

Complementary Stakeholder Protection: Sustainability Disclosure Quality and Accounting Conservatism in Indian Chemical Industry

Abstract

This study examines whether sustainability disclosure quality (SDQ) and accounting conservatism function as complementary mechanisms of corporate accountability and whether this relationship differs across environmental, social, and governance disclosure dimensions in the Indian chemical industry. Using a balanced panel of 3,520 firm-year observations, fixed-effects panel regressions were estimated. SDQ is measured through novel Sentence Transformer methodology (all-MiniLM-L6-v2) computing cosine similarities between 3,520 annual reports and 79 expert-validated ESG reference sentences. SDQ, environmental, social disclosure quality positively influence accounting conservatism, whereas governance disclosure quality is insignificant. The relationship strengthens across successive Indian sustainability reporting regimes, indicating deeper accountability under expanding disclosure requirements. This study analyzes the dimension-wise relationship between SDQ and conservatism in India's chemical sector. It develops a five-theory framework, distinguishes substantive from structural accountability, and advances the debate on sustainability disclosure as real versus symbolic accountability.

Keywords: Sustainability disclosure quality; accounting conservatism; panel data; Ball-Shivakumar model; Sentence Transformers; Stakeholder Theory; Legitimacy Theory; Agency Theory; Information Asymmetry Theory; Signalling Theory; India; chemical industry; BRSR; emerging market

Paper type: Research paper

Introduction

Corporate sustainability disclosure has become one of the defining accountability institutions of twenty-first-century capitalism, transforming from voluntary philanthropic communication in the 1970s into a quasi-mandatory transparency requirement enforced through legally backed frameworks across major economies. India exemplifies this transformation most dramatically: the

Securities and Exchange Board of India (SEBI) introduced mandatory BRR for the top 100 listed companies in 2012, extended requirements progressively to the top 500 and then top 1,000 firms, and in 2021 replaced BRR with the substantially more comprehensive BRSR framework — aligned with the Global Reporting Initiative (GRI), Sustainability Accounting Standards Board (SASB), and Task Force on Climate-Related Financial Disclosures (TCFD) — representing one of the most significant mandatory ESG disclosure transitions underway in any emerging economy. As sustainability reporting and financial reporting increasingly coexist within the same annual accountability documents and are produced by the same management teams, an important question arises: does the quality of firms' environmental, social, and governance disclosure relate systematically to the quality of their financial reporting?

This question is particularly relevant in relation to accounting conservatism, a core indicator of financial reporting quality. Accounting conservatism requires more stringent verification for the recognition of gains than losses. Basu's (1997) seminal work shows that earnings reflect bad news more quickly than good news, while Watts (2003) explains the persistence of conservatism through contracting efficiency, litigation protection, taxation, and regulation. In the context of sustainability disclosure, conservatism is important because it captures whether firms that communicate accountability externally also exercise prudence internally in financial reporting. A firm may produce extensive ESG disclosures while still engaging in aggressive accounting, or it may combine high-quality sustainability disclosure with timely recognition of economic losses.

Existing studies suggest a possible link between sustainability-related disclosure and accounting conservatism. Burke et al. (2020), using KLD aggregate CSR ratings for US-listed firms, examine the effect of CSR performance on conditional conservatism through stakeholder protection mechanisms. Shaw et al. (2021), in the Indian context, show that mandatory CSR reporting under Schedule VII of the Companies Act is associated with higher conservatism among firms with stronger corporate governance. Boulhaga et al. (2023) find evidence of complementarity between ESG ratings and conservatism among French firms using ASSET4 data. Pereira et al. (2021) report a positive association between environmental disclosure and conservatism among Portuguese firms, while Shen et al. (2021) find higher conservatism among CSR-compliant firms in China.

However, the existing literature remains limited in important ways. First, most studies rely on aggregate CSR or ESG scores and therefore cannot identify which specific ESG dimension drives the relationship with conservatism. Second, several studies measure compliance rather than disclosure quality, making it difficult to distinguish substantive reporting from symbolic or ceremonial disclosure. Third, checklist-based disclosure indices often assign equal value to disclosures regardless of their semantic depth or relevance. Finally, prior research has not developed an integrated theoretical framework explaining why sustainability disclosure quality and accounting conservatism should be complementary, nor has it examined whether this relationship differs across environmental, social, governance, and overall ESG disclosure dimensions.

This study addresses these gaps by analyzing 320 firms in India's chemical industry over the period 2012–2023, generating 3,520 firm-year observations. Sustainability disclosure quality is measured using a semantic approach based on the Sentence Transformer model all-MiniLM-L6-v2. This approach overcomes the problem of semantic blindness by estimating cosine similarities between annual report disclosures and 79 expert-validated ESG reference sentences. Four fixed-effect panel regression models are estimated, each incorporating Ball and Shivakumar's (2005) accrual-based measure of conditional conservatism and one sustainability disclosure quality dimension. The use of fixed effects is supported by Hausman tests, while multicollinearity diagnostics show variance inflation factors below 5 across all models.

The study is grounded in Stakeholder Theory, Legitimacy Theory, Agency Theory, Information Asymmetry Theory, and Signalling Theory. Together, these perspectives predict a positive complementarity between sustainability disclosure quality and accounting conservatism, while also allowing for dimension-specific differences in the strength of this relationship. India's chemical industry provides an especially appropriate empirical setting because it faces substantial environmental disclosure requirements under BRR and BRSR, has a direct connection between environmental risk and financial risk, covers 19 sub-industries, and spans the full transition from BRR to BRSR, thereby enabling an assessment of how the relationship evolves over time.

The panel regression analysis results indicate that overall SDQ ($\beta = 0.4206$, $p = 0.028$), EDQ ($\beta = 0.4246$, $p = 0.030$), and SDQ ($\beta = 0.3718$, $p = 0.044$) have significantly positive impacts on accounting conservatism, whereas there is no significant current impact of GDQ ($\beta = 0.1915$, $p = 0.333$). This order of impact – QEOD > QSOD > QGOD – has been accurately predicted by all the five theories by employing five different approaches. The synergy increases consistently in the context of India during the regulatory shift from BRR to BRSR because stringent substantive disclosure rules create true accountability benefits. This study adds to Burke et al.'s (2020) seminal work on US evidence of the aggregation of CSR that finds a complementarity between aggregate CSR and conservatism, as it disentangles this finding to find that complementarity occurs because the stakeholder protection substance of environmental and social disclosures triggers all five theoretical mechanisms, whereas governance disclosures trigger none because of the regulation compliance structure, thus answering the important question from the critical accounting perspective as to the circumstances under which sustainability disclosures are real or ceremonial accountability (Gray et al., 1995).

The section 2 of the paper summarizes the literature in three research strands, formulates a comprehensive five theory framework as presented in Table 2, and presents four hypotheses that can be tested. Section 3 outlines the research methodology, including Sentence Transformers, while section 4 presents the empirical findings, including the endogeneity test, time-varying heterogeneity analysis, and seven robustness panels. The fifth section is devoted to discussing theoretical contributions, themes, and managerial implications.

2. Literature Review and Hypothesis Development

The present review consolidates existing literature on the relationship between sustainability disclosure quality and accounting conservatism through structured searches conducted in Scopus and Google Scholar (1996 – 2025), based on the following search strings: ‘sustainability disclosure quality AND accounting conservatism’, ‘ESG disclosure AND conditional conservatism’, ‘CSR disclosure AND loss recognition’, ‘environmental disclosure AND accounting quality’, and ‘social reporting AND financial reporting quality’. A total of 105 studies has been retrieved initially; of those, only 10 studies directly addressed the topic of sustainability disclosure quality and accounting conservatism, while 93 and 2 studies were removed from the analysis due to their non-

relevance to either accounting conservatism or sustainability disclosure quality, respectively. In addition, a snowballing method was employed for identifying another 7 relevant studies from backward and forward citations of the key papers in both streams, bringing the total number of studies considered for the review to 17. The theory behind the study is informed by the extant literature on Stakeholder Theory, Legitimacy Theory, Agency Theory, Information Asymmetry and Signaling Theory, augmented by the works from the snowballing exercise throughout Section 2.3.

2.1 Sustainability Disclosure Quality: Evolution, Theory, and Measurement Challenges

Sustainability Disclosure Quality (SDQ) can be defined as the extent to which information about Environmental, Social, and Governance practices in corporations is comprehensive, accurate, reliable, and relevant (Clarkson et al., 2013). The history of corporate sustainability disclosure can be divided into three institutional stages. The first stage of voluntary philanthropic disclosure (1970s-1990s) involved environmentally and socially responsible statements being made at an early stage of development and not widely adopted. It could be described as mostly legitimacy-oriented rather than accountability-based based on Gray et al.'s (1995) longitudinal study. The second stage of disclosure (2000s-2010s) included the establishment of GRI Standards (2000) framework, SASB's industry-based materiality frameworks (2012), and TCFD's climate change guidance for companies (2017). These are standards that help organizations share information using a common language but without any requirement for disclosure. The third and most recent stage of quasi-mandatory sustainability disclosure (2010s-present) involves mandatory corporate sustainability reporting regimes such as Corporate Sustainability Reporting Directive (EU, 2021), SEC's climate disclosure regulations (2024), BRR & BRSR (India, 2012 & 2021).

Three major theories have been developed to help understand the reasons for sustainability disclosures by firms and evolution of practices due to institutional pressures. The first theory is legitimacy theory according to Cho and Patten (2007), Suchman (1995), and Meyer and Rowan (1977). Legitimacy theory implies that the information about sustainability disclosed by companies is associated with maintaining legitimacy in wider normative contexts. For example, Cho and Patten's (2007) research among US chemical companies has shown that increased level of disclosure corresponds to occurrence of environmental problems or regulatory pressures. This finding proves the strategic management of legitimacy. At the same time, the research conducted

by Gerged et al. (2020) among chemical companies in the Gulf Cooperation Council proves that environmental disclosures can have legitimacy-building functions. The second theory – stakeholder theory – assumes that disclosure is driven by demands of various stakeholder groups (Freeman, 1984; Donaldson & Preston, 1995; Dhaliwal et al., 2011). The third theory is institutional theory (Baldini et al., 2018) reveals how regulatory frameworks, industry norms, and peer pressures drive standardized reporting adoption through isomorphic mechanisms, explaining the convergence of chemical-sector disclosure practices under BRSR mandating.

SDQ measurement is found by our systematic literature review to be the key obstacle to development within this body of literature. There are three prominent methodologies that exhibit significant systematic limitations. Both binary and checklist methods (El-Abady et al., 2024; Putri et al., 2023; Abdallah, 2023) provide quality measures for meaningful commitments and boilerplate statements alike, which constitutes Helfaya and Whittington's (2019) 'semantic blindness.' El-Abady et al. (2024) state that their methodology is one whereby 'quality does not get measured, subjective interpretation is required without importance weighting, and it fails to distinguish between superficial and comprehensive disclosures.' Putri et al. (2023) note that their binary scoring framework based on the Global Reporting Initiative 'fails to cover all dimensions of sustainability as well as being subject to researcher interpretation.' Abdallah (2023) finds 'that binary coding ignores the complexities in quality measurement' due to incorrect equal weighting. Content analysis (Hummel and Schlick, 2016; Gerged et al., 2020) improves quality measurement over binary approaches but introduces subjective interpretation and becomes resource-intensive as samples grow: coding annual reports manually requires significant research effort and risks inconsistent application of scoring criteria across coders and time periods. Third party scores (Bloomberg ESG, MSCI, Sustainalytics; employed by Christensen et al., 2021; Baldini et al., 2018) lack transparency in their methodologies, possible bias towards bigger Western companies, and have an extremely narrow scope when it comes to emerging markets. All these constraints prevent any possibility of detecting SDQ conservatism in relation to particular dimensions using such scores – which is precisely what our Sentence Transformer technique allows for.

2.2 Accounting Conservatism and Sustainability Disclosure Quality Complementarity

Accounting conservatism implies that gains and losses have asymmetric measurement criteria such that losses are measured faster than gains. Since the introduction of Basu's (1997) model on

asymmetric timeliness of earnings, research on conservatism has been conducted within the context of it being a mechanism of accounting that prevents optimistic management, opportunistic earnings reports, and inefficient contracting. Watts (2003) considers conservatism in terms of contracting, legal disputes, tax, and regulations while LaFond and Watts (2008) view it as an information-quality mechanism that lessens information asymmetry between managers and external stakeholders. The conditional and unconditional conservatism distinction that Ball and Shivakumar (2005) provide is very important to this study since conditional conservatism implies timely recognition of losses and it can be measured by accrual-based measures that are helpful in emerging economies where market-based measures of returns might be questionable. Previous research indicates that conservatism differs among ownership structures, managerial incentives, firm features, institutional environment, and accruals (Givoly and Hayn, 2000; LaFond and Roychowdhury, 2008; Khan and Watts, 2009).

The literature linking sustainability reporting and accounting conservatism can be synthesized into three main streams. First, there is a body of evidence confirming the simple complementary nature of this link – firms with higher CSR or ESG orientation tend to choose conservative financial reporting because of their inherent similarity related to accountability and stakeholder protection (Burke et al., 2020; Boulhaga et al., 2023; Pereira et al., 2021; Shen et al., 2021; Garanina and Kim, 2023). Second, there is empirical research proving that the above-mentioned relationship is influenced by some factors including internal control quality, corporate governance, ownership structure, and mandatory disclosure rules (Shaw et al., 2021; Boulhaga et al., 2023; Garanina and Kim, 2023). Third, there is evidence suggesting that the relevance of the relationship increases due to the links between sustainability disclosure, conservatism, board diversity, accounting quality, and real business aspects like trade credit (Muhammad et al., 2025; Chen et al., 2025). These studies suggest that sustainability reporting and conservatism are interrelated but they fail to identify important sustainability disclosures and their impact on financial reporting.

Evidence from India is particularly relevant for our study insofar as it examines the relationship between sustainability and conservatism in the context of mandatory reporting and a developing country institutional environment. According to the findings by Shaw et al. (2021), mandatory CSR compliance in India positively impacts accounting conservatism, especially those firms with better board governance. Moreover, Patro and Pattanayak (2017) have found a significant positive correlation between CSR disclosure and accounting conservatism in Indian mining companies. These pieces of evidence are highly relevant, as they study environmentally vulnerable situations in India. Nevertheless, they analyze CSR expenditure compliance or binary disclosure index, but not disclosure quality. This difference is important since in mandatory disclosure frameworks the key variable is not the fact of disclosure of sustainability data, but its quality – substantive, quantified, specific, comparable, forward-looking, externally verifiable, and non-boilerplated. India's movement from BRR to BRSR further increases the relevance of disclosure quality because sustainability reporting expectations became more detailed, quantitative, and assurance-oriented over time.

The main methodological limitation in previous sustainability-conservatism studies is that the measurement of sustainability reporting is not always consistent with the theoretical mechanism under investigation. For instance, in the case of Burke et al. (2020), although the measures of sustainability used (CSR performance based on KLD data) are good proxies for stakeholder orientation, they combine environment, social and governance aspects without allowing any dimension-specificity of the complementarities. Boulhaga et al. (2023) employ ASSET4 ESG Ratings, which can serve as an indicator of external evaluation of the firm's ESG performance but not as a proxy for the quality, specificity or substance of sustainability disclosures by firms themselves. In the study of Shaw et al. (2021), the variable of interest is mandatory CSR compliance in India through the regulatory spending requirement which indicates whether firms fulfill their CSR responsibilities or not but not whether the disclosure is specific and decision-useful or general. The same variable is measured in Shen et al. (2021) study as well, while the authors focus on CSR disclosure compliance which again serves as a disclosure obligation indicator rather than a measure of different disclosure quality levels. Patro and Pattanayak (2017) construct a GRI-based CSR disclosure index for Indian mining firms, but their binary approach captures the presence or absence of disclosure items rather than the semantic richness of the information disclosed. Environmental Disclosure Index for Portuguese firms was developed by researcher Pereira et al. (2021). The importance of this index lies in the fact that it distinguishes between environmental and CSR disclosure. However, such a checklist approach still suffers from the inability to identify specificity, tone, numerical data, risk, and explanations of disclosure. Garanina and Kim (2023) offer evidence from the Russian companies regarding emerging markets; however, the indicator of CSR disclosure used by these authors fails to distinguish between environmental, social, and governance dimensions of disclosure.

This paper seeks to fill in four gaps in the previous literature. In terms of theoretical contribution, there is evidence of the association between the variables studied, but not much is found regarding the processes behind how quality sustainability disclosures and conservatism complement one another. On a contextual level, there is a lack of evidence from environmentally intensive industries in emerging markets even though it is where the financial reporting consequences of environmental and social risks will be seen best. In terms of characteristics, previous studies tend to treat CSR or ESG as one construct without acknowledging the difference between the three types of disclosures. Methodologically, this paper relies on the use of Semantic Measurement using the Sentence Transformer model, which has developed from the advancements in language representation and sentence embedding models (Devlin et al., 2019; Reimers and Gurevych, 2019). This allows the analysis to move beyond disclosure presence, compliance, and aggregate ESG ratings toward disclosure richness, specificity, and relevance.

2.3 Theoretical Framework

A multi-theory approach will be used in explaining the relationship between SDQ and accounting conservatism since none of the theories alone adequately explains the rationale behind complementary effects of sustainability and conservative reporting practices. Specifically, Stakeholder Theory, Legitimacy Theory, Agency Theory, Information Asymmetry Theory, and Signaling Theory all explain various ways through which environmental disclosure quality (QEOD), social disclosure quality (QSOD), and governance disclosure quality (QGOD) relate to accounting conservatism. It is thus predicted that QEOD is positively and strongly correlated with accounting conservatism, followed by QSOD while QGOD is least correlated with accounting conservatism. That is, $QEOD > QSOD > QGOD$.

The Stakeholder Theory provides explanations on complementation based on accountability to stakeholders. According to Freeman's (1984) stakeholder approach to organization, as elaborated in Donaldson and Preston's (1995) three-dimensional stakeholder theory, organizations that have a high level of stakeholder orientation are more likely to reflect this in both sustainability and accounting reports. For example, in the Indian chemical sector, environmental and social disclosure involves the regulators, community, workforce, creditors, and socially responsible investing (ESG investing). These stakeholders put pressure on organizations to make such disclosures and also require conservative accounting policies such as loss recognition. Governance disclosure, however, is less directly connected to affected stakeholders because it often reports board structures and monitoring arrangements rather than substantive exposure to environmental or social risk.

Legitimacy Theory describes complementarity as an aspect of maintaining social approval. Following the institutional perspective of legitimacy (Berger and Luckmann, 1966; Meyer and Rowan, 1977; Suchman, 1995), organizations in environmentally related industries are required to legitimize their sustainability efforts and ensure that their efforts are legitimate and not simply symbolic. High quality environmental and social disclosures lead to moral legitimacy since these disclosures indicate social and environmental responsibility. Good conservative accounting leads to legitimacy as well as it prevents too positive financial reporting and acknowledges negative aspects. The connection between governance disclosures and legitimacy is pragmatic as governance disclosures may satisfy the requirements of regulators without proving any substance of accountability. In mandatory disclosure settings, governance reporting may therefore become compliance-oriented or box-ticking rather than genuinely informative (Meqbel et al., 2024; Gerged et al., 2023).

The theory of agency lays out the main theoretical contradiction. According to Jensen & Meckling (1976) agency model, conservatism acts as a measure to control the opportunistic behavior of managers since it decreases the effects of acceleration of gains and deferral of losses. From this point, high SDQ and conservatism act as complementary mechanisms to monitor managers' actions. The former controls non-financial manipulation, while the latter controls financial manipulation (Watts, 2003; LaFond & Watts, 2008; Burke et al., 2020). Nevertheless, there is another interpretation which states that sustainability disclosures can be used to obtain legitimacy at the expense of earnings management or poor accounting quality (Prior et al., 2008). This contradiction adds the empirical research value. If SDQ is positively correlated with conservatism, the monitoring interpretation is reinforced. Otherwise, the opportunistic one seems more relevant. This tension makes the empirical test theoretically meaningful. If SDQ is positively associated with conservatism, the monitoring interpretation is strengthened. If SDQ coexists with weak conservatism or earnings management, the opportunistic interpretation becomes more plausible.

Information Asymmetry Theory helps in understanding the possible relationship between sustainability disclosure quality and conservatism loss recognition. Adverse selection by Akerlof (1970), signalling extension by Ross (1977), and information disclosure theory by Healy & Palepu (2001) posit that corporate disclosures help in minimizing information asymmetries between management and outside parties. Information asymmetries favor conservatism in situations where managers have privately held information that allows for deferred loss recognition. In the chemical industry, environmental disclosure helps in minimizing information asymmetries with regard to risks like liability risk, regulatory risk, clean-up costs, hazardous wastes, and regulations compliance. The risks mentioned above relate directly to conservative accounting in that they involve probable losses, provision of assets, impairment, and contingent liabilities. Social disclosures reduce information asymmetry regarding labor risk, safety risk, community risk, and social license risk, but the risks may not be quantifiable. Governance disclosure reduces asymmetry about board and committee structures, but such information is less directly tied to operational loss recognition.

Signalling Theory provides an understanding of why there is a difference in credibility across ESG dimensions. Spence (1973) costly signalling theory, which was applied to corporate finance and disclosure literature by Ross (1977) and Dhaliwal et al. (2011), indicates that credible signals have high costs of imitation. Credible signals of high-quality environment and social disclosures will need to be specific, quantitative, consistent, and forward-looking. The practice of accounting conservatism is also costly because it reduces earnings and optimistic reporting. When these two activities take place together, it shows credible managerial commitment to accountability. Governance disclosure is easier to imitate because it is possible to disclose board independence, committee structure, and governance policies without proving their efficiency.

These five theories converge on a similar prediction of order through different means: accountability of stakeholders, legitimacy from morality, monitoring pressure, risk minimization in terms of information, and costly signaling. This contributes greatly to the theoretical contributions as the association between the SDQ and conservatism does not have to rely on only one theoretical perspective. In addition, it explains why the dimensions of ESG are not theoretically equivalent. SDQ in the environment must have the greatest complementarity with conservatism since it is directly associated with liabilities, regulation, remediation, and loss recognition. SDQ in the social aspect is also expected to complement conservatism but possibly not as strongly since it is significant but not as measurable. SDQ in governance is expected to be least complementary because it is standard, compliance-based, and easily copied. The framework therefore advances a dimension-specific theory of sustainability disclosure quality and accounting conservatism.

Theoretical Synthesis

Table 2 below gives an overview of the systematic analysis of each theory's prediction with respect to QEOD, QSOD, and QGOD. What is interesting to note here is that despite being developed independently based on different fundamental assumptions and different causal explanations, five theoretical perspectives lead to the same order of predictions: $QEOD > QSOD > QGOD$. This independence leads to great analytical strength since the complementarity prediction holds even if one of the theories does not hold, and the ordered dimensional prediction holds regardless of the weightings applied to the mechanisms. Every one of the theories arrives at the result via its own particular mechanism – stakeholder protection content, moral vs. compliance legitimacy, true

monitoring vs. structure only, financial risk identification, and signaling credibility – thus giving a much more solid theoretical basis than could be given by any one perspective.

Table 2: Theoretical Synthesis — Predicted SDQ–Conservatism Complementarity by ESG Dimension

Theory (Seminal Work)	Core Prediction for SDQ–Conservatism	QEOD (Environmental)	QSOD (Social)	QCOD (Governance)	Predicted Hierarchy
Stakeholder Theory (Freeman, 1984; Donaldson & Preston, 1995)	Firms with genuine stakeholder orientation adopt both SDQ and conservatism as complementary protections (hub-and-spoke model)	Strong: directly engages communities, ecosystems, regulatory stakeholders; all mechanisms at full strength	Meaningful: employee welfare, community health, human rights; genuine but less financially material	Weak: describes internal decision-making structures; no direct external stakeholder engagement	QEOD > QSOD > QCOD
Legitimacy Theory (Suchman, 1995; Cho & Patten, 2007; Meyer & Rowan, 1977)	Both build legitimacy: SDQ through moral/cognitive legitimacy; conservatism through professional prudence norms	Strong: moral legitimacy demands genuine environmental accountability in chemical sector	Meaningful: social licence to operate requires authentic welfare commitment beyond compliance	Limited: primarily builds compliance (pragmatic) legitimacy; decoupled from moral legitimacy	QEOD > QSOD > QCOD
Agency Theory (Jensen & Meckling, 1976; Watts, 2003; LaFond & Watts, 2008)	Both constrain managerial opportunism: SDQ reduces non-financial manipulation scope; conservatism limits financial optimism	Strong: environmental risk monitoring most directly constrains manipulation through regulatory exposure	Meaningful: reputational, supply chain, employee welfare risks; less material than environmental	Ambiguous: describes oversight structures without constraining behaviour; monitoring without effect	QEOD > QSOD > QCOD
Information Asymmetry Theory (Akerlof, 1970; Healy & Palepu, 2001; LaFond & Watts, 2008)	SDQ reduces non-financial info asymmetry; conservatism constrains financial information exploitation; both reinforce equilibrium	Strong: environmental liabilities, remediation costs, regulatory compliance — most material, quantifiable risk info	Meaningful: reputational and supply chain risks; reduces asymmetry but less immediately quantifiable	Limited: reduces process asymmetry about oversight structures, not financial risk asymmetry	QEOD > QSOD > QCOD
Signalling Theory (Spence, 1973; Ross, 1977; Dhaliwal et al., 2011)	High-quality SDQ and conservatism are jointly costly, credible signals of genuine management commitment	Strong: hardest to mimic — requires specific, quantifiable, verifiable environmental content	Meaningful: harder to fake than governance; requires genuine welfare commitment evidence	Weak: easily mimicked — any firm can list committees without genuine commitment	QEOD > QSOD > QCOD

Convergent Prediction	All five independently grounded theories predict positive SDQ–conservatism complementarity in QEOD > QSOD > QGOD order	Strongest (all 5 mechanisms at full strength)	Significant (all 5 at moderate strength)	Weakest / Null (all 5 at low or zero strength)	QEOD > QSOD > QGOD
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SDQ = sustainability disclosure quality; QEOD/QSOD/QGOD = environmental/social/governance disclosure quality. The 'Predicted Hierarchy' column reflects convergent prediction across all five theoretical perspectives regarding the relative strength of SDQ–conservatism complementarity.

One last theoretical subtlety should be considered before moving on to hypotheses. While the null governance contemporaneous effect suggests governance disclosure may be permanently inconsequential for conservatism, the governance lag found in Section 4.3 (lag_QGOD $\beta = 0.4328$, $p = 0.041$) is supported by Legitimacy Theory and Agency Theory creating effects through delayed cultural change processes: Over an extended period of time, the quality of governance disclosure affects the organizational culture and institutional expectations, based on which conservatism decisions are made. It is the difference between governance disclosure in its current form, within the compulsory Indian BRR/BRSR system, where governance disclosure is mostly about compliance-based structural legitimacy, and the more sophisticated forms that might include governance disclosure involving quantifiable targets and sustainability considerations.

2.4 Research Gap and Study Positioning

Based on the literature review, there is indeed an established link between sustainability reporting and accounting conservatism; however, there still lacks adequate theorizing, contextualizing, and measurement of such a link. First, there is theoretical inadequacy because previous literature has assumed the existence of complementarity between the two without providing reasons for differences in complementarity along ESG dimensions. Second, there is contextual inadequacy because environmentally-intensive emerging markets have been relatively understudied, while they face high environmental risks, social visibility, and regulatory requirements. Third, there is characteristics inadequacy because CSR or ESG is usually viewed as a one-dimensional construct, even though the three different ESG categories may be quite different in their risks and stakeholders' interests. Fourth the methodological gap is that existing measures often capture ESG performance, disclosure compliance, or disclosure presence rather than semantic disclosure quality.

This research tries to bridge these gaps through the theoretical relevance, contextual relevance, characteristics and methodological relevance. Where sustainability disclosures reduce information asymmetry, signal credible accountability, and represent stakeholder-oriented, then the correct empirical proxy will not be CSR expenditures, ESG rating or checklist disclosure but the quality of the disclosure narratives. This means that the use of Sentence Transformer-based quality of disclosure ratings is not only a matter of technology but also theoretical relevancy of the study. The study further tests the hypothesis that the highest complementarity exists for the categories of QEOD, QSOD and QGOD which have the closest connection to risk perception, stakeholder safeguarding and conservative accounting, respectively.

Such a positioning adds value to the paper's contributions to the literature on accounting and sustainability disclosures. In a theoretical sense, it clarifies the mechanism of SDQ-conservatism complementarity by integrating five perspectives that converge on the issue. Contextually, it is relevant to the chemical sector in India because environmentally and socially motivated risks are economically material in this industry. From the perspective of the characteristics of the construct, it breaks up the concept of environmental, social, and governance disclosures into discrete components rather than considering ESG a single construct. Methodologically, it employs semantic SDQ measurement in order to differentiate substance disclosure from boilerplate disclosure.

2.5 Hypotheses Development

From the integration of all five theories the following four testable hypotheses emerge concerning the relationship between SDQ and accounting conservatism in the Indian chemical industry:

H1: Sustainability disclosure quality (QSD) positively relates to conditional accounting conservatism (CAC).

All five theories suggest that the positive association between SDQ and conservatism. Companies which are high-quality in their sustainability disclosures, which is measured semantically and not by presence of disclosure indicators, should exhibit conservative accounting behavior in line with the same stakeholder orientation toward both non-financial and financial reporting (Putri et al., 2023; Burke et al., 2020; Boulhaga et al., 2023).

H2: There is a positive association between environmental disclosure quality (QEOD) and conditional accounting conservatism.

In India's chemical sector, environmental disclosure is likely to create the highest degree of complementarity through issues that result in regulatory compliance cost, environmental remediation cost, climate-related impairment of assets, and long-term cost of resources resulting from constraints on resources, all of which are directly relevant to loss recognition under conservative accounting.

H3: There is a positive association between social disclosure quality (QSOD) and conditional accounting conservatism.

Social disclosure entails concerns about stakeholders' welfare in terms of worker welfare, community relations, human rights, and supply chain management, which are aligned with the welfare concerns in conservative accounting, which is inherently protective in nature (Gil-Marin et al., 2022; Burke et al., 2020).

H4: Governance disclosure quality (QGOD) does not have any contemporaneous relationship with conditional accounting conservatism.

The notion of governance disclosure is largely related to organizational structure for making decisions, and not about stakeholder protection itself, making it null or poor contemporaneous complements through all theoretical bases. In situations where governance disclosure acts as regulatory box-ticking in order to comply with the mandatory BRSR requirement (Meqbel et al., 2024; Gerged et al., 2023), there becomes an uncoupling of the notions of stakeholder protection, which drives conditional accounting conservatism.

3. Research Design

3.1 Sample and Data Sources

The study considers the case of 320 companies that operate in the chemical and chemical products industry in India and that are listed on the Bombay Stock Exchange during the period 2012-2013 to 2022-2023, resulting in an 11-year unbalanced panel consisting of 3,520 firm-years of data. The chemical industry represents an excellent environment to conduct this study because it is the sixth largest export industry in India; it creates the highest link between the environment and finance

due to costs incurred from regulations, clean-up costs, and handling hazardous substances; it fully covers the BRR-BRSR transition in India; and it consists of 19 sub-industries in India.

Beginning from an initial universe of BSE-listed chemical-sector firms identified from Centre for Monitoring Indian Economy Prowess IQ database, firms were excluded on three grounds: incomplete financial data across the study period; missing annual reports for three or more consecutive years; and insufficient firm-year observations for Ball-Shivakumar rolling window estimation. After these exclusions the final sample comprises 320 firms yielding 3,520 firm-year observations. The sample spans 19 chemical sub-sectors including drugs and pharmaceuticals, organic chemicals and polymers, fertilizers and agrochemicals, dyes and pigments, pesticides and crop protection, specialty chemicals, plastic packaging goods, and inorganic chemicals, providing substantial cross-sectional variation in environmental risk exposure. Financial and accounting data are sourced from PROWESS exclusively. Annual reports are collected through automated Python-based PDF scraping: text-embedded reports are processed using PyPDF2 and text-heavy reports requiring optical character recognition are processed using Selenium with pdf2image and pytesseract OCR.

3.2 SDQ Measurement: Sentence Transformer Methodology

3.2.1 Motivation and methodological foundation

This means that the major challenge in measurement lies in the operationalization of SDQ in a manner that measures substantive SDQ, not SDQ existence or its sheer quantity. Our systematic review of the literature on SDQ and accounting conservatism in a total of 17 articles found that each study suffered from the problem of semantic blindness noted by Helfaya and Whittington (2019). This problem arises when one uses dichotomous scores, GRI checklist scoring, KLD rating or ASSET4 scoring to score two firms: one saying "We are committed to our environmental responsibility" and another saying "We have reduced our Scope 1 greenhouse gas emissions by 18.3% during FY2023, based on an independently verified baseline of 2019 levels due to investments in catalytic converters technology, which were verified independently by Bureau Veritas under ISO 14064-3." Although both statements would score identically using any of the above scoring methods, they differ semantically in terms of their specific, quantitative, verifiable and material characteristics. Sentence Transformers (Reimers and Gurevych, 2019) address this issue by representing sentences in high dimensional semantic vector space using neural networks

based on huge volumes of human judgments of similarity. The particular model referred to here as all-MiniLM-L6-v2 is a six-layered transformer architecture that uses 384-dimensional embeddings after being trained on over a billion sentence pairs, thus producing an accuracy in Spearman correlation above 0.85 with respect to human evaluations of similarity. Similarity in cosines for a disclosure sentence and the reference sentence means that there is substantial similarity semantically; non-substantive and boilerplate text produces lower similarity values.

3.2.2 Reference sentence development

A total of 79 reference sentences that were expert-validated are constructed in environmental (28), social (26), and governance (25) dimensions, which combine key concepts from GRI Standards, SASB chemical industry materiality standards, and TCFD recommended disclosures. The reference sentences reflect specific, substantive, actionable disclosures that are provided by companies in the chemical industry with a sustainability mission. Environmental sentences involve disclosures regarding greenhouse gas emissions and targets, water usage and discharge with facility-level information, hazardous substance management, environmental compliance and violation details, provisions for remediation liability, and climate-related risk assessment. Social sentences include employee safety and health disclosure (in terms of incident rate), community interaction and effects, supply chain management, human rights management, and employee training. Governance sentences include board member diversification and independence, anti-corruption measures and related incidents, compensation structures of executives with sustainability performance, ESG committee oversight, and stakeholder engagement processes. Expert validation of the reference sentence corpus involves two accounting professors, one sustainability expert, three practitioners from sustainability managers in chemical sector firms, and a pilot study involving 20 randomly selected annual reports, where it was found that higher cosine similarity scores always corresponded to more substantive disclosures.

3.2.3 Implementation and validation

The seven-step implementation process: (1) automated PDF collection from BSE-listed chemical firms' annual reports; (2) text extraction using PyPDF2 for text-embedded documents and Selenium with pdf2image and pytesseract OCR for scanned documents; (3) sentence segmentation using NLTK; (4) 384-dimensional embedding generation via all-MiniLM-L6-v2; (5) cosine similarity computation between each disclosure sentence and all dimension-specific reference

sentences; (6) dimension score aggregation as the mean of maximum cosine similarities across all disclosure sentences — capturing whether any disclosure sentence is substantively close to each reference sentence, rewarding genuine coverage without penalising different disclosure styles; (7) min-max normalisation to [0, 1]. Overall QSD equals the equally-weighted average of QEOD, QSOD, and QGOD. Processing all 3,520 reports computationally requires a fraction of the time that equivalent manual content analysis would require, with perfect cross-rater consistency unavailable to manual approaches.

SDQ scores are computed as cosine similarities between each firm's annual report sentences and 79 expert-validated reference sentences across environmental, social, and governance dimensions. The all-MiniLM-L6-v2 model achieves Spearman correlation above 0.85 with human similarity assessments on standard benchmarks (Reimers and Gurevych, 2019), providing the semantic measurement foundation. Min-max normalisation to [0, 1] ensures comparability across firms and years. Overall QSD equals the equally-weighted average of QEOD, QSOD, and QGOD.

3.3 Accounting Conservatism Measurement

Building on the work of Ball & Shivakumar (2005), the basic conservatism measure:

$$AC_i = \alpha + \beta_1 CFO_i + \beta_2 Di + \beta_3 (Di \times CFO_i) + \epsilon_i$$

Where: AC_i = total accruals normalized by lagged total assets (net income - operating cash flow ÷ lagged total assets); CFO_i = operating cash flow normalized by lagged total assets; $Di = 1$ if $CFO_i < 0$ (0 otherwise); $Di \times CFO_i$ = interaction variable, whose sign determines conditional conservatism measure – asymmetry of responses in accruals to negative versus positive cash flow shocks. Firms' conservatism scores (AC_{it}) were calculated based on 5-year rolling windows (at least five observations per window). An accruals-based measure seems to be more suitable for Indian emerging economy due to under-developed financial markets with thin trading, analyst coverage and late price discovery, hence the invalidity of market-based timeliness measures from Basu (1997). Conservative accounting measure demonstrates significant variability (mean close to zero, SD = 2.841; range -100.08 to 32.81), representing heterogeneous practices in conditional conservatism across firms rather than measurement noise, which justifies winsorization at 1st/99th percentiles and sensitivity analysis at 2.5%/97.5% and 5%/95%.

3.4 Panel Regression Models and Specification

Four fixed-effect panel regression models estimate hypotheses H1-H4, using combinations of Ball & Shivakumar measures of conservatism and one SDQ dimension variable with four control variables:

$$\begin{aligned}\text{Model 1 (H1): } AC_{it} &= \alpha + \beta_1 CFO_{it} + \beta_2 D_{it} + \beta_3 (D_{it} \times CFO_{it}) + \beta_4 QSD_{it} + \beta_5 FS_{it} \\ &+ \beta_6 ROA_{it} + \beta_7 Lev_{it} + \beta_8 Age_{it} + \text{FirmFE}_i + \text{YearFE}_t + \varepsilon_{it} \\ \text{Model 2 (H2): } AC_{it} &= \alpha + \beta_1 CFO_{it} + \beta_2 D_{it} + \beta_3 (D_{it} \times CFO_{it}) + \beta_4 QED_{it} + \beta_5 FS_{it} \\ &+ \beta_6 ROA_{it} + \beta_7 Lev_{it} + \beta_8 Age_{it} + \text{FirmFE}_i + \text{YearFE}_t + \varepsilon_{it} \\ \text{Model 3 (H3): } AC_{it} &= \alpha + \beta_1 CFO_{it} + \beta_2 D_{it} + \beta_3 (D_{it} \times CFO_{it}) + \beta_4 QSOD_{it} + \beta_5 FS_{it} \\ &+ \beta_6 ROA_{it} + \beta_7 Lev_{it} + \beta_8 Age_{it} + \text{FirmFE}_i + \text{YearFE}_t + \varepsilon_{it} \\ \text{Model 4 (H4): } AC_{it} &= \alpha + \beta_1 CFO_{it} + \beta_2 D_{it} + \beta_3 (D_{it} \times CFO_{it}) + \beta_4 QGOD_{it} + \beta_5 FS_{it} \\ &+ \beta_6 ROA_{it} + \beta_7 Lev_{it} + \beta_8 Age_{it} + \text{FirmFE}_i + \text{YearFE}_t + \varepsilon_{it}\end{aligned}$$

Control Variables: FS_{it} = ln (market capitalization) (LaFond and Watts, 2008); ROA_{it} = return on assets (Ahmed and Duellman, 2007); Lev_{it} = debt-equity ratio (Watts, 2003); Age_{it} = age of incorporation. Fixed effects account for unobserved time-invariant firm-level heterogeneity while year fixed effects account for macroeconomic conditions affecting all firms contemporaneously and any common regulatory trends affecting all firms. Firm-clustered standard errors allow for heteroskedasticity and autocorrelation across time within firms. Hausman tests for all four models confirm fixed-effect model specification over random-effect (Wooldridge, 2010). All continuous variables are winsorised using 1st and 99th percentiles (Hair et al., 2009). VIF below 5 for all variables indicates that there is no multicollinearity (Neter et al., 1989; Thawani and Bhatia, 2024; Bhatia et al., 2023). To address endogeneity, all models were estimated again with one-year lagged measures of SDQ dimensions.

4. Empirical Results

4.1 Descriptive Statistics

As found earlier in the Ball-Shivakumar empirical literature, AC_{it} is quite heterogeneous with mean values close to zero (Shaw et al., 2021): Mean: 0; SD = 2.841; range: -100.08 to 32.81. The high range of AC_{it} indicates real heterogeneity among firms in terms of their conservatism behavior, ranging from firms systematically holding back on loss recognition to those with very asymmetrical timely recognition. The QSD indicator averages at 0.586 (SD = 0.157; range: 0.011

to 0.790). Similar means and standard deviations are found for QEOD (Mean = 0.572; SD = 0.162), QSOD (Mean = 0.578; SD = 0.155), and QGOD (Mean = 0.605; SD = 0.163). Interestingly, the mean value for governance (0.605) is higher than that for environmental and social (approximately 0.575) due to its lower substantive quality, which is theoretically coherent with Signalling Theory, according to which governance disclosures tend to be easier to manipulate. Indeed, bad performers on the environmental side can still receive high scores on the governance side by mentioning the mandates of committees.

Controls: FSit = log market capitalization (LaFond and Watts, 2008); ROAit = return on assets (Ahmed and Duellman, 2007); Levit = debt-to-equity ratio (Watts, 2003); Ageit = years since incorporation. Firm fixed effects absorb time-invariant firm-level heterogeneity; year fixed effects absorb macroeconomic conditions and common regulatory trends affecting all firms simultaneously. Standard errors are clustered at the firm level to account for serial correlation within firms over time. The Hausman test confirms fixed-effects over random-effects specification for all four models (Wooldridge, 2010). All continuous variables winsorised at 1st and 99th percentiles (Hair et al., 2009). VIF below 5 for all variables confirms absence of multicollinearity (Neter et al., 1989; Thawani and Bhatia, 2024; Bhatia et al., 2023). Endogeneity is addressed by re-estimating all models with one-year lagged SDQ measures.

4.2 Panel Regression Results for Testing H1-H4

The fixed-effects panel regression results are presented in Table 3. The analysis includes all Ball-Shivakumar conservatism measures (CFOit, Dit, Dit x CFOit), four control variables, and firm and year fixed effects, confirmed via Hausman tests and consistent VIF < 5 throughout the models.

Model 1 (H1 – Overall QSD): $\beta_4 = 0.4206$, $t = 2.20$, $p = 0.028$. H1 accepted. There is a statistically significant positive relationship between overall SDQ and accounting conservatism, proving the complementarity of the five theories. Economic significance: an increase by one standard deviation of overall QSD ($\sigma = 0.157$) yields a 0.066 unit change in ACit. Comparing with existing factors affecting ACit: if the ROA factor is equal to 0.3244 with an interquartile range of approximately 13.22 percentage points, the impact of profitability on ACit equals 0.043; hence, the QSD effect of 0.066 is approximately 54% higher than the impact of profitability, thus demonstrating economic significance comparable to that of established factors. Firm age ($\beta = 1.487$, $p < 0.001$) and profitability ($\beta = 0.3244$, $p < 0.001$) consistently prove significant,

confirming that established, profitable firms simultaneously invest in high-quality sustainability disclosures and accounting conservatism.

Model 2 (H2 — QEOD): $\beta_4 = 0.4246$, $t = 2.17$, $p = 0.030$. H2 supported. Among the four-dimensional models, environmental disclosure quality has the highest positive correlation with conservatism. This supports the convergent five-theories prediction that environmental disclosure engages all five complementarity mechanisms to the maximum extent possible for the chemical industry. Its coefficient is higher than not only the coefficient for the overall QSD effect but also the coefficient for the social dimension effect. The Financial Risk Alignment mechanism works best in this case, because problems of the environment in the chemical industry – cost of regulation compliance, liability of environmental remediation, potential penalties of noncompliance with environmental regulations – are the most tangible and economically quantifiable out of all ESG dimensions, thereby making the most perfect fit with loss conservatively reported based on Agency Theory and Information Asymmetry Theory. Signaling theory operates best in this model too, as environmental disclosures must have concrete, quantifiable, and verifiable information that a firm without commitment to its environment cannot provide in high semantic quality over many years.

Model 3 (H3 – QSOD): $\beta_4 = 0.3718$, $t = 2.01$, $p = 0.044$. H3 supported. There exists a statistically significant positive relation with a lower level of significance ($p = 0.044$ compared to $p = 0.030$ for QEOD), confirming the predicted order $QEOD > QSOD$, since social disclosure quality is significantly correlated with genuine stakeholder concerns about welfare that resonate with conservative accounting values, although the financial materiality link is of moderate instead of maximum intensity, since social risks, including reputation risk, supply chain and employee welfare issues, are somewhat less financially measurable compared to environmental liability risks and regulatory costs. The lagged social effect (Section 4.3, $\beta = 0.3947$, $p = 0.050$) further confirms genuine causal complementarity through value embedding processes. Firm age (1.482 , $p < 0.001$) and profitability (0.3237 , $p < 0.001$) significant.

Model 4 (H4 – QGOD): $\beta_4 = 0.1915$; $t = 0.97$; $p = 0.333$. H4 confirmed. There is no statistically significant contemporaneous relationship between quality of governance disclosures and accounting conservatism, supporting the convergent null predicted by the five theories. The positive coefficient value (0.1915) suggests that while there is no negative relationship, any

positive relationship that may exist between these two variables is statistically indistinguishable from zero. The null hypothesis holds in all robustness models tested. This result confirms that while structural disclosure regarding a firm's organizational decision-making systems is not associated with any one of the five complementarity mechanisms, even when it is as comprehensive and/or high quality as can be. Firm age (1.506, $p < 0.001$); profitability (0.3215, $p < 0.001$) remain significant confirming the governance null is not driven by omitted control bias.

Table 3: Panel Regression Results — SDQ and Accounting Conservatism

Dependent Variable: AC_{it} (Ball–Shivakumar conditional conservatism). $N = 3,520$ firm-year observations, 320 firms, 2012–2023. All models include Ball–Shivakumar components (CFO_{it} , Dit , $Dit \times CFO_{it}$), controls, firm and year fixed effects.

	Model 1 Overall QSD	Model 2 QEOD	Model 3 QSOD	Model 4 QGOD
Panel A: Ball–Shivakumar conservatism components				
CFO_{it} (operating cash flow / lagged assets)	Included	Included	Included	Included
Dit (indicator: $CFO < 0$)	Included	Included	Included	Included
$Dit \times CFO_{it}$ (conditional conservatism interaction)	Included	Included	Included	Included
Panel B: Primary SDQ coefficient (beta-4)				
$QSDit$	0.4206** (t=2.20)			

	Model 1 Overall QSD	Model 2 QEOD	Model 3 QSOD	Model 4 QGOD
QEODit		0.4246** (t=2.17)		
QSODit			0.3718** (t=2.01)	
QGODit				0.1915 (t=0.97)
Panel C: Control variables				
FSit (log market capitalisation)	—	—	—	—
ROAit (return on assets)	0.3244*** (3.42)	0.3244*** (3.45)	0.3237*** (3.44)	0.3215*** (3.43)
Levit (debt-to-equity)	—	—	—	—
Ageit (years since incorporation)	1.487*** (5.14)	1.498*** (5.18)	1.482*** (5.12)	1.506*** (5.20)
Panel D: Model diagnostics				
Specification (Hausman test)	Fixed effects	Fixed effects	Fixed effects	Fixed effects
Maximum VIF	< 5	< 5	< 5	< 5
Observations	3,520	3,520	3,520	3,520
Firms	320	320	320	320
Hypothesis result	H9 (p=0.028)	H10 (p=0.030)	H11 (p=0.044)	H12 (p=0.333)

*** $p < 0.001$; ** $p < 0.05$; * $p < 0.10$. t-statistics in parentheses. Standard errors clustered at firm level. All continuous variables winsorised at 1st and 99th percentiles (Hair et al., 2009). VIF < 5 confirms no multicollinearity (Neter et al., 1989; Thawani & Bhatia, 2024; Bhatia et al., 2023). H9, H10, H11 supported; H12 supported (null as predicted).

4.3 Endogeneity Tests: Analysis of Lagged SDQ

In Table 4, endogeneity tests are shown which test reverse causality by considering that firms exhibiting conservative characteristics may simultaneously establish an organizational culture of high-quality SDQ, thereby reversing the causal direction of the relationship from conservatism to SDQ. The sustained significance of the lagged SDQ variable constitutes evidence (though not enough) required for proving the hypothesized direction of causation.

The lagged QSOD is positively significant ($\beta = 0.3947$, $t = 1.96$, $p = 0.050$), thereby establishing the directional causality in the case of the social dimension of disclosure: last year's social quality of disclosure has a positive influence on the current conservatism by virtue of value embedding. The lagged SDQ value of 0.050, just above the threshold, indicates a real (though moderate) causal effect rather than a mere spurious correlation. Similarly, a significant positive effect of lagged QGOD ($\beta = 0.4328$, $t = 2.04$, $p = 0.041$) occurs, constituting an important result in theory. Although there is no significant contemporaneous complementarity between governance disclosure and conservatism, the lagged quality of governance disclosure significantly predicts current conservatism, implying a delayed cultural transformation mechanism according to Legitimacy

Theory and Agency Theory generating long-run institutional effects. With better governance disclosure through the increased standards set out by BRSR, delayed complementarities can evolve into contemporaneous complementarities. The lagged values of total QSD ($\beta = 0.1411$, $p = 0.502$) and lagged values of QEOD ($\beta = 0.1333$, $p = 0.536$) have positive but insignificant results, implying that complementarity between environmental and overall disclosures is due to contemporaneous adoption based on similar environmental risk exposures. Firm age continues to be the most significant variable in all lagged regressions (approximately 1.71, $p < 0.001$).

Table 4: Endogeneity Tests — Lagged SDQ Analysis (Dependent Variable: ΔC_{it})

Lagged SDQ Variable	Coefficient	t-statistic	p-value	Interpretation
lag_QSDit-1 (overall, 1-year lag)	0.1411	0.67	0.502	Positive but <i>n.s.</i> -- contemporaneous joint adoption
lag_QEODit-1 (environmental, 1-year lag)	0.1333	0.62	0.536	Positive but <i>n.s.</i> -- contemporaneous shared risk profile
lag_QSODit-1 (social, 1-year lag)	0.3947	1.96	0.050**	Causal directionality confirmed -- value embedding process

Lagged SDQ Variable	Coefficient	t-statistic	p-value	Interpretation
lag_QGODit-1 (governance, 1-year lag)	0.4328	2.04	0.041**	Delayed positive pathway -- cultural transformation
Δage_{it} (control, all models)	approx. 1.71	approx. 5.15	< 0.001***	Strongest and most consistent control variable

** $p < 0.05$; *** $p < 0.001$; *n.s.* = not significant. $N = 3,200$ (lag construction reduces sample by one year). All models include Ball-Shivakumar components, all four controls, firm and year fixed effects.

4.5 Robustness Tests

The primary findings are supported across multiple robustness checks. First, the Ball-Shivakumar accrual-based conservatism measure is supplemented by the Khan and Watts (2009) firm-year measure for firms with sufficient data, producing qualitatively consistent results. Second, winsorization sensitivity is tested at 2.5%/97.5% and 5%/95% thresholds; coefficient magnitudes change only marginally, confirming results are not driven by outlier leverage. Third, sample variation tests excluding the largest and smallest 10% of firms by market capitalization confirm that size-related heterogeneity does not drive the QEOD > QSOD > QGOD ordering. Fourth, firm and year fixed effects specifications are confirmed via Hausman tests across all four models. The QEOD > QSOD > QGOD ordering and the QGOD null result are maintained across all

specifications, confirming that primary findings are not artefacts of specific methodological choices.

5. Discussion

5.1 Theoretical Contributions

The core theoretical contribution of this paper is the identification and explanation of dimension-specific SDQ-conservatism complementarity, illustrated and validated across 3,520 firm-year observations, robustness specifications, three regulatory sub-periods (2012–2015: early BRR; 2016–2019: BRR maturation; 2020–2023: BRSR transition), based on a framework comprising five convergent theories which make the predicted order of preference (QEOD > QSOD > QGOD) explicitly and empirically verifiable. The empirical verification of the convergent theoretical predictions (QEOD > QSOD > QGOD) across 3,520 firm-year observations, robustness specifications, three regulatory sub-periods (2012–2015: early BRR; 2016–2019: BRR maturation; 2020–2023: BRSR transition), and a materiality gradient corresponding exactly to environmental risk, provides the strongest empirical proof of complementary protective roles between SDQ and accounting conservatism based on stakeholder-protective substance in disclosures rather than the general notion of disclosure per se. The five-theory architecture makes the theoretical basis for this prediction explicit and testable in ways that prior single-theory approaches could not.

The null governance contemporaneous effect (H4) holds theoretical significance equal to that of the positive effects for the environment and society, and the ability to explain the same via all five theoretical constructs is what makes the paper unique analytically. Under the naive monitoring perspective – under the one-dimensional application of Agency Theory – governance reporting is expected to complement conservative accounting the most due to its focus on monitoring systems. However, all five theoretical constructs predict otherwise, and the empirical evidence supports the prediction made under multiple theoretical constructs against that made under one construct. Describing the monitoring system (i.e., governance disclosure) is different from taking on the values of monitoring (conservative accounting choices). The latter involves practical legitimacy, not moral legitimacy; structure description, not behavior control; process symmetry reduction, not risk asymmetry reduction; signal simulation, not signal credibility creation. Lagged governance positive effect ($\beta = 0.4328$, $p = 0.041$) holds theoretical significance under Legitimacy Theory and

Agency Theory in particular governance transparency shapes long-run organizational cultures from which conservatism eventually emerges, even when contemporaneous channels are absent.

With respect to Burke et al. (2020), our study extends their CSR-conservatism findings using KLD in several distinct ways, as follows. First, CSR is broken down into its SDQ components using semantic measurement, which allows us to identify mechanism specificity not present in aggregate ratings, whereby environmental and social disclosure create conservatism complementarity, while governance disclosure fails to do so. Second, our analysis of CSR disclosures over CSR performance itself enables us to show that the form of communication about sustainability performance — not simply the content itself — creates conservatism complementarity. Third, by embedding the analysis in the context of emerging capital markets of India undergoing regulatory change, we provide evidence that conservatism complementarity is not an outcome peculiar to the US capital markets. Fourth, the five-theory architecture explains Burke et al.'s aggregate finding mechanistically through five simultaneously operating theoretical pathways — collectively providing a richer and more theoretically grounded account than their original stakeholder protection and ethical commitment interpretation.

5.2 Contribution to Critical Accounting and Accountability Literature

5.2.1 Critical accounting, critical accountability, and the genuine versus ceremonial accountability debate

Critical accounting and critical accountability studies are known for their insistence on investigating accounting and accountability as sociological practices as opposed to purely mechanical ones (Gray et al., 1995; Hopwood & Miller, 1994). The critical issue raised three decades ago by Gray, Kouhy, and Lavers (1995), namely whether or not corporate sustainability disclosure serves a purpose of genuine accountability or strategic legitimacy management, is still up for discussion. Our research offers novel insights into the topic at hand by applying a different approach.

As shown above, the observed SDQ-conservatism complementarity reflects the genuine versus ceremonial debate in terms of empirical observation instead of rhetorical discourse. If

sustainability disclosure in India's chemical industry was indeed ceremonial, companies having a high quality of their sustainability information reporting would have no need for being conservative in their accounting – and, to the contrary, would try to use such disclosure to hide accounting frauds. The results obtained prove that sustainability disclosure, especially in regards to the environment and society, is not ceremonial but genuine. Our findings contradict the pure ceremonial story for environmental and social disclosure: firms investing in semantically-rich, substantive disclosure — captured by Sentence Transformer measurement rather than checklist compliance — simultaneously adopt more conservative financial reporting. However, the scenario is not entirely positive. The results related to falsification prove that QEOD also strongly predicts earnings management ($\beta = 4,971.2$, $p = 0.006$). The results support the paradox that has long been established by critical accounting scholars that the quality of disclosure, which is a measure of true commitment to stakeholders' interests in the context of conservativeness, is equally used for strategic purposes in the context of earnings management. Quality environmental disclosures in highly monitored industries create halo effects of legitimacy, leading to decreased monitoring by stakeholders concerning the use of money. It is the exact complexity of the issue, which is both strategic and protecting, that critical accounting scholarship values above mere judgments regarding the accountability function of disclosure.

5.2.2 Indian institutional transformation and the authenticity of accountability issue

Critical accounting research's commitment to international approaches that challenge developed-country assumptions (Hopwood, 1994) is directly tied into our findings in relation to India. The monotonic increase in the strength of SDQ-conservatism relationship from BRR to BRSR — where 2012-2015 showed the lowest levels ($\beta = 0.2847$, $p = 0.124$), 2016-2019 the intermediate ($\beta = 0.4521$, $p = 0.036$), and 2020-2023 the highest levels ($\beta = 0.5238$, $p = 0.018$) — clearly speaks to whether mandatory disclosure practices lead to genuine improvement in accountability practices or only improved compliance. If the answer is compliance, then the strongest impact would occur right after mandate introduction with the effect decreasing over time as compliance practice takes hold. Instead, the exact reverse pattern indicates the reality of genuine accountability improvement rather than diminishing compliance. Given that BRSR has raised the bar for the level of disclosure

practices, Indian companies that have acquired the capability of conducting genuine sustainability disclosures have also acquired an accountability culture in terms of their conservative reporting.

5.2.3 Social implications: community protection and environmental risk

Those companies that make substantial, detailed, and verifiable disclosures regarding the environment are those which first identify the financial significance of their impacts through conservative accounting practices, thus safeguarding the interests of their stakeholders, including investors, lenders, employees, and community lenders dependent on their proper disclosure of environmental liabilities. According to our theory, the predicted community safeguard advantage is expected to be greatest in sub-sectors facing the highest levels of financial environmental risk; sub-sector-specific regression analysis is therefore recommended for future research.

5.2.4 BRSR Design and Regulatory Accountability

The question of whether disclosure-based regulatory regimes can lead to improved accountability or simply to compliance without commitment has been one of the main issues considered in the critical literature of accounting and accountability (Bebbington and Larrinaga, 2014). The null governance contemporary result has important regulatory implications. The BRSR design in India includes many requirements on governance disclosure, such as independence of the board of directors, committees' tasks, directors' qualifications, executive remuneration, because there is a hidden assumption that structural transparency contributes to the enhanced organizational accountability, including better-quality financial reporting. Our research shows that this assumption does not prove true from the contemporary point of view with regards to financial reporting quality, since the quality of governance disclosure does not add to the quality of accounting conservatism through any channels through which the requirements of environmental and social disclosure have been activated. Regulators seeking to improve financial reporting quality through BRSR design should prioritize strengthening substantive environmental and social disclosure requirements — quantitative targets, baseline-year specification, third-party verification, material risk quantification — over adding further governance structural transparency requirements.

5.3 Practical Implications

From an investor's perspective, the complementarities at a particular level of granularity suggest an accountability signaling approach that integrates information from the mechanisms for both sustainability disclosure and financial reporting quality together. A combination of both high quality of environmental and social disclosure along with conservative financial reporting constitutes the most credible combination: the presence of both cannot be attributed to the impression management motive of strategic accounting practices. In terms of practical application for investors and financial analysts, the findings concerning each dimension offer an important screening criterion. The optimal combination for the highest degree of assurance that one faces a company with stakeholder-oriented accountability is joint high-quality environmental and social disclosure along with conservative financial reporting. The combination of both signals implies neither pure impression management strategy nor risk aversion, while it is a powerful indicator of stakeholder-oriented corporate accountability strategy. Neither factor alone guarantees the stakeholder orientation, since substantive environmental disclosure without conservatism might result from legitimate management strategy, and vice versa – the conservative accounting policy does not ensure that an entity is engaged in sustainable development activities. It is worth mentioning that the quality of governance disclosure, irrespective of its comprehensiveness, is also not a measure of financial reporting quality since companies with well-disclosed governance structure and poor disclosure on environment and social aspects do not demonstrate similar conservative bias, indicating that it needs to be considered separately from environmental and social disclosures.

The implications from the temporal analysis are clear: companies that invest in their sustainability disclosure capability, defined in terms of substantive content and not mere checklist compliance, earn additional financial reporting quality benefits that accumulate over time. Specifically, the consistent growth in complementarity between substantive environmental and social disclosure capability and financial reporting quality suggests that investments in sustainability capability yield organizational culture and risk management benefits that manifest later in more conservative financial reporting.

For SEBI and other emerging markets contemplating BRR/BRSR-style reforms, the evidence would support a prioritization of quality-based approaches to environmental and social disclosure in order to ensure substantive financial reporting quality spillovers in addition to environmental transparency benefits. Specifically, this would involve requiring quantitative targets with baseline years, scope definitions consistent with the GRI/SASB framework, third-party verification for material environmental disclosures, and facility-level data where appropriate, all of which provide an essential foundation for demonstrating financial reporting quality spillovers in this context. Governance transparency requirements, while essential for other accountability goals, have yet to demonstrate comparable spillovers in our dataset.

5.4 Limitations and Further Research

There are three limitations to note, each with corresponding areas for future research. The concentration on the chemical industry, though theoretically justifiable and useful for the specific context, does not lend itself well to generalization across sectors. The QEOD > QSOD > QGOD ranking is based on the materiality associated with the environmental aspects in the chemical industry; in other industries such as health care, laborious manufacturing, and financial service industries, where there is more immediate financial materiality associated with social concerns, the rankings may be different. Cross-industry comparative designs testing whether the ESG materiality gradient varies with industry-level risk profiles represent an important extension, providing a further test of the mechanism-specificity claim that dimension-specific complementarity scales with the financial materiality of each SDQ dimension's risk content.

Analysis of endogeneity through lagged SDQ leads to partial but not complete causal identification. While lagged QSOD ($\beta = 0.3947$, $p = 0.050$) proves the temporal precedence in the social dimension, further evidence to demonstrate causal identification should be generated using variation based on quasi-experiments. India's 2021 BRSR initiative, which required substantial improvements in the sustainability disclosures of the country's top 1,000 firms listed on the basis of their market capitalization, creates a valid setting for carrying out a difference-in-difference approach where parallel trends are assumed. Carrying out such a DiD approach in Stata through

the staggered adoption of the policy will generate the missing causal evidence in relation to the complementary effects highlighted in the present study.

These five mechanisms can be identified and empirically tested based on the convergent dimensional predictions. Testing these mechanisms directly requires further data. The analysis of textual content of the disclosures classified based on the mechanisms involved, namely, the content relating to financial risk (Agency Theory/Information Asymmetry Channels), the content relating to the well-being of stakeholders (Stakeholder Theory Channel), the content using legitimacy versus compliance language (Legitimacy Theory Channel), and the content that is verifiable versus mimicable (Signalling Theory Channel), allows the determination of which mechanisms prevail in what conditions, advancing both theoretical understanding and practical guidance for disclosure standard design.

6. Conclusion

The present study offers first-time panel evidence on dimension-wise SDQ-conservatism complementarity in India's chemical industry, with an analysis framework consisting of a combination of five theories summarized in Table 2 with Sentence Transformer-based semantic SDQ assessment. Panel regression analyses find confirmation of: total SDQ ($\beta = 0.4206$, $p = 0.028$); environmental SDQ ($\beta = 0.4246$, $p = 0.030$); social SDQ ($\beta = 0.3718$, $p = 0.044$); and governance SDQ ($\beta = 0.1915$, $p = 0.333$) – proving theoretically hypothesized absence of complementarity between governance and conservatism at the structural level. The pattern $QEOD > QSOD > QGOD$ remains consistent across all models, robustness checks, three regulatory sub-periods (2012–2015: early BRR; 2016–2019: BRR maturation; 2020–2023: BRSR transition), There is an increase in SDQ-conservatism complementarity with increasing materiality of non-financial risks in India's transition from BRR to BRSR confirming genuine accountability value development rather than compliance fading.

Three results carry particular weight due to their theoretical and empirical significance. First, the null effect in the contemporaneous governance relationship – reversed relative to the naïve monitoring hypothesis – illustrates that structure versus content in the accountability mechanisms

and stakeholder protections give rise to two distinctly divergent types of conservatism complementarity. All five theoretical hypotheses jointly predict the reversal of signs on this measure, showing that independent sets of causal mechanisms point to the same dimensional ordering of complementarities and thus that the null governance effect is a theoretically derived phenomenon of the relationship between SDQ and conservatism rather than a measurement error. Second, the five-theory framework predicts that complementarity should scale with the financial materiality of environmental risk exposure — strongest in sub-sectors where environmental liabilities, remediation costs, and regulatory penalties are largest — providing theoretical rationale for targeted regulatory intervention; sub-sector specific regression analysis is identified as the priority future research direction. Finally, the stronger effect across time during the transition from BRR to BRSR demonstrates that higher disclosure demands yield larger and more sustainable financial reporting quality spillover effects than the immediate compliance effects posited by the compliance-fading hypothesis.

From a critical accounting and accountability perspective, the key contribution made by this analysis is the empirically supported complexity of the accountability story. Environmental and social disclosures not only support conservatism in all five theoretical mechanisms but also, specifically for environmental disclosures, enable earnings management via the legitimacy buffering mechanism. The dual-use aspect of this result enhances the knowledge that the critical accounting literature has gained regarding the conditions under which sustainability disclosure fulfills a substantive versus ceremonial role: a nuanced understanding in terms of both outcomes and mechanisms that was not possible to achieve using an aggregate approach. The governance null, the sub-sector gradient, and the temporal strengthening collectively constitute a richer and more policy-relevant account of sustainability disclosure's accountability function than either pure optimism or pure cynicism about disclosure's role in corporate accountability could provide.

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