A Systemic Literature Review of Climate Risk Indicators in Financials of Banks

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Abstract

Climate change is increasingly recognized as a core financial risk that compels banks to rethink traditional approaches to risk management. This study focuses on climate risk indicators and their integration into banking practice, focusing on implications for financial performance and resilience. Drawing on studies, case analyses and regulatory reports published between 2000 and 2024, this review examines methods such as stress testing, scenario analysis, econometric modelling and big data analytics. Past research and information had pointed towards the improved resilience of low and non-performing products. This has been particularly visible in Europe and New Zealand (Day, Gan & Teece, 2022; ECB 2022). On the contrary, Asian (Sub-continent) and Middle Eastern and African markets have indicated some deficiencies from a regulatory and information perspective (Asian Development Bank, 2021). The need for standardized methodologies across the globe has therefore been a key finding. Availability to data (translated to information) is a visible gap that will need focus. As such the need to shift towards Climate Risk (CR) integration on a global platform will be key in archiving parity within this space (Hong, Karolyi & Scheinkman, 2023).

Keywords: climate risk indicators, financial sustainability, credit risk management, climate change adaptation, green finance

Introduction

It is evident that climate change is simply an environment concern. Instead, a key variable or determinant that drives Financial Risk for Banks. Physical Risks is therefore a key consideration. Natural disasters such as floods and fires have the ability and proven to have cause severe damage to assets. This in turn causing depreciation of one's credibility or credit rating. Transition risk on the other hand is linked with decarbonization and is shifting regulation, to destabilize carbon-intensive investments (Huang et al., 2018; Fatima et al., 2022). Yet, the integration of climate risk indicators into financial reporting remains an inconsistent practice, particularly in jurisdictions with diverse regulatory and market contexts.

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In New Zealand, banks must balance global expectations, shaped by the Paris Agreement and sustainable development goals (SDG), with local financial realities (Reserve Bank of New Zealand [RBNZ], 2023). While progress has been made through the environmental, social & governance (ESG) initiatives, significant gaps remain in embedding climate risk into measures of financial performance. This is particularly relevant, given that New Zealand on of the pioneering members of the initiatives, globally.

This study, therefore examines the methodologies used to integrate climate risk within the banking framework and practice. By connecting climate risk to financial outcomes, the research attempts to highlight opportunities to strengthen risk management practices and align banking operations with sustainable goals.

Global initiatives such as Task Force on Climate related financial disclosure (TCFD, 2017) and the network for greening financial systems (NGFS) call for transparent and standardize disclosure. In European (EU) Central Bank has advanced climate stress testing as a supervisory too (ECB, 2022). The RBNZ has adopted similar guidance's, the challenge remains around portfolio exposure and the credit assessment (RBNZ, 2023)

Indicators such as carbon intensity, disaster frequency and regulatory exposure are essential for mapping financial vulnerabilities (Doe,2021). However, its usefulness is often constrained by weak data, especially in developing economies (Mastrorillo et al., 2016). New analytical tools machine learning and big data offer the potential to improve modelling precision and support better decision-making (Zhou et al., 2019).

Banks are responding through green bonds and renewable energy investments, strategies that lower emissions, whilst strengthening market competitiveness. (Miller, 2023; Yue & Nedopil, 2025). Still, adoption is uneven: while some institutions have embraced scenario analysis and stress testing, others lag behind (Koh et al., 2021).

Integrating climate risk is both a regulatory imperative and strategic advantage. Institutions that embed sustainability at the core of their operations not only enhance resilience, but also positions itself to seize emerging opportunities (Thompson & Davies, 2024)

In achieving some parity, the following will be key to understand and establish

- What climate risk indicators are used in banking, and how can they be categorized for practical application.
- How effective are current integration methodologies in enhancing risk management.
- Understanding the relationship between climate risks & financial performance within the banking sector.

Research Objectives

This study addresses critical gaps in the literature currently available on climate risk in banking by focusing on three closely connected objectives.

First it seeks to identify & categorize climate risk indicators (CRI) that are relevant to the banking sector, which in turn provides a structured framework for assessing their financial relevance and operational applicability or suitability. Second, it will evaluate the methodologies used to integrate climate risks into financial assessments, thereby emphasizing their effectiveness, limitations and potential to strengthen risk management practices. The third objective would be to examine the implications of climate risk integration for banks and its stability, financial performance and generating new insights into how sustainability initiatives that directly intersect with profitability, resilience and long-term competitiveness (Smith & Johnson, 2022; Liu, Zhao, & Zhou, 2024).

In doing so, the study attempts to contribute to the academic conversation by bridging the gap between theory and practice. It furthermore attempts to offer empirical evidence on the financial impacts of climate risks, extends the applicability of established frameworks such as stakeholder and institutional theory from a banking context. Developing a list of recommendations for banks, policymakers and regulators can be considered an overarching goal that would eventuate in clarifying how climate risk indicators can be embedded systematically into financial systems to enhance both stability and sustainability (Hong, Karolyi, & Scheinkman, 2023).

Literature Review

The availability of literature on climate risk in banking has expanded rapidly, recognising that climate change has an impact, not only on the environments, but also concerns and the inherent financial risks (Dennis, 2022). Scholars generally distinguish between physical risks such as hurricanes, floods and wildfires and transition risks that may arise from regulatory reforms, technological innovations and market shifts towards low-carbon economies (Nguyen, Pham, & Le, 2023; Smith & Johnson, 2022). Both forms of risk directly affect banks through asset devaluation, market volatility and credit defaults that highlight the urgency of embedding climate related considerations into financial risk frameworks.

Climate Risk Indicators (CRI) in Banking

A growing segment of research emphasises the value of CRI metrics that are able to link environmental exposure to financial outcomes. Portfolio carbon intensity, reliance on carbon-intensive

industries and geographic exposure to climate hazards are some of these examples. Battiston et al. (2017) demonstrates that European banks heavy exposure to fossil fuel assets have a greater systemic vulnerability. In recent times Liu et al (2024) has found that banks in emerging markets and that too, where governance is weak, exhibits higher financial instability., when climate exposures are poorly managed.

However, the usage of such indicators remains fragmented across multiple jurisdictions and with inconsistent definitions, measurements and standards being a part of it (Korzeb, Niedziółka, Szpilko, & Di Pietro, 2024).

Methodologies for Climate Risk Assessment

There are a diverse number of methodologies available and applied to assess climate risk and that too unevenly applied. Econometric models are deemed to be widely used to establish statistical relationships between climate variables and financial outcomes. However, there are some limitations, due to the limited data availability coupled with assumption of linearity (Greene, 2018; Hsiang et al., 2017). Scenarios analysis and stress testing are generally promoted by regulators such as ECB (2022) and the NFGS (2021). One of the reasons for this is due to its ability to provide structured approach to assessing banks resilience under multiple climate futures. Yet its utility heavily depends on the specific scenario designs and assumptions, whereby limiting its comparability (Weber, Scholten, & Menz, 2020).

Emerging techniques, such as the usage of ‘big data analytics and artificial intelligence (AI) seem to drive ahead in terms of its prominence and choice preference. By integrating satellite imagery, emission data (firm level) and unstructured financial disclosure, some of these tools are able to capture non-linear relationships between climate events and banking performance. (Hoffmann, Jarvis, & Jones, 2021; Pfarr Hofer & Stelzer, 2025). However, smaller institutions often lack the resources and infrastructure to adopt such tools, creating disparities in preparedness across the sector (Korzeb et al., 2024).

Theoretical Perspectives

Theoretical frameworks provide further insights into bank’s responses to climate risk. Stakeholder Theory (Freeman, 1984) has underscored influence of customers, regulators and investors in shaping climate-related strategies. Institutional Theory (Scott, 2014) explains how banks adopt practices under the regulatory and normative pressures, particularly through initiatives like the TCFD (2017). The Resource Based View (Barney, 1991) has highlighted internal capabilities such as advanced analytics and skilled personnel as resources for competitive advantage in climate risk management.

Sustainability frameworks including Triple Bottom Line Theory (TBL) (Elkington, 1997) and the Natural Capital Theory (NCT) (Costanza et al., 1997), extends these discussions by emphasising the need to balance Environmental, Social & Economic Objectives (ESG), also referred as ESG Goals. However, the application to bank or financial institutions, especially financially performance remains limited. The ability to bridge these theoretical perspectives with empirical evidence, represents an important step in understanding how climate risk management can simultaneously support financial resilience and sustainable objectives (Nguyen et al., 2023).

Regional Disparities in Adoption

Empirical evidence shows significant regional variation in climate risk integration. European banks, supported by strong regulatory frameworks, are at the forefront of climate stress testing and disclosure (European Central Bank, 2022). New Zealand banks have similarly advanced under the Reserve Bank's mandatory TCFD-aligned reporting requirements (Dey, Gan, & Teece, 2022). In contrast, adoption in Asia and Sub-Saharan Africa is hindered by limited data and weaker institutional capacity (Asian Development Bank, 2021). These disparities highlight the need for greater standardization in climate risk methodologies and cross-border cooperation.

Gaps in the Literature

While the literature demonstrates the growing importance of climate risk integration, significant gaps remain. Few studies provide quantitative evidence linking climate risk management to bank performance metrics such as ROA, ROE, or NPL ratios. Additionally, research often focuses on large, global banks, leaving small and regional institutions underexamined. There is also limited comparative work across regions, despite the clear importance of regulatory and institutional context. Addressing these gaps is critical for advancing both academic inquiry and practical policy design.

Conceptual Framework

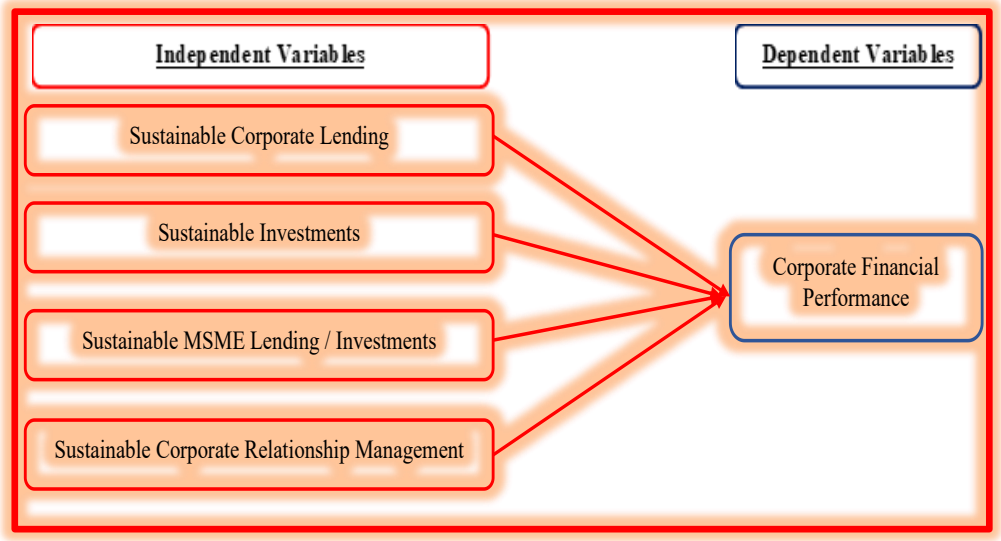
The framework revolves around the idea that climate risk acts as a critical factor influencing corporate financial performance, particularly in the banking industry. This framework links physical climate risks (e.g., extreme weather events) & the transition risks (e.g., policy and market changes), and attempt to establish the performance metrics of banks, such as Return on Equity (ROE), Return on Assets (ROA), and non-performing loan (NPL) ratios.

Independent Variables (IV)

I. Corporate Sustainable Lending

II. Sustainable Investments
III. Sustainable MSME Lending/ Investments
IV. Sustainable Corporate Relationship Management

Dependent Variable (DV)
Corporate Financial Performance



Climate Risk (Dependent Variable): Defined as the probability of loss or negative financial impact resulting from climate change, either due to physical events like floods, hurricanes, or long-term shifts in climate patterns (physical risks) or due to the transition to a low-carbon economy (transition risks) (Agliardi & Agliardi, 2019).

Corporate Financial Performance (CFP) (Independent Variable): Measured through a bank's key financial indicators such as ROE, NPL ratios, and liquidity ratios. These metrics help assess a bank and its ability to generate returns and manage risks (Bătae, Dragomir, & Feleagă, 2021).

Regulatory Frameworks: Incorporating global regulatory policies such as the Task Force on Climate-related Financial Disclosures (TCFD) and Network for Greening the Financial System (NGFS), which mandate climate risk disclosure and integration into financial assessments (KPMG - Global IFRS Institute, 2021).

Hypotheses	Relationship / Impact	References

H1	There is a significant and positive relationship between Climate Risk (CR) and Sustainable Corporate Lending (SCL)	(Nawaz, 2021) , (Tschakert, 2010), (Taghizadeh-Hesary, 2020), (Sartzetakis, 2021)
H2	There is a significant positive relationship between Climate Risk (CR) and Sustainable Investments (SI)	(Amini, M., & Rahmani, A., 2023) , (Monasterolo, I., 2020) , (Agliardi, E., & Agliardi, R., 2019)
H3	There is a significant negative relationship between Climate Risk (CR) Return on Equity (ROE)	(Sun, Y., Yang, Y., Huang, N., & Zou, X., 2020), (Khatri-Chhetri, 2021) , (Owen, R., Brennan, G., Lyon, F., & Harrer, T., 2020)
H4	There is a significant negative relationship between Climate Risk (CR) and Return on Investment (ROI)	(Park, H., & Kim, J. D., 2020) , (Tara, K., Singh, S., & Kumar, R., 2015)

Prior studies have indicated that exposure to climate hazards, particularly with physical risks such as floods and natural disasters can erode Banks's credibility and thereby increase non-performing loans (NPL). This in turns adversely influences the profitability of the organisation (Elijido-Ten & Clarkson, 2019).

Banks have traditionally invested heavily on fossil fuel-based industries. The introduction some policies such as 'carbon pricing' and 'emission trading schemes' have exerted influence on these traditional industries (Sun et al, 2020). It is therefore noticed that institutions have now shifting towards the adopting ESG frameworks and some 'climate stress testing' methodologies to ease these pressure (Ozili, 2022).

Below are a few considerations that banks should focus on, with a view of improving its portfolio quality and more importantly its Risk ratings of assets or portfolio.

Integration of Climate Risk in Credit Risk Assessment and Management. This is a process that will need some targeted industries to be driven, where Climate Risks remain relatively higher risks. Farming, Agriculture, real estate and energy are some of these industries that can be identified for this purpose. This is particularly important, given the country's drive and income generating potential traditionally. However, there is a limitation in empirical evidence and is an area that will need to be managed (Fatima et al, 2022)

Maintain and improving the quality of data collected and used within this space. Collecting and retaining climate related data is a long process and given that the journey and focus on Climate Related Risk has been relatively a new initiative, it provides and natural challenge.

However, it has been observed that a greater focus on maintain quality data has provided the opportunity to now put it to better practice.

Creating an environment to prompt or proactively disclose climate related risks. Carvajal & Nadeem (2022), in a study conducted has pointed out that t would be important to develop

Upskilling staff and resources. Advocating banks and financial institutions to consider utilizing material that can strongly influence knowledge-enhancement process of staff. With ESG guidelines now being used across most organizations and is being familiarized, it would be key ensure that these are integrated into the financial services framework. This in turn will help improve the level of confidence in dealing with sustainability related challenges (Ozili, 2022)

Conclusion

Climate change has emergence as a key determinant of financial sustainability, thus compelling banks to incorporate CRI into its assessment and reporting practices. It is also acknowledged that both physical and transition risk arising from policy reforms, stringent regulatory frameworks and competitive carbon pricing, have significant consideration, thereby shaping finance and banking financial performance (Huang et al, 2018; Sun et al, 2020). Addressing these challenges requires not only a adoption of a series of standardized methodologies, but supported with reliable and accurate data and stronger regulatory alignment across jurisdictions.

Physical risks undermine the quality of loan portfolios by increasing borrower defaults in climate-sensitive sectors, such as real estate and agriculture. These risks are therefore able to elevate NPL ratios and erode collateral values, creating direct credit losses for banks (Sun et al, 2020). Transition risks, by contrast, primarily have an effect on banks, with concentrated exposure to fossil fuel dependent industries. Much stringent environmental regulations and the implementation of carbon taxes can rapidly devalue assets in these sectors, amplifying systemic vulnerability (Huang et al, 2018).

Banks will require a model supported by globally accepted methodologies. Usage of some of these methodologies such as the TCFD (2017) and NGFS (2021) will be key in the journey within the banking industry.

In conclusion, integrating Climate Risk into banks is both regulatory necessity and a strategic imperative. Organisations that proactively ensure that these risks are identified proactively, creating sustainable, resilient portfolios, while those that delay adaptation, risk heightened credit exposures and reputational damage in an increasingly carbon-constrained global economy.

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