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Climate change risk-related engagement and credit risk in the South African banking system

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Abstract

This paper investigates the relationship between climate and environmental (C&E) engagement and credit risk in the South African banking sector over the period 2008–2023. Although climate-related risks are increasingly recognised as a material threat to financial stability, empirical evidence, especially in emerging markets, remains limited. South Africa presents a unique environment, characterised by high exposure to physical and transition climate risks, and associated with a soft-law, principles-based disclosure regime. Using this setting, we develop a novel text-based indicator of C&E engagement by analysing the C&E-related content of over 600 investor reports from domestic South African banks. Our empirical strategy combines fixed-effects panel regressions, instrumental variable estimation and Heckman selection models to assess the association between C&E engagement and credit portfolio quality, proxied by the non-performing loan (NPL) ratio and NPL growth. Results consistently indicate that banks with higher C&E engagement experience significantly lower impaired loan ratios, even after controlling for endogeneity. These findings suggest that, in an environment characterised by soft mandatory requirements, voluntary environmental disclosure serves as a credible signal of cautious risk management practices and contributes to enhanced credit quality.

JEL classification

G21, G28, Q01, Q51, Q54

Keywords

Climate and environmental (C&E) engagement, C&E risk, credit quality, non-performing loans, text mining, sustainability

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1. Introduction

Climate and environmental (C&E) issues are emerging as critical dimensions of financial and economic stability. As the effects of climate change intensify and global efforts to decarbonise accelerate, many economic actors face growing exposure to both physical and transition risks. Physical risks stem from the direct consequences of environmental events such as droughts, floods and hurricanes on economic assets and infrastructure, while transition risks emerge from policy, legal, technological and market changes related to the green transition (Task Force on Climate-related Financial Disclosures (TCFD) 2017). The inability to fully consider these risks can jeopardise the operations of firms in a broad range of sectors, especially sectors most reliant on carbons, and generate huge losses in the entire economy. However, preparing for the transition to a low-carbon society requires firms to make significant investments (McCollum et al. 2013), which, in most cases, depend on external financing – primarily through bank loans (Campiglio 2016). Moreover, banks are the only economic agents capable of creating new credit (Disyatat 2011), thus influencing the functioning of economic systems. Consequently, by providing credit to low-polluting firms, banks can play a key role in facilitating the green transition. It is therefore important to understand whether and how banks consider C&E issues in their lending strategies, because overlooking these risks can compromise borrowers' risk profile (Huang et al. 2022), amplifying credit losses. Banks incorporating C&E risks in their strategic orientation should see an improvement in their performance and financial stability (Chiaramonte et al. 2022).

When examining how banks incorporate C&E issues in their risk management practices, however, empirical challenges arise, not only due to their internal nature, but also because researchers can only infer them from investor reports. The issue is that, in typical *comply-or-explain* environments, these reports only contain the necessary amount of information to be compliant (Asplund 2020). This raises concerns about whether the reporting activity is just a box-ticking exercise or a reflection of banks' genuine engagement with C&E issues. However, there are contexts, such as South Africa (SA), where disclosure requirements are largely principles-based rather than strictly imposed by the regulator (Ramalho 2020). In these settings, a higher amount of disclosure may, in fact, reflect a more proactive approach to sustainability, thus

signalling a deeper internalisation of C&E issues within the organisation (Clarkson et al. 2008).

By using SA's soft regulation approach to disclosure requirements, this paper develops a novel text-based indicator of banks' C&E engagement that goes beyond the classic scores produced by external providers and is thus also applicable to non-listed institutions. Using this new indicator, our research aims to explore the relationship between C&E engagement and the credit portfolio quality of South African banks.

To investigate this relationship, we analyse a sample of South African banks, covering the period from 2008 to 2023. Bank-specific, accounting-based data were obtained from the BA900 economic returns[1] filed by banks, which are publicly accessible via the South African Reserve Bank (SARB) website. To assess C&E engagement in South African banks, we develop an indicator using a bag-of-words approach, a commonly used method in the literature to quantify corporate disclosures (Loughran and McDonald 2016), applied to banks' investor reports. We then run a series of panel regressions using our text-based measure as the main explanatory variable to assess the relationship between C&E engagement and credit portfolio quality, proxied by the non-performing loan (NPL) ratio and NPL growth.

Our results reveal a significant negative relationship between C&E engagement and credit portfolio quality: banks with higher C&E engagement exhibit credit portfolios of better quality. This relationship holds when we adjust the dependent variable definition and apply alternative econometric strategies to account for endogeneity issues, including an instrumental variable regression and a Heckman selection model.

SA provides an ideal setting to study the relationship between banks' C&E engagement and credit risk for three main reasons. First, the country faces significant climate risks, both from transition pressures, given its heavy reliance on carbon-

[1] Accounting-based data from the BA900 economic returns are available from 2008. Since we use independent variables lagged by four quarters (i.e. one year) in our analysis, to avoid losing an entire year of observations we collect banks' annual reports from 2007. In the remainder of the paper, we will use 2007 as the starting year when referring to the textual analysis of annual reports, and 2008 as the starting year when referring to the econometric analysis.

intensive sectors, and from physical risks such as droughts, floods and storms (Regelink 2022). Second, despite being an emerging market, SA has a highly developed banking sector, with sophisticated institutions that dominate the national financial landscape (Simbanegavi, Greenberg and Gwatidzo 2015). This combination of emerging market conditions and mature banking practices offers a unique context to analyse the integration of C&E considerations into the decision-making process of financial institutions. Third, SA has adopted a principles-based and voluntary approach to C&E disclosure. This contrasts with the more prescriptive regulatory approaches of regions such as the European Union (EU), allowing for the study of whether soft-law mechanisms can effectively promote the consideration of C&E issues within banks' risk management practices.

This paper addresses a gap at the intersection of climate risk, voluntary disclosure and financial stability in emerging markets by making three key contributions. First, we introduce a novel text-based indicator of C&E engagement. This approach allows us to address the traditional limitations of prior studies, which rely exclusively on scores from external providers and are subject to issues of limited coverage and inter-rater agreement (Berg, Kölbel and Rigobon 2022). Our broader coverage of both listed and unlisted entities offers a more comprehensive and accurate depiction of C&E engagement within the banking sector in an emerging economy.

Second, while a growing body of research has examined how mandatory environmental regulations influence lending behaviour and credit risk in advanced economies (e.g. Delis et al. 2023; Gambacorta et al. 2023), little is known about whether, and how, banks' engagement with C&E issues affects objective financial outcomes such as asset quality, particularly in emerging markets. Our results show that voluntary C&E engagement can translate into tangible improvements in credit risk management even in emerging markets, where environmental challenges are more pressing and regulatory frameworks remain subject to significant and ongoing changes (Haji, Coram and Troshani 2022).

Third, we contribute to the literature on the relationship between disclosure quality and financial performance (Tsang, Frost and Cao 2023). Specifically, we highlight the signalling value of voluntary C&E engagement in a soft-law regulatory environment,

showing that such engagement can credibly indicate stronger risk management practices and contribute to improved credit portfolio quality.

The remainder of the paper is organised as follows: section 2 introduces the institutional settings of the research, section 3 presents the literature review and research hypothesis, section 4 describes the data and methodology, section 5 presents the results and section 6 concludes.

2. Institutional framework

In SA, the corporate disclosure landscape has undergone a profound transformation over the past three decades, largely driven by the successive iterations of the King Reports on Corporate Governance (King Report, hereafter). These reports have been developed by the King Committee on Corporate Governance, chaired initially by former Supreme Court Judge Mervyn King. The King Report was first published in 1994 (King I Report) and then updated three times before the fourth version (King IV Report) was issued in 2016.

Unlike traditional prescriptive regulatory frameworks, the King Reports are a series of principles-based guidelines designed to promote sound governance structures, ethical leadership, stakeholder inclusivity and sustainable value creation across organisations. Their influence extends across both listed and unlisted companies, embedding within South Africa's corporate culture the expectation that firms voluntarily uphold high standards of transparency and accountability (Natesan 2020). In contrast to mandatory corporate governance frameworks such as the EU's 2014 Non-Financial Reporting Directive, the King Report adopts a non-legislative approach and is based on principles and recommended practices (Ramalho 2020). The philosophy guiding the King Report is based on three fundamental pillars: leadership, sustainability and responsible corporate citizenship. It conceptualises sound governance as being rooted in effective and ethical leadership. According to the King Committee, corporate leaders must guide their organisations towards achieving sustainable outcomes across economic, social and environmental dimensions. Sustainability, within this framework, is regarded as one of the cornerstones of firms' activities. Furthermore, the notion of corporate citizenship derives from a company's status as a juristic person under the

South African Constitution, thereby obligating it to operate in a socially and environmentally responsible manner.

The most recent version, the King IV Report, introduces a significant shift from previous approaches by adopting an ‘apply and explain’ regime (Asplund 2020). This marks a move away from the earlier ‘comply or explain’ (King I and II Reports) and ‘apply or explain’ (King III Report) frameworks. The aim was to encourage organisations not just to declare whether they adhere to governance principles but to demonstrate how they apply them in practice, particularly in relation to stakeholder engagement, ethical leadership and sustainability. More importantly, the King IV Report emphasises outcome-based governance, including achieving an ethical culture, good performance, effective control and legitimacy. Under the ‘apply and explain’ approach, disclosure is not merely about compliance but is viewed as a tool for transparency and accountability. Organisations are expected to explain their governance practices in narrative form, addressing which principles and practices have been implemented and how these contribute to the intended outcomes. This model encourages meaningful stakeholder dialogue and a departure from tick-box compliance (Rossouw 2020).

The evolution of SA’s corporate disclosure framework closely aligns with international trends in integrated reporting and sustainable finance, reinforcing the significance of environmental engagement within corporate governance. In this setting, banks operating in SA, regardless of their listing status, are encouraged to comply with the King IV Report to improve their transparency in terms of social and environmental responsibility. Additionally, banks listed on the Johannesburg Stock Exchange (JSE) are obligated in terms of the JSE Listing Requirements to report annually, following the ‘apply and explain’ approach, the extent to which they have complied with the King IV Report principles. Moreover, in 2021, the JSE issued its Sustainability Disclosure Guidance and Climate Disclosure Guidance to inform listed companies about best practice in environmental, social and governance (ESG) and climate disclosures and help them navigate the dynamic environment of global reporting standards. Thus, the King Reports have not only shaped corporate governance norms but also laid the foundation for a voluntary yet powerful disclosure regime that serves as the basis for our analysis of banks’ C&E engagement in SA.

There is strong momentum within the entire banking sector to incorporate sustainability practices. For example, the Banking Association South Africa introduced voluntary Principles for Managing Environmental and Social Risks in 2015, to which many of its members signed up. The country's leading financial institutions also participate in various international initiatives including the United Nations Environment Programme Finance Initiative (UNEP FI) on reporting in line with the Financial Stability Board (FSB) and the Task Force on Climate-related Financial Disclosure (TCFD) recommendations on climate risk disclosure. Moreover, in early August 2023, the SARB Prudential Authority released draft guidance for banks on integrating climate-related risks into their governance and risk management frameworks, including guidance on banks' internal capital adequacy assessment process.

Therefore, although there are currently no legislative obligations in SA requiring organisations to disclose C&E information, the country's unique context has fostered a natural focus on these issues. Consequently, all organisations, both listed and unlisted, are encouraged to enhance their transparency around C&E-related matters. This proactive approach aims to raise public awareness about the environmental impacts of business operations and aligns with international trends towards greater corporate accountability in sustainability. As such, banks in SA are expected not only to consider environmental factors in their risk assessments but to disclose these considerations as part of their broader strategy narratives.

3. Literature review and research hypothesis

Banks have become central players in supporting a smooth transition to a more environmentally responsible society as they can finance projects that reduce human impacts on the planet (Aslan et al. 2022; Reghezza et al. 2022). This trend is reinforced by the demands of stakeholders and investors that banks become more responsible in their lending practices to avoid financing more polluting sectors (Richardson 2009; Kölbel et al. 2020).

However, the integration of environmental responsibility strategies into banking operations should not be viewed solely as a means of fulfilling social expectations of corporate responsibility, but also as a potential driver of positive business performance and long-term value creation (Azmi et al. 2021; Caby, Ziane and Lamarque 2022).

Empirical studies have shown that banks more exposed to green firms tend to show lower levels of credit risk (Galletta and Mazzù 2023; Birindelli et al. 2022), because those firms are typically less exposed to C&E-related losses (Li 2025). Conversely, although banks can compensate for environmental risks by charging higher interest rates on loans to brown firms (Delis et al. 2023; Degryse et al. 2023), the lack of standardised risk assessment frameworks may lead to inconsistent practices and systemic vulnerabilities (Chiaramonte et al. 2022; Ehlers, Packer and de Greiff 2022).

Beyond firm-level effects, climate risk is increasingly seen as a systemic threat to financial stability (Basel Committee on Banking Supervision 2021). The literature suggests that without robust climate risk management, banks may accumulate exposures that can exacerbate financial fragility during extreme weather events or regulatory changes (Dafermos, Nikolaidi and Galanis 2018; Liu et al. 2024). Therefore, the only suitable way to correctly manage C&E risk is to develop an integrated climate risk assessment system, aligning lending with sustainability goals (Furrer, Hamprecht and Hoffmann 2012). This requires important investments and organisational changes. Only truly C&E-engaged banks would be willing to incur such costs, making the signal more credible and allowing stakeholders to differentiate between genuinely committed banks (Spence 1978). These *responsible* banks are more likely to avoid exposure to environmentally risky sectors and incorporate transition and physical risks into their credit-screening processes. They would build credit portfolios with firms that are better aligned with sustainable practices, which are less volatile and more resilient, especially in the face of climate-related shocks (Li 2025). Banks that genuinely engage in C&E practices would tend to internalise C&E risks into credit assessments. Consequently, voluntary C&E engagement could serve as an informative signal of superior risk management quality, even in the absence of regulatory disclosure obligations.

While there is a growing literature on how mandatory regulations affect the lending decisions and credit quality of banks in developed countries (e.g. Delis et al. 2023; Gambacorta et al. 2023), little is known about whether and how banks' voluntary C&E engagement correlates with objective financial outcomes such as credit portfolio quality, particularly in emerging markets like SA, which grapple with issues like energy transition, water scarcity and climate vulnerability (Regelink 2022). As a result, the literature has not yet addressed whether banks operating under voluntary sustainability

frameworks are able to credibly signal environmental responsibility and whether such engagement translates into improved credit portfolio quality. In fact, although voluntary initiatives can promote corporate sustainability practices (Asplund 2020; Ramalho 2020), they may result in diverse disclosure quality and create challenges in distinguishing genuine engagement from greenwashing (Berg, Kölbel and Rigobon 2022). This study aims to fill this gap by exploring whether environmental engagement under a hybrid soft-law framework, as opposed to a *hard regulation approach* as in the EU, is associated with better credit outcomes, thus testing the signalling value of voluntary C&E disclosure practices in the South African banking sector. Thus, we formulate the following hypothesis:

H1: *Banks showing a higher C&E engagement have a higher credit portfolio quality.*

4. Data and methodology

4.1 Text mining of South African banks' reports

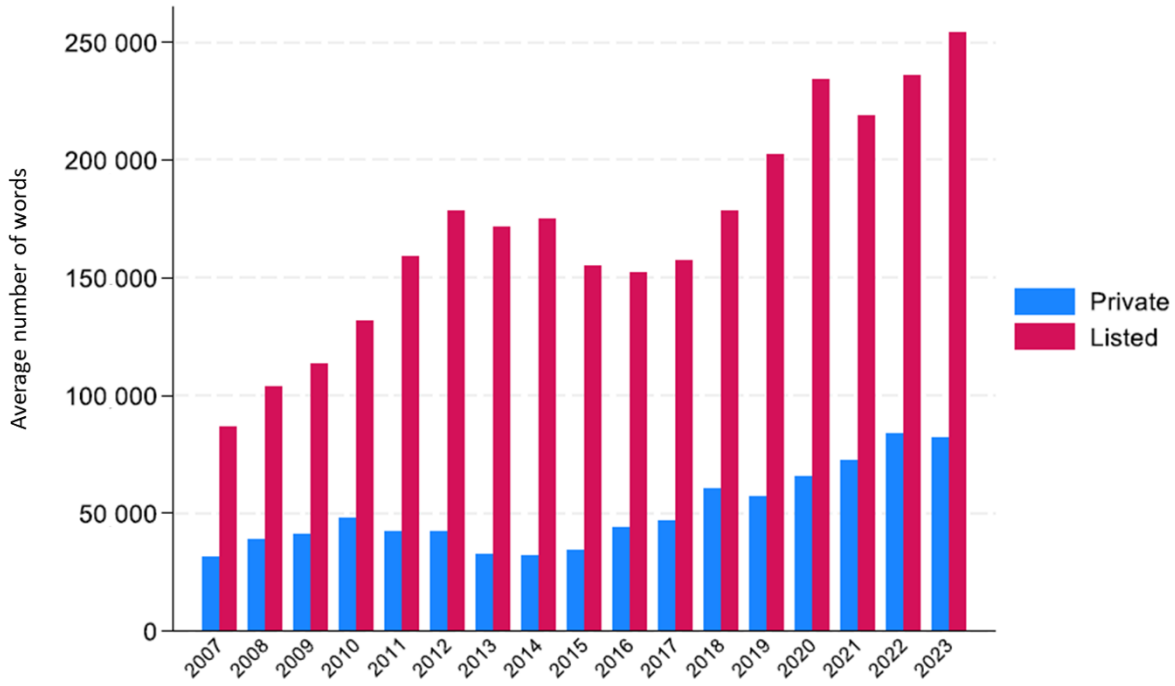
We create a measure of banks' engagement in C&E issues using a comprehensive text-mining approach. Specifically, we construct a proxy from the annual reporting suite of the banking groups in our sample.[2] Investor reports are chosen as the foundation for this proxy because banks use these documents to communicate their commitment to serving the interests of a broad range of stakeholders (Giner, Allini and Zampella 2020; Jizi et al. 2014). To build the dataset, we retrieve from corporate websites the reports published by the banks in our sample in the period 2007–2023. Our sample includes 213 annual reports, 148 integrated reports and 51 sustainability reports. It also includes 235 shorter, more specialised reports that banks use to disclose their sustainability efforts, such as TCFD reports and Principles for Responsible Banking reports. In total, we analyse 647 documents.

Figure 1 shows a steady increase in the average word count of corporate disclosures by both listed and private firms in SA from 2007 to 2023, with listed firms consistently disclosing more. This trend aligns with the evolution of SA's corporate governance

[2] We collect reports at the parent level when subsidiary reporting is not available. This approach is effective because banks typically prepare reports at the parent level, offering comprehensive insights into the activities of the entire banking group (Giannetti et al. 2023).

frameworks, particularly the shift from the King III Report (2009) to King IV Report (2016). The King IV Report introduced the 'apply and explain' approach, which moved beyond compliance to encourage meaningful narrative reporting. This likely contributed to the rise in disclosure volume, as organisations were required to articulate how governance principles were implemented, especially around ethics, sustainability and stakeholder engagement. Listed firms, which must incorporate JSE requirements, have been more responsive to these frameworks, reflecting increased regulatory attention and pressure from investors.

Figure 1: Average number of words in investor reports per year



To capture the C&E narratives specific to South African banks we employ a *bag-of-words* approach, a method commonly used in the accounting literature to measure the amount of disclosure in corporate reports (Loughran and McDonald 2016). This approach involves calculating the frequency of words from a predefined word list, often referred to as a *dictionary*, within the text of annual reports. By quantifying these occurrences, the method provides insights into the emphasis placed on specific themes or topics, enabling a systematic analysis of the content and focus areas highlighted in the reports. We developed a customised dictionary to capture C&E-related disclosures in banks' investor reports. Our word list builds on the specialised dictionary created by Giannetti et al. (2023) for European banks and is enriched with

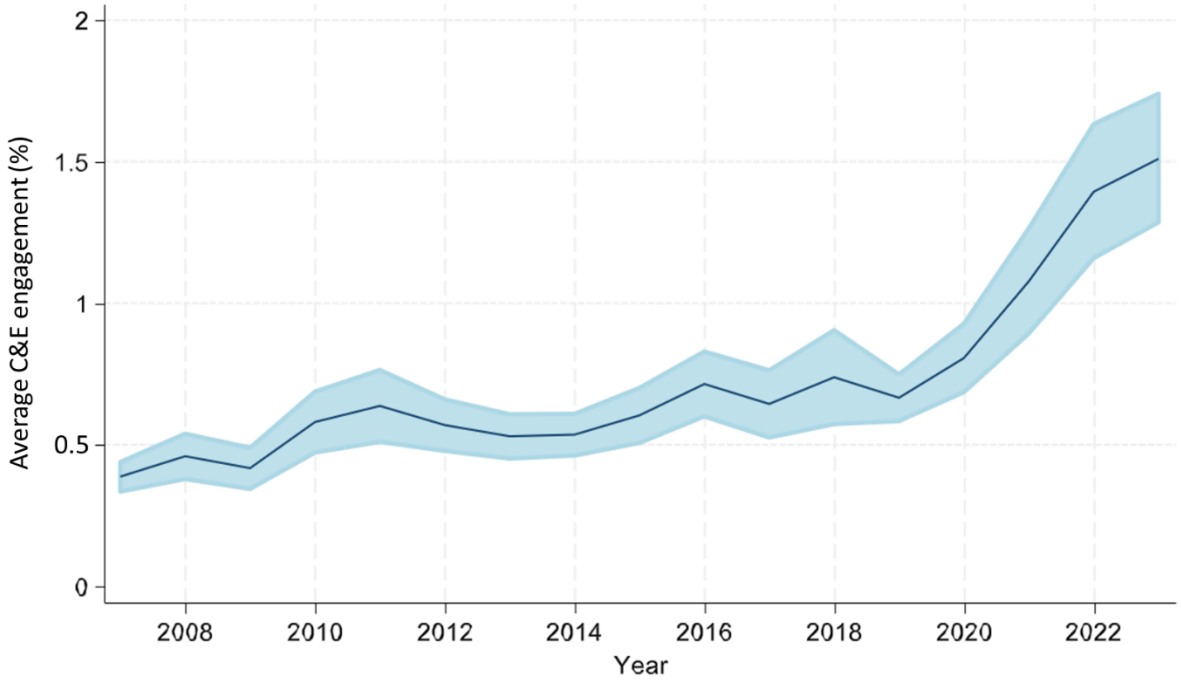
terms from two additional dictionaries by Abraham, Olbert and Vasvari (2024) and De Amicis and Falconieri (2024), both designed to capture corporate environmental disclosures. The resulting augmented word list includes a wide range of terms and phrases reflecting banks' environmental strategies and commitments, such as 'carbon', 'emission intensity' and 'circular economy'. To ensure the dictionary's relevance to our context, we also incorporated terms specific to the South African setting. These additions include key concepts like 'Just Energy Transition Investment' and 'African Natural Capital Alliance', which reflect the environmental priorities and frameworks in the region. The final dictionary is a comprehensive collection of 353 C&E-related terms, designed to capture the scope of banks' C&E disclosures. The complete list of terms is provided in Table A in the annexure.

We used this customised dictionary to analyse the content of the annual reports included in our sample. To prepare the reports for analysis, we converted all documents from .pdf format to .txt files. For each bank-year pair, we merged the corresponding report files into a single document, ensuring that each bank-year pair was represented as a unique observation in our dataset. Next, we applied a series of standard preprocessing steps to the text, following best practices outlined by Hickman et al. (2022). These steps included tokenisation (breaking down each text into individual and lowercased tokens); stemming (reducing words to their root forms to standardise variations); and stopword removal (excluding common non-informative words such as 'and' and 'the' to focus on meaningful terms). Once the text preprocessing was complete, we applied keyword matching to the processed corpus, identifying all occurrences of terms present in our customised dictionary. The relative frequency of these dictionary terms – calculated as the ratio of keyword occurrences to the total word count in each document – serves as our proxy for a given bank's C&E engagement in a particular year. This approach aligns with the methodology used in the literature (Abraham, Olbert and Vasvari 2024; Giannetti et al. 2023), allowing us to systematically quantify the emphasis banks place on C&E issues in their annual disclosures. Our empirical strategy rests on the assumption that in a context characterised by a soft regulation approach, where disclosure on specific topics is not mandated, an increased level of disclosure may, in fact, indicate a more proactive stance towards sustainability, thereby signalling a deeper integration of C&E issues within the organisation (Al-Tuwaijri et al. 2004; Clarkson et al. 2008). Therefore, in our

empirical setting, C&E engagement refers to a level of disclosure that goes beyond what is required by regulation. It reflects a voluntary, proactive commitment by banks to communicate their sustainability strategies, risks and performance in greater depth. This notion is particularly relevant in the South African context, where the regulatory approach to corporate disclosure is largely principles-based and non-prescriptive. The prevailing *apply-and-explain* philosophy, as outlined in the King Reports on Corporate Governance, encourages companies to adopt flexible, outcome-based reporting practices rather than adhere to fixed disclosure templates. As such, engagement captures the discretionary dimension of environmental transparency that can signal a bank's integration of C&E concerns beyond compliance (Kolk 2016).

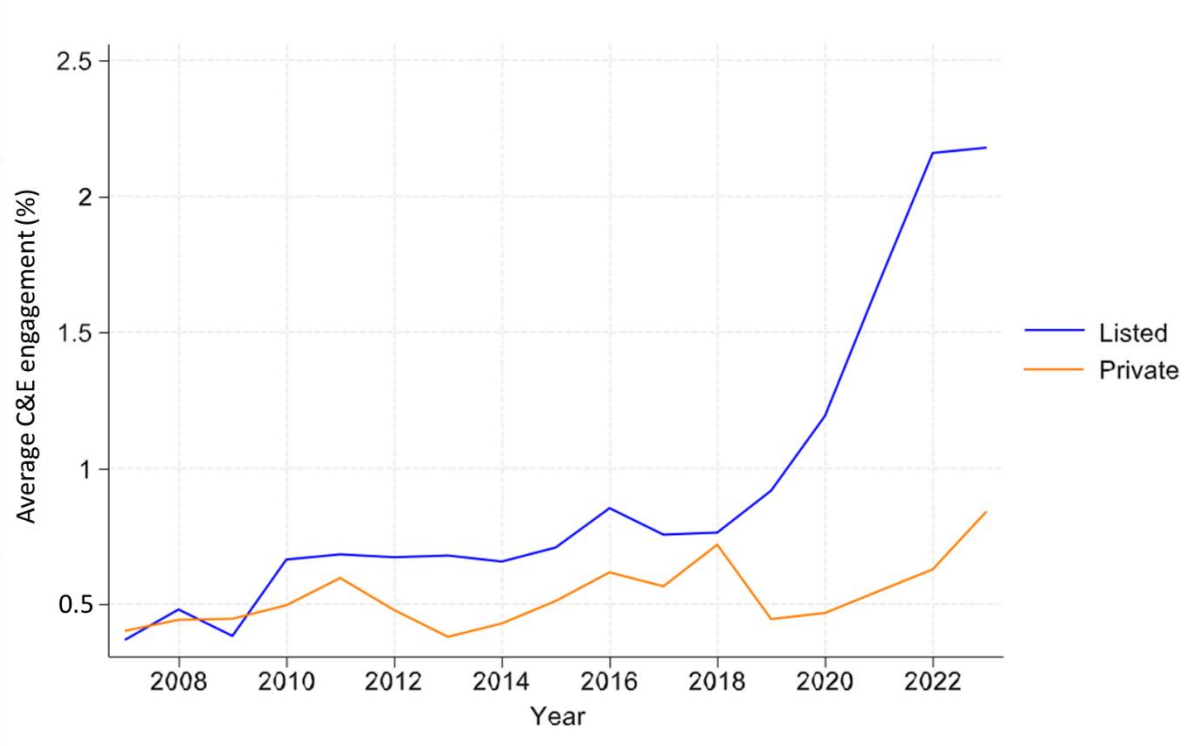
Figure 2 presents the change in average C&E engagement among banks over the observation period. The data indicate a clear upward trend, with engagement levels steadily increasing over time. In the early years of the sample, average C&E engagement remained relatively low, fluctuating around 0.4%. From 2020 onwards, the increase becomes more pronounced, with an appreciable acceleration leading to an average engagement level exceeding 1.6% by 2023. The widening shaded area suggests growing variability among banks, indicating that while some institutions are rapidly enhancing their environmental engagement, others are progressing at a slower pace. This suggests a growing emphasis on sustainability in the South African banking sector, potentially influenced by regulatory, social or market-driven factors (Cohen, Kadach and Ormazabal 2023; Krueger et al. 2024).

Figure 2: Average C&E engagement over time (in %)



To validate our measure of C&E engagement, we conduct univariate and multivariate tests. First, we compare our measure of engagement between listed and private banks in our sample. Figure 3 presents the change in average engagement for both listed and private banks over the observation period. The data reveal an appreciable difference between the two groups, with listed banks showing a significantly stronger upward trajectory. In the earlier years of the sample, both listed and private banks exhibited relatively low and comparable levels of engagement, fluctuating around 0.4% to 0.5%. However, from about 2010, listed banks experienced a steady increase, followed by a sharp acceleration from 2016, the year of the introduction of the King IV Report, reaching an average awareness level of over 2.2% by 2023. In contrast, private banks displayed more variability. By 2023, they had reached an awareness level of around 1%, still lagging behind their listed counterparts. This trend suggests that listed banks – likely due to greater public scrutiny and regulatory pressures (Abraham, Olbert and Vasvari 2024; Cohen, Kadach and Ormazabal 2023) – have been more active in integrating environmental considerations, while private banks are progressing at a slower pace.

Figure 3: Comparison of average C&E engagement over time (in %) between listed and private banks



As an additional validation test, we examine the correlation between our measure of engagement and ESG ratings. As documented in prior studies (Basu et al. 2022; Christensen, Serafeim and Sikochi 2022), we expect a positive association between firms' sustainability disclosure and environmental ratings. Figure 4 presents the relationship between our measure of C&E engagement and two widely used ESG-related indicators:[3] the Bloomberg Environmental Disclosure Score[4] (Panel A) and the Refinitiv Emissions Score[5] (Panel B). Both indicators capture the extent and quality of a company's environmental disclosures, similar to our constructed measure. The

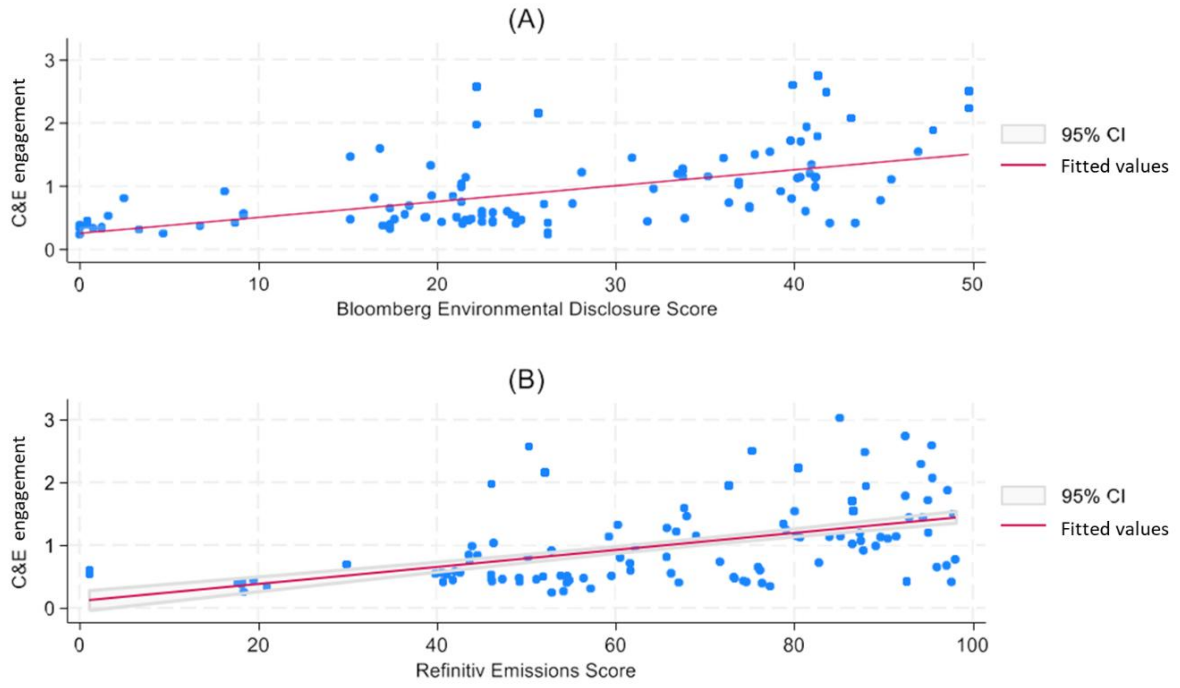
[3] Given that both Bloomberg and Refinitiv only produce these scores for listed firms, we only consider the listed banks in our sample to conduct this validation test.

[4] The Bloomberg Environmental Disclosure Score is a proprietary metric developed by Bloomberg that evaluates the extent of a company's environmental disclosure. It is based on publicly available information and reflects the quantity and quality of environmental data reported rather than performance or impact. Scores range from 0.1 to 100, with higher values indicating more comprehensive disclosure.

[5] The Refinitiv Emissions Score is a component of Refinitiv's ESG framework that assesses a company's performance in managing and disclosing greenhouse gas emissions. This score specifically evaluates a company's commitment to and effectiveness in reducing environmental emissions from production and operations. The score ranges from 0 to 100, with higher values indicating stronger emissions-related disclosure and management practices.

scatter plots illustrate a positive correlation in both cases, as indicated by the fitted regression lines. While the strength of the association appears moderate, the positive slope suggests that banks showing greater environmental engagement tend to show higher ESG-related scores. Overall, these results provide further support for the validity of our engagement measure by demonstrating its alignment with established disclosure-based ESG metrics.

Figure 4: Correlation between C&E engagement and Bloomberg Environmental Disclosure Score (Panel A) and Refinitiv Emissions Score (Panel B)



Additionally, we conduct two multivariate tests to further confirm the reliability of our engagement measures. First, we conduct a multivariate analysis in which our C&E engagement measure serves as the dependent variable. Specifically, we regress this measure on various indicators of voluntary disclosure adoption, as well as external ESG-related scores. Given that prior research suggests a positive association between voluntary sustainability disclosures and firms' reputations for environmental responsibility (Basu et al. 2022; Christensen, Serafeim and Sikochi 2022; Giannetti et al. 2023), we expect to observe a positive relationship between these explanatory variables and environmental engagement. This analysis allows us to assess whether banks that actively engage in voluntary sustainability reporting and receive higher ESG evaluations also demonstrate greater engagement in sustainability issues.

The results of this regression analysis are presented in Table 1. Columns 1–2 present the results for the whole sample, while columns 3–5 show the results for the subsample of listed firms, given that the independent variables are not available for private banks. Column 1 shows that listed banks (LISTED) exhibit significantly higher levels of C&E engagement than private banks, with a coefficient of 1.339 ($p < 0.01$), suggesting that public banks face greater incentives or pressures to increase transparency on environmental matters. In column 2, the inclusion of an integrated reporting (IR) indicator reinforces this association, indicating that banks adopting integrated reporting frameworks tend to demonstrate greater engagement. Columns 3–4 introduce the Bloomberg Environmental Disclosure Score (BLOOMBERG) and the Refinitiv Emissions Score (EMISSIONS_SCORE), which are positively and significantly associated with C&E engagement, validating that firms with greater disclosure levels are more environmentally engaged. Finally, column 5 adds a dummy variable for signatory banks to the Equator Principles – a voluntary framework for responsible project financing. The Equator Principles are also positively associated with C&E engagement (0.101, $p < 0.05$), suggesting that banks adhering to this initiative are more committed to sustainability considerations. Across all specifications, this relationship is robust to the addition of time and bank fixed effects and bank-level control variables. The control variables incorporated into the analysis capture key characteristics of the banks, such as size and leverage, ensuring that the observed correlation is not influenced by these factors.

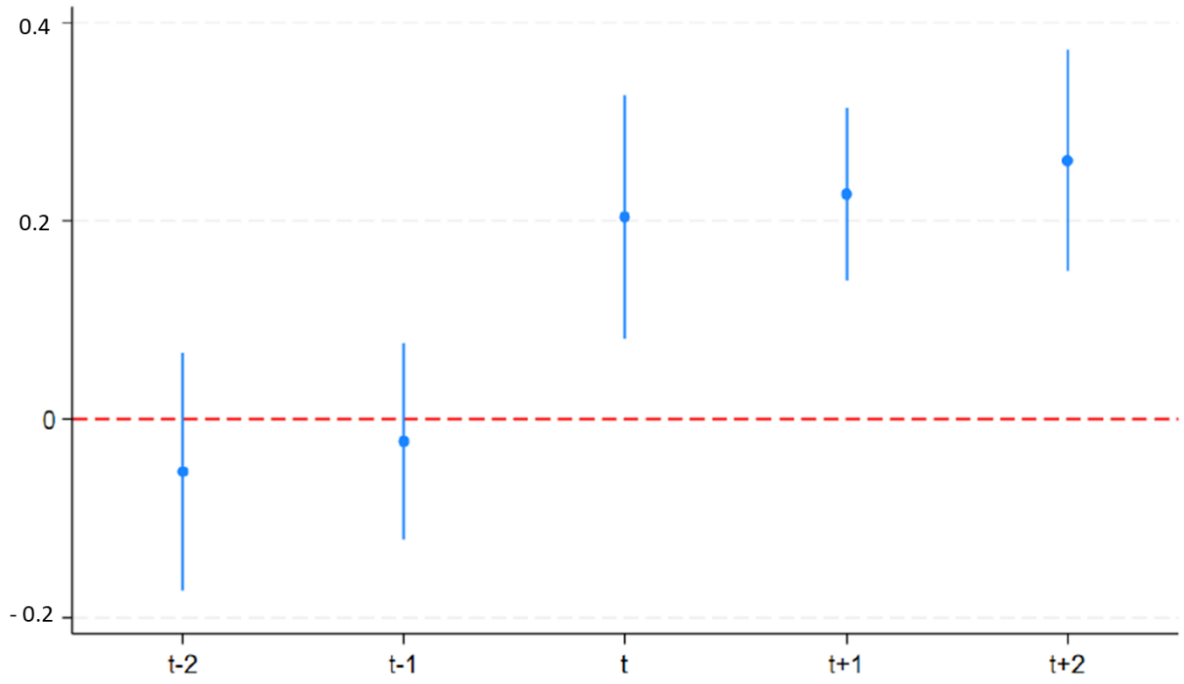
Table 1: Validation tests

	(1)	(2)	(3)	(4)	(5)
	Engagement	Engagement	Engagement	Engagement	Engagement
LISTED	1.339***				
	(0.217)				
IR		0.157***			
		(0.0377)			
BLOOMBERG			0.00675***		
			(0.00207)		
EMISSIONS_SCORE				0.00390***	
				(0.000798)	
EQUATOR					0.101**
					(0.0435)
Bank controls	Yes	Yes	Yes	Yes	Yes
CONSTANT	1.718***	2.051***	3.443***	6.392***	6.615***
	(0.570)	(0.569)	(0.991)	(2.050)	(2.086)
Time FE	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes
R-squared	0.655	0.659	0.856	0.875	0.870
N	894	894	390	388	384

Note: The table reports the results of analyses of the relation between banks' environmental engagement and environmental efforts. Across all specifications, the dependent variable is C&E engagement. Ordinary least squares (OLS) regressions are used to estimate the models with robust standard errors. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

Lastly, Figure 5 presents the results of a regression analysis in which we include dummy variables indicating the number of years relative to a bank's adoption of the Equator Principles, where *t* is the adoption year. The graph shows the coefficients of the dummy variables for years relative to the adoption year: the y-axis shows the coefficient estimates and their 95% confidence intervals. The coefficients for the years preceding adoption are close to zero and statistically insignificant, suggesting no discernible trend in C&E engagement before signing. However, starting from the adoption year, the coefficients become positive and increase over time, with significant effects observed in the years following adoption. This pattern suggests that banks exhibit a stronger commitment to considering C&E issues in the period after their formal alignment with the Equator Principles.

Figure 5: C&E engagement around Equator Principles signing



Note: This figure shows coefficient estimates from a regression of banks' engagement on relative event years indicating the number of years relative to a bank's adoption of the Equator Principles. The y-axis shows coefficient estimates and their 95% confidence intervals.

Taken together, these findings provide strong evidence that our measure effectively captures the C&E engagement of banks in our sample. The positive and significant relationships between our measure and voluntary disclosure practices, ESG ratings and the adoption of sustainability frameworks confirm its validity as an indicator of banks' engagement with environmental concerns.

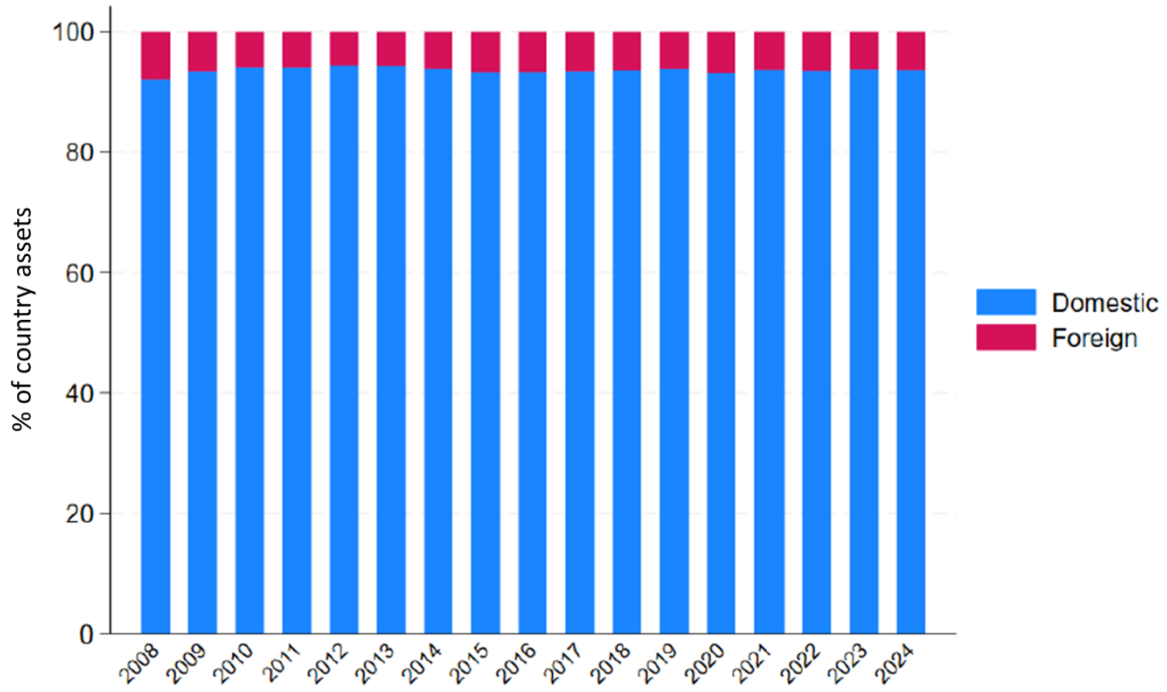
4.2 Banks' balance sheet data

This study examines the influence of banks' C&E engagement on the quality of their credit portfolios by analysing data from all registered domestic banks operating in SA. We collect bank-specific, accounting-based data from the BA900 economic returns filed by banks, which are publicly accessible on the SARB website. These balance sheet data cover the period from 2008 to 2023. The initial sample is composed of all 43 banks operating in SA, both domestic and foreign-owned.[6] From this sample we discard all foreign-owned banks for two reasons. First, given that foreign-owned banks

[6] Foreign banks in SA include foreign-controlled banks, branches of foreign banks and representative offices, while domestic banks include locally controlled banks and mutual banks.

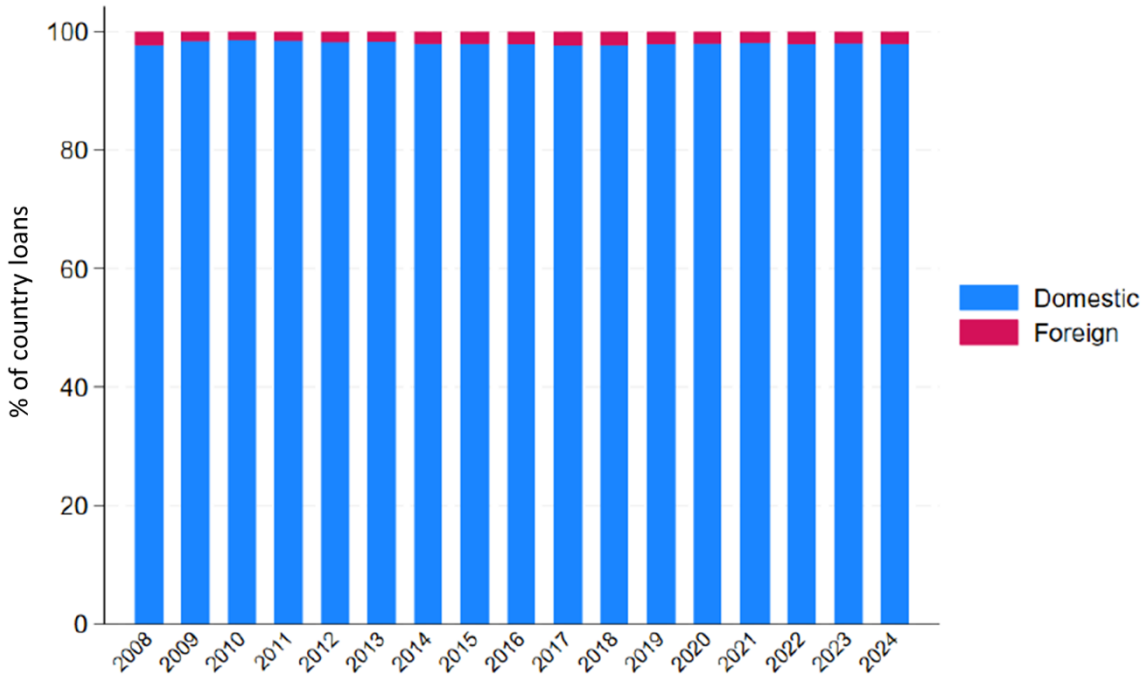
have headquarters in different countries where a hard regulation approach may be in place, we discard them from our sample to fully capture the influence of the soft regulation approach on banks' credit portfolio quality. Second, foreign banks represent a small fraction of the entire banking sector in SA, both in terms of market share (Figure 6) and lending (Figure 7). In fact, in our investigation period, the pooled market share of foreign banks in terms of total assets amounts to 6.27% (untabulated) and their loan market share averages about 2% (untabulated). This leaves us with a sample of 20 domestically owned banks, from which we discard one bank which was liquidated before 2008.[7] The final dataset comprises 19 domestically owned South African banks, covering the period from 2008 to 2023, for a total of 894 bank-quarter observations.

Figure 6: Market share (as % of total assets) – foreign vs domestic banks



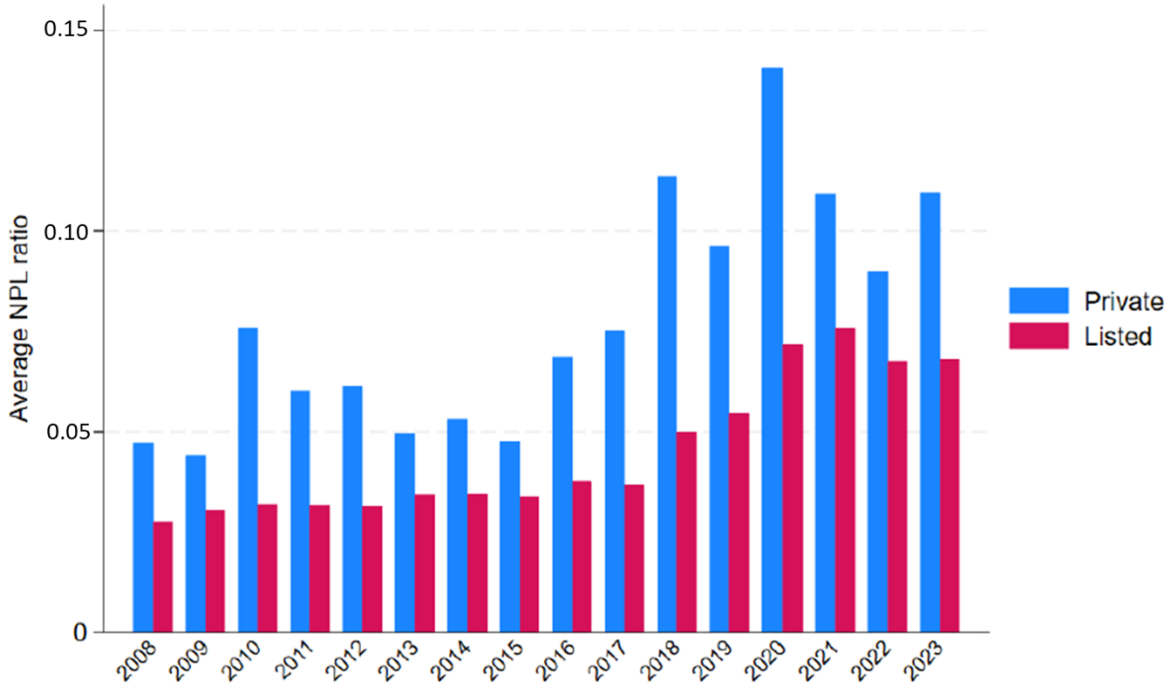
[7] The Regal Treasury Private Bank Limited was put under curatorship in 2001 and liquidated in 2004.

Figure 7: Loan market share (as % of total loans) – foreign vs domestic banks



For our analysis we use as the dependent variable two distinct measures of portfolio quality: the ratio of impairments to the total amount of gross loans (IMP_GROSSLOANS), a commonly used proxy for banks' asset quality, and the growth rate of impairments (IMP_GRW). Figure 8 shows how our credit quality indicator changes over time in our sample. Across the entire sample, private banks consistently exhibit higher NPL ratios than their listed counterparts. While the overall trend shows some fluctuations, a pronounced spike in NPL ratios is observed in 2020, likely linked to the economic disruptions caused by the COVID-19 pandemic. That year marks the peak in average NPLs for both categories, with private banks experiencing a particularly sharp rise. After this period, there is a modest decline, although private banks continue to display relatively higher NPL ratios than listed banks. This divergence may reflect differences in risk management practices, regulatory oversight or customer base composition. Overall, the data suggest that private banks tend to carry greater credit risk exposure, possibly due to less stringent governance or more aggressive lending practices, especially during times of economic stress.

Figure 8: Temporal evolution of the NPL ratio – listed vs private banks



Our main explanatory variable is the C&E engagement indicator (ENGAGEMENT) described in section 4.1. This is used as a proxy to capture how much each bank is interested in and focused on C&E issues. Moreover, our analysis incorporates a set of bank-specific control variables that have been shown to influence bank credit quality (Anastasiou, Louri and Tsionas 2016; Naili and Lahrichi 2022). Therefore, we include the natural logarithm of a bank's total assets as a proxy for bank size (SIZE); the equity-to-total-assets ratio (EQUITY_TA) to measure bank capitalisation; the ratio of loans and advances to total assets (GROSSLOANS_TA) to capture variations in asset composition and lending intensity; the deposits-to-loans ratio (DEP_LOANS) to account for differences in funding structure and liquidity; and the growth rate of the total loans (gr_LOANS) to capture any dynamics in banks' lending activities. To mitigate potential endogeneity issues, all explanatory variables are lagged by four quarters. Moreover, since our text-based measure is computed annually, we lag this variable by four quarters.

Table 2 reports the descriptive statistics of all variables used in our empirical analysis. The average impaired gross loans ratio (IMP_GROSSLOANS) is 7%, with a standard deviation of 9%, indicating moderate variation across banks. The growth rate of

impaired loans (IMP_GRW) shows a mean of 6% but exhibits greater variability (S.D. = 35%), suggesting substantial differences in loan performance dynamics. The C&E engagement measure (ENGAGEMENT) has a mean of 0.72% and a standard deviation of 0.57%, indicating appreciable variation in banks' engagement levels. Overall, these statistics highlight the variability in credit portfolio quality and environmental engagement across the sample.

Table 2: Descriptive statistics (pooled sample)

Variable	N	Mean	S.D.	Q1	Median	Q3
IMP_GROSSLOANS	894	0.07	0.09	0.01	0.03	0.06
IMP_GRW	891	0.06	0.35	-0.01	0.03	0.10
ENGAGEMENT (%)	894	0.72	0.57	0.31	0.51	0.99
SIZE	894	17.28	2.65	15.22	16.47	20.23
EQUITY_TA	894	0.16	0.12	0.07	0.12	0.21
GROSSLOANS_TA	894	0.57	0.21	0.47	0.58	0.69
DEP_LOANS	894	3.35	28.97	1.09	1.22	1.54
gr_LOANS	894	0.05	0.24	0.00	0.02	0.05
LISTED	894	0.45	0.50	0.00	0.00	1.00
IR	894	0.63	0.48	0.00	1.00	1.00
BLOOMBERG	390	27.89	12.91	21.11	26.22	39.90
EQUATOR	384	0.48	0.50	0.00	0.00	1.00
EMISSIONS_SCORE	388	65.46	24.27	46.40	69.06	87.39

Note: This table shows the descriptive statistics of all variables used in our analysis.

Table 3 presents the correlations between the independent variables used in our study. The correlation coefficients range from a minimum of -0.50 to a maximum of 0.50. To further exclude any collinearity issues, Table 3 also reports the variance inflation factor (VIF) values of our independent variables: no variables show VIF values larger than 2, which is less than the critical value indicating the presence of collinearity (O'Brien 2007).

Table 3: Correlations

	VIF	ENGAGEMENT	SIZE	EQUITY_TA	GROSSLOANS_TA	DEP_LOANS	gr_LOANS
ENGAGEMENT	1.48	1					
SIZE	1.98	0.505***	1				
EQUITY_TA	1.71	-0.0771*	-0.502***	1			
GROSSLOANS_TA	1.16	-0.0596	0.193***	-0.275***	1		
DEP_LOANS	1.07	-0.0566	-0.0813*	0.0854*	-0.193***	1	
gr_LOANS	1.25	-0.0700*	-0.115***	0.386***	-0.191***	0.185***	1

Note: This table presents the correlations of the variables used in the main analysis. ***, ** and * indicate significance level at 0.01, 0.05 and 0.1 respectively.

4.3 Econometric analysis

To test our research hypothesis, we match our newly developed scores with accounting-based, bank-specific data obtained on a monthly frequency from the banks' BA900 economic returns, accessible on the SARB website. We then aggregate the data to a quarterly frequency to construct our dataset and employ panel data regression to examine the relationship between C&E engagement and credit portfolio quality, as outlined below:

$$Credit\ Quality_{i,t} = \beta_1(C\&E\ Engagement)_{i,t-4} + \boldsymbol{\beta}(\boldsymbol{Controls})_{i,t-4} + \alpha_i + \tau_t + \varepsilon_{i,t} \qquad (1)$$

where i refers to the bank, t indicates the quarter, α_i indicates the bank fixed effect, τ_t is the quarter fixed effect and ε_i is the idiosyncratic error. The main dependent variable is the ratio of impairments to the total amount of gross loans (IMP_GROSSLOANS). We also use the growth rate of impairments (IMP_GRW) as an additional check. Our main explanatory variable is the C&E engagement indicator (ENGAGEMENT) described in section 4.1 and the controls are those reported in section 4.2.

Regarding the relationship between C&E engagement and credit quality, we expect that banks which genuinely integrate C&E considerations into their operations will also incorporate C&E-related risks into their credit assessment processes. By systematically evaluating the environmental impact and sustainability profile of borrowers, these banks are likely to reduce their exposure to firms engaged in environmentally harmful or high-risk activities. This proactive risk management approach should result in a more resilient credit portfolio, with lower default probabilities and, consequently, improved credit quality. Therefore, we expect a negative relationship between C&E engagement and NPL ratios.

5. Results

To test our research hypothesis – whether banks with greater C&E engagement have higher quality credit portfolios – we employ a panel fixed-effects regression, with the results presented in Table 4 (models 1 to 4). The independent variable serves as a proxy for bank C&E engagement, while the dependent variables are the ratio of impaired loans to gross loans (models 1 and 2) and the growth rate of impaired loans (models 3 and 4). Models 1 and 3 incorporate quarter fixed effects, whereas models 2

and 4 also include bank fixed effects, allowing us to control for time-invariant bank-specific characteristics.

Table 4: Baseline regression results

	(1) IMP_GROSSLOANS	(2) IMP_GROSSLOANS	(3) IMP_GRW	(4) IMP_GRW
ENGAGEMENT (t-4)	-0.0428*** (0.00574)	-0.00838*** (0.00303)	-0.0713 (0.0459)	-0.0734** (0.0368)
SIZE (t-4)	0.0118*** (0.00249)	0.0203*** (0.00529)	-0.00505 (0.0123)	-0.105* (0.0616)
EQUITY_TA (t-4)	0.252*** (0.0426)	0.00569 (0.0258)	0.441* (0.228)	0.895*** (0.335)
GROSSLOANS_TA (t-4)	0.00927 (0.0252)	-0.0325 (0.0198)	-0.111 (0.0987)	-0.285 (0.211)
DEP_LOANS (t-4)	-0.000156** (0.0000681)	-0.00000814 (0.0000277)	-0.000440 (0.000367)	-0.00141 (0.00111)
gr_LOANS (t-4)	-0.0509*** (0.0121)	-0.00319 (0.00538)	0.0552 (0.0685)	-0.100 (0.132)
LISTED	-0.0487*** (0.0135)	–	0.0968 (0.0615)	–
CONSTANT	-0.132*** (0.0480)	-0.264*** (0.0994)	0.130 (0.196)	1.939* (1.148)
Bank FE	No	Yes	No	Yes
Quarter FE	Yes	Yes	Yes	Yes
R-squared	0.0952	0.885	0.0532	0.0793
N	815	815	813	813

Note: This table reports the estimates of the baseline model presented in Equation 1. The dependent variables are the ratio between the impairment and the total amount of gross loans (IMP_GROSSLOANS) and the growth rate of impairments (IMP_GRW). The main explanatory variable is the text-based measure of C&E engagement (ENGAGEMENT) presented in section 3.2. Robust standard errors are presented in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

Our findings show a negative and statistically significant relationship between the independent and dependent variables, indicating that banks showing higher C&E engagement tend to have both lower levels of impaired loans and slower growth in impairment. These results highlight the role of C&E-conscious banking practices in mitigating credit risk and improving portfolio quality. Specifically, banks that provide greater C&E disclosures in their financial reports appear to be more effective in managing credit risk exposure and optimising loan portfolio quality. This suggests that climate engagement is not merely a corporate social responsibility initiative but also a factor that enhances financial stability by reducing credit deterioration and improving asset quality management.

Considering bank control variables, larger banks tend to register high impairment loans over gross loans (Louzis, Vouldis and Metaxas 2012), although they show a slower growth in impairment loans. In general, better capitalised banks seem to have higher impairment loans in their credit portfolio. This result is in line with the theory that managers in highly capitalised banks have to seek higher returns on assets to compensate their shareholders for the higher riskiness of shareholders' investment. The high risk profile for such banks leads to a positive relationship between capital and NPLs (Barth, Caprio and Levine 2004; Macit 2012; Cucinelli et al. 2018).

5.1 Robustness checks

To strengthen the validity of these findings, we conduct two robustness checks (Table 5 and Table 7) using an alternative C&E engagement measure – a dummy variable equals 1 if a bank's C&E engagement is higher than the quarter sample mean and zero otherwise. The results in columns 1 to 4 (Table 5) again reveal a negative and significant relationship (coefficients = -0.0092, $p < 0.01$ and -0.0573, $p < 0.10$) between the dummy variable and both the level and growth in impairment over gross loans. The statistical significance of the results underscores that the relationship between C&E engagement and credit portfolio quality persists when employing a different yet comparable engagement measure.

Table 5: Robustness test – high C&E engagement dummy

	(1) IMP_GROSSLOANS	(2) IMP_GROSSLOANS	(3) IMP_GRW	(4) IMP_GRW
HIGH_ENGAGEMENT (t-4)	-0.0485*** (0.00663)	-0.00920*** (0.00250)	-0.0374 (0.0245)	-0.0573* (0.0315)
SIZE (t-4)	0.0138*** (0.00257)	0.0216*** (0.00515)	-0.00812 (0.0121)	-0.0941 (0.0595)
EQUITY_TA (t-4)	0.252*** (0.0415)	0.00968 (0.0264)	0.395* (0.232)	0.907*** (0.339)
GROSSLOANS_TA (t-4)	0.00875 (0.0249)	-0.0303 (0.0200)	-0.102 (0.0944)	-0.271 (0.210)
DEP_LOANS (t-4)	-0.000137** (0.0000591)	-0.0000140 (0.0000288)	-0.000398 (0.000358)	-0.00146 (0.00112)
gr_LOANS (t-4)	-0.0484*** (0.0133)	-0.00397 (0.00560)	0.0671 (0.0674)	-0.102 (0.134)
LISTED	-0.0573*** (0.0137)	–	0.0919 (0.0612)	–
CONSTANT	-0.173*** (0.0480)	-0.290*** (0.0964)	0.152 (0.207)	1.712 (1.106)
Bank FE	No	Yes	No	Yes
Quarter FE	Yes	Yes	Yes	Yes
R-squared	0.115	0.885	0.0492	0.0784
N	815	815	813	813

Note: This table reports the estimates of the baseline model presented in equation 1. The dependent variables are the ratio between the impairment and the total amount of gross loans (IMP_GROSSLOANS) and the growth rate of impairments (IMP_GRW). The main explanatory variable is a dummy variable (HIGH_ENGAGEMENT) equal to 1 if a bank's C&E engagement is higher than the quarter sample mean, 0 otherwise. Robust standard errors are presented in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

To address potential endogeneity issues related to our independent variable – bank C&E engagement – we conduct two additional robustness checks. First, we exploit a two-stage least squares (2SLS) estimation strategy where we instrument our C&E engagement measure using a shift-share instrument logic (Breuer 2022). Specifically, we construct our instrument by interacting an aggregate shift (SA's yearly CO_2 emissions per capita) with a share that captures each bank's relative exposure to environmental trends, measured as the proportion of its total assets relative to the entire banking sector's assets in the same quarter. The instrument $Z_{i,t}$ (CO2_per_capita_w) is computed as follows:

$$Z_{i,t} = \left(\frac{Bank\ i\ assets\ in\ quarter\ t\ of\ year\ y}{Total\ banking\ sector\ assets\ in\ quarter\ t\ of\ year\ y}\right) \times CO_2\ per\ capita\ in\ year\ y \quad (2)$$

This approach exploits exogenous variation in national CO_2 emissions per capita while weighting it by each bank's weight in the financial system, ensuring that the instrument captures differences in banks' exposure to environmental pressures rather than endogenous firm-specific characteristics. The validity of our instrument lies in the role played by external environmental pressures and heterogeneous exposure in shaping firm-level engagement in C&E-related issues. Since banks operate in an open environment where they respond to broader economic conditions and regulatory signals, their environmental disclosures and C&E engagement are driven not only by bank-specific characteristics but also by external pressures, including climate policies, investor sentiment and public scrutiny (Bolton and Kacperczyk 2021; Leuz and Wysocki 2016). CO_2 per capita serves as a proxy for these external environmental pressures, as higher national emissions can intensify regulatory oversight, stakeholder concerns and industry-wide expectations for climate transparency. However, banks might not experience these pressures uniformly. We posit that larger banks, which hold a greater share of total sectoral assets, will tend to incur higher social pressures and thus have stronger incentives to align with sustainability trends. The interaction of overall national CO_2 emissions with banks' asset shares allows us to capture differential exposure to climate-related pressures in a way that is exogenous to individual bank characteristics, ensuring that variation in the instrument is not directly driven by endogenous firm-level decisions. Following this logic, our instrument provides a plausibly exogenous source of variation in engagement levels, strengthening the causal interpretation of our results. Therefore, our first-stage equation is as follows:

$$C\&E\ Engagement_{i,t} = \theta\ (CO_2\_per\_capita\_w)_{i,t-4} + \beta_2(Controls)_{i,t-4} + \alpha_i + \tau_t + \varepsilon_{i,t} \quad (3)$$

In the second stage of the 2SLS we use $\widehat{C\&E\ Engagement}_{i,t}$, predicted with equation 3, to explain the dynamics of banks' impairments:

$$Credit\ Quality_{i,t} = \beta_1\left(\widehat{C\&E\ Engagement}\right)_{i,t-4} + \beta_2(Controls)_{i,t-4} + \alpha_i + \tau_t + \varepsilon_{i,t} \quad (4)$$

where the dependent variables, the controls and the fixed effects are the same as those used in equation 1.

The first stage of the instrumental variable (IV) model indicates that the instrumental variable has a negative and statistically significant relationship with the bank C&E engagement measure. Specifically, higher CO_2 emissions per capita, weighted by bank size, are associated with lower bank engagement. Our main findings are confirmed in the second stage of the regression model, when the instrumented variable (ENGAGEMENT_IV) is included. The results corroborate the negative and statistically significant relationship between C&E engagement and both the level and growth of impaired loans, reinforcing the robustness of our initial analysis. The Kleibergen-Paap F-statistic always shows a high value, suggesting that our instrument is strongly correlated with the endogenous regressor and is, thus, relevant, reducing concerns about it being a weak instrument.

Table 6: Instrumental variable regression

	(1) First stage	(2) Second stage	(3) First stage	(4) Second stage
CO2_per_capita_w (t-4)	-1.106*** (0.132)		-1.108*** (0.131)	
ENGAGEMENT_IV (t-4)		-0.024** (0.010)		-0.185* (0.098)
SIZE (t-4)	0.043 (0.035)	0.018*** (0.006)	0.055 (0.036)	-0.119* (0.068)
EQUITY_TA (t-4)	0.629*** (0.220)	0.017 (0.024)	0.726*** (0.236)	0.984*** (0.355)
GROSSLOANS_TA (t-4)	0.025 (0.140)	-0.032 (0.020)	0.060 (0.143)	-0.276 (0.207)
DEP_LOANS (t-4)	0.001*** (0.000)	0.000 (0.000)	0.001*** (0.000)	-0.001 (0.001)
gr_LOANS (t-4)	-0.116* (0.062)	-0.005 (0.006)	-0.119* (0.063)	-0.117 (0.133)
Bank FE	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes
R-squared	0.677	0.042	0.676	0.037
N	815	815	813	813
Kleibergen-Paap F-statistic		70.693		71.039

Note: This table reports the estimates of the 2SLS model presented in equations 3 and 4. The dependent variable in columns 1 and 3 is the text-based measure of C&E engagement (ENGAGEMENT) presented in section 3.2. The dependent variables used in columns 2 and 4 are the ratio between the impairment and the total amount of gross loans (IMP_GROSSLOANS) and the growth rate of impairments (IMP_GRW) respectively. Robust standard errors are presented in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

The last robustness check implemented to address endogeneity concerns is the Heckman two-step model. Bank C&E engagement is measured using the dummy variable previously defined in Table 5. The first step involves a probit regression model, where the dependent variable is the dummy variable representing bank engagement, and the explanatory variables are the same as those used in the first stage of the IV regression model.

Table 7 presents the results of the second step, showing that banks with C&E engagement above the sample mean for the year exhibit a lower ratio of impaired loans to gross loans compared to those with lower engagement. These findings reinforce the main analysis, supporting the notion that banks with stronger environmental commitments tend to maintain higher credit portfolio quality.

Table 7: Heckman selection – second step

	(1) IMP_GROSSLOANS	(2) IMP_GRW
HIGH_ENGAGEMENT (t-4)	-0.0127* (0.00721)	-0.0166 (0.0362)
MILLS	-0.0110 (0.0116)	0.0335 (0.0480)
SIZE (t-4)	0.0220 (0.0279)	-0.00321 (0.0583)
EQUITY_TA (t-4)	0.0328 (0.0844)	0.239 (0.344)
GROSSLOANS_TA (t-4)	-0.0996* (0.0559)	-0.130 (0.248)
DEP_LOANS (t-4)	-0.0115 (0.0117)	-0.00843 (0.0469)
gr_LOANS (t-4)	-0.0129 (0.0115)	0.165 (0.132)
CONSTANT	-0.217 (0.463)	-0.00797 (1.025)
Bank FE	Yes	Yes
Quarter FE	Yes	Yes
R-squared	0.282	0.121
N	732	738

Note: This table reports the estimates of the second step of the Heckman selection model. The dependent variables are the ratio between the impairment and the total amount of gross loans (IMP_GROSSLOANS) and the growth rate of impairments (IMP_GRW) respectively. To the set of control variables we include the inverse Mills' ratio (MILLS) obtained from a probit regression to control for potential selection bias. The results of the first stage of the Heckman two-step model are presented in Table B in the annexure. Robust standard errors are presented in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

6. Discussion and conclusions

Over the past decade, C&E risks have become increasingly recognised as material threats to the financial system (Basel Committee on Banking Supervision 2021). Given their key role in modern economies, banks are especially exposed to these risks, be it through direct lending to carbon-intensive sectors or indirect exposure through broader economic disruptions. One key channel through which C&E risks may materialise is asset deterioration, reflected in rising NPLs. Accordingly, integrating environmental considerations into risk management and disclosure practices has emerged as a strategic priority for financial institutions (Furrer, Hamprecht and Hoffmann 2012).

In this context, we examine whether greater engagement with C&E issues can enhance credit portfolio quality in the South African banking sector. SA represents a particularly relevant case given its dual vulnerability to physical climate shocks (e.g. droughts and floods) and transition risks tied to its carbon-intensive economy. Moreover, the country's reliance on principles-based, voluntary disclosure frameworks allows us to explore whether non-mandatory sustainability engagement can translate into tangible improvements in financial stability. Our aim is thus to understand whether higher C&E engagement can result in a better-quality credit portfolio.

To investigate this relationship, we developed a novel text-based indicator of environmental engagement using a customised dictionary of C&E-related terms applied to a corpus of over 600 investor reports issued by South African banks. This engagement measure captures the depth and frequency of banks' voluntary disclosures on C&E issues. We then examined the association between this indicator and key credit portfolio quality metrics by employing fixed-effects panel regressions, a 2SLS approach, and a Heckman selection model to ensure the robustness of our findings. Our results provide robust evidence that banks with higher levels of voluntary C&E engagement experience significantly higher credit portfolio quality.

These findings carry important implications for policymakers. First, our evidence suggests that banks with higher levels of C&E engagement tend to maintain better credit portfolio quality, as indicated by lower NPL ratios and NPL growth, even in the absence of mandatory environmental disclosure mandates. This implies that voluntary C&E engagement has a potential stabilising effect on financial institutions and

suggests that fostering genuine sustainability practices within banks can contribute to overall financial system resilience in emerging markets.

Second, our study highlights the potential effectiveness of soft-law mechanisms in driving actual change. In the South African context where frameworks like the King IV Report remain largely non-mandatory, our results indicate that such principles-based approaches can still foster credible engagement through a market- and stakeholder-driven influence. The South African banking sector's structural exposure to carbon-intensive industries and acute climate vulnerabilities makes it a particularly interesting setting. Hence, our findings imply that under the right institutional and market conditions, voluntary disclosure regimes can support systemic financial resilience and may serve as a potential complement to hard regulatory obligations.

Third, the substantial variation in engagement levels between private and listed banks might call for more focused policy approaches: targeted support could help smaller institutions build the capacity to integrate C&E issues within their risk management frameworks, thus promoting a more seamless transition to a carbon-free economy.

In sum, although South Africa shares several structural characteristics with other emerging markets, such as a high dependency on carbon-intensive sectors and heightened transition risks, the regulator opted for a different institutional approach to C&E issues compared to other emerging economies. Rather than adopting top-down interventions like those seen in other similar economies (Campiglio et al. 2018; Gabor and Brown 2025), SA has sought to foster a stakeholder-oriented governance culture. This principles-based approach aims to integrate sensitivity to broad social interests, including environmental sustainability, within firms' strategic vision.

Against this backdrop, our findings, while aligned with those of studies on the banking sector of emerging markets (Azmi et al. 2021), suggest that it is indeed possible to foster meaningful C&E engagement through soft institutional nudges rather than rigid regulatory mandates, resulting in enhanced credit portfolio quality. This suggests that stakeholder-oriented governance can foster more cautious and forward-looking credit practices, enabling banks to better anticipate and manage C&E risks in their lending activities. That said, as highlighted in section 2, South Africa is increasingly aligning

itself with international regulatory trends and has initiated efforts to strengthen its climate-related financial policies. However, it remains too early to assess the impact of these measures on financial stability, as both regulatory implementation and institutional uptake will require time to materialise.

In terms of limitations, while our engagement measure captures the intensity of C&E disclosure, it does not directly assess the quality or sincerity of these statements. Future research could combine textual analysis with qualitative assessments or case studies to evaluate the authenticity and implementation of disclosed environmental policies. Furthermore, although our findings are robust to multiple estimation techniques, additional work could explore long-term financial outcomes beyond credit risk, such as profitability, capital adequacy or market valuation, in relation to C&E engagement.

The shortcomings of this study open several avenues for future research. First, the cross-country generalisability of our findings remains to be tested. It could be worth understanding whether voluntary C&E disclosure principles carry similar financial implications in other emerging markets with soft-law regimes. A second avenue for research would be to understand the role of institutional investors and other stakeholders in incentivising genuine C&E engagement.

In conclusion, this paper contributes to the debate on whether C&E engagement by banks, especially in non-mandatory disclosure environments, translates into improvements in financial performance, specifically in credit risk management. Our results show that, in the South African banking system, C&E engagement is not a purely symbolic act but a strategic behaviour with important implications for asset quality and financial stability. As the global financial sector continues to struggle with the challenges of climate change, insights from such contexts are crucial in informing both academic research and policy design aimed at fostering sustainable finance.

Annexures

Table A: List of C&E-related keywords

afforestation	CRMF	green loan	recyclable
African Natural Capital Alliance	cruelty	green mortgage	recycle
agriculture	dark green	green movement	reduce packaging
agro	decarbonisation	green party	reforestation
air	decarbonization	green product	regeneration
air quality	decarbonize	green project	related financial disclosure
air travel	deforestation	green revenue	renewable
algal biofuel	desertification	green road	renewable energy
alternative energy	diesel	green tagging	reusable
animal	dirty oil	green transformation	road vehicular conversion
aquaculture	diversity	greenfield	SBTi
asbestos	drill	greenhouse	Science Based Targets Initiative
atmosphere	eco citizen	greenhouse gas	science based targets
automobile	eco design	greenwashing	Scope 1
automotive	eco ideas	GRI	Scope 2
based	eco markets	groundwater	Scope 3
bio	eco solutions	groundwater pollution	SDG
biodegradable	ecological	habitat	SDGs
biodiversity	ecologically	hazardous	SEA
bioeconomy	ecology	hazardous waste	SF6
biofiber	economics of climate change	heat	silicium
biofuel	ecosystem	HFC	solar
biomass	ecotourism	householding	sox
biomimetics	effluent	hybrid	soy
biphenyls	electric	hydraulic turbine	spills
bottled water	emission	hydro	steel
brownfield	emission intensity	hydrocarbon	stewardship
building	emission reduction	hydroelectric	stranded asset
building certification	emissions trading	hydrofluorocarbon	substantially green
bunker fuel	endangered	hydropower	sugar
business travel	energy consumption	invasive species	sulphur hexafluoride
cap and trade	energy efficiency	ISO 14000	sulphuric
car	energy management	ISO 26000	superfund
carbon certification	energy policy	Just Energy Transition Investment	sustainability
carbon	energy positive	land	sustainable business
carbon biological sink	energy savings	land remediation	sustainable cities
carbon capture	energy star	landfill	sustainable development
carbon dioxide	energy strategy	laughing gas	Sustainable Development Goal

carbon disclosure	energy usage	lead	sustainable economic growth
Carbon Disclosure Project	energy	light green	sustainable economy
carbon footprint	environment	mass	sustainable energy
carbon market	EPA	metal	sustainable fishing
carbon neutral	equator	methane	sustainable forest management
carbon offsetting	Equator Principles	mines	sustainable management of water
carbon price	ESG	mining	sustainable packaging
carbon pricing	farmer	mountain	sustainable product
carbon sequestration	fish	N2O	sustainable resource
carbon sink	footprint	natural capitalism	sustainable tourism
carbon storage	forest	natural disaster	sustainable trade
carbon trust	forest degradation	natural gas	sustainable transport
CDP	forest management	natural resource	sustainable use of water
cement	forest resources	natural risk	sustainably managed
certified building	forest stewardship	NDC aspects	TCFD
CH4	forestry management	net	temperature
chemicals	fossil	net zero	thermal coal
chlorofluorocarbon	fossil fuel	neutral	toxic
circular	fracking	nextgen	toxicity
circular economy	free	nitrification	transition risk
clean	fresh water	nitrogen	transport
clean tech	freshwater	nitrous oxide	tree
cleaner	fuel	nuclear	trichlorofluoromethane
cleantech	geothermal	nuclear reprocessing	uranium
cleanup	GHGs	NZBA	vegan
climate	glass	ocean	vegetable
climate action	Global Reporting Initiative	oil	vegetarian
climate change adaptation	global warming	oil spill	vehicle
climate change mitigation	GMO	organic	warming
climate clock	grabbing	ozone	waste
climate finance	green	ozone depletion	waste disposal method
climate financial forum	green America	paper	wastewater treatment
Climate Financial Risk Forum	green bond	paper usage	water
climate fund	green building	Paris Agreement	water consumption
climate risk	green chemistry	Paris goal	water discharge
climate risk appetite dashboard	green climate	perfluorocarbon	water pollution
climate risk management framework	green concrete	pesticide	water stewardship

climate transition	green consumer trends	petrol	water storage
CO2	green deal	PFC	water stress
coal	green development	photovoltaic	water withdrawal
coal exposure	green economy	physical risk	weather
coastal infrastructure	green electricity	planet	WEEE
cogeneration	green energy	plastic	wetlands
commut	green finance	pollution	wilderness
composting	green hydrogen	power management	wildlife
conservation	green infrastructure	Principles for Responsible Banking	wind
contamination	green innovation	product	WLTP
COP	green investing	rainforest	wood
coral	green leap	rechargeable	zero banking alliance
Corporate Knights	green lease	reclaimed	zoning
corporate travel			

Table B: Heckman selection – first step

	(1) **HIGH_ENGAGEMENT**
SIZE (t-4)	-2.738*** (0.388)
SIZE_sq (t-4)	0.0918*** (0.0116)
EQ_TA (t-4)	10.74*** (1.520)
EQ_TA_sq (t-4)	-13.92*** (2.082)
GROSSLOANS_TA (t-4)	6.762*** (1.930)
DEP_LOAN (t-4)	0.165 (0.564)
DEP_LOAN_sq (t-4)	-0.132 (0.102)
gr_LOANS (t-4)	0.524 (0.752)
gr_LOANS_sq (t-4)	-0.287 (0.243)
CONSTANT	21.01*** (3.822)
Pseudo R-squared	0.330
N	815

Note: This table reports the estimates of the first-stage model of the Heckman selection model. The dependent variable is a dummy variable (HIGH_ENGAGEMENT) equal to 1 if a bank climate engagement is higher than the quarter sample mean, 0 otherwise. Robust standard errors are presented in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% level respectively.

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