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Climate-related financial policies and bank risks: do environmental sustainability factors matter?

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Abstract

Purpose – This paper examines the impact of climate-related financial policies (CFPs) on bank risks, utilizing a comprehensive global dataset spanning from 2000 to 2021. It explores whether CFPs influence bank risk levels across different regions and regulatory environments.

Design/methodology/approach – Using a dataset comprising 2,534 bank-year observations, this study employs robust econometric techniques, including two-stage least squares (2SLS) and difference-in-differences (DiD) approaches, to mitigate endogeneity concerns and validate the findings. The analysis distinguishes between regions with strong regulatory frameworks, such as North America and Europe, and those with weaker regulatory settings, such as Asia and developing countries.

Findings – CFPs generally reduce bank risks in regions with strong regulatory frameworks, such as North America and Europe. However, in Asia and developing countries, CFPs initially increase risks, highlighting transitional challenges. Environmental sustainability factors moderate this relationship, with stronger CFP effects in countries with weaker environmental policies. These findings align with stakeholder theory and the resource-based view.

Practical implications – This study provides critical insights for policymakers and financial regulators by highlighting the need for region-specific CFP implementation strategies. While CFPs enhance bank resilience to climate-related risks, their effectiveness depends on regulatory maturity and economic conditions. Financial institutions must integrate tailored risk management strategies to navigate the short-term challenges associated with CFP adoption in developing economies.

Originality/value – Evidence from this research provides on the differential effects of CFPs on bank risks across diverse regulatory and economic contexts, offering insights into financial policy effectiveness.

Keywords Climate-related financial policies, Bank risk, Financial regulation, Environmental sustainability

Paper type Research article

1. Introduction

Climate change has emerged as a critical source of risk for the banking sector, amplifying financial vulnerabilities through both physical channels, such as asset depreciation linked to extreme weather, and transition mechanisms, including the losses associated with adapting to a low-carbon economy (Alsaiari *et al*., 2023; Le *et al*., 2023). These challenges can elevate default rates, erode the value of collateral, and threaten the stability of financial institutions. To counter these effects, climate-related financial policies (CFPs), such as sustainable lending requirements

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and mandatory environmental disclosures, are increasingly being adopted. Such policies are intended to align banking practices with environmental objectives, strengthen risk assessment frameworks, and build confidence among stakeholders (D'Orazio and Popoyan, 2019).

The literature acknowledges the growing significance of CFPs in risk mitigation (Alsaiari *et al*., 2023; Liu *et al*., 2023a, b, 2024a), there is little consensus on how these policies function across different regulatory regimes and socio-economic contexts (Cui *et al*., 2024; Mueller and Sfrappini, 2025). Over the past decade, research has highlighted how robust CFP frameworks can prompt banks to realign their lending portfolios and manage climate-induced shocks (Lamperti *et al*., 2021). However, empirical evidence is mixed, while CFPs often enhance financial stability in developed markets with mature regulation, they can introduce new risk factors in developing economies still navigating the transition to sustainable finance (de Moraes *et al*., 2024).

Crucially, environmental sustainability factors such as regulatory maturity, stakeholder engagement, and policy support for green innovations are believed to shape the net effect of CFPs on bank risk (D'Orazio and Thole, 2022). Despite their recognized importance, these moderating elements are not uniformly incorporated into existing research designs, leaving policymakers and industry leaders with an incomplete picture of how best to implement climate finance reforms (D'Orazio and Popoyan, 2019). Prior studies have also tended to focus on single-country or single-region samples, making it difficult to generalize findings across diverse institutional contexts (Popoyan and Galanis, 2022; Yahya *et al*., 2025). As a result, it is still unclear whether the same collection of climate policies that prove effective in North America or Europe can be successfully implemented in Asia or other emerging markets, where foundational infrastructure, regulatory frameworks, and macroeconomic conditions may vary considerably (Gabriel and Aung, 2025; Wang *et al*., 2024).

To address these gaps, this paper offers a comprehensive, cross-country investigation into the effect of CFPs on bank risk, utilizing 2,534 bank-year observations from 2000 to 2021. Advanced econometric techniques, including two-stage least squares (2SLS) and difference-in-differences (DiD), are employed to address endogeneity concerns and support credible causal inference. Our study not only disentangles the distinct roles of strong versus weak regulatory settings but also highlights how sustainability factors, such as environmental policy strictness and stakeholder pressures, shape the trajectory of bank risk following the enactment of CFPs. This multi-regional approach builds upon stakeholder theory and the resource-based view, positing that banks must integrate environmental considerations into their strategic resources, risk appetites, and stakeholder relationships to achieve long-term stability.

This research makes several contributions to the climate finance and financial stability literature. Firstly, it addresses a persistent gap by examining how CFPs operate across both advanced and developing markets, thereby offering comparative evidence that can inform policymakers about the importance of regulatory context. Second, it highlights the moderating effect of environmental sustainability factors, demonstrating that CFPs do not produce uniform outcomes; rather, their effects vary depending on local governance capabilities and environmental aspirations. Lastly, the study provides practical guidance for crafting region-specific implementation strategies, emphasizing that sound regulatory frameworks and sustainability-oriented mandates are essential for banks to manage both the immediate and long-term consequences of climate change.

The remainder of this paper is structured as follows: Section 2 outlines the research hypotheses, Section 3 describes the data and empirical methodology, Section 4 presents the results, and Section 5 concludes with key implications for policy and practice.

2. Literature review and hypotheses development

2.1 Theories background

Stakeholder Theory suggests that organizations, including banks, exist within a network of interdependent relationships that extend beyond shareholders (Freeman, 1984). Accordingly,

banks that pay greater attention to climate policies can mitigate risks by aligning with the interests of broader societal and environmental stakeholders, thereby stabilizing their operations. In the context of climate-related financial regulations, banks cannot confine their strategies to merely appeasing equity holders but must respond to a broader network of constituents such as customers, regulators, local communities, and activist groups (Jones *et al*., 2018). By proactively engaging stakeholders who champion environmental responsibility, banks can better anticipate reputational hazards, regulatory shifts, and evolving market preferences. Such engagement may take the form of transparent climate-related disclosures, green lending policies, or collaborative sustainability initiatives. Consequently, banks that successfully integrate stakeholder concerns into their business strategies can mitigate climate-associated risks more effectively (Clarkson *et al*., 2011).

The resource-based view (RBV) proposes that by integrating climate-related policies, banks can enhance their long-term sustainability and reduce vulnerabilities to both financial and non-financial risks. While Stakeholder Theory centres on external relationships, RBV focuses on the internal resources and capabilities that enable businesses to develop a competitive advantage (Barney, 1991; Wernerfelt, 1984). In the realm of climate-related financial challenges, essential internal resources include not only capital adequacy and risk management expertise but also specialized knowledge in assessing environmental exposures and integrating climate metrics into portfolio modelling (Amore and Bennedsen, 2016). Possessing rare and inimitable capabilities such as advanced Environmental, Social, and Governance (ESG) analytics could allow a bank to price climate risks more accurately and innovate in green financial products, thereby reducing exposure to shocks triggered by shifting regulatory landscapes or severe weather events. Within this framework, banks that strategically bolster their internal competencies can better seize market opportunities and protect themselves against the systemic vulnerabilities inherent in climate change.

2.2 Hypotheses development

2.2.1 CFPs and bank risk. There is growing evidence that climate-related risks can undermine financial stability (Le *et al*., 2023; Liu *et al*., 2024b), recent scholarship has turned to investigating how well-crafted CFPs might dampen these vulnerabilities. In particular, the CFPs refer to initiatives by governments or central banks, such as mandatory climate information, green credit frameworks or environmental-linked capital requirements, aimed at integrating climate risk into financial decisions (D'Orazio and Thole, 2022). By systematically integrating climate metrics into the supervisory and lending processes, the CFPs have the potential to shape bank risk profiles in different ways.

First, the CFPs may encourage banks to screen more carefully for carbon-intensive or environmentally-risky projects, thereby reducing future defaults caused by climate shocks or by tightening environmental regulation (An *et al*., 2023; Birindelli *et al*., 2024). This channel is especially pronounced in heavily polluting industries, where stricter climate finance reforms have spurred shifts in capital allocation toward cleaner assets (Cui *et al*., 2024).

Second, climate-related regulatory mechanisms, whether stress tests or disclosure requirements, provide banks with more clarity on how to price physical and transition risks, which will lead to a higher capital buffer and a more stable portfolio (Lamperti *et al*., 2021). Such measures encourage institutions to reassess loans that are vulnerable to extreme weather conditions or regulatory changes, thereby increasing overall resilience (Jung *et al*., 2025). Third, recent empirical studies suggest that compliance by banks with the CFP can strengthen the confidence of stakeholders, strengthen their reputational capital, and reduce legal, operational, and liquidity risks (An *et al*., 2023; Liu *et al*., 2023a, b). Over time, this holistic approach to climate risk from both a risk management and a strategic point of view can protect banks from sudden market revaluations associated with carbon-intensive exposures. Taken together, this holistic approach to climate risk management and strategic positioning can protect banks from sudden market revaluations associated with carbon-intensive exposures.

Following to D'Orazio and Thole (2022) framework, the country-level CFP index captures the extent to which a nation has enacted binding rules for green finance, prudential oversight, and climate-related disclosures. Higher CFP index values thus imply an environment where financial institutions are more incentivized and often obligated to align with decarbonization goals. We posit that such an environment promotes conservative risk-taking behaviours and fosters robust risk-assessment processes, leading to lower overall risk exposures in the banking sector.

H1. Climate-related financial policies reduce bank risk.

2.2.2 Environmental sustainability as a moderator of the relationship between CFPs and bank risk. Although climate-related financial policies aim at reducing bank risks by integrating climate considerations into prudential and lending processes, their ultimate impact may depend on environmental sustainability factors that are present at both the bank and corporate level (An *et al*., 2023; D'Orazio and Thole, 2022; Galletta *et al*., 2022). These factors typically span a broad range of metrics such as ESG scores, green innovation capacities, or carbon reduction commitments that signal an entity's readiness to comply with and leverage green finance initiatives. When firms demonstrate robust sustainability credential, for instance transparent emissions reporting or strong track records in green innovation they may respond more positively to CFP-driven requirements such as mandatory climate disclosure or strict lending standards (Cui *et al*., 2024). In this context, climate-focused banks are more likely to offer favourable loan terms to environmentally proactive borrowers, reinforcing the risk-reducing effect of CFPs (Degryse *et al*., 2023). Conversely, banks dealing with clients that have weaker sustainability practices could face higher uncertainty around environmental exposures, thereby diluting the stabilizing impact of regulatory policies (Le *et al*., 2023). Moreover, banks that embed environmental sustainability into their operations through initiatives like green credit portfolios and comprehensive climate-risk management protocols can further enhance the effectiveness of CFPs (D'Orazio and Popoyan, 2019; Liu *et al*., 2023a, b). Banks with advanced ESG practices may integrate policy requirements more thoroughly into credit risk modelling, thereby mitigating climate-related vulnerabilities more effectively (An *et al*., 2023).

By contrast, banks lacking robust environmental governance may struggle to implement CFP mandates, causing policy-induced compliance burdens to overshadow potential risk reductions (Galletta *et al*., 2022). Lastly, empirical research suggests that an institution's governance structures, for example, dedicated climate committees and board oversight can strengthen the link between sustainable policy adoption and bank resilience, preventing reputational or operational crises (Liu *et al*., 2024b). Thus, higher levels of environmental sustainability, whether at the borrower or lender level, act as a moderator: they either magnify or diminish how effectively CFPs reduce bank risk.

H2. Environmental sustainability factors moderate the impact of CFPs on bank risk.

3. Methodology

3.1 Data

We compile country-level data on the Climate-Related Financial Policies Index [1] (CRFPI), which reflects both the adoption and enforceability of global climate-related financial policies. This dataset includes 74 countries from 2000 to 2020, as described by D'Orazio and Thole (2022). Bank-level data are sourced from the Capital IQ database, while macroeconomic controls at the country level are taken from the World Bank. To maintain a consistent panel, only those countries with available data across CRFPI, Capital IQ, and the World Bank databases are included, resulting in a final sample comprising 2,534 observations from 33 countries over the period 2000–2021. To limit the influence of outliers, all key variables are winsorized at the 1st and 99th percentiles.

3.2 Variable measurement

3.2.1 Dependent variable: bank risk. Following the approach of Bui *et al*. (2023), Lee *et al*. (2024), this study uses loan loss provisions as the main proxy for bank risk. Three ratios are calculated: loan loss reserves to total assets (LLP/Assets), to total equity (LLP/Equity), and to total loans (LLP/Loans). For robustness, alternative risk metrics are incorporated, such as the Z-score, which measures bank stability as the sum of ROA and equity-to-assets, divided by the standard deviation of ROA (Danisman and Tarazi, 2020; Liu *et al*., 2024a, b), as well as the ratio of non-performing loans to total loans (NPL/Loans) and to total assets (NPL/Assets) (Le *et al*., 2023; Liu *et al*., 2023a, b).

3.2.2 Independent variables. The core independent variable, the CRFPI, follows the methodology of D'Orazio and Thole (2022) and measures the comprehensiveness and enforceability of national climate-related financial policies on a scale from 0 to 1. Higher values indicate more ambitious and binding policy regimes.

3.2.3 Control variables. For bank-specific controls, we use bank size, calculated as the natural logarithm of total assets. Larger banks often benefit from economies of scale, improving risk management and reducing the likelihood of loan losses (Bourkhis and Nabi, 2013; Vithessonthi, 2016). Leverage, defined as the ratio of total assets to total equity, is also included. While higher leverage may increase financial risk, well-capitalized banks can manage their leverage effectively to mitigate risk (Agoraki *et al*., 2011; Zhang *et al*., 2024). We also consider diversification, measured as the ratio of non-interest income to net income. Banks that diversify revenue streams through non-interest activities may be less reliant on traditional lending, thus reducing risk (DeYoung and Roland, 2001). Revenue growth, calculated as the annual growth rate of a bank's revenue, is another control. Rapid revenue growth may lead to riskier lending practices or expansion (Fahlenbrach *et al*., 2018). Efficiency is measured using the cost-to-income ratio, as more efficient banks are generally better at controlling operations and reducing loan losses (Sun *et al*., 2017).

For country-specific controls, we include GDP growth, which annual percentage increase in gross domestic product, to proxy for macroeconomic health (Koju *et al*., 2018). Market concentration, which is measured by Herfindahl-Hirschman Index (HHI), captures the degree of market power in the banking sector (Boyd and De Nicoló, 2005). Further details on the variable measurements are provided inAppendix A.

3.3 Model specification

To investigate the relationship between climate related financial policies and bank risk, we estimate the following benchmark regression model:

$$BankRisk_{i,j,t} = \alpha_0 + \beta CFP_{j,t-1} + \gamma X_{i,j,t-1} + \delta Z_{j,t-1} + countryFE + YearFE + \varepsilon_{it} \quad (1)$$

Where: *Bankrisk* refers to the risk, proxied by loan-loss provisions. *CFP* denotes the lagged climate-related financial policies index at the country level. *X* includes bank-specific control variables (*size*, *leverage*, *diversification*, $growth_{revenue}$, and *efficiency*), while *Z* includes country-specific control variables (GDP_{growth} and *HHI*). The model also incorporates fixed effects for firm and year.

3.4 Endogeneity problem

Endogeneity is a critical issue in policy impact studies, as banks operating in riskier environments may be more likely to adopt CFPs, or unobserved country-level characteristics could jointly influence both CFP adoption and bank risk (Angrist and Pischke, 2009; Wooldridge, 2010). To mitigate these risks, we implement a 2SLS regression, utilizing forest area as an instrumental variable for CFP. Forest area is selected because it is plausibly exogenous to bank risk, it is correlated with a country's propensity to implement climate policies but does not directly affect bank-specific risk outcomes (Kim *et al*., 2025).

Furthermore, we apply a Difference-in-Differences (DiD) approach to account for unobserved time-varying external shocks, particularly those associated with major global policy changes. The 2015 Paris Agreement serves as a natural experiment, allowing us to distinguish between pre- and post-policy periods and assess whether CFPs have a differential impact on bank risk after this global commitment (Tran *et al.*, 2024). By including an interaction term (*CFP*PostParis*), we directly test for changes in the effectiveness of CFPs in the wake of heightened international regulatory alignment.

4. Results

4.1 Descriptive statistics

Table 1 presents the regional distribution of banks and observations in our study, highlighting the geographical spread of the dataset used to examine the impact of climate-related financial policies on bank risks. The majority of the sample is from North America (United States and Canada), comprising 253 banks with 1,493 observations, accounting for 58.92% of the total. The second-largest region is Europe, with 69 banks and 465 observations, making up 18.35% of the sample. Given Europe's leadership in implementing climate-related financial regulations, this data offers critical insights into how these policies affect bank risks in a region with advanced climate finance frameworks (Lee *et al*., 2024). Asia/Pacific follows with 61 banks and 419 observations (16.54% of the sample), a region whose growing economic significance and increasing focus on sustainability initiatives may provide a valuable comparison to Europe's more developed climate policies (Le *et al*., 2023; Lee *et al*., 2022, 2024). Latin America is underrepresented, constituting 4.74% of the sample, while Africa and the Middle East make up only 1.46%.

Table 2 presents descriptive statistics for the key variables in this study. The mean LLP/Assets in our sample is 0.012, significantly higher than the mean of 0.005 reported by Olszak *et al*. (2018). The mean LLP/Equity (0.126) and LLP/Loans (0.019) in our sample are both lower than the corresponding means of 0.202 and 0.036 reported by Lee *et al*. (2024). These differences reflect variations in bank risk responses across studies, possibly influenced by differences in regulatory environments or regional characteristics.

The correlation matrix in Table 3 explores the relationship between CFP and bank risk, measured by LLP/Asset, LLP/Equity, and LLP/Loans. Notably, CFP shows a significant negative correlation with LLP/Asset (−0.088), LLP/Equity (−0.124), and LLP/Loans (−0.037), suggesting that stronger climate-related financial policies are associated with lower bank risk. While statistically significant, these correlations are modest in magnitude, indicating that CFP explains some variation in bank risk but is not a dominant factor.

4.2 Main results

Table 4 presents the results assessing the impact of CFP on various measures of bank risk. Across all specifications, the estimated coefficients for CFP are negative and highly significant

Table 1. Sample distribution

Region	# Banks	# Obs	Percentage
Africa/Middle East	3	37	1.46%
Asia/Pacific	61	419	16.54%
Europe	69	465	18.35%
Latin America and Caribbean	12	120	4.74%
North America	253	1,493	58.92%
Total	398	2,534	100%

Source(s): Authors' calculations

Table 2. Descriptive statistic

Variable	Obs	Mean	Std. dev.	Min	Max
LLP/Asset	2,534	0.012	0.009	0.002	0.055
LLP/Equity	2,534	0.126	0.108	0.020	0.622
LLP/Loans	2,534	0.019	0.016	0.003	0.090
CFP	2,534	0.373	0.214	0.000	1.000
Size	2,534	8.311	1.872	4.321	12.131
Leverage	2,534	11.355	4.362	4.402	25.802
Diversified	2,534	0.770	0.149	0.393	0.971
$Growth_{Revenue}$	2,534	0.084	0.178	−0.412	1.052
Efficiency	2,534	0.661	0.365	−0.294	1.896
GDP_{Growth}	2,534	0.019	0.026	−0.057	0.096
HHI	2,534	0.087	0.102	0.042	0.549

Source(s): Authors' calculations

(at the 1% level): −0.003 for LLP/Asset, −0.048 for LLP/Equity, and −0.005 for LLP/Loans. These findings lend strong support to Hypothesis 1, demonstrating that CFPs are associated with reduced bank risk. This outcome is in line with the conclusions of earlier studies (Birindelli *et al*., 2022, 2024; An *et al*., 2023) which highlight the effectiveness of climate-focused policies in lowering both systemic and credit risk in the banking sector. Furthermore, this outcome is consistent with Stakeholder Theory, which suggests that banks aligning with broader societal and regulatory stakeholders can mitigate reputational, legal, and credit-related vulnerabilities. By internalizing the expectations of regulators, customers, and communities through compliance with CFPs, banks strengthen their legitimacy and operational stability, thereby reducing their overall risk exposure.

With respect to the control variables, the analysis reveals that larger banks generally face lower risk, as indicated by the consistently negative and significant coefficients for bank size, corroborating previous evidence on bank stability (Le *et al*., 2023). Leverage displays a negative association with risk for LLP/Asset and LLP/Loans, while its effect is positive for LLP/Equity, suggesting that the influence of leverage on risk may depend on the risk metric employed. Diversification and revenue growth are both positively and significantly related to bank risk in all models. In contrast, higher efficiency, robust GDP growth, and greater market concentration are each linked to lower levels of risk, echoing patterns reported in recent literature (An *et al*., 2023; Chiaramonte *et al*., 2024; Lee *et al*., 2024).

4.3 The moderate effect of the environmental sustainability factors

This section investigates whether three environmental sustainability factors, including Environmental Innovation (ENI), Environmental Score (ENV), and Environmental Policy Stringency (EPS), influence the relationship between CFPs and bank risk. ENV represents an indicator of environmental performance, whereas ENI and EPS capture broader sustainability dimensions related to innovation and policy. To do so, the analysis divides the sample into high and low groups based on the median value for each factor and re-estimates the main regression accordingly.

4.3.1 The moderate effect of environmental innovation – ENI. Results presented in Table 5 indicate that CFPs are associated with a significant reduction in bank risk among institutions with high ENI scores. Specifically, for these banks, CFPs are linked to lower LLP/Asset, LLP/Equity, and LLP/Loans ratios, all significant. However, in the low ENI group, CFP does not significantly impact any risk measures. This suggests that banks actively engaged in environmental innovation benefit more from CFP in terms of risk reduction, whereas banks with lower innovation levels do not experience the same benefits.

Table 3. Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) LLP/Asset	1.000										
(2) LLP/Equity	0.881***	1.000									
	(0.000)										
(3) LLP/Loans	0.926***	0.843***	1.000								
	(0.000)	(0.000)									
(4) CFP	−0.088***	−0.124***	−0.037*	1.000							
	(0.000)	(0.000)	(0.062)								
(5) Size	0.140***	0.239***	0.263***	−0.147***	1.000						
	(0.000)	(0.000)	(0.000)	(0.000)							
(6) Leverage	−0.101***	0.264***	−0.011	−0.129***	0.394***	1.000					
	(0.000)	(0.000)	(0.596)	(0.000)	(0.000)						
(7) Diversified	0.274***	0.204***	0.194***	0.265***	−0.323***	−0.260***	1.000				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)					
(8) $Growth_{Revenue}$	−0.028	−0.054***	−0.034*	−0.051**	−0.091***	−0.121***	−0.044**	1.000			
	(0.164)	(0.007)	(0.087)	(0.011)	(0.000)	(0.000)	(0.027)				
(9) Efficiency	−0.107***	−0.173***	−0.122***	0.151***	0.096***	−0.160***	0.127***	0.182***	1.000		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)			
(10) GDP_{Growth}	0.068***	0.035*	0.053***	−0.133***	0.142***	−0.070***	−0.014	0.244***	0.358***	1.000	
	(0.001)	(0.081)	(0.008)	(0.000)	(0.000)	(0.000)	(0.471)	(0.000)	(0.000)		
(11) HHI	−0.024	−0.048**	0.028	−0.203***	0.158***	0.241***	−0.115***	−0.021	−0.012	−0.024	1.000
	(0.233)	(0.016)	(0.157)	(0.000)	(0.000)	(0.000)	(0.000)	(0.281)	(0.530)	(0.236)	

Note(s): Significance levels are indicated by ***, **, and * for the 1%, 5%, and 10% levels, respectively
Source(s): Authors' calculations

Table 4. The impact of CFP and bank risk

Variables	(1) LLP/ $Asset_{it+1}$	(2) LLP/ $Equity_{it+1}$	(3) LLP/ $Loans_{it+1}$
CFP	−0.003***	−0.048***	−0.005***
	(−4.187)	(−7.172)	(−4.434)
Size	−0.002***	−0.030***	−0.004***
	(−9.289)	(−10.477)	(−9.461)
Leverage	−0.000***	0.002***	−0.001***
	(−6.303)	(3.370)	(−4.968)
Diversified	0.014***	0.173***	0.024***
	(11.659)	(13.214)	(12.068)
$Growth_{Revenue}$	0.003***	0.033***	0.005***
	(5.166)	(5.851)	(6.146)
Efficiency	−0.003***	−0.022***	−0.005***
	(−5.092)	(−3.865)	(−5.194)
GDP_{Growth}	−0.020***	−0.227***	−0.047***
	(−4.688)	(−4.805)	(−6.561)
HHI	−0.036***	−0.155*	−0.046***
	(−4.397)	(−1.709)	(−3.320)
Constant	0.031***	0.261***	0.049***
	(12.275)	(9.391)	(11.625)
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	2,534	2,534	2,534
Adj R^2	0.198	0.230	0.208

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

4.3.2 The moderate effect of the environmental score pillar – ENV. Table 6 shows that for banks with high Environmental Scores, CFP significantly reduces risk across all three measures: LLP/Asset (−0.004), LLP/Equity (−0.079), and LLP/Loans (−0.008), all significant at the 1% level. In contrast, for banks with low Environmental Scores, CFP is not significantly associated with risk reduction. This finding suggests that banks adopting broader environmental practices experience stronger risk-reducing effects from CFP.

4.3.3 The moderate effect of environmental stringency policies – EPS. Table 7 examines the moderating effect of EPS. In countries with high EPS, CFP has a smaller but still significant negative effect on risk: LLP/Asset (−0.001), LLP/Equity (−0.046), and LLP/Loans (−0.003), significant at the 5% or 1% level. In contrast, in countries with low EPS, CFP has a stronger negative effect on risk: LLP/Asset (−0.005), LLP/Equity (−0.056), and LLP/Loans (−0.007), all significant. This suggests that in countries with weaker environmental policies, CFP plays a more critical role in mitigating bank risk, while in countries with stringent policies, its effect is present but less pronounced.

The results across Tables 5–7 consistently demonstrate that environmental sustainability factors significantly influence the relationship between CFPs and bank risk. Banks with higher environmental innovation and scores benefit more from CFP in reducing risk, while the stringency of environmental policies shapes this relationship differently across regions. Interestingly, CFP has a stronger effect in countries with weaker environmental policies, highlighting its compensatory role in such contexts.

The moderating analyses further reinforce the theoretical underpinnings of the RBV. Banks with higher environmental innovation and stronger environmental scores experience more pronounced risk-reducing effects from CFPs, indicating that ESG-related resources and

Table 5. The moderate effect of ENI

Variables	(1) High environmental innovation score LLP/ $Asset_{it+1}$	(2) LLP/ $Equity_{it+1}$	(3) LLP/ $Loans_{it+1}$	(4) Low environmental innovation score LLP/ $Asset_{it+1}$	(5) LLP/ $Equity_{it+1}$	(6) LLP/ $Loans_{it+1}$
CFP	−0.004***	−0.082***	−0.008***	−0.001	−0.011	−0.001
	(−3.868)	(−6.780)	(−4.694)	(−1.310)	(−1.534)	(−0.664)
Size	−0.001***	−0.021***	−0.003***	−0.003***	−0.039***	−0.005***
	(−2.868)	(−3.768)	(−3.684)	(−11.535)	(−14.754)	(−11.076)
Leverage	−0.000***	0.002*	−0.000***	−0.001***	0.001	−0.001***
	(−3.621)	(1.869)	(−2.896)	(−6.262)	(1.184)	(−5.916)
Diversified	0.018***	0.240***	0.033***	0.008***	0.077***	0.010***
	(9.663)	(10.813)	(10.637)	(4.944)	(5.462)	(4.157)
$Growth_{Revenue}$	0.004***	0.052***	0.008***	0.002***	0.012**	0.003***
	(4.087)	(5.032)	(5.351)	(3.191)	(2.171)	(2.582)
Efficiency	−0.003***	−0.038***	−0.006***	−0.003***	−0.012**	−0.004***
	(−3.206)	(−3.458)	(−4.127)	(−5.211)	(−2.087)	(−3.707)
GDP_{Growth}	−0.007	−0.063	−0.022*	−0.026***	−0.253***	−0.057***
	(−0.986)	(−0.703)	(−1.751)	(−5.163)	(−5.472)	(−6.920)
HHI	−0.008	0.103	−0.006	−0.145***	−1.000***	−0.186***
	(−0.769)	(0.779)	(−0.332)	(−9.678)	(−7.239)	(−7.557)
Constant	0.022***	0.214***	0.042***	0.047***	0.400***	0.071***
	(4.380)	(3.553)	(4.917)	(16.906)	(15.535)	(15.527)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	974	974	974	1,560	1,560	1,560
Adj R^2	0.201	0.278	0.253	0.275	0.270	0.239

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

capabilities enhance the effectiveness of external policies. These banks are better positioned to implement CFP requirements, embed them into risk management systems, and transform compliance into a source of resilience and competitive advantage. Conversely, in contexts with weaker environmental policy stringency, CFPs play a compensatory role, exerting stronger influence on risk outcomes. This pattern suggests that external climate-related policies can substitute for institutional deficiencies, further demonstrating the contingent nature of policy effectiveness.

4.4 Robustness checks

To confirm the reliability of our results, we perform several supplementary analyses: (1) a 2SLS estimation, (2) a DiD approach, and (3) tests using alternative definitions of risk. Collectively, these checks address issues of endogeneity, external shocks, and measurement validity, as summarized in Table 8.

4.4.1 2SLS analysis. To mitigate concerns regarding endogeneity, forest area is utilized as an instrumental variable for CFPs in our 2SLS regressions. This variable is deemed suitable as it is correlated with climate policy adoption but, theoretically, is unrelated to individual bank risk. The 2SLS results (Table 8, columns 1–3) indicate that CFPs continues to exert a significant negative influence on all three bank risk indicators (LLP/Assets, LLP/Equity, LLP/Loans), each at the 1% threshold level. These findings reinforce the robustness of our baseline results, even when controlling for possible endogeneity.

4.4.2 Difference-in-difference – DiD. To address the impact of major external shocks, we implement a DiD analysis, using the 2015 Paris Agreement as an exogenous event. We

Table 6. The moderate effect of ENV

Variables	(1) High environmental score LLP/ $Asset_{it+1}$	(2) LLP/ $Equity_{it+1}$	(3) LLP/ $Loans_{it+1}$	(4) Low environmental score LLP/ $Asset_{it+1}$	(5) LLP/ $Equity_{it+1}$	(6) LLP/ $Loans_{it+1}$
CFP	−0.004***	−0.079***	−0.008***	0.000	−0.004	0.001
	(−4.503)	(−6.951)	(−5.317)	(0.295)	(−0.505)	(1.018)
Size	−0.002***	−0.025***	−0.003***	−0.003***	−0.040***	−0.005***
	(−3.895)	(−5.024)	(−4.759)	(−10.978)	(−13.973)	(−10.572)
Leverage	−0.000***	0.003**	−0.000**	−0.001***	0.000	−0.001***
	(−3.132)	(2.471)	(−2.556)	(−7.245)	(0.386)	(−6.557)
Diversified	0.018***	0.236***	0.033***	0.007***	0.074***	0.011***
	(10.521)	(11.341)	(11.145)	(4.185)	(5.062)	(3.982)
$Growth_{Revenue}$	0.003***	0.048***	0.007***	0.002***	0.012**	0.002**
	(4.040)	(4.932)	(5.392)	(3.086)	(2.210)	(2.428)
Efficiency	−0.002***	−0.031***	−0.006***	−0.004***	−0.014**	−0.004***
	(−2.751)	(−3.087)	(−3.863)	(−5.746)	(−2.550)	(−3.920)
GDP_{Growth}	−0.012*	−0.113	−0.030**	−0.022***	−0.220***	−0.049***
	(−1.677)	(−1.347)	(−2.522)	(−4.109)	(−4.714)	(−5.706)
HHI	−0.016	0.034	−0.014	−0.173***	−1.160***	−0.231***
	(−1.547)	(0.278)	(−0.801)	(−9.202)	(−6.960)	(−7.567)
Constant	0.023***	0.237***	0.044***	0.051***	0.415***	0.075***
	(5.337)	(4.454)	(5.953)	(16.858)	(15.532)	(15.252)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1,096	1,096	1,096	1,438	1,438	1,438
Adj R^2	0.207	0.275	0.252	0.284	0.269	0.250

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

introduce a PostParis dummy (equal to 1 for years after 2015) and include an interaction term (*CFP*PostParis*) to examine how the relationship between CFP and bank risk changes following this global policy milestone.

The results in Table 8 (columns 4–6) show that the *PostParis* coefficient is negative and significant across all risk measures, indicating a decrease in bank risk (*LLP/Assets, LLP/Equity, LLP/Loans*) after the Paris Agreement. The *CFP*PostParis* interaction term is positive and significant, suggesting that while the negative relationship between CFP and bank risk weakens post-Agreement, CFP still reduces risk overall. This implies that the 2015 Paris Agreement moderates CFP's effect on bank risk.

4.4.3 An alternative measurement of risk. We further test the robustness of our results by using alternative measurements of CFPs. Instead of the original dependent variables, we use Z-score, NPL/Loans, and NPL/Assets as proxies for bank risk. As shown in Table 8 (columns 7–9), the results remain consistent with our baseline findings. CFPs is positively and significantly related to the Z-score, indicating improved bank stability, and a significantly negative effect on both NPL/Loans and NPL/Assets, all at the 1% level. These results confirm that CFPs consistently reduces bank risk, regardless of the risk measure used.

4.5 Heterogeneity analysis

4.5.1 Regional differences. We further explore whether CFP's impact on bank risk varies by region by conducting separate estimations for North America, Europe, and Asia (Table 9). Results show that CFPs significantly reduce bank risk in North America and Europe, with the effect especially strong in Europe, possibly due to more comprehensive regulatory

Table 7. The moderate effect of EPS

Variables	(1) High EPS LLP/ $Asset_{it+1}$	(2) LLP/ $Equity_{it+1}$	(3) LLP/ $Loans_{it+1}$	(4) Low EPS LLP/ $Asset_{it+1}$	(5) LLP/ $Equity_{it+1}$	(6) LLP/ $Loans_{it+1}$
CFP	−0.001**	−0.046***	−0.003**	−0.005***	−0.056***	−0.007***
	(−2.508)	(−4.695)	(−2.455)	(−5.503)	(−6.208)	(−4.704)
Size	−0.001***	−0.022***	−0.002***	−0.004***	−0.039***	−0.006***
	(−3.251)	(−4.929)	(−3.362)	(−10.776)	(−11.582)	(−10.960)
Leverage	−0.000***	0.002**	−0.000***	−0.001***	0.002**	−0.001***
	(−4.673)	(2.174)	(−3.807)	(−4.893)	(2.074)	(−3.813)
Diversified	0.016***	0.221***	0.026***	0.008***	0.071***	0.017***
	(9.923)	(11.682)	(9.619)	(4.313)	(3.976)	(5.589)
$Growth_{Revenue}$	0.003***	0.046***	0.006***	0.002***	0.020***	0.005***
	(4.137)	(5.163)	(4.398)	(3.278)	(2.925)	(4.301)
Efficiency	−0.001	−0.013	−0.003**	−0.006***	−0.039***	−0.008***
	(−1.317)	(−1.504)	(−2.210)	(−7.863)	(−5.588)	(−6.533)
GDP_{Growth}	−0.004	−0.071	−0.011	−0.046***	−0.473***	−0.099***
	(−0.624)	(−0.992)	(−1.059)	(−7.486)	(−7.876)	(−9.835)
HHI	−0.021*	−0.039	−0.020	−0.088***	−0.653***	−0.126***
	(−1.861)	(−0.300)	(−1.081)	(−7.094)	(−5.369)	(−6.187)
Constant	0.018***	0.172***	0.030***	0.052***	0.437***	0.079***
	(5.122)	(4.058)	(4.970)	(14.046)	(12.079)	(12.980)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1,313	1,313	1,313	1,221	1,221	1,221
Adj R^2	0.138	0.203	0.140	0.353	0.348	0.367

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

frameworks and higher environmental standards. Conversely, in Asia, CFPs are associated with an increase in certain risk measures, suggesting that regional differences in policy enforcement and economic structure may shape policy effectiveness.

4.5.2 Heterogeneity across developed vs. developing countries. Finally, we compare the CFP-bank risk relationship across developed and developing economies (Table 10). The analysis reveals that in developed markets, CFPs robustly decrease bank risk, likely reflecting advanced regulatory systems and greater policy integration. In contrast, in developing countries, CFPs appear to increase risk, potentially due to weaker enforcement, economic volatility, or less experience managing green financial reforms. These findings underscore the importance of considering both institutional context and economic maturity when evaluating climate policy outcomes in banking.

5. Discussion and conclusion

5.1 Discussion

By using a dataset of 2,534 bank-year observations from 2000 to 2021, this study provides comprehensive evidence that CFPs are effective in reducing bank risk, particularly in environments with robust regulatory frameworks and high levels of environmental innovation and performance, aligns with previous empirical findings (Birindelli *et al*., 2022, 2024; An *et al*., 2023). These findings strongly support Hypothesis 1, confirming that CFPs mitigate bank risk, and are consistent with recent empirical literature. From a theoretical standpoint, our results align with both stakeholder theory and the RBV. Stakeholder theory suggests that banks

Table 8. Robustness check: 2SLS, staggered DiD, alternative measurement of risk

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	2SLS			Staggered DiD			Alternative measurement of CFP		
Variables	LLP/ $Asset_{it+1}$	LLP/ $Equity_{it+1}$	LLP/ $Loans_{it+1}$	LLP/ $Asset_{it+1}$	LLP/ $Equity_{it+1}$	LLP/ $Loans_{it+1}$	$Zscore_{it+1}$	NPL/ $Loans_{it+1}$	NPL/ $Asset_{it+1}$
CFP	−0.020***	−0.167***	−0.033***	−0.007***	−0.065***	−0.012***	0.775***	−1.172***	−0.683***
	(−3.716)	(−3.833)	(−3.813)	(−6.292)	(−5.411)	(−6.654)	(8.923)	(−7.706)	(−6.980)
PostParis				−0.004***	−0.041***	−0.006***			
				(−8.746)	(−8.041)	(−8.334)			
CFP*PostParis				0.010***	0.077***	0.017***			
				(8.486)	(5.966)	(8.424)			
Size	−0.001*	−0.020***	−0.002*	−0.002***	−0.030***	−0.004***	0.389***	−0.375***	−0.205***
	(−1.674)	(−3.352)	(−1.905)	(−9.258)	(−10.568)	(−9.408)	(10.654)	(−5.874)	(−4.985)
Leverage	−0.001***	−0.001	−0.001***	−0.000***	0.002***	−0.001***	−0.015*	−0.035**	−0.026***
	(−4.116)	(−0.717)	(−3.834)	(−6.979)	(2.676)	(−5.561)	(−1.722)	(−2.299)	(−2.632)
Diversified	0.013***	0.170***	0.023***	0.014***	0.175***	0.025***	−0.886***	3.364***	2.124***
	(5.984)	(6.961)	(6.006)	(12.184)	(13.472)	(12.609)	(−5.241)	(11.365)	(11.154)
$Growth_{Revenue}$	0.001	0.022**	0.003*	0.003***	0.031***	0.005***	−0.239***	0.638***	0.377***
	(1.154)	(2.184)	(1.815)	(5.096)	(5.538)	(6.134)	(−3.255)	(4.975)	(4.563)
Efficiency	−0.002**	−0.020**	−0.004***	−0.003***	−0.024***	−0.005***	0.337***	−0.825***	−0.420***
	(−2.540)	(−2.269)	(−2.731)	(−5.615)	(−4.131)	(−5.725)	(4.508)	(−6.298)	(−4.988)
GDP_{Growth}	−0.067***	−0.547***	−0.123***	−0.005	−0.084*	−0.023***	5.706***	−4.229***	−1.648**
	(−3.912)	(−3.965)	(−4.439)	(−1.147)	(−1.680)	(−3.043)	(9.356)	(−3.962)	(−2.399)
HHI	−0.013	0.005	−0.008	−0.039***	−0.168*	−0.051***	2.754**	−7.963***	−6.758***
	(−0.771)	(0.042)	(−0.308)	(−4.863)	(−1.877)	(−3.786)	(2.362)	(−3.902)	(−5.146)
Constant				0.032***	0.274***	0.051***	0.762**	4.439***	2.590***
				(12.905)	(9.965)	(12.198)	(2.125)	(7.071)	(6.410)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	2,521	2,521	2,521	2,534	2,534	2,534	2,534	2,534	2,534
Adj R^2	0.105	0.119	0.070	0.228	0.253	0.237	0.191	0.187	0.162

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

Table 9. Heterogeneity across regions

Variables	(1) North America LLP/ $Asset_{it+1}$	(2) LLP/ $Equity_{it+1}$	(3) LLP/ $Loans_{it+1}$	(4) Europe LLP/ $Asset_{it+1}$	(5) LLP/ $Equity_{it+1}$	(6) LLP/ $Loans_{it+1}$	(7) Asia LLP/ $Asset_{it+1}$	(8) LLP/ $Equity_{it+1}$	(9) LLP/ $Loans_{it+1}$
CFP	−0.008***	−0.069***	−0.011***	−0.010***	−0.165***	−0.019***	0.006***	0.013	0.008***
	(−11.867)	(−11.470)	(−9.898)	(−4.363)	(−5.957)	(−5.110)	(4.371)	(0.942)	(3.348)
Size	−0.003***	−0.041***	−0.006***	−0.001	−0.029***	−0.002*	−0.003***	−0.022**	−0.005***
	(−15.126)	(−19.945)	(−15.577)	(−1.300)	(−3.281)	(−1.903)	(−3.453)	(−2.468)	(−3.156)
Leverage	−0.000***	0.002***	−0.000**	−0.000**	0.001	−0.001**	−0.001***	−0.001	−0.001***
	(−3.117)	(3.771)	(−2.418)	(−2.202)	(0.617)	(−2.310)	(−4.529)	(−0.737)	(−3.047)
Diversified	0.009***	0.091***	0.017***	0.018***	0.254***	0.030***	0.001	0.018	0.002
	(8.335)	(8.883)	(9.376)	(5.675)	(6.646)	(5.799)	(0.190)	(0.405)	(0.298)
$Growth_{Revenue}$	0.001***	0.009**	0.003***	0.005***	0.082***	0.010***	0.000	0.009	−0.001
	(3.567)	(2.448)	(4.510)	(3.901)	(4.732)	(4.437)	(0.022)	(0.450)	(−0.253)
Efficiency	−0.002***	−0.006	−0.003***	−0.003*	−0.043**	−0.008***	−0.007***	−0.058***	−0.008***
	(−5.050)	(−1.574)	(−4.328)	(−1.870)	(−2.270)	(−3.268)	(−3.957)	(−3.223)	(−2.661)
GDP_{Growth}	−0.039***	−0.463***	−0.085***	0.002	−0.027	0.004	−0.018	−0.099	−0.036*
	(−10.011)	(−12.984)	(−13.169)	(0.118)	(−0.168)	(0.177)	(−1.648)	(−0.869)	(−1.892)
HHI	−0.096***	−0.491***	−0.127***	−0.199***	−0.968	−0.264**	−0.120**	−0.530	−0.155
	(−10.100)	(−5.666)	(−8.138)	(−2.866)	(−1.138)	(−2.336)	(−2.066)	(−0.868)	(−1.509)
Constant	0.043***	0.381***	0.065***	0.035***	0.422***	0.064***	0.066***	0.484***	0.099***
	(19.285)	(18.864)	(17.854)	(3.726)	(3.659)	(4.158)	(5.968)	(4.136)	(5.022)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs	1,525	1,525	1,525	465	465	465	395	395	395
Adj R^2	0.459	0.510	0.461	0.229	0.331	0.279	0.252	0.079	0.171

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

Table 10. Heterogeneity analysis: developed vs developing countries

Variables	(1) Developed countries LLP/ $Asset_{it+1}$	(2) Developed countries LLP/ $Equity_{it+1}$	(3) Developed countries LLP/ $Loans_{it+1}$	(4) Developing countries LLP/ $Asset_{it+1}$	(5) Developing countries LLP/ $Equity_{it+1}$	(6) Developing countries LLP/ $Loans_{it+1}$
CFP	−0.006***	−0.078***	−0.010***	0.008***	0.043**	0.011***
	(−9.980)	(−10.679)	(−9.593)	(4.762)	(2.556)	(3.705)
Size	−0.002***	−0.029***	−0.004***	−0.002**	−0.026***	−0.003
	(−9.511)	(−10.049)	(−10.006)	(−2.386)	(−2.876)	(−1.581)
Leverage	−0.000***	0.003***	−0.000***	−0.001***	0.002	−0.001**
	(−4.971)	(3.741)	(−3.857)	(−3.434)	(1.073)	(−2.101)
Diversified	0.015***	0.192***	0.027***	0.002	0.020	0.000
	(13.779)	(14.623)	(14.928)	(0.394)	(0.450)	(0.036)
$Growth_{Revenue}$	0.003***	0.037***	0.006***	0.003	0.018	0.005
	(6.088)	(6.662)	(7.388)	(1.422)	(0.805)	(1.234)
Efficiency	−0.002***	−0.017***	−0.004***	−0.012***	−0.079***	−0.014***
	(−3.529)	(−2.847)	(−4.495)	(−6.272)	(−4.324)	(−4.143)
GDP_{Growth}	−0.020***	−0.236***	−0.043***	−0.029**	−0.268**	−0.073***
	(−4.747)	(−4.710)	(−6.080)	(−2.345)	(−2.188)	(−3.311)
HHI	−0.021**	−0.045	−0.039***	−0.116***	−0.801***	−0.135***
	(−2.312)	(−0.422)	(−2.640)	(−5.952)	(−4.149)	(−3.918)
Constant	0.025***	0.214***	0.041***	0.070***	0.570***	0.096***
	(11.162)	(7.978)	(10.928)	(5.935)	(4.882)	(4.608)
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs	2,150	2,150	2,150	384	384	384
Adj R^2	0.263	0.295	0.294	0.329	0.179	0.220

Note(s): *t*-statistics are shown in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively

Source(s): Authors' calculations

responding proactively to societal and regulatory expectations are better equipped to manage risk, while the RBV underscores the importance of internal capabilities, such as environmental innovation and expertise, in sustaining a competitive advantage and effectively addressing climate-related exposures.

Importantly, the evidence also supports Hypothesis 2, showing that environmental sustainability factors significantly moderate the relationship between CFPs and bank risk. The risk-reducing impact of CFPs is notably stronger among banks and regions with higher environmental innovation and sustainability practices, but weaker or negligible where such factors are less developed. This underscores the complementary roles of external policy initiatives and internal institutional capabilities in shaping financial stability outcomes. These findings underscore that CFPs are most effective when external regulatory pressures are complemented by internal institutional capabilities. The study thus advances the literature by demonstrating that the success of CFPs depends on a dual foundation of the bank's own capacity to integrate sustainability into its operations, and the strength of the surrounding regulatory environment.

5.2 Implications

The results carry several important implications. First, they demonstrate that the effectiveness of CFPs is not automatic but conditional on both bank-level capacities and regulatory contexts. This finding refines stakeholder theory and RBV perspectives by empirically showing that policy interventions achieve the greatest impact when they are supported by strong institutional environments and firm-level innovation. Conversely, where regulatory

enforcement is weak and bank capabilities are underdeveloped, CFPs may yield limited or even adverse outcomes.

For policymakers, this suggests that a "one-size-fits-all" approach to climate-related financial regulation is unlikely to succeed. In developing economies or jurisdictions with weaker governance, CFPs should be accompanied by capacity-building measures, such as technical assistance, subsidies for green innovation, and phased implementation strategies to manage transitional risks. Regulators in advanced economies should instead focus on refining and harmonizing CFPs with existing environmental and financial governance frameworks to maximize synergies.

For banks, the findings highlight the importance of strengthening internal capabilities to fully leverage CFPs. This includes investing in green innovation, improving environmental risk assessment systems, enhancing disclosure quality, and embedding sustainability into strategic and credit decisions. By building these capacities, banks can reduce their vulnerability to climate-related risks while simultaneously creating long-term value.

From a research perspective, our study highlights the conditional nature of CFP effectiveness. Future research should further disentangle the mechanisms through which internal capabilities and external institutions jointly shape the impact of CFPs on financial stability. Examining bank-level adoption of CFP initiatives and their interaction with other regulatory tools such as capital requirements or green taxonomies, would also provide valuable insights.

5.3 Limitations and future research

This research is not without limitations. Our measure of CFP is at the country level, which may not reflect intra-country variations or the precise bank-level intensity of CFP adoption. Future research should examine bank-level CFP initiatives and explore the interplay between climate regulation and other dimensions of financial governance. Additionally, investigating the long-term dynamic impacts of CFPs as climate policies and financial markets continue to evolve represents a promising avenue for future study.

Note

1. https://zenodo.org/records/7599914

Supplementary material

The supplementary material for this article can be found online.

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