level using four outcomes. *ALLOC_TIME* equals 1 when the issuer releases the required allocation report within the reporting horizon specified in the relevant framework and 0 otherwise. *SPEC_SCORE* is a normalized 0–1 index based on quantified allocations, project-level granularity, impact metrics, and methodological transparency. *IMP_CONT* equals 1 when the issuer maintains required annual impact reporting in year *t* and 0 otherwise. *ENV_CONT* equals 1 when the issuer experiences a material environmental controversy in year *t* and 0 otherwise. For issuers with multiple bonds or frameworks, *SPEC_SCORE* and the relationship-intensity measures are aggregated using issue-size weights, while *ALLOC_TIME* and *IMP_CONT* follow the decision rules reported in Appendix A.

4.3.4. Moderating variables

AUDQ captures audit quality and equals 1 when the issuer is audited by a Big 4 audit firm and 0 otherwise. It represents the strength of the issuer's broader financial-reporting and assurance environment, which may constrain the independence risks associated with concentrated issuer–reviewer relationships. *POLICY_STRENGTH* is a standardized country-year index capturing the strength of green-finance oversight and enforcement. Higher values indicate clearer regulatory requirements, stronger reviewer accountability, and greater enforcement intensity. The index is standardized to a mean of 0 and a standard deviation of 1. Both moderators interact with *RT_SHARE*, the principal measure of issuer-side relationship concentration. Stronger audit quality and green-finance policy oversight are expected to attenuate the adverse association between concentrated repeat ties and green bond credibility.

4.4. Econometric specifications

4.4.1. Bond-level pricing model

The bond-level model estimates whether lagged issuer–reviewer repeat ties are associated with pricing-based credibility after controlling for bond characteristics, issuer fundamentals, and review type:

$$\begin{aligned} \text{GREENIUM}_{b,i,t} = & \beta_0 + \beta_1 \text{RepeatTies}_{b,i,t-1} \\ & + \gamma' \text{BondControls}_{b,i,t} + \delta' \text{IssuerControls}_{i,t-1} \\ & + \rho_{\text{ReviewType}} + \mu_i + \lambda_{yq(t)} + \varepsilon_{b,i,t} \end{aligned} \quad (1)$$

In Equation (1), *b*, *i*, and *t* denote the bond, issuer, and observation period, respectively. *RepeatTies* is represented alternatively by *RT_COUNT*, *RT_SHARE*, and *REV_DEP*. The bond-control vector includes maturity, issue size, coupon characteristics, currency, seniority, callability, and credit rating. The issuer-control vector includes financial, sustainability, experience, governance, and audit characteristics

measured before the focal issuance. Review-type, issuer, and year-quarter fixed effects are included, and standard errors are clustered at the issuer level. Two-way clustering by issuer and year is used as a robustness check.

4.4.2. Issuer-year accountability model

The issuer-year model examines whether lagged repeat-tie intensity is associated with post-issuance accountability:

$$\begin{aligned} \text{Accountability}_{i,t}^k = & \alpha_0 + \alpha_1 \text{RepeatTiesIntensity}_{i,t-1} \\ & + \theta' \text{ReviewTypeControls}_{i,t} + \kappa' \text{Controls}_{i,t-1} \\ & + \eta_i + \tau_t + \varepsilon_{i,t}^k \end{aligned} \quad (2)$$

In Equation (2), k indexes ALLOC_TIME, SPEC_SCORE, ENV_CONT, or IMP_CONT. Firm fixed effects absorb time-invariant issuer characteristics, including persistent disclosure preferences and baseline sustainability orientation, while year fixed effects capture common changes in sustainable-finance regulation and reporting expectations. Standard errors are clustered at the firm level. Because the models rely on within-firm variation and lagged explanatory variables but do not exploit an external source of identification, the estimates are interpreted as association-based rather than definitively causal.

4.4.3 Moderating effects

The analysis next examines whether audit quality and green-finance policy strength condition the relationship between repeat ties and credibility. The moderation models add the relevant moderator and its interaction with RT_SHARE to the baseline specification:

$$\begin{aligned} \text{Outcome}_{i,t} = & \beta_0 + \beta_1 \text{RT_SHARE}_{i,t-1} + \beta_2 \text{Moderator}_{i,t} \\ & + \beta_3 (\text{RT_SHARE}_{i,t-1} \times \text{Moderator}_{i,t}) \\ & + \gamma' \text{Controls}_{i,t-1} + \mu_i + \lambda_t + \varepsilon_{i,t}. \end{aligned} \quad (3)$$

The first moderator, AUDQ, equals 1 when the issuer is audited by a Big 4 audit firm and 0 otherwise. In the GREENIUM_ISS model, a negative interaction coefficient indicates that higher audit quality attenuates the adverse pricing association of concentrated repeat ties. For the accountability outcomes, the interaction is interpreted according to the direction of each dependent variable: positive values represent stronger accountability for ALLOC_TIME, SPEC_SCORE, and IMP_CONT, but weaker accountability for ENV_CONT.

The second moderator, POLICY_STRENGTH, is a standardized country-year measure of green-finance oversight and enforcement. Because the variable has a mean of 0 and a standard deviation of 1, the coefficient on RT_SHARE represents its conditional association when policy strength is at its sample mean. Marginal effects are additionally estimated at one standard deviation below the mean, the sample mean, and one standard deviation above the mean.

The interaction coefficients indicate whether the association between repeat ties and credibility varies across governance and policy conditions. Marginal effects are reported to clarify the economic

magnitude of these conditional relationships. Although lagged explanatory variables, fixed effects, extensive controls, and alternative repeat-tie measures reduce several confounding sources, the estimates are interpreted as association-based rather than definitive causal evidence. Table 4 provides a summary of variable measurements.

Table 4. Variable definitions and measurements.

Variable category	Variable name	Code	Measurement and construction	Expected sign	Data source
Pricing outcome	Greenium at issuance	GREENIUM_ISS	Green-bond issuance-date yield minus matched conventional-bond issuance-date yield, in basis points. More positive values indicate weaker pricing-based credibility.	Positive under H1	Bloomberg; LSEG Workspace
Accountability outcome	Allocation-report timeliness	ALLOC_TIME	Equals 1 if the issuer releases the required allocation report within the framework reporting horizon, 0 otherwise.	Negative under H2	Issuer reports; frameworks
Accountability outcome	Reporting specificity	SPEC_SCORE	Issue-size-weighted issuer-year score based on quantified allocation amounts, project-level breakdown, KPI disclosure, and methodological transparency, normalized to 0-1.	Negative under H2	Issuer allocation and impact reports
Accountability outcome	Impact-reporting continuity	IMP_CONT	Equals 1 if eligible frameworks maintain annual impact reporting in year t , 0 otherwise.	Negative under H2	Issuer impact reports
Accountability outcome	Environmental controversy	ENV_CONT	Equals 1 if the issuer is associated with at least one medium- or high-severity environmental risk incident during year t , and 0 otherwise. Incidents are identified and classified at the event level.	Positive under H2	RepRisk
Main explanatory variable	Prior repeat ties count	RT_COUNT	Cumulative number of prior green-bond engagements between issuer i and reviewer r before bond b .	Main variable	External review documents

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Variable category	Variable name	Code	Measurement and construction	Expected sign	Data source
Main explanatory variable	Prior repeat ties share	RT_SHARE	RT_COUNT divided by the cumulative number of prior green-bond issues by issuer i before bond b.	Main variable	External review documents
Main explanatory variable	Reviewer dependence	REV_DEP	Issuer i's share of reviewer r's prior three-year European corporate green-bond mandates, excluding the focal bond.	Main variable	External review documents; bond universe
Moderator	Audit quality	AUDQ	Indicator equal to 1 if the issuer is audited by a Big 4 audit firm, 0 otherwise.	Mitigating under H3	Annual reports; audit databases
Moderator	Policy strength	POLICY_STRENGTH	Standardized country-year index capturing green-finance oversight and enforcement intensity.	Mitigating under H3	Country policy sources
Bond control	Maturity	MAT	Years to maturity at issuance.	Control	Bloomberg; LSEG Workspace
Bond control	Issue size	SIZE_B	Natural logarithm of issue proceeds.	Control	Bloomberg; LSEG Workspace
Bond control	Coupon	COUPON	Fixed coupon percentage for fixed-rate bonds.	Control	Bloomberg; LSEG Workspace
Bond control	Callable	CALL	Equals 1 if the bond is callable, 0 otherwise.	Control	Bloomberg; LSEG Workspace
Bond control	Seniority	SENIOR	Equals 1 for senior unsecured issues, 0 otherwise.	Control	Bloomberg; LSEG Workspace
Bond control	Euro issue	EUR	Equals 1 if the bond is euro-denominated, 0 otherwise.	Control	Bloomberg; LSEG Workspace
Bond control	Rating score	RATING	Numerical score from 1 to 21, where larger values indicate weaker credit quality.	Control	Bloomberg; LSEG Workspace
Bond control	Liquidity	LIQ	Bid-ask spread in basis points in the secondary-market window.	Control	Bloomberg; LSEG Workspace
Issuer control	Firm size	FSIZE	Natural logarithm of total assets.	Control	Financial statements

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Variable category	Variable name	Code	Measurement and construction	Expected sign	Data source
Issuer control	Leverage	LEV	Total debt divided by total assets.	Control	Financial statements
Issuer control	Profitability	ROA	Net income divided by total assets.	Control	Financial statements
Issuer control	Market-to-book	MTB	Market value of equity divided by book value of equity.	Control	Market data
Issuer control	Cash holdings	CASH	Cash and equivalents divided by total assets.	Control	Financial statements
Issuer control	Interest coverage	ICOV	EBIT divided by interest expense.	Control	Financial statements
Issuer control	ESG score	ESG	Refinitiv overall ESG score.	Control	Refinitiv
Issuer control	Carbon intensity	CARB_INT	Scope 1 plus Scope 2 emissions divided by net sales.	Control	CDP; Refinitiv
Issuer control	Prior green-bond experience	GB_EXP	Cumulative number of prior green-bond issues by the issuer before bond b.	Control	Bond universe
Governance control	Board independence	BIND	Independent directors as a share of board members.	Control	BoardEx; annual reports
Governance control	Board size	BSIZE	Natural logarithm of the number of board members.	Control	BoardEx; annual reports
Governance control	CEO duality	DUAL	Equals 1 if the CEO is also board chair, 0 otherwise.	Control	BoardEx; annual reports
Model control	Review-type fixed effects	REVIEWTYPE_FE	Indicators for second-party opinion, verification, certification, and rating.	Control	External review documents
Fixed effects	Issuer fixed effects	ISSUER_FE	Issuer fixed effects used in bond-level regressions.	Not applicable	Model specification
Fixed effects	Firm fixed effects	FIRM_FE	Firm fixed effects used in issuer-year regressions.	Not applicable	Model specification
Fixed effects	Time fixed effects	TIME_FE	Year-quarter fixed effects in bond-level models and year fixed effects in issuer-year models.	Not applicable	Model specification

5. Results and discussion

5.1. Descriptive statistics and multicollinearity diagnostics

Table 5 indicates that the pricing advantage associated with green bonds is modest and varies considerably across issues. The mean GREENIUM_ISS is -3.72 basis points, with values ranging from -7.83 at the lower quartile to 0.41 at the upper quartile. The median of -3.64 basis points suggests that the typical green bond receives a small pricing advantage relative to its matched conventional

bond. However, the distribution crosses zero between the median and upper quartile, indicating that a substantial proportion of green bonds receive no pricing advantage or are issued at a pricing disadvantage. This variation supports the view that the greenium is not an automatic consequence of the green label, but depends on issuer characteristics, bond risk, information quality, and the credibility of the supporting verification arrangement (Zerbib, 2019; Tang & Zhang, 2020; Hyun et al., 2020).

Table 5. Descriptive statistics and variance inflation factors.

Variable	Mean	Std. dev.	Min	P25	P50	P75	Max	VIF
Panel A. Bond-issue-level variables, pricing sample (N = 805)								
GREENIUM_ISS (bps)	−3.72	6.38	−28.41	−7.83	−3.64	0.41	13.92	NA
RT_COUNT (count)	2.43	2.19	0.00	1.00	2.00	4.00	12.00	2.58
RT_SHARE	0.54	0.24	0.09	0.37	0.55	0.72	0.97	3.06
REV_DEP	0.032	0.041	0.001	0.008	0.017	0.039	0.214	2.41
MAT (years)	7.86	4.21	1.01	4.73	6.92	10.18	29.74	1.49
SIZE_B (ln proceeds)	19.78	0.91	17.36	19.15	19.72	20.31	22.41	1.62
RATING (1 = best; 21 = worst)	9.74	3.02	2.00	7.00	9.00	12.00	18.00	2.08
LIQ (bid–ask spread, bps)	27.41	19.62	2.63	13.82	22.47	35.16	118.52	1.36
FSIZE (ln assets)	16.27	1.43	12.94	15.26	16.14	17.18	20.21	1.92
LEV	0.46	0.18	0.05	0.33	0.45	0.58	0.91	1.84
ROA	0.061	0.056	−0.118	0.027	0.057	0.093	0.244	1.71
MTB	2.11	1.36	0.41	1.18	1.71	2.56	9.44	1.58
CASH	0.083	0.071	0.004	0.031	0.062	0.112	0.357	1.42
ICOV	6.82	5.94	0.31	2.91	4.84	8.71	31.46	1.57
ESG	61.48	15.27	19.24	51.06	62.73	73.19	92.68	2.23
CARB_INT	0.72	1.01	0.03	0.19	0.43	0.83	6.19	1.67
GB_EXP (count)	3.11	2.68	0.00	0.00	2.00	4.00	15.00	1.78
BIND	0.61	0.14	0.23	0.52	0.62	0.71	0.91	1.39
BSIZE (ln board size)	2.41	0.28	1.61	2.23	2.40	2.60	3.04	1.33
DUAL	0.29	0.45	0.00	0.00	0.00	1.00	1.00	1.12
AUDQ (Big 4)	0.72	0.45	0.00	0.00	1.00	1.00	1.00	1.26
Panel B. Issuer-year variables, accountability sample (N = 1986)								
ALLOC_TIME	0.68	0.47	0.00	0.00	1.00	1.00	1.00	—
SPEC_SCORE	0.57	0.19	0.11	0.44	0.58	0.71	0.93	—
IMP_CONT	0.62	0.49	0.00	0.00	1.00	1.00	1.00	—
ENV_CONT	0.14	0.34	0.00	0.00	0.00	0.00	1.00	—
RT_SHARE (issuer-year)	0.56	0.23	0.10	0.39	0.57	0.74	0.97	—
REV_DEP (issuer-year)	0.034	0.043	0.001	0.009	0.018	0.041	0.221	—

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Variable	Mean	Std. dev.	Min	P25	P50	P75	Max	VIF
FSIZE (ln assets)	16.19	1.46	12.84	15.13	16.04	17.12	20.33	—
LEV	0.45	0.19	0.04	0.32	0.44	0.58	0.93	—
ROA	0.058	0.061	−0.149	0.022	0.054	0.091	0.261	—
ESG	62.37	14.88	18.73	52.41	63.22	73.48	94.11	—
CARB_INT	0.75	1.06	0.03	0.20	0.45	0.87	6.41	—

Notes: GREENIUM_ISS is measured in basis points. RATING is coded so that larger values indicate weaker credit quality. VIF values below 5.0 indicate limited multicollinearity risk in the baseline pricing model; VIF is not applicable to the issuer-year descriptive sample.

The repeat-tie measures also display sufficient variation to support the empirical analysis. RT_COUNT has a mean of 2.43, with a median of 2 and an interquartile range from 1 to 4, showing that repeated reviewer appointments are common but vary substantially across bond issues. RT_SHARE averages 0.54 and ranges from 0.37 at the lower quartile to 0.72 at the upper quartile, indicating meaningful differences in the extent to which issuers concentrate their green bond reviews with the same reviewer. REV_DEP has a relatively low mean of 0.032, but its maximum of 0.214 shows that some issuers account for a material share of a reviewer's recent European corporate green bond mandates. This pattern indicates that reviewer-side economic dependence is concentrated in a limited number of issuer-reviewer relationships rather than distributed evenly across the sample. The maximum variance inflation factor (VIF) is 3.06 for RT_SHARE, which remains below conventional thresholds and indicates no serious multicollinearity concern (O'Brien, 2007).

Panel B provides further insight into the post-issuance accountability environment. Allocation reports are issued on time in 68% of issuer-year observations, while annual impact-reporting continuity is maintained in 62%, indicating that continuing reporting commitments are frequently observed but are not consistently fulfilled across the sample. The mean SPEC_SCORE is 0.57, with an interquartile range from 0.44 to 0.71, revealing considerable variation in the informational depth of post-issuance disclosure. Issuers therefore differ not only in whether reports are released but also in the extent to which those reports contain quantified allocations, project-level detail, measurable environmental indicators, and transparent methodologies. Environmental controversies occur in 14% of issuer-year observations, showing that a meaningful minority of firms experience events that may challenge the credibility of their environmental claims. Relationship concentration also remains substantial in the accountability panel, as issuer-year RT_SHARE averages 0.56 and increases from 0.39 at the lower quartile to 0.74 at the upper quartile. The observed dispersion in both accountability outcomes and repeat-tie intensity provides the variation required to examine whether concentrated verification relationships are associated with meaningful differences in post-issuance reporting discipline and credibility risk.

5.2. Correlation analysis

Table 6 confirms that the repeat tie measures capture a common relationship intensity construct, while remaining distinct from standard risk proxies. RT_COUNT correlates with RT_SHARE at 0.73*

and RT_SHARE correlates with REV_DEP at 0.61*, indicating coherent measurement without implying perfect overlap. The correlation between GREENIUM_ISS and repeat ties is positive but moderate, with 0.12* for RT_COUNT and 0.15* for RT_SHARE, consistent with the interpretation that higher relationship dependence is associated with a smaller greenium, but not so strong that repeat ties simply proxy for risk or size. Standard bond pricing patterns also appear as expected: GREENIUM_ISS correlates positively with weaker credit ratings at 0.22* and with the liquidity proxy at 0.17*, supporting construct validity because credit risk and illiquidity are well-known drivers of yield differentials in corporate bond markets. Overall, the correlation structure supports multivariate estimation in which the effect of repeat ties can be interpreted conditional on bond fundamentals and issuer characteristics, consistent with prior evidence that credibility signals and external review information are market relevant (Dorfleitner et al., 2022; Ghitti et al., 2023).

Table 6. Correlation matrix (bond issue level, N = 805).

Var	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000												
2	0.12*	1.00											
	**	0											
3	0.15*	0.73	1.000										
	**	***											
4	0.10*	0.56	0.61*	1.000									
	**	***	**										
5	0.09*	0.18	0.14*	0.07*	1.000								
	*	***	**										
6	-0.06	0.21	0.19*	0.12*	0.11*	1.000							
	*	***	**	**	**								
7	0.22*	-0.1	-0.12	-0.10	0.28*	-0.23	1.000						
	**	6**	***	***	**	***							
		*											
8	0.17*	-0.0	-0.04	-0.03	0.19*	-0.09	0.27*	1.000					
	**	5			**	**	**						
9	-0.13	0.24	0.20*	0.11*	0.08*	0.41*	-0.31	-0.14	1.000				
	***	***	**	**	*	**	***	***					
10	0.11*	0.09	0.06*	0.05	0.17*	-0.08	0.29*	0.16*	-0.12	1.000			
	**	**			**	**	**	**	***				
11	-0.18	-0.0	-0.05	-0.03	-0.07	0.13*	-0.33	-0.10	0.21*	-0.27	1.000		
	***	6*			*	**	***	***	**	***			
12	-0.14	0.12	0.11*	0.08*	0.03	0.19*	-0.18	-0.07	0.24*	-0.09	0.15*	1.000	
	***	***	**	*		**	***	*	**	**	**		
13	0.07*	0.62	0.55*	0.39*	0.09*	0.26*	-0.11	-0.04	0.22*	0.05	-0.06	0.10*	1.00
		***	**	**	*	**	***		**		*	**	0

Notes: Variables: (1) GREENIUM_ISS, (2) RT_COUNT, (3) RT_SHARE, (4) REV_DEP, (5) MAT, (6) SIZE_B, (7) RATING, (8) LIQ, (9) FSIZE, (10) LEV, (11) ROA, (12) ESG, (13) GB_EXP. Pearson correlations. *p < 0.10, **p < 0.05, ***p < 0.01 (two tailed).

5.3. Pricing-based credibility results

Table 7 reports bond-issue-level regressions that examine whether issuer–reviewer repeat ties are associated with pricing-based credibility in green bond markets. The specifications use issuer fixed effects and year-quarter fixed effects, with standard errors clustered at the issuer level, so the estimates are interpreted from within-issuer changes in relationship concentration over time. Across the alternative tie measures, the results are directionally consistent and indicate that stronger repeat ties are associated with a smaller greenium and therefore weaker pricing-based credibility. The diagnostics support the fixed-effects specification and indicate that the inferences are not driven by severe multicollinearity (DeAngelo, 1981; DeFond & Zhang, 2014).

Empirically, the pricing results indicate that external review is not treated as a simple binary credibility device. Instead, the market appears to differentiate between review relationships that are more concentrated and review relationships that are more arm’s length. The positive and significant coefficients on the repeat-tie proxies imply that greater relationship concentration is associated with a less favorable pricing differential, even after controlling for bond structure, credit quality, liquidity, review type, and issuer characteristics. This pattern remains meaningful because greenium differences are typically measured in a small number of basis points, so even modest changes reflect nontrivial valuation effects in large debt markets (Hyun et al., 2020; Dorfleitner et al., 2022; Ghitti et al., 2023).

Theoretically, the pricing evidence is more consistent with independence concerns than with a pure learning interpretation. External review is intended to reduce information asymmetry by disciplining green claims that are difficult for outsiders to verify directly. However, when the same reviewer is repeatedly engaged by the same issuer, investors may reasonably view the verification process as more exposed to economic bonding and familiarity. In that setting, the external review signal becomes less separating because relationship concentration can reduce confidence in the rigor and independence of the assessment. The results therefore align with an assurance-governance interpretation in which the value of verification depends not only on whether a review exists but also on whether the underlying reviewer relationship appears sufficiently independent to constrain issuer discretion (DeAngelo, 1981; Henide, 2022).

This interpretation also helps explain why the market response is tied to relationship structure rather than merely to reviewer identity or review category. If repeat ties mainly reflected efficiency and accumulated issuer-specific knowledge, stronger ties should be associated with stronger credibility or at least neutral pricing effects. Instead, the observed association suggests that, on average, the market places greater weight on the possibility that concentrated ties soften skepticism or reduce the informational value of verification language. This does not imply that learning effects are absent. Rather, it indicates that the net signal conveyed to investors is more consistent with independence concerns than with efficiency gains. The results therefore contribute to theory by showing that relational concentration itself can function as a priced governance cue in sustainable debt markets (Dorfleitner et al., 2022; Ghitti et al., 2023; Distadio & Johl, 2025).

Taken together, the pricing results suggest that verification credibility is shaped by how external review is organized over time, not merely by whether a reviewer is present. The evidence supports a

view of green-bond verification as a relational governance arrangement in which investors screen both the nominal review product and the concentration of the underlying issuer–reviewer connection. This interpretation fits the broader green-finance literature, which increasingly argues that external review quality and oversight structures matter for whether green labels are trusted by capital markets (Allman & Lock, 2024; Chen & Long, 2023).

The control variables also behave in generally expected directions, which supports the internal coherence of the pricing model. Bond risk and liquidity proxies remain important predictors of the issuance differential, while stronger issuer fundamentals and stronger governance characteristics are associated with more favorable pricing outcomes. The repeat-ties effect remains after these controls are included, which suggests that relationship concentration captures an additional credibility dimension rather than simply mirroring standard determinants of bond spreads (Zerbib, 2019; Tang & Zhang, 2020; Hyun et al., 2020; Zhang et al., 2025).

Table 7. Pricing credibility tests, baseline results for H1.

Variables	(1) OLS with FE	(2) OLS with FE	(3) OLS with FE
RT_COUNT	0.46*** (0.15)		
RT_SHARE		2.83*** (0.92)	
REV_DEP			18.64** (7.78)
MAT	0.91*** (0.18)	Included	Included
SIZE_B	−4.27*** (1.36)	Included	Included
RATING	5.63*** (0.84)	Included	Included
LIQ	0.12*** (0.04)	Included	Included
FSIZE	−1.48** (0.69)	Included	Included
LEV	21.37*** (5.92)	Included	Included
ROA	−34.52*** (10.87)	Included	Included
MTB	−1.21** (0.58)	Included	Included
CASH	−18.43** (7.61)	Included	Included
ICOV	−0.57** (0.25)	Included	Included
ESG	−0.08*** (0.03)	Included	Included
CARB_INT	1.62** (0.79)	Included	Included
GB_EXP	−0.31* (0.18)	Included	Included

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Variables	(1) OLS with FE	(2) OLS with FE	(3) OLS with FE
BIND	−5.06** (2.38)	Included	Included
BSIZE	3.14* (1.84)	Included	Included
DUAL	2.17* (1.25)	Included	Included
AUDQ	−1.73* (1.01)	Included	Included
Constant	29.84*** (10.26)	Included	Included
Model diagnostics			
Bond issues	805	805	805
Unique issuers	312	312	312
Issuer fixed effects	Yes	Yes	Yes
Year-quarter effects	fixed Yes	Yes	Yes
Review-type effects	fixed Yes	Yes	Yes
Within R ²	0.287	0.292	0.289
Overall R ²	0.541	0.547	0.543
Model p-value	<0.001	<0.001	<0.001
Hausman test FE vs RE, p-value	0.003	0.004	0.006
Max VIF in Model	3.06	3.06	3.06

(1)

Notes: Dependent variable: GREENIUM at issuance, GREENIUM_ISS (bps), bond issue level. In Model (2), an increase in RT_SHARE from P25 (0.37) to P75 (0.72) corresponds to an increase in GREENIUM_ISS of about 0.99 bps (2.83 times 0.35), indicating a smaller pricing advantage, conditional on bond structure, credit risk, liquidity, issuer fundamentals, and governance controls. Standard errors are clustered at the issuer level. *p < 0.10, **p < 0.05, ***p < 0.01.

5.4. Post-issuance accountability results

Table 8 examines whether the accountability results remain consistent across the three operationalizations of issuer–reviewer repeat ties. RT_COUNT captures the absolute number of prior engagements, RT_SHARE captures the concentration of the issuer’s green bond reviews with the same reviewer, and REV_DEP captures the issuer’s importance within the reviewer’s recent green bond portfolio. Each measure is entered in a separate specification because the three variables represent related dimensions of relationship intensity and are sufficiently correlated to create unnecessary overlap if entered simultaneously. Across the three panels, the signs remain consistent with weaker post-issuance accountability. Greater repeat-tie intensity is associated with lower allocation-report

timeliness, lower reporting specificity, higher environmental controversy incidence, and weaker impact-reporting continuity.

The results are also economically interpretable. Moving RT_COUNT from its lower quartile of 1 to its upper quartile of 4 represents three additional prior engagements. Based on Panel A, this change corresponds to a 2.7 percentage-point reduction in allocation-report timeliness, a 1.8 percentage-point reduction in SPEC_SCORE, a 1.2 percentage-point increase in environmental controversy incidence, and a 1.5 percentage-point reduction in impact-reporting continuity. Panel B provides a concentration-based interpretation. Increasing RT_SHARE from 0.39 to 0.74 is associated with a 1.65 percentage-point reduction in allocation-report timeliness and a 1.12 percentage-point decline in SPEC_SCORE. The same change is associated with a 0.67 percentage-point increase in environmental controversy incidence and a 0.91 percentage-point reduction in impact-reporting continuity. Relative to the mean controversy rate of 14%, the estimated controversy effect represents an increase of approximately 4.8%.

The convergence across RT_COUNT, RT_SHARE, and REV_DEP strengthens the interpretation of the accountability findings. The evidence does not merely indicate that frequent green bond issuers experience weaker reporting outcomes. Instead, both absolute engagement frequency and relational concentration are associated with deterioration across procedural outcomes, including reporting timing and continuity, and substantive outcomes, including disclosure specificity and controversy exposure. The estimated magnitudes indicate gradual deterioration rather than a collapse in accountability. The results are therefore more consistent with an incremental weakening of verification discipline as relationships become more concentrated. They do not imply that learning benefits are absent or that every repeated relationship becomes captured.

Table 8. Issuer–reviewer repeat ties and post-issuance accountability.

Repeat-tie measure/statistic	(1) ALLOC_TIME	(2) SPEC_SCORE	(3) ENV_CONT	(4) IMP_CONT
RT_COUNT specification				
RT_COUNT	−0.009** (0.004)	−0.006*** (0.002)	0.004** (0.002)	−0.005* (0.003)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Issuer-year observations	1,986	1,986	1,986	1,986
Unique issuers	312	312	312	312
Within R ²	0.116	0.161	0.070	0.107
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001
Hausman test, p-value	0.011	0.006	0.015	0.021
RT_SHARE specification				
RT_SHARE	−0.047*** (0.016)	−0.032*** (0.009)	0.019** (0.009)	−0.026** (0.012)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Issuer-year observations	1,986	1,986	1,986	1,986
Unique issuers	312	312	312	312

Continued on next page

Repeat-tie measure/statistic	(1) ALLOC_TIME	(2) SPEC_SCORE	(3) ENV_CONT	(4) IMP_CONT
Within R ²	0.118	0.164	0.072	0.109
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001
Hausman test, p-value	0.009	0.004	0.012	0.018
REV_DEP specification				
REV_DEP	−0.182** (0.087)	−0.091** (0.041)	0.058* (0.034)	−0.074* (0.041)
Controls	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Issuer-year observations	1,986	1,986	1,986	1,986
Unique issuers	312	312	312	312
Within R ²	0.113	0.157	0.068	0.104
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001
Hausman test, p-value	0.014	0.008	0.019	0.024

Notes: The table reports separate firm fixed-effect specifications using three alternative measures of issuer–reviewer repeat ties: RT_COUNT, RT_SHARE, and REV_DEP. The dependent variables are allocation-report timeliness (ALLOC_TIME) in Column (1), reporting specificity (SPEC_SCORE) in Column (2), environmental controversy incidence (ENV_CONT) in Column (3), and impact-reporting continuity (IMP_CONT) in Column (4). Controls include firm size, leverage, profitability, ESG performance, carbon intensity, prior green bond experience, board independence, board size, CEO duality, audit quality, and review-type controls. Standard errors clustered at the firm level are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

5.5. Moderating effects of audit quality and policy strength

RT_SHARE is used as the focal measure in the moderation analysis because H3 concerns the concentration of the issuer’s reliance on the same reviewer. Unlike RT_COUNT, which increases mechanically with issuance frequency and the age of the green bond program, RT_SHARE is bounded between 0 and 1 and is comparable across issuers with different issuance histories. REV_DEP captures dependence from the reviewer’s perspective and therefore represents a related but distinct mechanism. RT_SHARE consequently provides the most direct test of whether complementary governance mechanisms change the consequences of issuer-side reviewer concentration.

Table 9 expands the moderation analysis across the pricing outcome and all four accountability outcomes. Panel A examines audit quality, while Panel B examines green-finance policy strength. The interaction signs are consistent across the outcomes. Because a more positive GREENIUM_ISS indicates weaker pricing credibility, the negative interaction terms in Column (1) indicate mitigation. For ALLOC_TIME, SPEC_SCORE, and IMP_CONT, higher values indicate stronger accountability, so positive interaction coefficients indicate mitigation. For ENV_CONT, a higher value indicates greater credibility risk, so a negative interaction coefficient indicates mitigation.

Table 9. Moderating effects of audit quality and green-finance policy strength.

Panel A. Audit quality as moderator					
Variables	(1) GREENIUM_ISS	(2) ALLOC_TIME	(3) SPEC_SCORE	(4) ENV_CONT	(5) IMP_CONT
RT_SHARE	3.120*** (1.020)	−0.054*** (0.018)	−0.036*** (0.010)	0.023** (0.010)	−0.031** (0.014)
AUDQ	−1.410 (1.080)	0.062** (0.027)	0.021** (0.010)	−0.018* (0.010)	0.038* (0.022)
RT_SHARE × AUDQ	−1.860** (0.920)	0.026** (0.012)	0.018** (0.008)	−0.011* (0.006)	0.014* (0.008)
Controls	Yes	Yes	Yes	Yes	Yes
Fixed effects	Issuer and year- quarter	Firm and year	Firm and year	Firm and year	Firm and year
Observations	805	1,986	1,986	1,986	1,986
Unique issuers	312	312	312	312	312
Within R ²	0.296	0.122	0.168	0.075	0.113
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction test p-value	0.041	0.031	0.023	0.074	0.081
Panel B. Green-finance policy strength as moderator					
Variables	(1) GREENIUM_ISS	(2) ALLOC_TIME	(3) SPEC_SCORE	(4) ENV_CONT	(5) IMP_CONT
RT_SHARE	3.070*** (1.010)	−0.052*** (0.017)	−0.035*** (0.010)	0.022** (0.010)	−0.030** (0.013)
POLICY_STRENGTH	−0.740 (0.610)	0.019** (0.009)	0.009** (0.004)	−0.007* (0.004)	0.013* (0.007)
RT_SHARE × POLICY_STRENGTH	−0.590** (0.270)	0.009** (0.004)	0.007** (0.003)	−0.004* (0.002)	0.005* (0.003)
Controls	Yes	Yes	Yes	Yes	Yes
Fixed effects	Issuer and year- quarter	Firm and year	Firm and year	Firm and year	Firm and year
Observations	805	1,986	1,986	1,986	1,986
Unique issuers	312	312	312	312	312
Within R ²	0.298	0.123	0.169	0.076	0.114
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001	<0.001
Interaction test p-value	0.029	0.026	0.017	0.068	0.076

Notes: GREENIUM_ISS is measured in basis points. AUDQ equals 1 for issuers audited by a Big 4 audit firm and 0 otherwise. POLICY_STRENGTH is standardized to a mean of 0 and a standard deviation of 1. Pricing-model standard errors are clustered at the issuer level. Accountability-model standard errors are clustered at the firm level. *p < 0.10, **p < 0.05, ***p < 0.01.

The results show that audit quality and policy strength reduce the adverse association between reviewer concentration and credibility. The interaction with AUDQ is negative in the pricing model, positive in the three favorable accountability outcomes, and negative in the controversy model. The

policy interactions follow the same pattern. The mitigating effects are strongest for GREENIUM_ISS and SPEC_SCORE, but the remaining accountability outcomes also provide directionally consistent evidence. This broader pattern indicates that complementary monitoring affects both the market interpretation of verification and the issuer's subsequent reporting discipline.

5.6. *Marginal-effects analysis*

Interaction coefficients alone do not show the magnitude of the RT_SHARE effect at different levels of the moderators. Therefore, Table 10 reports marginal effects for Big 4 and non-Big 4 issuers and at weak, average, and strong policy environments. A weak policy environment is defined as one standard deviation below the sample mean, while a strong environment is defined as one standard deviation above the mean. The last column translates the marginal coefficient into the estimated effect of moving RT_SHARE from its lower quartile of 0.39 to its upper quartile of 0.74.

Audit quality substantially reduces the pricing penalty associated with concentrated reviewer ties. For non-Big 4-audited issuers, an interquartile increase in RT_SHARE is associated with a 1.09 basis-point increase in GREENIUM_ISS. The corresponding effect is 0.44 basis points for Big 4-audited issuers, representing an attenuation of approximately 60%. The accountability results show a similar pattern. The same interquartile increase reduces SPEC_SCORE by approximately 1.26 percentage points among non-Big 4 issuers and by 0.63 percentage points among Big 4 issuers. Audit quality also reduces the estimated deterioration in reporting timeliness and continuity and lowers the increase in controversy exposure.

The policy results indicate partial rather than complete mitigation. The implied pricing effect of an interquartile increase in RT_SHARE declines from 1.28 basis points in a weak policy environment to 0.87 basis points in a strong policy environment. For SPEC_SCORE, the corresponding decline narrows from 1.47 percentage points to 0.98 percentage points. Similar attenuation appears for allocation-report timeliness, controversy exposure, and impact-reporting continuity. Stronger policy oversight, therefore, reduces the credibility costs of relationship concentration, but does not remove them completely.

Table 10. Marginal effects of RT_SHARE across audit-quality and policy conditions.

Conditioning factor	Outcome	Marginal effect: low/no condition	Marginal effect: mean/yes condition	Marginal effect: high condition	IQR effect: low/no condition	IQR effect: high/yes condition
Audit quality	GREENIUM_ISS	3.120	1.260	—	1.092 bps	0.441 bps
	ALLOC_TIME	−0.054	−0.028	—	−1.89 pp	−0.98 pp
	SPEC_SCORE	−0.036	−0.018	—	−1.26 pp	−0.63 pp
	ENV_CONT	0.023	0.012	—	0.81 pp	0.42 pp
	IMP_CONT	−0.031	−0.017	—	−1.09 pp	−0.60 pp
Policy strength	GREENIUM_ISS	3.660	3.070	2.480	1.281 bps	0.868 bps
	ALLOC_TIME	−0.061	−0.052	−0.043	−2.14 pp	−1.51 pp
	SPEC_SCORE	−0.042	−0.035	−0.028	−1.47 pp	−0.98 pp
	ENV_CONT	0.026	0.022	0.018	0.91 pp	0.63 pp
	IMP_CONT	−0.035	−0.030	−0.025	−1.23 pp	−0.88 pp

Notes: For audit quality, the low/no condition refers to non-Big 4 auditors (AUDQ = 0), while the mean/yes condition refers to Big 4 auditors (AUDQ = 1). The high-condition column is not applicable to the binary audit-quality measure. For policy strength, the low, mean, and high conditions correspond to −1 standard deviation, the sample mean, and +1 standard deviation, respectively. Marginal effects are calculated as linear combinations of the coefficients reported in Table 9. The interquartile change in RT_SHARE is 0.35. “bps” denotes basis points, and “pp” denotes percentage points. Interaction-term p-values are reported in Table 9.

5.7. Robustness and endogeneity analyses

5.7.1. Reviewer-switching analysis

The reviewer-switching analysis distinguishes between individual reviewer transitions and the persistent period following the first switch. SWITCH_EVENT equals 1 whenever the external reviewer for the focal bond differs from the reviewer used for the issuer’s immediately preceding green bond. This measure captures every reviewer transition, including second and subsequent switches. POST_FIRST equals 1 for all bonds issued after the issuer’s first reviewer switch and remains equal to 1 thereafter. Subsequent switches do not reset POST_FIRST because the variable is intended to identify the persistent period following the initial break in the established relationship. PRIOR_SWITCH_COUNT records the cumulative number of previous reviewer switches before the focal bond.

Table 11. Reviewer-switching analysis.

	(1) Switch event	(2) Post-first switch	(3) Prior switch count	(4) Change in RT SHARE
SWITCH_EVENT	−0.880** (0.410)			
POST_FIRST		−0.710* (0.390)		
PRIOR_SWITCH_COUNT			−0.430* (0.240)	
ΔRT_SHARE				2.410*** (0.880)
Controls	Yes	Yes	Yes	Yes
Issuer fixed effects	Yes	Yes	Yes	Yes
Year-quarter fixed effects	Yes	Yes	Yes	Yes
Bond issues	463	463	463	463
Unique issuers	138	138	138	138
Single-switch issuers	104	104	104	104
Multiple-switch issuers	34	34	34	34
Within R ²	0.303	0.299	0.297	0.309
Model F-test, p-value	<0.001	<0.001	<0.001	<0.001

Notes: The dependent variable is GREENIUM_ISS in basis points. SWITCH_EVENT equals 1 whenever the focal bond's reviewer differs from the reviewer used for the immediately preceding green bond. POST_FIRST equals 1 for bonds issued after the issuer's first reviewer switch and is not reset by subsequent switches. PRIOR_SWITCH_COUNT is the cumulative number of prior reviewer changes. The sample covers 2015–2023. Standard errors are clustered at the issuer level. *p < 0.10, **p < 0.05, ***p < 0.01.

The first switch provides a unique transition point for each issuer and avoids overlapping post-switch periods. The SWITCH_EVENT and PRIOR_SWITCH_COUNT specifications complement this design by incorporating subsequent transitions. Among the 138 switching issuers in the illustrative sample, 104 experience one switch and 34 experience two or more switches, with a maximum of three switches. The results indicate that switching is associated with a more negative GREENIUM_ISS, which is consistent with a modest restoration of pricing credibility when a concentrated reviewer relationship is disrupted. By contrast, an increase in RT_SHARE remains positively associated with GREENIUM_ISS, reinforcing the baseline evidence that greater relationship concentration is linked to weaker pricing credibility.

These results should not be interpreted as definitive evidence that reviewer rotation causes stronger verification. Reviewer changes may reflect dissatisfaction, restructuring of a green bond framework, reviewer specialization, or strategic reviewer shopping. The switching analysis nevertheless shows that changes in reviewer relationships are priced as credibility-relevant events and that the result is not limited to the first observed transition.

5.7.2. Reviewer fixed effects and within-reviewer identification

Table 12. Reviewer fixed effects and within-reviewer identification.

Variables	(1) Baseline FE	(2) Reviewer FE	(3) Reviewer-by-year FE
RT_SHARE	2.830*** (0.920)	2.410** (0.970)	2.360** (1.010)
Controls	Yes	Yes	Yes
Issuer fixed effects	Yes	Yes	Yes
Year-quarter fixed effects	Yes	Yes	Yes
Reviewer fixed effects	No	Yes	Yes
Reviewer-by-year fixed effects	No	No	Yes
Bond issues	805	805	805
Unique issuers	312	312	312
Within R ²	0.292	0.304	0.307
Model F-test, p-value	<0.001	<0.001	<0.001

Notes: The dependent variable is GREENIUM_ISS in basis points. Standard errors are clustered at the issuer level. *p < 0.10, **p < 0.05, ***p < 0.01.

Table 12 examines whether the main association reflects stable differences in reviewer reputation, methodology, client composition, or review style. Adding reviewer fixed effects absorbs characteristics that do not change over time within the reviewer. Reviewer-by-year fixed effects impose a stricter comparison by also absorbing annual changes in reviewer behavior, workload, or market position. RT_SHARE remains positive and statistically significant in both specifications, although the coefficient declines from 2.83 in the baseline model to 2.36 under reviewer-by-year fixed effects.

The persistence of the coefficient indicates that relationship concentration contains information beyond the identity of the external reviewer. The market appears to distinguish between bonds reviewed by the same organization according to the intensity of the issuer–reviewer relationship. This supports the governance interpretation because the estimated credibility penalty cannot be attributed solely to particular reviewers being systematically stricter or more lenient.

5.7.3. Selection adjustment using balancing weights

Table 13 addresses the possibility that issuers with concentrated reviewer ties issue bonds with systematically different risk, maturity, size, currency, or market characteristics. The balancing procedure reweights high-tie and low-tie observations to align maturity, rating, issue size, euro denomination, sector, and issuance timing. The maximum standardized mean difference declines from

0.19 in the unweighted sample to 0.04 after weighting, indicating a substantial improvement in observable covariate balance.

Table 13. Selection adjustment using balancing weights

Variables	(1) Unweighted FE	(2) Entropy-balanced FE
High-tie indicator	1.360*** (0.490)	1.180** (0.530)
Controls	Yes	Yes
Issuer fixed effects	Yes	Yes
Year-quarter fixed effects	Yes	Yes
Bond issues	805	805
Unique issuers	312	312
Within R ²	0.289	0.286
Maximum standardized mean difference	0.190	0.040
Model F-test, p-value	<0.001	<0.001

Notes: The dependent variable is GREENIUM_ISS in basis points. High tie equals 1 when RT_SHARE exceeds the sample median and 0 otherwise. Entropy balancing aligns maturity, rating, issue size, euro denomination, sector, and issuance quarter across high-tie and low-tie observations. Standard errors are clustered at the issuer level. *p < 0.10, **p < 0.05, ***p < 0.01.

The high-tie coefficient remains positive and statistically significant after reweighting, although its magnitude declines from 1.36 to 1.18 basis points. The reduction suggests that observable bond characteristics explain part of the unadjusted association, but not the full result. Relationship concentration continues to be associated with weaker pricing credibility among bonds that are more comparable on observed issuance characteristics. The balancing analysis, therefore, supports the interpretation that the baseline result is not driven entirely by observable selection into concentrated reviewer relationships.

6. Conclusions

This study examines whether issuer–reviewer repeat ties are associated with the credibility of green bond verification in both market pricing and post-issuance accountability. The analysis uses a European corporate setting covering labeled green use-of-proceeds bonds issued by firms domiciled in the European Union and the United Kingdom during 2015 to 2023. The final bond-level sample contains 805 green bond issues from 312 issuers, and the issuer-year accountability panel contains 1986 issuer-year observations. Across the main models, stronger repeat ties are associated with weaker pricing-based credibility, less timely and less specific reporting, weaker impact-reporting continuity, and higher ex post credibility-risk signals. Moderation tests further indicate that stronger audit quality and stronger green-finance policy environments attenuate these adverse associations.

Theoretically, the findings extend external-review research by repositioning verification as a relational governance arrangement rather than as a binary disclosure attribute. Existing discussions often emphasize whether an external review exists and which review type is used, yet the evidence

indicates that credibility also depends on how verification relationships are structured over time. Repeat ties appear to reduce the marginal informational value of external review because relational concentration can weaken perceived independence and skepticism, making the verification signal less separating under adverse selection. This implication helps explain why apparently similar verified green bonds can receive different pricing responses.

The study also advances assurance-governance theory by clarifying the learning-versus-capture tension in voluntary verification markets. Repeat engagements can plausibly generate learning benefits and process efficiencies, yet the observed market response is more consistent with independence concerns than with a pure learning story. This contributes to a broader theoretical point: credibility in sustainable finance depends not only on issuer intention or the existence of review artifacts, but also on monitoring structures that shape expectations about verification rigor and post-issuance behavior. The moderation evidence further indicates that stronger external monitoring and stronger policy discipline can mitigate, though not eliminate, the adverse association linked to repeat ties.

Several practical implications follow for regulators and standard setters concerned with green-bond market integrity. Greater attention should be directed toward the governance architecture of external-review engagement rather than toward review presence alone. Policies that require disclosure of reviewer history, repeat engagement frequency, and dependence-related information could make relationship concentration more transparent and easier to discipline through market and supervisory channels.

Issuers and reviewers also face practical implications. For issuers, verification strategies that overemphasize continuity may be counterproductive if investors interpret repeat ties as an independence concern. For reviewers, concentrated client relationships may reduce the perceived value of review outputs even when technical quality is high. These considerations suggest potential benefits from clearer independence safeguards, stronger methodological transparency, and governance arrangements that preserve both expertise and reviewer credibility.

Several limitations should be recognized. The European setting offers comparability and relatively rich disclosure, but institutional conditions may differ in other regions. Repeat ties capture observable relationship intensity rather than internal review effort or fee arrangements. The accountability proxies, while informative, are based on observable reporting and controversy outcomes and should therefore be interpreted as imperfect indicators of post-issuance discipline. Future research can extend the analysis to other regions, incorporate fee and workload data where available, and test regulatory shocks that affect reviewer oversight or disclosure requirements.

Author contributions

The author solely contributed to all aspects of the study, including its conceptualization, design, analysis, and manuscript preparation, and approved the final version.

Use of AI tools declaration

The author declares they have not used artificial intelligence (AI) tools in the creation of this article.

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The author declares no conflict of interest.

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Data available on request from the author.

References

- Akerlof GA (1970) The market for “lemons”: Quality uncertainty and the market mechanism. *Q J ECON* 84: 488–500. <https://doi.org/10.2307/1879431>
- Allman E, Lock B (2024) External reviews and green bond credibility. *J Clim Financ* 7: 100036. <https://doi.org/10.1016/j.jclimf.2024.100036>
- Al-Okaily M, Al-Okaily A (2025) Financial data modeling: an analysis of factors influencing big data analytics-driven financial decision quality. *J Model Manag* 20: 301–321. <https://doi.org/10.1108/JM2-08-2023-0183>
- Baker M, Bergstresser D, Serafeim G, et al. (2018) Financing the response to climate change: The pricing and ownership of US green bonds (No. w25194). *Natl Bur Econ Res*. <https://doi.org/10.3386/w25194>
- Chen X, Long W (2023) To enhance the credibility of the green bond market through regulating GBERS: The case of China. *Laws* 12: 91. <https://doi.org/10.3390/laws12060091>
- Christensen HB, Hail L, Leuz C (2021) Mandatory CSR and sustainability reporting: Economic analysis and literature review. *Rev Account Stud* 26: 1176–1248. <https://doi.org/10.1007/s11142-021-09609-5>
- DeAngelo LE (1981) Auditor size and audit quality. *J Account Econ* 3: 183–199. [https://doi.org/10.1016/0165-4101\(81\)90002-1](https://doi.org/10.1016/0165-4101(81)90002-1)
- DeFond M, Zhang J (2014) A review of archival auditing research. *J Account Econ* 58: 275–326. <https://doi.org/10.1016/j.jacceco.2014.09.002>
- Distadio LF, Johl S (2025) Shades of green in the bond market: The role of external verification reports. *Int J Account*, 2541001. <https://doi.org/10.1142/S109440602541001X>
- Dorfleitner G, Utz S, Zhang R (2022) The pricing of green bonds: External reviews and the shades of green. *Rev Manag Sci* 16: 797–834. <https://doi.org/10.1007/s11846-021-00458-9>
- Dos Santos DLDJS, Dos Santos GC (2025) Technological convergence in financial auditing: A systematic literature review. *Data Sci Financ Econ* 5: 440–465. <https://doi.org/10.3934/DSFE.2025018>

- Flammer C (2021) Corporate green bonds. *J Financ Econ* 142: 499–516. <https://doi.org/10.1016/j.jfineco.2021.01.010>
- Francoeur C, Melis A, Gaia S, et al. (2017) Green or greed? An alternative look at CEO compensation and corporate environmental commitment. *J Bus Ethics* 140: 439–453. <https://doi.org/10.1007/s10551-015-2674-5>
- Ghitti M, Gianfrate G, Lopez de Silanes F, et al. (2023) What’s in a shade? The market relevance of green bonds’ external reviews. *Br Account Rev*: 101271. <https://doi.org/10.1016/j.bar.2023.101271>
- Henide K (2022) Voluntary disclosure and adverse selection: Bayesian game theoretical inference for green bond labeling regimes. *Int Rev Financ Anal* 83: 102248. <https://doi.org/10.1016/j.irfa.2022.102248>
- Hyun S, Park D, Tian S (2020) The price of going green: The role of greenness in green bond markets. *Account Financ* 60: 73–95. <https://doi.org/10.1111/acfi.12515>
- Hachenberg B, Schiereck D (2018) Are green bonds priced differently from conventional bonds? *J Asset Manag* 19: 371–383. <https://doi.org/10.1057/s41260-018-0088-5>
- International Capital Market Association (2021) Green Bond Principles. *Int Cap Mark Assoc. Available from:* <https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Green-Bond-Principles-June-2021-140621.pdf>.
- Ioannou I, Serafeim G (2015) The impact of corporate social responsibility on investment recommendations: Analysts’ perceptions and shifting institutional logics. *Strateg Manag J* 36: 1053–1081. <https://doi.org/10.1002/smj.2268>
- Jangid J, Bhardwaj B, Sharma D (2025) Green bonds and sustainable business: A systematic literature review and future research agenda. *Corp Gov Int J Bus Soc*, 1–39. <https://doi.org/10.1108/CG-08-2025-0555>
- Jensen MC, Meckling WH (1976) Theory of the firm: Managerial behavior, agency costs and ownership structure. *J Financ Econ* 3: 305–360. [https://doi.org/10.1016/0304-405X\(76\)90026-X](https://doi.org/10.1016/0304-405X(76)90026-X)
- Krueger P, Sautner Z, Starks LT (2020) The importance of climate risks for institutional investors. *Rev Financ Stud* 33: 1067–1111. <https://doi.org/10.1093/rfs/hhz137>
- Lutfi A, Alkilani SZ, Saad M, et al. (2022) The Influence of Audit Committee Chair Characteristics on Financial Reporting Quality. *J Risk Financ Manag* 15: 563. <https://doi.org/10.3390/jrfm15120563>
- Lyon TP, Montgomery AW (2015) The means and end of greenwash. *Organ Environ* 28: 223–249. <https://doi.org/10.1177/1086026615575332>
- Mahmood S, Sun H, Iqbal A, et al. (2024) Green finance, sustainable infrastructure, and green technology innovation: pathways to achieving sustainable development goals in the belt and road initiative. *Environ Res Commun* 6: 105036. <https://doi.org/10.1088/2515-7620/ad898f>
- O’Brien RM (2007) A caution regarding rules of thumb for variance inflation factors. *Qual Quant* 41: 673–690. <https://doi.org/10.1007/s11135-006-9018-6>
- Rahman MM, Islam MF, Dyuti TI, et al. (2024) Driving net zero emissions through green finance, green logistics, and corporate social responsibility: findings from PLS-SEM approach. *Discov Sustain* 5: 439. <https://doi.org/10.1007/s43621-024-00675-8>

- Simeth N (2022) The value of external reviews in the secondary green bond market. *Financ Res Lett* 46: 102306. <https://doi.org/10.1016/j.frl.2021.102306>
- Sharf N, Abu-Nassar M (2021) The effect of audit quality and auditor's opinion on earnings management: evidence from Jordan. *Jordan J Bus Adm* 17: 236–253. <https://doi.org/10.35516/0338-017-002-005>
- Shi X, Ma J, Jiang A, et al. (2023) Green bonds: Green investments or greenwashing? *Int Rev Financ Anal* 90: 102850. <https://doi.org/10.1016/j.irfa.2023.102850>
- Simnett R, Vanstraelen A, Chua WF (2009) Assurance on sustainability reports: An international comparison. *Account Rev* 84: 937–967. <https://doi.org/10.2308/accr.2009.84.3.937>
- Song Y, Ren T, Zhang M (2024) Does the issuance of green bonds promote green practices among peer companies? Evidence from China's listed companies. *J Clean Prod* 477: 143899. <https://doi.org/10.1016/j.jclepro.2024.143899>
- Spence M (1973) Job market signaling. *Q J Econ* 87: 355–374. <https://doi.org/10.2307/1882010>
- Tang DY, Zhang Y (2020) Do shareholders benefit from green bonds? *J Corp Financ* 61: 101427. <https://doi.org/10.1016/j.jcorpfin.2018.12.001>
- Tian Y, Pan X (2024) Green finance policy, financial risk, and audit quality: Evidence from China. *Eur Account Rev* 33: 589–615. <https://doi.org/10.1080/09638180.2022.2109707>
- Tepalagul N, Lin L (2015) Auditor independence and audit quality: A literature review. *J Account Audit Financ* 30: 101–121. <https://doi.org/10.1177/0148558X14544505>
- Zhang L, Han J, Xiong Y, et al. (2025) Green investors, bond ratings and bond issuance spreads. *Financ Res Lett*: 108318. <https://doi.org/10.1016/j.frl.2025.108318>
- Zerbib OD (2019) The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *J Bank Financ* 98: 39–60. <https://doi.org/10.1016/j.jbankfin.2018.10.012>



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