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# The impact of environmental, social, and governance disclosure on credit risk: Evidence from South African firms



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**Background:** Environmental, social, and governance (ESG) disclosure can influence a firm's credit risk by improving transparency, strengthening risk management, and signalling stability to lenders and rating agencies. In South Africa, where information asymmetry, governance weaknesses, and macroeconomic volatility persist, understanding this relationship is important for promoting financial stability and advancing sustainable investment practices.

**Aim:** This study investigates how ESG disclosure affects three dimensions of credit risk: probability of default (PD), cost of debt (COD), and credit model scores (CMS). It also evaluates whether individual ESG pillars exert distinct effects, thereby identifying which sustainability dimensions are most relevant in the South African context.

**Setting:** The analysis covers 78 non-financial Johannesburg Stock Exchange firms from 2017 to 2023.

**Method:** The study employs baseline ordinary least squares and fixed-effects models, and instrumental-variable two-stage least squares for PD and COD, and ordered probit models, with and without a conditional mixed-process framework, for CMS, allowing treatment of endogeneity.

**Results:** Higher ESG disclosure lowers PD and improves CMS but does not affect COD. Governance drives reductions in PD, while environmental and social pillars strengthen CMS, indicating that ESG components operate through different credit risk channels.

**Conclusion:** Environmental, social, and governance disclosure influences two credit risk measures, highlighting its relevance for credit evaluation in South Africa.

**Contribution:** This study provides the first South African evidence on the ESG-credit risk relationship using different proxies and endogeneity-corrected models. It advances academic debates on ESG in emerging markets and offers practical insights for regulators, lenders, and investors integrating ESG factors into credit-risk evaluation.

**Keywords:** ESG disclosure; credit risk; probability of default; default risk; cost of debt; JSE.

## Introduction

Environmental, social and governance (ESG) disclosure has become a central topic in finance research, reflecting a global shift towards integrating non-financial information into assessments of a firm's value and risk (Chi, Wu & Zheng 2020). Unlike traditional financial reporting, ESG disclosure provides broader insights into environmental performance, labour practices, governance structures and societal impacts (Raimo et al. 2021). As stakeholders increasingly incorporate non-financial information into their evaluation of long-term risk and a firm's value, ESG disclosure has emerged as an important signalling mechanism through which firms communicate transparency, accountability and organisational stability (Attig et al. 2013; Hamrouni, Boussaada & Toumi 2019).

While ESG reporting is now institutionalised in many developed economies, its diffusion across emerging markets is shaped by weaker institutional environments, inconsistent enforcement and heightened socio-political instability (Adardour et al. 2025). South Africa reflects these dynamics. Although the Johannesburg Stock Exchange (JSE) does not formally mandate ESG disclosure, its alignment with the King IV Code has effectively created a de facto expectation for sustainability reporting (Corvino et al. 2020). More recently, the JSE's Sustainability Disclosure Guidance (2022) signalled further alignment with global reporting standards

(Haywood et al. 2025). However, these developments unfold within an environment characterised by weak state capacity, periodic governance failures, corruption scandals and macroeconomic volatility (Ngcobo, Zhou & Pillay 2025), which may distort both the incentives for ESG disclosure and the credibility stakeholders attach to it. This institutional fragility raises uncertainty about whether the expected benefits of ESG transparency materialise in a high-risk emerging economy.

Existing evidence linking ESG disclosure to credit risk originates largely from developed or relatively stable emerging markets, where ESG transparency reduces information asymmetry, strengthens lender trust and enhances a firm's reputation with credit rating agencies (Bhattacharya & Sharma 2020; Xu, Xu & Yu 2021). Empirical studies typically document negative associations between ESG disclosure and both default likelihood and borrowing costs (Do & Vo 2023; Eliwa et al. 2019). Yet, it remains unclear whether these risk-reducing effects persist in environments where macroeconomic instability may dominate credit decisions. This gap motivates a broader question on whether the incentives and benefits of ESG disclosure remain salient when lenders prioritise financial resilience over non-financial transparency.

South Africa provides an important context in which to examine this question. Although the financial system is well developed, it remains highly concentrated, and banks have historically relied on traditional financial indicators, profitability, leverage and cash-flow strength, when pricing debt (Ojah & Pillay 2009). In such a setting, ESG disclosure may exert limited influence on borrowing decisions if broader macroeconomic and institutional risks overshadow firm-level sustainability practices. In addition, the country's credit markets operate against the backdrop of state-owned enterprise failures, recurring corruption scandals and energy-supply instability, all of which may weaken the perceived credibility of governance disclosures. These contextual factors provide a theoretically meaningful basis for expecting different ESG–credit risk dynamics from those documented in more stable markets.

Against this background, this study examines the effect of ESG disclosure on credit risk among 78 non-financial firms listed on the JSE from 2017 to 2023. Beyond aggregate ESG scores, the analysis disaggregates environmental, social and governance pillars, recognising that each dimension may influence lenders and credit assessors through distinct channels. Credit risk is captured using three complementary proxies, probability of default (PD), cost of debt (COD) and credit model scores (CMS), representing market-based, accounting-based and categorical assessments of creditworthiness. Methodological rigour is enhanced through a sequence of baseline estimations, such as the ordinary least squares (OLS) and fixed-effects models for PD and COD, and a baseline ordered probit for CMS, followed by instrumental-variable two-stage least squares (IV-2SLS) and a conditional mixed-process (CMP) framework to address endogeneity across continuous and ordinal credit-risk measures.

The findings of this study indicate that ESG disclosure significantly reduces PD, driven primarily by governance transparency, while improvements in CMS are shaped by environmental and social disclosures. However, neither aggregate ESG disclosure nor its pillars significantly affect the COD. This null result aligns with expectations for South Africa's risk environment, in which lenders continue to rely heavily on financial metrics, and where macroeconomic and institutional risks may overshadow non-financial indicators in debt pricing. Despite this, the significant effects observed for PD and CMS underscore the growing relevance of ESG information for long-term creditworthiness, which is consistent with South Africa's broader shift towards responsible and sustainable finance under King IV and the JSE's 2022 guidance. The differing results across PD, COD and CMS are theoretically expected, as each proxy captures a distinct dimension of credit risk. Principal factor analysis (PFA) further demonstrates that the three measures do not load onto a single underlying construct, supporting the rationale for analysing them separately.

This study makes five key contributions. Firstly, it provides the first empirical assessment of the ESG–credit risk relationship in South Africa, offering insights relevant to high-risk emerging markets more broadly. Secondly, by disaggregating ESG into its pillars, it reveals which sustainability dimensions matter for credit risk and why. Thirdly, it addresses endogeneity, an important limitation in earlier studies, through appropriate econometric techniques tailored to both continuous and ordinal credit-risk measures. Fourthly, by employing multidimensional indicators of credit risk, it strengthens conceptual clarity around the mechanisms linking ESG transparency to lender perceptions. Fifthly, the study offers practical implications: for banks and regulators, the results support integrating ESG metrics into credit evaluation models; for firms, they highlight the value of increased transparency for financing and investor confidence; and for investors, they signal the role of ESG reporting as an indicator of long-term stability.

The remainder of this article is structured as follows. Section Literature review and hypotheses development develops the theoretical framework, reviews related literature and presents the hypotheses. Section Methods outlines the data and methodology. Section Results presents the empirical results. Section Conclusion concludes with implications for firms, investors, lenders and policymakers.

## Literature review and hypotheses development

The relationship between ESG disclosure and credit risk can be understood through the lenses of agency theory, legitimacy theory, and stakeholder theory. The agency theory posits that managers may act in their own interests, especially when information asymmetry exists (Meckling & Jensen 1976). Environmental, social, and governance disclosure serves as a crucial communication tool between companies and their stakeholders, thereby improving transparency and subsequently mitigating information asymmetry (Raimo

et al. 2021). By reducing asymmetry, these disclosures foster trust among creditors, who perceive firms with robust ESG reporting as more reliable and less risky (Atif & Ali 2021). As a result, firms with higher ESG disclosure often benefit from better borrowing conditions, including a lower COD (Hamrouni et al. 2019). Hence, within the agency framework, ESG disclosures reduce credit risk by mitigating information asymmetry between managers and lenders (Raimo et al. 2021).

Legitimacy theory further underscores the role of ESG disclosure in reducing credit risk. This theory postulates that firms continually strive to align their activities with societal norms and expectations to maintain legitimacy (Hamrouni et al. 2019). As corporate responsibilities have expanded beyond financial performance to include social and environmental responsibilities (Lindawati et al. 2015), ESG disclosures demonstrate a firm's commitment to these responsibilities. This enhances public approval, corporate reputation, and stakeholder trust, ultimately increasing the firm's perceived value among stakeholders, including investors and creditors (Hamrouni et al. 2019). For lenders, improved legitimacy signals a firm's ability to meet financial obligations and manage risks effectively, indicating greater creditworthiness (Xu et al. 2021). Thus, legitimacy theory suggests that ESG disclosures help to reduce credit risk by strengthening the firm's reputation and building stakeholders' confidence.

The stakeholder theory complements the legitimacy framework by emphasising that firms should consider the interests of their stakeholders in decision-making, as the value of a firm is generated through its interdependent relationships with these stakeholders (Bhattacharya & Sharma 2020). With stakeholders increasingly focusing on sustainability activities, firms can use ESG disclosures to fulfil stakeholder interests while simultaneously enhancing their reputation (Hamrouni et al. 2019). By providing transparent information on ESG practices, companies can foster trust and loyalty with stakeholders, facilitating better engagement and support (Atif & Ali 2021). Transparent ESG reporting allows stakeholders, including creditors, to assess a company's performance and long-term viability directly, thereby influencing their funding decisions (Jafar et al. 2024). This transparency not only enhances the company's reputation but also improves its access to external funding, thus associating ESG disclosure with reduced credit risk.

These theories highlight the multifaceted role of ESG disclosure in reducing credit risk through transparency and reputation-building. Although research on this topic remains scarce, existing studies provide support for these theoretical propositions, consistently linking ESG disclosure to lower credit risk through three primary dimensions: lower default risk, reduced debt costs, and higher credit ratings. Accordingly, the empirical review and the remainder of this study focus on how ESG disclosures influence each of these credit risk dimensions.

### Environmental, social, and governance disclosure and default risk

The empirical evidence generally points towards a negative association between ESG disclosure and default risk, but the underlying mechanisms and contextual conditions differ across studies. Across American markets, ESG disclosure appears to reduce default risk by improving operational stability and lowering information asymmetry. For instance, Atif and Ali (2021) analyse non-financial U.S. firms over 2006–2017, employing an IV-2SLS approach to address endogeneity. They find that higher ESG transparency significantly decreases default probability, partly through enhanced profitability and more stable cash flows. Their disaggregated results further show that all three ESG pillars contribute to this effect, suggesting that lenders interpret ESG disclosure as a signal of stronger internal processes and long-term financial resilience.

However, evidence from emerging markets indicates that the mechanism may operate differently. Do and Vo (2023) provide evidence from 17 emerging economies between 2000 and 2018, showing that mandatory ESG disclosure reduces default risk. Using a difference-in-differences (DiD) design comparing firms subject to disclosure mandates with those not affected, they find that greater transparency lowers the PD primarily by reducing information asymmetry. Their results suggest that in environments characterised by weaker institutions and limited investor protection, ESG disclosure functions as a credible informational signal, partially substituting for weak external monitoring mechanisms.

Recent work also adds a methodological dimension to this debate. Bonacorsi et al. (2024) analyse a large panel of European listed firms using supervised machine-learning models and find that ESG disclosure significantly enhances the predictive accuracy of credit-risk classifications. Importantly, their marginal-effect estimates show that the governance pillar contributes most strongly to reducing predicted default probability. This introduces a meaningful asymmetry: although ESG disclosures collectively improve credit-risk assessments, lenders and predictive models appear to place disproportionate weight on governance-related transparency, which directly mitigates managerial opportunism, and strengthens internal controls. This pattern is consistent with agency-theoretic predictions but also suggests that improvements in default-risk outcomes may be unevenly driven across ESG pillars, with environmental and social disclosures playing a weaker role.

Collectively, these studies indicate that ESG disclosure lowers default risk. This forms the basis for hypothesis one:

**H1**: ESG disclosure reduces the probability of default for JSE-listed firms.

### Environmental, social, and governance disclosure and cost of debt

The empirical evidence between ESG disclosure and the COD reveals considerable heterogeneity, indicating that the

link between sustainability disclosure and borrowing costs is not uniform across ESG pillars, countries, nor institutional environments. A central conceptual debate in the literature concerns whether lenders reward ESG disclosure because it genuinely improves a firm's underlying risk profile or merely because it enhances transparency in contexts where formal governance systems are weak.

Evidence from developed economies generally supports the information asymmetry reduction channel. Hamrouni, Uyar and Boussaada (2020), examining French listed firms between 2010 and 2015 using GLS, show that aggregate ESG disclosure lowers borrowing costs by enhancing legitimacy and reducing creditor uncertainty. However, their disaggregated results show that environmental disclosure reduces debt costs, social disclosure increases costs, and governance disclosure has no effect. Their article explicitly argues that ESG does not operate as a single construct in creditor decision-making; instead, creditors actively differentiate signals, rewarding disclosures perceived as risk-reducing (environmental) while penalising those viewed as costly (social).

More recent emerging-market evidence adds a contrasting perspective. Malik and Kashiramka (2024), studying Indian listed firms from 2015 to 2021, found that aggregate ESG scores reduce borrowing costs, but environmental scores increase them. They argue that environmental initiatives in India are often costly, regulatory-driven, or associated with compliance burdens, leading creditors to treat environmental activities as risk-enhancing rather than risk-reducing. In contrast, social and governance disclosures decrease borrowing costs, suggesting that lenders prioritise dimensions linked more closely to stakeholder stability and internal controls.

Evidence from Asia further underscores that ESG disclosure does not uniformly reduce debt costs. Chi et al. (2020) find that CSR disclosure reduces borrowing costs for Taiwanese public firms but not private firms. Their results highlight that creditors assess not only what firms disclose but also who is disclosing it: public firms' disclosures are more credible because of more stringent oversight, whereas CSR disclosures by private firms are viewed as resource-diverting and potentially opportunistic. This connects directly with agency theory debates about the possibility of managerial misuse of CSR initiatives.

Global cross-country findings provide broader insight into the role of country-level governance quality. Using a fixed-effects model across 919 non-financial firms in 32 countries (2010–2019), Raimo et al. (2021) show that ESG disclosure reduces COD only when disclosure quality is high, when sustainability information is externally assured, and when institutional governance is strong. Their findings demonstrate that ESG effects are moderated by the credibility of disclosure and by macro-governance quality, supporting the idea that ESG transparency operates differently across institutional environments. Evidence from mandatory disclosure settings provides further nuance. Xu et al. (2021), studying China's mandatory CSR disclosure reform using DiD and PSM, find that enforcing mandatory reporting reduces borrowing costs, but only when reports are lengthy and detailed. Their findings emphasise that lenders reward substantive sustainability information.

Based on the empirical evidence, hypothesis two is proposed:

**H2:** ESG disclosure lowers the cost of debt for JSE-listed firms.

### Environmental, social, and governance disclosure and credit rating

Credit ratings reflect an external assessment of a firm's long-term creditworthiness, and a small growing body of research suggests that ESG disclosure has become an important informational input in these evaluations. However, the evidence is heterogeneous, shaped by differences in institutional environments, the credibility of ESG information, and the extent to which ratings agencies integrate non-financial data into their models.

Across emerging markets, studies generally report a positive association between ESG disclosure and stronger credit ratings, but the underlying mechanisms often diverge. For example, Chi et al. (2020) found that CSR disclosure improves credit ratings only for publicly listed Taiwanese firms, suggesting that the credibility and usefulness of ESG information depend on its external verifiability and exposure to market scrutiny. Private firms, in contrast, receive no rating benefit, implying that disclosure alone is insufficient unless embedded within institutionalised reporting structures. Using an ordered probit model to account for the ordinal nature of credit rating categories, Chi et al. (2020) further showed that rating agencies appear to reward disclosures that are observable, regulated, and subject to external monitoring. This highlights a broader conceptual issue in the literature: ESG disclosure affects credit ratings not simply through improved performance, but through the credibility of the information environment in which disclosures are made.

A similar pattern appears in India, where Bhattacharya and Sharma (2019) found that ESG disclosure improves credit ratings primarily for small- and medium-sized firms, with no measurable benefits for larger firms. This challenges the assumption that larger firms always gain more from sustainability reporting. Their disaggregated analysis further shows that social and environmental disclosures exert stronger positive effects on credit ratings than governance, which is statistically insignificant, suggesting that rating agencies may prioritise ESG pillars asymmetrically. Importantly, using an ordered logistic regression model, the authors also document reverse causality, whereby firms with higher credit ratings subsequently disclose more ESG information. This reinforces a major methodological concern in this literature that ESG disclosure may be both a determinant and a consequence of creditworthiness, underscoring the need for models capable of addressing endogeneity.

In European markets, the mechanism appears to hinge more on predictive utility than on signalling. Agosto, Giudici and Tanda (2023) demonstrate that ESG disclosure, especially when integrated with textual analysis, substantially enhances the accuracy of credit rating models. This suggests that rating agencies increasingly incorporate ESG information not merely as a reputational signal but as quantifiable risk-relevant data that improves model performance. Their findings also show that fuller disclosure corresponds to better predicted ratings, implying that opacity itself is penalised in credit assessments.

Similarly, Hajek, Sahut and Myskova (2024) used natural language processing to show that ESG-rich textual disclosures improve rating outcomes in Germany. Their pillar-level evidence contradicts Bhattacharya and Sharma (2019) as governance emerges as the strongest predictor, with environmental and social signals improving assessments through reduced operational, regulatory, and reputational risks. This inconsistency highlights an active debate on which ESG factors rating agencies prioritise, and whether these priorities differ systematically between developed and emerging markets.

Taken together, this literature points to a consistent pattern: despite cross-country and methodological differences, ESG disclosure generally enhances credit ratings either by improving information transparency or strengthening predictive models. This empirical foundation motivates the study's third hypothesis:

**H3:** ESG disclosure increases the creditworthiness of JSE-listed firms.

# Data and methodology

## Sample

The initial sample for this study consists of firms listed on the JSE from 2017 to 2023. The study period was chosen to capture a phase of significant transformation in South Africa's ESG disclosure and regulatory environment. The starting year, 2017, coincides with the implementation of the King IV, which required all JSE-listed companies to disclose how they apply sustainability reporting practices (Corvino et al. 2020). This marked the beginning of more structured and standardised ESG disclosure among JSE-listed firms. The endpoint of 2023 was selected to incorporate the most recent available data and to reflect the effects of major developments such as the JSE's Sustainability and Climate Disclosure Guidance (2022) and the post-pandemic emphasis on sustainable recovery and responsible investment.

Consistent with prior research, financial firms are excluded, as they are subject to different disclosure regulations, accounting standards, and financing policies that may introduce biases (Raimo et al. 2021). Additionally, firms with missing data are also removed from the sample. Following these exclusions, the final dataset comprises 78 non-financial JSE-listed firms.

Environmental, social, and governance disclosure and financial statement data are sourced from Bloomberg, a platform widely recognised as a primary source for CSR-related information (Atif & Ali 2021; Bhattacharya & Sharma 2020; Raimo et al. 2021). Credit risk data are obtained from the S&P Capital IQ database.

## Model specification

To investigate the impact of ESG disclosure score and its individual components on the credit risk of firms, the following base model is derived (Equation 1):

$$Y_{it} = \beta_0 + \beta_1 X_{it} + \gamma n_{it} + e_{it} \quad \text{[Eqn 1]}$$

where $i = 1 \ldots N$ *and* $t = 1 \ldots 7$; $Y_{it}$ is either the PD, COD, or CMS; $X_{it}$ is either the composite ESG disclosure score, environmental disclosure score, social disclosure score, or governance disclosure score; $n_{it}$ is the vector of control variables; and $e_{it}$ is the error term. The measurement of the variables is outlined in Table 1.

The dependent variable, credit risk, is measured using three proxies: PD, COD, and CMS. These measures represent distinct dimensions of how lenders and financial markets evaluate a firm's risk profile.

Probability of default measures the likelihood that a firm will default on its obligations within a specific time frame and is derived from Merton's (1974) distance-to-default (DtD), which quantifies the number of standard deviations by which a firm's asset value exceeds its default point (Atif & Ali 2021). However, PD is not equivalent to DtD; instead, it is calculated as $N(-DtD)$, where $N$ is the cumulative standard normal distribution function (Do & Vo 2023). This transformation converts DD into a probability, providing a more direct measure of default risk. Probability of default ranges from 0 to 100, with higher percentages indicating greater default risk.

The second proxy, COD, represents the interest rate a firm pays on its bank loans, bonds and other forms of interest-bearing debt capital (Johnson 2020). Following Eliwa, Aboud and Saleh (2021), Atif and Ali (2021) and Raimo et al. (2021), this study calculates COD as the ratio of a firm's interest expense to its average debt. Firms perceived as less risky benefit from lower borrowing costs, while riskier firms face higher interest expenses (Raimo et al. 2021).

The final proxy, CMS, developed by S&P Global Market Intelligence, provides a quantitative assessment of long-term credit scores based on corporate financial and socioeconomic data (Vadakoott et al. 2023). While CMS calculations are informed by S&P's rating criteria, they differ by excluding qualitative assessments and subjective opinions (S&P Global Market Intelligence 2011). Credit model scores instead rely solely on quantifiable metrics such as total assets, efficiency, profitability, gearing,

liquidity, debt service capacity, and country risk (Vadakoott et al. 2023). By excluding qualitative factors, CMS provides a robust and unbiased reflection of the tangible impacts of ESG disclosure practices on a firm's fundamentals. Credit model scores is grouped into 20 categories, ranging from aaa (highest) to cc (lowest), with each reflecting a firm's ability to meet debt obligations. For estimation purposes, CMS is converted into an ordered numeric scale (Attig et al. 2013) running from 20 (aaa) to 1 (cc), as detailed in Table 2.

The explanatory variables are Bloomberg's composite ESG disclosure score, component-level environmental disclosure, social disclosure and governance disclosure scores. The ESG disclosure score is based on 120 indicators across dimensions of the corporate environment, social and governance performance (Johnson 2020). Bloomberg assesses companies annually by gathering ESG information disclosed in ESG and CSR reports, sustainability reports, annual reports, or other official sources (Eliwa et al. 2021). The ESG disclosure scores range from 0 to 100, measuring how comprehensively a company discloses risks, opportunities, and practices related to ESG factors (Eliwa et al. 2021; Hamrouni et al. 2019). The environmental disclosure score reflects the proportion of environmental data points a firm reports relative to the full set of industry-relevant indicators, ranging from 0 (no disclosure) to 100 (full disclosure). The social and governance disclosure scores are calculated in the same manner, capturing the extent of a firm's reporting on social and governance indicators using the same 0–100 scale.

Several firm-specific control variables are also specified. Return on assets (ROA) is included as firms with stronger financial performance are generally associated with lower credit risk due to greater capacity to repay debt (Raimo et al. 2021). Firms with superior financial performance are also more capable of paying dividends (Nyere & Wessen 2019); thus, the dividend payout ratio is specified.

Firm size is incorporated, as larger firms tend to exhibit greater financial stability, translating to lower default risk (Atif & Ali 2021). The leverage ratio is considered because higher leverage increases financial obligations and subsequently the risk of default (Raimo et al. 2021). Firm's age is specified because older, more reputable firms typically face lower credit risk, while younger, less mature firms are more vulnerable to financial distress (Atif & Ali 2021). Finally, following Eliwa et al. (2021), industry and year dummy variables are included to control for sector and time-specific shocks.

**TABLE 2:** Credit score classifications.

| Credit model scores | Assigned rating score | Grade |
|---|---|---|
| aaa | 20 | Highest grade |
| aaa- | 19 | Very high grade |
| aa+ | 18 | Very high grade |
| aa- | 17 | Very high grade |
| a+ | 16 | High grade |
| a | 15 | High grade |
| a- | 14 | High grade |
| bbb+ | 13 | Minimum investment grade |
| bbb | 12 | Minimum investment grade |
| bbb- | 11 | Minimum investment grade |
| bb+ | 10 | Low grade speculative |
| bb | 9 | Low grade speculative |
| bb- | 8 | Low grade speculative |
| b+ | 7 | Very speculative |
| b | 6 | Very speculative |
| b- | 5 | Very speculative |
| ccc+ | 4 | Substantial risk |
| ccc | 3 | Substantial risk |
| ccc- | 2 | Substantial risk |
| cc | 1 | Very poor quality |

*Source*: Own elaboration based on information from Kedia, S., Rajgopal, S. & Zhou, X.A., 2017, 'Large shareholders and credit ratings', *Journal of Financial Economics* 124(3), 632–653. https://doi.org/10.1016/j.jfineco.2017.03.007

Notes: This table provides the classification of credit scores ranging from aaa (highest rating) to cc (lowest rating).

**TABLE 1:** Variable definitions.

| Variables | Measure |
|---|---|
| **Dependent variables** | |
| Probability of default (PD) | The Merton (1974) probability of financial default |
| Cost of debt (COD) | The ratio of interest expense to average debt |
| Credit model score (CMS) | Credit scores coded from '20' (aaa) to '1' (cc) |
| **Independent variables** | |
| ESG disclosure score (ESGD) | Score aggregating 120 dimensions relating to environmental, social, and governance disclosures for each firm |
| Environmental disclosure score (ED) | The environmental disclosure dimension of ESG performance |
| Social disclosure score (SD) | The social disclosure dimension of ESG performance |
| Governance disclosure score (GD) | The governance disclosure dimension of ESG performance |
| **Control variables** | |
| Return on assets (ROA) | The ratio of net income to total assets |
| Dividend payout | The ratio of dividends per share to earnings per share |
| Leverage | The ratio of long- and short-term debt to total assets |
| Ln (Size) | The natural log of net assets |
| Ln (Age) | The natural log of the number of years since the establishment of the firm to the observation date |
| Industry dummies | Each dummy variable is equal to 1 if the firm is in the corresponding industry and zero otherwise. |
| Year dummies | Each dummy variable is equal to 1 if the observation refers to the corresponding year and zero otherwise |

Note: Please see the full reference list of the article, Naidu, D.D., 2026, 'The impact of environmental, social, and governance disclosure on credit risk: Evidence from South African firms', *South African Journal of Economic and Management Sciences* 29(1), a6459. https://doi.org/10.4102/sajems.v29i1.6459, for more information.

ESG, environmental, social, and governance; Ln, natural logarithm.

## Methods

A common issue confronting studies that focus on ESG disclosure and credit risk is that of endogeneity. The analysis begins with a series of baseline OLS (a pooled model without time or industry dummies; a model including industry dummies; and a model including both industry and year dummies) and a fixed-effects (FE) model with industry and time dummies. However, these panel estimation techniques rely on the strict exogeneity assumption, which is unlikely to hold in this context (Schultz, Tan & Walsh 2010). To address this, the study also applies an IV approach with the 2SLS method to test hypotheses one and two. However, these methods are unsuitable for hypothesis three because of the ordinal nature of CMS. Accordingly, the analysis first estimates a baseline ordered probit model to account for the ordered structure of CMS (Bennell et al. 2006). However, because the ordered probit relies on the same exogeneity assumption as OLS and FE, it may also suffer from endogeneity. Therefore, the study employs a CMP framework as the preferred specification, as it extends the ordered probit to allow for endogenous regressors in nonlinear settings (Ren et al. 2022; Roodman 2011). Together, these methods ensure that the estimates for all three hypotheses are robust to endogeneity and aligned with the measurement properties of each credit-risk proxy. The endogeneity-corrected models are discussed next.

### Instrumental-variable and two-stage least squares approach

The IV approach requires the selection of a valid instrument that satisfies two conditions: (1) the instrument is strongly correlated with the endogenous variable (ESG disclosure); and (2) it must be unrelated to the dependent variables, except through its effect on the endogenous variable (Atif & Ali 2021). The instrumental variables used in this study include the industry-level mean ESG disclosure of other firms and its lagged counterpart. For the pillar-level analyses, the corresponding industry-level mean values for the ESG disclosures and their lagged versions are also employed as instruments. The rationale behind using these instruments is that a company's ESG score may be strongly influenced by industry peers, given their similar business models and investment opportunities, but it is improbable that the ESG industry average directly impacts the company's credit risk (Atif & Ali 2021).

Equation 2 represents the first stage of the 2SLS method, where the instruments and control variables are regressed on the endogenous variable to isolate its fitted exogenous component:

$$X_{it} = \beta_0 + \beta_1 IV_{it} + \beta_1 IV_{it-1} + \gamma n_{it} + e_{it} \quad \text{[Eqn 2]}$$

$IV_{it}$ represents the industry-level mean ESG disclosure or the individual ESG disclosure scores from all other firms within the same industry.

In the second stage, the fitted variable ($X^*_{it}$) and control variables are regressed on the dependent variables (Equation 3):

$$Y_{it} = \beta_0 + \beta_1 X^*_{it} + \gamma n_{it} + e_{it} \quad \text{[Eqn 3]}$$

### Ordered probit model and conditional mixed-process

The relationship between ESG disclosure and CMS is expressed in Equation 4:

$$CMS^*_{it} = \delta_0 + \delta_1 X_{it} + \delta_2 n_{it} + e_{it}, \text{with } CS_{it} = \begin{cases} 1 \text{ if } & CS^*_{it} \le \mu_1 \\ 2 \text{ if } & \mu_1 < CS^*_{it} \le \mu_2 \\ 3 \text{ if } & \mu_2 < CS^*_{it} \le \mu_3 \\ . & \\ . & \\ . & \\ 20 \text{ if } & CS^*_{it} > \mu_{19} \end{cases} \quad \text{[Eqn 4]}$$

where $CMS^*_{it}$ is an unobservable latent variable that represents credit scores; $\mu_r$ is the threshold parameters of the credit scores.

In contrast to previous research that used the ordered probit model without addressing endogeneity (Chi et al. 2020), this study incorporates the CMP model to account for this issue. The CMP technique enables the inclusion of instrumental variables within the ordered probit framework (Ren et al. 2022; Roodman 2011). Using a maximum likelihood estimator, the CMP model jointly estimates Equations (2) and (4), creating a system of recursive equations (Roodman 2011). Within this system, an endogenous independent variable in one equation can simultaneously function as the dependent variable in another, thus effectively addressing endogeneity (Li, Ma & Gong 2023).

# Results

## Descriptive statistics

Table 3 presents the descriptive statistics for the variables. The average default probability is 3.1%, indicating a relatively low risk of firms in the sample defaulting on their debt obligations. The average COD is 8.9% and ranges between 0.01% and 56.3%. The mean credit score of 7.812 suggests a rating closer to bb- (low-grade speculative) but slightly leaning towards b+ (very speculative). This indicates that while firms generally demonstrate the capacity to meet debt obligations, they still face business or financial uncertainties that could increase their credit risk in the future.

The mean ESG disclosure score indicates that, on average, JSE-listed firms comply with 51.8% of the 120 disclosure categories constituted by the measure. The range (0.007–0.782) indicates substantial variability in ESG disclosure practices

across companies, with some scoring very low and others relatively high. This reflects differing levels of commitment to ESG transparency among firms. The environmental (0.359), social (0.342), and governance (0.791) pillar averages reveal that governance performance is relatively strong across firms, while environmental and social practices lag behind. Regarding the control variables, the average ROA is 9.5%, suggesting moderate profitability. The mean leverage ratio reveals that, on average, firms finance 26.1% of their assets with debt, indicating a greater reliance on equity financing. The average dividend payout ratio indicates that 45.4% of earnings are distributed to shareholders. The mean firm size, measured in net assets, is R26 984 017, and the average firm age is 51.83 years, indicating that most firms in the sample are well-established.

Table 4 presents the correlation matrix for all variables. As anticipated, the correlation between ESG disclosure and PD is negative, indicating that higher ESG disclosure is linked to lower default risk. However, contrary to previous studies, ESG disclosure exhibits a positive correlation with the COD, suggesting that increased ESG transparency may lead to higher borrowing costs. Nonetheless, the positive correlation between ESG disclosure and credit scores is consistent with existing research. The individual ESG pillars display the same directional correlations as the composite score, reinforcing the overall pattern. All pairwise correlations were below 0.80, indicating the absence of severe multicollinearity among the explanatory variables (Shrestha 2020). This is supported by the variance inflation factors (VIFs) computed for the explanatory variables (see Appendix 1, Table 1-A1). Across all specifications, the mean VIF values range between 1.032 and 1.042, which is substantially below the conservative threshold of 5 (Alauddin & Nghiem 2010). All individual VIFs are close to 1, indicating very low correlation among regressors. Overall, the diagnostics confirm that multicollinearity is not a concern in this study.

## Regression results

Table 5 presents the results examining the relationship between ESG disclosure and alternative measures of credit risk. Panel A reports the effects of aggregate ESG disclosure on the PD, COD, and CMS across multiple estimation techniques, while Panel B provides the corresponding results for the separate ESG components. Table 6 reports the first stage IV-2SLS regressions and the corresponding CMP system estimates, with models 1 and 2 confirming the validity of the instrumental variables through their statistically significant ability to predict both the composite

**TABLE 3:** Descriptive statistics.

| Variables | Mean | Std. dev. | Min | Max | Skewness | Kurtosis |
|---|---|---|---|---|---|---|
| Probability of default (PD) | 0.031 | 0.043 | 0.000 | 0.587 | 6.124 | 67.096 |
| Cost of debt (COD) | 0.089 | 0.062 | 0.001 | 0.563 | 3.836 | 24.496 |
| Credit model score (CMS) | 7.812 | 1.558 | 3.000 | 11.000 | -0.549 | 3.178 |
| ESG disclosure score | 0.518 | 0.117 | 0.007 | 0.782 | -0.683 | 5.160 |
| Environmental disclosure score | 0.359 | 0.199 | 0.000 | 0.823 | 0.140 | 2.399 |
| Social disclosure score | 0.342 | 0.146 | 0.000 | 0.810 | -0.070 | 2.850 |
| Governance disclosure score | 0.791 | 0.203 | 0.000 | 0.986 | 0.041 | -2.435 |
| Return on assets | 0.095 | 0.125 | -0.450 | 0.727 | -0.082 | 7.755 |
| Dividend payout | 0.454 | 0.882 | -0.208 | 12.952 | 9.867 | 126.868 |
| Leverage | 0.261 | 0.169 | 0.000 | 0.769 | 0.442 | 2.903 |
| Ln (Size) | 10.203 | 2.338 | 0.000 | 37.371 | 5.808 | 58.310 |
| Ln (Age) | 3.948 | 0.715 | 0.693 | 5.153 | -0.985 | 4.635 |

Notes: This table reports the descriptive statistics for the credit risk measures (PD, COD and CMS), composite ESG disclosure and pillar level scores and control variables (ROA, dividend payout, leverage, ln[size], and ln[age]) from the period 2017 to 2023.

ROA, return on assets; Ln, natural logarithm; Std. dev., standard deviation; min, minimum; max, maximum; ESG, environmental, social and governance.

**TABLE 4:** Correlation matrix.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Probability of default (PD) | 1.000 | - | - | - | - | - | - | - | - | - | - | - |
| (2) Cost of debt | -0.030 | 1.000 | - | - | - | - | - | - | - | - | - | - |
| (3) Credit model score | -0.245 | 0.060 | 1.000 | - | - | - | - | - | - | - | - | - |
| (4) ESG disclosure score | -0.087 | 0.200 | 0.303 | 1.000 | - | - | - | - | - | - | - | |
| (5) Environment pillar | -0.077 | 0.222 | 0.333 | 0.747 | 1.000 | - | - | - | - | - | - | - |
| (6) Social pillar | -0.091 | 0.231 | 0.218 | 0.656 | 0.637 | 1.000 | - | - | - | - | - | |
| (7) Governance pillar | -0.122 | 0.047 | 0.182 | 0.494 | 0.381 | 0.474 | 1.000 | - | - | - | - | - |
| (8) Return on assets | -0.208 | 0.136 | 0.330 | 0.143 | 0.178 | 0.196 | 0.088 | 1.000 | - | - | - | |
| (9) Dividend payout | -0.099 | 0.010 | -0.047 | 0.051 | -0.003 | 0.060 | 0.050 | 0.045 | 1.000 | - | - | - |
| (10) Leverage | 0.113 | -0.157 | -0.243 | 0.049 | -0.011 | -0.022 | -0.099 | -0.145 | 0.046 | 1.000 | - | - |
| (11) Ln (Size) | -0.051 | 0.081 | 0.142 | 0.158 | 0.167 | 0.024 | 0.120 | 0.029 | 0.054 | 0.076 | 1.000 | - |
| (12) Ln (Age) | -0.033 | -0.005 | -0.016 | 0.126 | 0.116 | 0.103 | 0.139 | -0.041 | 0.054 | 0.016 | 0.036 | 1.000 |

Notes: This table shows the correlation coefficients between credit risk measures, ESG disclosure scores and control variables from 2017 to 2023.

ESG, environmental, social, and governance; Ln, natural logarithm.

ESG disclosure score and the individual pillar scores. The KP rk Wald *F*-statistic for model 1 further indicates that the instruments exhibit sufficient strength for reliable identification.

The results across panel A consistently show that ESG disclosure reduces PD. This effect remains directionally consistent across OLS and FE models, although the magnitude increases once endogeneity is addressed within the IV-2SLS specification, suggesting that the true effect of ESG disclosure is understated in non-IV models. Specifically, the results from the IV-2SLS specification demonstrate that a 1% increase in ESG disclosure reduces PD by 0.108%. This highlights the positive role of ESG disclosure in reducing default risk by improving transparency, reputation, and stakeholder trust (Do & Vo 2023). These factors foster customer loyalty and operational efficiency, ensuring consistent cash flows that improve a firm's ability to meet financial obligations, thereby directly lowering default probabilities (Atif & Ali 2021). This aligns with the theoretical framework and empirical evidence discussed in section ESG disclosure and default risk, providing strong support for hypothesis one. For the PD, firms in the Basic Materials and Technology sectors exhibit significantly lower default risk because of ESG disclosures, as per Table 7.

**TABLE 5:** Impact of environmental, social, and governance disclosure on alternative measures of credit risk.

| Variables | Model 1: Probability of default | | | | | Model 2: Cost of Debt | | | | | Model 3: Credit model score | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS | OLS | FE | IV-2SLS | OLS | OLS | OLS | FE | IV-2SLS | Ordered Probit | CMP-Ordered Probit |
| **Panel A: Aggregate ESG Disclosure** | | | | | | | | | | | | |
| ESG disclosure | -0.019 | -0.033** | -0.036** | -0.058 | -0.108** | 0.015 | -0.036 | -0.033 | 0.001 | -0.046 | 0.826 | 3.882*** |
| Return on assets | -0.064*** | -0.048*** | -0.046*** | -0.018 | -0.038** | 0.048 | 0.066 | 0.060 | 0.006 | 0.061* | 2.117*** | 1.895*** |
| Dividend payout | -0.004*** | -0.003*** | -0.003*** | -0.002* | -0.002 | -0.000 | -0.000 | 0.000 | 0.001 | 0.003 | -0.097*** | -0.084 |
| Leverage | 0.025** | 0.037*** | 0.037*** | 0.021 | 0.027** | -0.002 | 0.033 | 0.030 | -0.076* | -0.031 | -1.060*** | -1.459*** |
| Ln (Size) | -0.001 | -0.000 | -0.000 | 0.000 | -0.000 | 0.003** | 0.003** | 0.003** | 0.000 | 0.002 | 0.029 | 0.032 |
| Ln (Age) | -0.002 | -0.004 | -0.004 | -0.006 | 0.001 | -0.001 | -0.001 | -0.001 | 0.034 | 0.002 | 0.189*** | -0.054 |
| Constant | 0.057*** | 0.059*** | 0.055*** | 0.080 | 0.082*** | 0.057* | 0.038 | 0.053 | -0.030 | 0.086 | - | - |
| *R*-squared | 0.065 | 0.121 | 0.126 | 0.010 | 0. 127 | 0.024 | 0.057 | 0.087 | 0.022 | 0.107 | - | - |
| atanhrho_12 | - | - | - | - | - | - | - | - | - | - | - | -0.237** |
| **Panel B: Aggregate ESG Disclosure** | | | | | | | | | | | | |
| Environmental | -0.007 | -0.013 | -0.014 | -0.001 | -0.024 | -0.007 | -0.013 | -0.008 | -0.013 | -0.024 | 0.627* | 2.193*** |
| Social | -0.007 | -0.013 | -0.014 | -0.001 | -0.024 | 0.020 | 0.017 | 0.022 | -0.004 | 0.044 | 0.627* | 3.087*** |
| Governance | -0.033** | -0.027* | -0.027** | 0.016 | -0.031* | -0.033 | -0.037 | -0.037 | 0.005 | -0.025 | 0.185 | -0.280 |
| Industry FE | No | Yes | Yes | No | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Year FE | No | No | Yes | No | Yes | No | No | Yes | No | Yes | Yes | Yes |
| Firm FE | No | No | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes |

Notes: Panel A reports results for aggregate ESG disclosure with control variables, while Panel B reports only the coefficients for the Environmental, Social, and Governance pillars, without control variables. Robust standard errors applied. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. For the Probability of Default and Cost of Debt, columns report OLS, Industry Fixed Effects, Industry + Year Fixed Effects, Firm Fixed Effects, and IV-2SLS specifications. For the Credit Model Score, results are estimated using Ordered Probit and IV-Ordered Probit via the CMP.

ESG, environmental, social, and governance; Ln, natural logarithm; CMP, conditional mixed-process; OLS, ordinary least squares; FE, fixed-effects; IV-2SLS, instrumental-variable two-stage least squares.

**TABLE 6:** First-stage IV and conditional mixed-process system estimates.

| Variables | Model 1 | | | | Model 2 | | | |
|---|---|---|---|---|---|---|---|---|
| | ESG disclosure | Environmental | Social | Governance | ESG disclosure | Environmental | Social | Governance |
| ESGDIV | -0.884*** | - | - | - | 0.595*** | - | - | - |
| $ESGDIV_{t-1}$ | -0.548*** | - | - | - | 0.051 | - | - | - |
| EDIV | - | -1.836*** | - | - | - | 0.681** | - | - |
| $EDIV_{t-1}$ | - | -1.178*** | - | - | - | 0.076 | - | - |
| SDIV | - | - | -0.703*** | - | - | - | 0.437*** | - |
| $SDIV_{t-1}$ | - | - | -0.562*** | - | - | - | 0.244 | - |
| GDIV | - | - | - | -1.560*** | - | - | - | -0.551** |
| $GDIV_{t-1}$ | - | - | - | -1.011*** | - | - | - | 0.094 |
| Return on assets | 0.030 | 0.155** | 0.170*** | -0.056 | 0.078* | 0.220*** | 0.234*** | 0.141 |
| Dividend payout | 0.007 | -0.001 | 0.008 | 0.004 | 0.004 | -0.005 | 0.004 | 0.004 |
| Leverage | 0.010** | 0.095** | 0.110* | -0.061 | 0.055 | 0.106* | 0.080* | -0.075 |
| Ln (Size) | 0.002 | 0.004 | -0.002 | 0.003 | 0.004* | 0.011*** | -0.001 | 0.009* |
| Ln (Age) | 0.010 | 0.032*** | 0.036** | 0.028 | 0.020** | 0.043*** | 0.028** | 0.037* |
| Constant | 1.212*** | 1.249*** | 0.722*** | 2.933*** | 0.058 | -0.245*** | -0.041 | 0.910*** |
| $R^2$ | 0.427 | 0.557 | 0.312 | 0.365 | - | - | - | - |
| Partial $R^2$ | 0.124 | 0.284 | 0.085 | 0.278 | - | - | - | - |
| KP rk Wald | 11.574 | 70.063 | 15.291 | 46.120 | - | - | - | - |

Notes: Model 1 presents the first stage regression results from the IV-2SLS model and Model 2 presents the estimates for the endogenous explanatory variables within the CMP system. Statistical significance is denoted by * at the 10% level, ** at the 5% level, and *** at the 1% level. $ESGDIV/ESGDIV_{t-1}$, $EDIV/EDIV_{t-1}$, $SDIV/SDIV_{t-1}$, and $GDIV/GDIV_{t-1}$ are the instruments for the composite ESG, environmental, social, and governance disclosures, respectively.

ESG, environmental, social, and governance; Ln, natural logarithm; CMP, conditional mixed-process; IV-2SLS, instrumental-variable two-stage least squares.

**TABLE 7:** Impact of environmental, social, and governance disclosure on credit risk across industries.

| Industry | Probability of default | Cost of debt | Credit rating |
|---|---|---|---|
| Basic materials | -0.082*** | -0.001 | 0.841 |
| Consumer goods | 0.036 | 0.210 | 5.271* |
| Consumer services | 0.056 | 0.003 | -1.905 |
| Health care | -0.035 | -0.132 | 0.000 |
| Industrials | 0.067 | -0.135 | -1.216 |
| Technology | -0.744* | 0.211 | -37.742 |
| Telecommunications | 0.026 | 0.045 | -6.713 |

Notes: The table reports industry-specific ESG disclosure coefficients only. Significance levels: ***, $p < 0.01$; **, $p < 0.05$; *, $p < 0.10$.

ESG, environmental, social, and governance.

The disaggregated results in panel B show that governance disclosure is the only ESG component that significantly reduces PD. This reflects the role of governance transparency, particularly disclosures related to oversight, internal controls, and risk management, in strengthening a firm's financial stability (Moridu 2023). In South Africa, where information asymmetry, regulatory uncertainty, and past governance failures have heightened credit risk, such disclosures are especially important. The significance of the governance pillar indicates that the overall ESG–default risk relationship is driven primarily by improvements in governance transparency rather than environmental or social disclosures.

While ESG disclosure is shown to reduce PD, model 2 within panels A and B find no significant association between ESG disclosure and the COD for JSE-listed firms, leading to the rejection of hypothesis two. This suggests that South African lending institutions do not currently incorporate ESG disclosure factors into their corporate debt pricing decisions. This finding contrasts with prior research discussed in section ESG disclosure and COD that identified negative relationships between ESG disclosures and borrowing costs. The divergence from previous studies may stem from South Africa's unique economic and institutional challenges, including systemic inequalities, political instability, corporate failures, and economic volatility (Zungu & Greyling 2025). These structural barriers intensify systematic and financial risks for South African firms (Ojah & Pillay 2009; Smit & Watkins 2012), potentially overshadowing the benefits of ESG transparency. Hence, in such a volatile environment, lending institutions may prioritise immediate financial metrics when pricing corporate loans (Bhat et al. 2020; Psillaki, Tsolas & Margaritis 2010). This emphasis on immediate financial health likely diminishes the relevance of ESG disclosures in debt pricing decisions, thus explaining the insignificant relationship. Consistent with this interpretation, the individual ESG disclosure pillars also show no significant effect on the COD.

The results in model 3 of panel A reveal a significant positive relationship between ESG disclosure and CMS, indicating that greater ESG transparency enhances a firm's creditworthiness. While the ordered probit indicates a positive insignificant association, the effect becomes significant in the CMP-ordered probit model, reinforcing hypothesis three. However, as observed in section Model Specification, CMS differs fundamentally from traditional credit ratings by excluding qualitative factors and focusing solely on quantifiable financial indicators (Vadakoott et al. 2022). Hence, unlike prior studies, the positive relationship observed between ESG disclosure and CMS is not influenced by any perceptual biases or qualitative assumptions inherent in traditional credit rating processes (Ioannou, Wójcik & Pažitka 2021). The result instead reflects tangible improvements in key financial metrics aggregated within CMS. This emphasises the financial benefits of ESG disclosures, which is often overlooked in earlier studies that primarily attribute their results to improved stakeholder perceptions.

The findings from model 3 therefore indicate that the benefits of ESG disclosures extend beyond merely enhancing stakeholder perceptions, as they directly strengthen the firm fundamentals captured within CMS. These improvements not only contribute to higher creditworthiness but may also yield broader advantages, including increased operational performance, efficiency, and liquidity, which help to position firms for long-term sustainability and greater competitiveness. This suggests that, for JSE-listed firms, ESG disclosures offer additional financial benefits beyond improving creditworthiness. Table 7 shows that firms in the Consumer Goods sector receive significantly higher credit scores. Similar to Bhattacharya and Sharma (2020), the disaggregated results in panel B (model 3) show that environmental and social disclosure scores exhibit positive effects on CMS, while governance disclosure is insignificant. This distinction reflects the differing sensitivities of the credit risk measures: governance primarily mitigates downside risk that is captured by PD but not by CMS. Conversely, environmental and social disclosure improves operational efficiency, stakeholder relationships, and revenue stability, which are attributes that feed directly into the financial ratios embedded within CMS. Thus, the environmental and social pillars enhance creditworthiness through financial performance channels, whereas governance reduces default risk through risk-management channels.

The differences in results across the dependent variables are somewhat expected, as each measure captures a different, yet related, facet of credit risk. This distinction is supported by the PFA results presented in Appendix 3, which show that although the eigenvalues suggested a single underlying factor, the loadings were weak (PD = –0.387; COD = 0.113; CMS = 0.396) and the uniqueness values were high (0.84–0.99). The low loadings indicate that the proxies do not load strongly onto a common latent construct, inferring that each measure provides a distinct and complementary perspective on credit risk.

Regarding the control variables from panel A, a negative relationship is observed between ROA and the PD. This is

consistent with Atif and Ali (2021) and Do and Vo (2023), who argue that profitable firms are better positioned to generate consistent cash flows and meet debt obligations, thus reducing default risk. This also explains the positive association between ROA and CMS, as higher profitability often signals stronger creditworthiness, aligning with Chi et al. (2020). Similarly, the negative linkage between dividend payout ratio and default risk further indicates that firms with stable cash flows are less likely to default and are thus more capable of making dividend payments (Alam & Hossain 2012).

Consistent with earlier studies (Atif & Ali 2021; Do & Vo 2023), the leverage ratio is positively related to the PD, as highly leveraged firms are obligated to service larger debt loads, making them more vulnerable to default. The increased default probability translates to lower credit scores (S&P Global Market Intelligence 2011), thus explaining the negative linkage between leverage ratio and CMS. Firm's size exhibits mixed effects across the models. Consistent with Xu et al. (2021), the firm's size is positively associated with the COD, as larger firms may experience greater information asymmetry and agency problems (Naidu et al. 2022), leading to higher borrowing costs. Conversely, the firm's size positively influences CMS, suggesting that larger firms benefit from higher credit ratings because of their stronger market position, resource availability, and enhanced financial stability, supporting Attig et al. (2013) and Chi et al. (2020).

The control variables for the individual components are similar to that of panel A. The full regression results for panel B with control variables are available in Appendix 2 (Table 1-A2, Table 2-A2, and Table 3-A2).

## Conclusion

This study examines the relationship between ESG disclosure and credit risk of non-financial firms listed on the JSE from 2017 to 2023, providing recent evidence on this subject matter. Credit risk is measured using market-based (PD), accounting-based (COD), and categorical (CMS) measures. In contrast to traditional credit ratings, the CMS does not incorporate quantitative assessments and opinions and instead relies solely on quantifiable metrics. This exempts the proxy from biases often present within traditional credit ratings.

Baseline OLS and FE models are supplemented with IV-2SLS and ordered probit–CMP estimation to correct for endogeneity across both continuous and ordinal credit-risk measures. The results indicate that ESG disclosure exhibits significant relationships with PD and CMS. Specifically, ESG disclosure decreases the PD, which is attributed to improved reputation, customer loyalty, and more stable cash flows. A positive association is found between ESG disclosure and CMS, reflecting tangible improvements in a firm's core financial metrics. Contrary to prior studies, no significant relationship was observed between ESG disclosure and the COD, suggesting that it is not relevant to the firm's borrowing conditions. This is attributed to the unique economic and institutional challenges faced in South Africa, which may overshadow the relevance of ESG disclosure in debt pricing decisions.

The pillar-level analysis provides additional insights, while the governance disclosure is the only component that significantly reduces default risk; the environmental and social pillars exert significant positive effects on CMS, suggesting that these dimensions contribute to improved financial-based creditworthiness. None of the pillars, however, exhibits a significant relationship with the COD, reinforcing the finding that ESG disclosure factors, individually or collectively, are not incorporated into South African firm's borrowing costs.

The overall results of this study therefore indicate that while ESG disclosure reduces credit risk through default risk and increased credit scores, its influence on COD may be diluted by the need to address more immediate socio-economic challenges within the South African landscape. This highlights the importance of tailoring ESG frameworks to local contexts, as a standardised, universal approach may not be feasible in markets such as South Africa.

The study's findings offer several implications. Firstly, lenders should incorporate a firm's ESG disclosure levels when assessing the COD, as the results indicate that ESG disclosures significantly influence default probability and CMS. By incorporating CSR disclosures alongside traditional financial indicators, lenders can achieve a better understanding of a firm's overall risk profile. Moreover, embedding disclosure practices into lending decisions can incentivise firms to prioritise sustainability, yielding societal and environmental benefits. Secondly, firms should integrate ESG disclosures into their corporate strategy to reduce default risk and enhance creditworthiness, which, in turn, may strengthen stakeholder relationships. Thirdly, policymakers should prioritise promoting comprehensive ESG reporting frameworks to lower default risks and foster a more sustainable and resilient corporate environment. Finally, investors can use ESG disclosure levels to evaluate default risk. Based on the results of this study, investors are encouraged to invest in firms with high ESG disclosure and should demand higher risk premiums from those with weaker disclosure practices.

This study is not without limitations. Firstly, the limited availability of ESG disclosure data for South African firms constrains the sample size and time frame. Secondly, the study focuses solely on South Africa, which may limit the generalisability of the results to other countries. Future research could address this by conducting cross-country analyses, enabling a comparison of ESG impacts across diverse markets and yielding broader insights. Lastly, future research could delve deeper into the individual components of CMS to identify which specific metrics drive the observed positive relationship with ESG disclosure. Future studies can also differentiate between voluntary and mandatory ESG disclosures in order to determine how each type uniquely influences credit risk.

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## Competing interests

The author, Delane D. Naidu, serves as an editorial board member of this journal. Delane D. Naidu has no other competing interests to declare.


## CRediT authorship contribution

Delane D. Naidu: Conceptualisation, Methodology, Formal analysis, Investigation, Writing – original draft, Visualisation, Project administration, Software, Validation, Data curation, Writing – review & editing. The author confirms that this work is entirely their own, has reviewed the article, approved the final version for submission and publication, and takes full responsibility for the integrity of its findings.

## Ethical considerations

This article followed all ethical standards for research without direct contact with human or animal subjects.


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## Data availability

The data that support the findings of this study are publicly available from IRESS, Equity RT and Bloomberg Inc.

## Disclaimer

The views and opinions expressed in this article are those of the author and are the product of professional research. It does not necessarily reflect the official policy or position of any affiliated institution, funder, agency, or that of the publisher. The author is responsible for this article's findings and content.

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Appendices starts on the next page →

# Appendix 1

**TABLE 1-A1:** Variance inflation factors of explanatory variables.

| Variables | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| $\chi_{it}$ | 1.069 | 1.081 | 1.074 | 1.055 |
| Return on assets | 1.052 | 1.067 | 1.058 | 1.041 |
| Leverage | 1.034 | 1.037 | 1.032 | 1.037 |
| Ln (Size) | 1.033 | 1.032 | 1.021 | 1.028 |
| Ln (Age) | 1.023 | 1.025 | 1.01 | 1.024 |
| Dividend payout | 1.011 | 1.008 | 1.009 | 1.009 |
| Mean VIF | 1.037 | 1.042 | 1.034 | 1.032 |

Notes: $\chi_{it}$ is ESG disclosure in model 1, environmental disclosure in model 2, social disclosure in model 3 and governance disclosure in model 4.
VIF, variance inflation factors; Ln, natural logarithm.

# Appendix 2

**TABLE 1-A2:** Impact of Environmental Disclosure and control variables on credit risk.

| Variables | Panel A: Probability of default | | | | | Panel B: Cost of debt | | | | | Panel C: Credit model score | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS | OLS | FE | IV-2SLS | OLS | OLS | OLS | FE | IV-2SLS | Ordered probit | CMP-Ordered probit |
| E disclosure | -0.007 | -0.013 | -0.014 | -0.001 | -0.024 | -0.007 | -0.013 | -0.008 | -0.013 | -0.024 | 0.627* | 2.193*** |
| Return on assets | -0.065*** | -0.050*** | -0.047*** | -0.019 | -0.041*** | -0.055 | -0.008 | -0.005 | 0.008 | 0.062 | 2.079*** | 1.801*** |
| Dividend payout | -0.004* | -0.004*** | -0.004*** | -0.002** | -0.003* | 0.002 | -0.005 | -0.006 | 0.000 | 0.002 | -0.092** | -0.060 |
| Leverage | 0.020* | 0.030** | 0.030** | 0.023 | 0.019* | 0.006 | 0.036 | 0.036 | -0.082* | -0.033 | -1.040*** | -1.379*** |
| Ln (Size) | -0.001 | -0.000 | -0.000 | 0.000 | -0.000 | 0.002 | 0.003 | 0.003 | 0.000 | 0.002** | 0.027 | 0.027 |
| Ln (Age) | -0.002 | -0.004 | -0.004 | -0.015 | 0.001 | 0.002 | 0.003 | 0.002 | 0.059 | 0.002 | 0.182** | |
| Industry FE | Yes | 0.019*** | Yes | No | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Year FE | No | Yes | Yes | No | Yes | No | No | Yes | No | Yes | Yes | Yes |
| Firm FE | No | No | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes |
| Constant | 0.050*** | No | 0.035* | 0.085 | 0.057*** | 0.069 | 0.047 | 0.068 | -0.123 | 0.068** | - | - |
| $R$-squared | 0.063 | 0.114 | 0.119 | 0.009 | 0.158 | 0.040 | 0.205 | 0.027 | 0.022 | 0.096 | - | - |
| atanhrho_12 | - | - | - | - | - | - | - | - | - | - | - | -0.205** |

Notes: For the Probability of Default and Cost of Debt, columns report OLS, Industry Fixed Effects, Industry + Year Fixed Effects, Firm Fixed Effects, and IV-2SLS specifications. For the Credit Model Score, results are estimated using Ordered Probit and IV-Ordered Probit via the CMP. Significance levels: ***, $p < 0.01$; **, $p < 0.05$; *, $p < 0.10$.

CMP, conditional mixed-process; OLS, ordinary least squares; FE, fixed-effects; IV-2SLS, instrumental-variable two-stage least squares; Ln, natural logarithm.

**TABLE 2-A2:** Impact of Social Disclosure and control variables on credit risk.

| Variables | Panel A: Probability of default | | | | | Panel B: Cost of debt | | | | | Panel C: Credit model score | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS | OLS | FE | IV-2SLS | OLS | OLS | OLS | FE | IV-2SLS | Ordered probit | CMP-Ordered probit |
| S disclosure | -0.007 | -0.013 | -0.014 | -0.001 | -0.024 | 0.020 | 0.017 | 0.022 | -0.004 | 0.044 | 0.627* | 3.087*** |
| Return on assets | -0.065*** | -0.050*** | -0.047*** | -0.019 | -0.041*** | -0.059 | -0.013 | -0.012 | 0.008 | 0.050 | 2.079*** | 1.544*** |
| Dividend payout | -0.004* | -0.004*** | -0.004*** | -0.002** | -0.003* | -0.001 | -0.007 | -0.008 | 0.000 | 0.002 | -0.092** | -0.088 |
| Leverage | 0.020* | 0.030** | 0.030** | 0.023 | 0.019* | 0.007 | 0.032 | 0.032 | -0.084** | -0.042 | -1.040*** | -1.366*** |
| Ln (Size) | -0.001 | -0.000 | -0.000 | 0.000 | -0.000 | 0.001 | 0.003 | 0.003 | 0.000 | 0.002** | 0.027 | 0.052** |
| Ln (Age) | -0.002 | -0.004 | -0.004 | -0.015 | 0.001 | 0.001 | 0.003 | 0.001 | 0.055 | -0.001 | 0.182** | -0.097 |
| Industry FE | Yes | 0.019*** | Yes | No | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Year FE | No | Yes | Yes | No | Yes | No | No | Yes | No | Yes | Yes | Yes |
| Firm FE | No | No | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes |
| Constant | 0.050*** | No | 0.035* | 0.085 | 0.057*** | 0.066 | 0.042 | 0.071 | -0.112 | 0.058** | - | - |
| $R$-squared | 0.063 | 0.114 | 0.119 | 0.009 | 0.158 | 0.050 | 0.205 | 0.212 | 0.026 | 0.100 | - | - |
| atanhrho_12 | - | - | - | - | - | - | - | - | - | - | - | -0.372*** |

Notes: For the Probability of Default and Cost of Debt, columns report OLS, Industry Fixed Effects, Industry + Year Fixed Effects, Firm Fixed Effects, and IV-2SLS specifications. For the Credit Model Score, results are estimated using Ordered Probit and IV-Ordered Probit via the CMP. Significance levels: ***, $p < 0.01$; **, $p < 0.05$; *, $p < 0.10$.

CMP, conditional mixed-process; OLS, ordinary least squares; FE, fixed-effects; IV-2SLS, instrumental-variable two-stage least squares; Ln, natural logarithm.

**TABLE 3-A2:** Impact of Governance Disclosure and control variables on credit risk.

| Variables | Panel A: Probability of default | | | | | Panel B: Cost of debt | | | | | Panel C: Credit model score | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OLS | OLS | OLS | FE | IV-2SLS | OLS | OLS | OLS | FE | IV-2SLS | Ordered probit | CMP-Ordered probit |
| G disclosure | -0.033** | -0.027* | -0.027** | 0.016 | -0.031* | -0.033 | -0.037 | -0.037 | 0.005 | -0.025 | 0.185 | -0.280 |
| Return on assets | -0.052*** | -0.042** | -0.046*** | -0.018 | -0.045*** | -0.051 | -0.003 | -0.001 | 0.008 | 0.058 | 2.191*** | 2.373*** |
| Dividend payout | -0.003 | -0.002 | -0.002 | -0.002* | -0.003 | 0.002 | -0.007 | -0.008 | 0.001 | 0.002 | -0.093** | -0.065 |
| Leverage | 0.011 | 0.019 | 0.018 | 0.022 | 0.013 | 0.005 | 0.037 | 0.037 | -0.084** | -0.039 | -0.928*** | -1.451*** |
| Ln (Size) | -0.000 | -0.000 | -0.000 | 0.000 | -0.000 | 0.002 | 0.003 | 0.003 | 0.000 | 0.002** | 0.032 | 0.059*** |
| Ln (Age) | -0.001 | -0.005 | -0.004 | -0.016 | 0.001 | 0.003 | 0.005 | 0.004 | 0.055 | 0.002 | 0.197** | -0.007 |
| Industry FE | Yes | 0.019*** | Yes | No | Yes | No | Yes | Yes | No | Yes | Yes | Yes |
| Year FE | No | Yes | Yes | No | Yes | No | No | Yes | No | Yes | Yes | Yes |
| Firm FE | No | No | No | Yes | Yes | No | No | No | Yes | Yes | Yes | Yes |
| Constant | 0.070*** | 0.066*** | 0.060*** | 0.074 | 0.057*** | 0.084* | 0.065 | 0.091 | -0.115 | 0.083*** | - | - |
| $R$-squared | 0.061 | 0.121 | 0.132 | 0.010 | 0.158 | 0.069 | 0.224 | 0.230 | 0.027 | 0.139 | - | - |
| atanhrho_12 | - | - | - | - | - | - | - | - | - | - | - | 0.300*** |

Notes: For the Probability of Default and Cost of Debt, columns report OLS, Industry Fixed Effects, Industry + Year Fixed Effects, Firm Fixed Effects, and IV-2SLS specifications. For the Credit Model Score, results are estimated using Ordered Probit and IV-Ordered Probit via the CMP. Significance levels: ***, $p < 0.01$; **, $p < 0.05$; *, $p < 0.10$.

CMP, conditional mixed-process; OLS, ordinary least squares; FE, fixed-effects; IV-2SLS, instrumental-variable two-stage least squares; Ln, natural logarithm.

# Appendix 3

**TABLE 1-A3:** Factor loadings and uniqueness.

| Variable | Panel B: Factor loadings and uniqueness | |
|---|---|---|
| | Factor 1 loading | Uniqueness |
| Probability of default | -0.3874 | 0.8500 |
| Cost of debt | 0.1127 | 0.9873 |
| CMS | 0.3961 | 0.8431 |

CMS, credit model scores.

**TABLE 2-A3:** Factor structure of credit risk measures.

| Factor | Panel A: Eigenvalues and variance | | | |
|---|---|---|---|---|
| | Eigenvalue | Difference | Proportion (%) | Cumulative (%) |
| Factor 1 | 0.31966 | 0.32635 | 2.52 | 2.52 |
| Factor 2 | -0.00669 | 0.17925 | -0.05 | 2.46 |
| Factor 3 | -0.18594 | - | -1.46 | 1.00 |