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ESG and Loan Loss Provisioning in Banks: The Moderating Role of National Climate Policy

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ABSTRACT

This study examines how banks' environmental, social, and governance (ESG) performance is associated with loan loss provisioning, a key channel through which banks recognize expected credit losses. Moreover, this relationship is further investigated by considering the moderating role of national climate policy and response performance. Using a dynamic panel dataset of 576 commercial banks worldwide over the period 2010-2023, the study combines bank-level ESG and financial data with country-level Climate Change Performance Index (CCPI) data. The System GMM estimator is employed to address dynamic persistence in provisioning, unobserved bank-level heterogeneity, and potential endogeneity. The results show that ESG performance is significantly associated with loan loss provisioning, but its effect depends on the national climate policy and response context. The findings suggest that, under stronger climate policy and response conditions, ESG reflects not only risk-mitigation capacity but also banks' ability to identify climate-related and transition risks earlier and recognize expected credit losses more prudently. Robustness checks using the inverse hyperbolic sine transformation of loan loss provisions support the stability of the main results. The study contributes to the banking and sustainable finance literature by showing that the role of ESG in credit risk recognition is context-dependent rather than uniform across national climate environments.

Keywords: ESG, Loan loss provisioning, Expected credit loss recognition, National climate policy and response performance, CCPI.

Introduction

Today, climate change and sustainability are no longer peripheral concerns for the financial system. They have increasingly become sources of risk with direct implications for asset quality, credit allocation and financial stability. Physical shocks arising from extreme weather events, together with transition risks associated with decarbonization, can affect asset values, firms' repayment capacity and expected losses in banks' loan portfolios (Battiston *et al*., 2017; Network for Greening the Financial System, 2019; Bolton *et al*., 2020). This recognition has prompted banking supervisors to require credit institutions to integrate climate-related risks into governance, strategy, risk appetite and credit assessment processes (Basel Committee on Banking Supervision, 2022). Against this background, understanding how banks identify and respond to sustainability-related risks has become an urgent issue for both academic research and policy debate.

In banking, loan portfolio quality and expected credit loss recognition constitute key channels through which climate and sustainability risks may affect financial stability. When borrowers face higher environmental compliance costs, stranded assets, declining cash flows, or legal risks, their probability of default and banks' expected credit losses may increase. Loan loss provisions therefore reflect not only observed deterioration in loan portfolio quality but also banks' prudence in recognizing expected credit losses (Laeven & Majnoni, 2003; Beatty & Liao, 2011; Bushman & Williams,

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2012). This approach is particularly relevant because climate-related risks are often long-term, non-linear, and difficult to quantify using traditional credit risk models.

Alongside the rise of sustainable finance, environmental, social and governance (ESG) factors have increasingly been viewed as an important component of bank risk management. At the corporate level, prior studies show that sustainability practices may be associated with stronger governance processes, a longer-term orientation and better operating performance (Eccles *et al*., 2014; Friede *et al*., 2015). In credit markets, evidence also indicates that social and environmental responsibility information can affect loan conditions, the cost of debt, and bank-borrower relationships (Goss & Roberts, 2011; Chava, 2014; Houston & Shan, 2022). This suggests that ESG is not merely a disclosure tool or a reputational signal, but may also serve as an informational capability that helps banks assess, monitor, and price credit risk.

ESG may influence banks' credit risk recognition through two mechanisms. The risk-mitigation mechanism suggests that stronger ESG performance improves governance, borrower screening, and post-lending monitoring, thereby reducing information asymmetry and enhancing loan portfolio quality. Conversely, the risk-identification mechanism implies that ESG capabilities enable banks to detect climate-related, regulatory, and transition risks earlier, leading to more timely and prudent loan loss provisioning.

The relative strength of these mechanisms depends on the national climate policy environment. Clearer climate regulations, disclosure requirements, and supervisory expectations increase the visibility of transition risks and strengthen the integration of ESG information into credit decisions and provisioning behaviour. In weaker policy environments, ESG may have a less pronounced effect on credit risk recognition.

Although previous studies have examined ESG in lending activities and climate risk in loan pricing, the existing literature has not fully explained how national climate policy and response performance may condition the relationship between bank-level ESG and loan loss provisioning (Ehlers *et al*., 2021; Houston & Shan, 2022).

This study addresses this gap by examining whether national climate performance moderates the relationship between banks' ESG performance and loan loss provisioning. It combines bank-level data from Refinitiv Eikon with the Climate Change Performance Index (CCPI) to construct a global dynamic panel of commercial banks for 2010–2023. System GMM is employed to address persistence in the error term, bank-specific heterogeneity, and potential endogeneity (Arellano & Bover, 1995; Blundell & Bond, 1998; Roodman, 2009).

The study contributes by positioning ESG as a credit-risk management capability and examining loan loss provisioning as a direct channel through which banks recognize expected credit losses. It further shows that the ESG–provisioning relationship varies across national climate-policy contexts. The findings highlight the importance of integrating ESG into credit-risk management and aligning ESG disclosure, climate-risk supervision, and loan loss provisioning during the low-carbon transition.

The remainder of the paper is structured as follows. Section 2 reviews the literature and develops the research hypotheses. Section 3 presents the empirical model and data. Section 4 reports and discusses the empirical results. Section 5 concludes the paper.

Literature Review and Hypothesis Development

ESG Performance and Banks' Loan Loss Provisioning

In banking, credit risk arises primarily from the possibility that borrowers fail to meet their debt obligations in full. Owing to the nature of financial intermediation, banks do not merely provide funds; they also act as delegated monitors by collecting information and controlling borrower behavior throughout the life of the loan (Diamond, 1984; Boot, 2000). The quality of information and monitoring capacity is therefore central to banks' ability to identify, measure, and control credit risk.

Theoretically, ESG may affect loan loss provisioning through two channels. First, the risk-mitigation mechanism suggests that stronger ESG performance enhances governance, transparency, internal controls, borrower screening, and credit monitoring, thereby reducing information asymmetry and lending risks (Eccles *et al*., 2014; Friede *et al*., 2015). Consistently, ESG-related factors influence loan pricing, borrower selection, and bank–borrower relationships (Goss & Roberts, 2011; Chava, 2014; Houston & Shan, 2022).

Second, under the risk-identification mechanism, ESG capabilities enable banks to detect environmental, climate, regulatory, reputational, and transition risks earlier. Banks may consequently recognize expected credit losses more promptly and prudently. Thus, higher provisions may reflect stronger risk identification and provisioning practices rather than poorer loan portfolio quality.

This perspective is particularly appropriate when credit risk recognition is examined through loan loss provisions. Loan loss provisions do not merely reflect realized losses; they also capture banks' expectations about future credit losses, their prudence in risk recognition, and the resilience of their balance sheets. Studies on bank provisioning show that provisioning behavior is closely related to the credit cycle, loss recognition, risk governance, and financial discipline (Laeven & Majnoni, 2003; Beatty & Liao, 2011; Bushman & Williams, 2012).

An important caveat is that ESG ratings are not perfectly homogeneous signals. Berg, Kölbel and Rigobon (2022) show that ESG ratings from different providers can diverge substantially because of differences in scope, measurement and weighting. This indicates that ESG should be interpreted as a composite information source rather than as an absolute and error-free measure of sustainability. When integrating ESG into credit risk management, banks require the capability to process and translate sustainability information into appropriate lending and provisioning decisions.

H1: Banks' ESG performance is significantly associated with loan loss provisioning, as measured by the loan loss provision ratio.

National Climate Policy and Response Performance and Banks' Loan Loss Provisioning

Climate-related risk is increasingly recognized as a source of financial risk with direct implications for the banking system. These risks are commonly divided into two broad categories: physical risk and transition risk.

Climate-related risks can affect banks through several channels. At the borrower level, they may weaken cash flows, increase compliance costs, reduce collateral values, or make business models less sustainable. At the loan portfolio level, climate shocks or transition policies may increase the probability of default and expected credit losses in carbon-intensive sectors or among borrowers heavily dependent on carbon-related assets. Battiston *et al*. (2017) show that climate policy risk can propagate through the financial system via financial institutions' exposures to sectors sensitive to the low-carbon transition. Bolton *et al*. (2020) emphasize that climate risk is non-linear, difficult to forecast, and capable of generating severe financial shocks if not identified on time.

This recognition has been reflected in international supervisory guidance. Network for Greening the Financial System (2019) identifies climate change as a source of financial risk that falls within the mandates of central banks and financial supervisors. The Basel Committee on Banking Supervision (2022) also emphasizes the need to integrate climate-related financial risks into banks' governance, strategy, internal controls, risk management and disclosure. These developments indicate that climate risk is no longer a peripheral issue of social responsibility but a core component of bank risk management and prudential supervision.

National climate policy may influence loan loss provisioning by shaping the visibility and predictability of transition risk. Clearer climate regulations and disclosure requirements enable banks to assess borrowers' climate exposures and adjust provisioning more effectively. Consistent with this view, carbon and environmental risks are reflected in loan pricing and borrowing costs, particularly when transition risks become more visible (Chava, 2014; Ehlers *et al*., 2021).

However, the effect of climate policy and response performance on loan loss provisioning may operate in two directions. On the one hand, a clearer climate policy and response environment may improve information quality, enhance banks' ability to forecast risk, and reduce long-term credit losses. In this case, higher national climate performance may be associated with lower provisioning. On the other hand, stronger climate policy and response performance may make transition risks more visible and easier to identify, especially for borrowers in carbon-intensive sectors or with business models that are less adaptable to the low-carbon transition. In this case, banks may increase provisions to reflect higher expected credit losses during the transition period.

In this study, national climate policy and response performance is proxied by the Climate Change Performance Index (CCPI). The CCPI evaluates countries' climate performance across four categories: greenhouse gas emissions, renewable energy, energy use, and climate policy (Germanwatch, NewClimate Institute and Climate Action Network International, various years). Because the CCPI captures both climate outcomes and policy orientation, it is suitable for measuring the external institutional environment that may affect how banks identify and recognize credit risk.

Based on these arguments, the study expects national climate policy and response performance to be significantly related to banks' loan loss provisioning behavior.

H2: National climate policy and response performance is significantly associated with banks' loan loss provisioning, as measured by the loan loss provision ratio.

The Moderating Role of Climate Policy and Response Performance in the ESG-Provisioning Relationship

Prior studies provide evidence that ESG can affect credit conditions, bank-borrower relationships, and lenders' risk assessments (Goss & Roberts, 2011; Chava, 2014; Houston & Shan, 2022). Another stream of research emphasizes that climate risk and climate policy can influence loan pricing, credit allocation, and financial stability (Battiston *et al*., 2017; Network for Greening the Financial System, 2019; Ehlers, Packer and de Greiff, 2021; Basel Committee on Banking Supervision, 2022). However, these two research streams have often been examined separately. An important gap is that the literature has not fully explained whether the national climate policy and response context changes the way bank-level ESG is translated into credit risk identification and loan loss provisioning.

Climate policy and response performance may moderate the ESG–provisioning relationship by altering the informational value of ESG. In weaker policy environments, ESG primarily improves governance, borrower screening, and credit monitoring, potentially reducing loan loss provisions. In stronger environments, clearer regulations, disclosure requirements, and supervisory expectations enable ESG-oriented banks to identify climate and transition risks earlier, potentially increasing provisions or weakening ESG's negative effect on them. Consistent with institutional theory (North, 1990), the effect of bank-level ESG on provisioning therefore depends on the national climate policy and response context.

H3: National climate policy and response performance positively moderates the relationship between ESG performance and loan loss provisioning, as measured by the loan loss provision ratio.

Materials and Methods

Empirical Model and Data

To test the relationship between ESG and loan loss provisioning, and to examine the moderating role of national climate policy and response performance as captured by the CCPI, the study estimates the following dynamic panel model:

$$LLPR_{it} = \beta_0 + \beta_1 LLPR_{i,t-1} + \beta_2 ESG_{i,t-1} + \beta_3 log(DP_{i,t-1}) + \beta_4 EA_{i,t-1} + \beta_5 NIM_{i,t-1} + \beta_6 CCPI_{n,t-1} + \beta_7 (ESG_{i,t-1} \times CCPI_{n,t-1}) + \mu_i + \varepsilon_{it} \quad (1)$$

where LLPR denotes the bank's loan loss provision ratio; ESG is the aggregate ESG score; log(DP) is the logarithm of total deposits; EA is the ratio of equity to total assets; NIM is net interest margin; CCPI is the Climate Change Performance Index of the country in which the bank operates; and ESG × CCPI is the interaction term used to test the moderating effect of national climate policy and response performance. The subscripts i, n, and t denote bank, country, and year, respectively.

The study uses data from two main sources: bank-level financial data from Refinitiv Eikon (formerly Thomson Reuters Eikon) and country-level climate performance data from the Climate Change Performance Index (CCPI), published by Germanwatch and the NewClimate Institute.

Refinitiv Eikon provides detailed financial information for commercial banks, including loan loss provisions and deposits. Refinitiv ESG Scores provide information on banks' aggregate ESG performance, which reflects the extent of banks' sustainable business practices over the period 2010-2023. After filtering out banks with incomplete data, the final sample consists of 576 commercial banks worldwide.

The moderating variable, CCPI, is obtained from the annual CCPI reports. The index is based on assessments by more than 450 independent experts from over 60 countries and reflects the climate performance of 63 countries and the European Union. The CCPI is widely used as an independent and transparent instrument for monitoring national progress in climate mitigation and climate policy and response performance.

Given the dynamic nature of loan loss provisioning and the persistence of ESG and bank size, System GMM is employed to address potential endogeneity and instrument weakness (Arellano & Bover, 1995; Blundell & Bond, 1998).To address these issues, the study applies the System GMM estimator proposed by Arellano and Bover (1995) and Blundell and Bond (1998). System GMM helps control for endogeneity and unobserved bank-level heterogeneity and is particularly suitable for estimating dynamic models with moderating effects and complex panel structures.

Data processing and estimation are conducted in Stata 17. After excluding incomplete observations and log-transforming total deposits, the study estimates the model using System GMM, with model validity assessed by the Hansen and AR(2) tests. Marginal effects of ESG are evaluated at the 25th, 50th, and 75th percentiles of CCPI, and the turning point is estimated to identify the threshold at which the ESG effect changes sign. As a robustness check, LLPR is replaced with asinh(LLP).

Results and Discussion

Empirical Results and Discussion

Descriptive Statistics

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LLPR	3,806	0.007567	0.021698	-0.13971	0.998556
ESG	3,806	46.83098	21.10126	2.397773	95.73984
DP	3,806	1.88E+11	4.46E+11	0	4.78E+12
EA	3,806	0.095981	0.036442	-0.04205	0.455016
NIM	3,211	0.029499	0.017185	-0.1151	0.217
CCPI	3,806	45.64551	13.65324	11.2	79.61

Source: Authors' calculation

The descriptive statistics indicate a multi-country dataset with substantial heterogeneity. In terms of sustainability practices, ESG has a mean of 46.83, a standard deviation of 21.10, and a wide range from 2.40 to 95.74, suggesting considerable cross-bank variation in ESG implementation and disclosure. At the institutional-context level, the CCPI also displays sizeable dispersion, with a mean of 45.65, a standard deviation of 13.65, and a range from 11.20 to 79.61. This dispersion reflects heterogeneity in climate policy and response environments and transition pressures across countries, which is a key source of variation for testing the moderating role of climate policy and response performance.

With respect to loan loss provisioning, LLPR has a mean of 0.0076 and a standard deviation of 0.0217, indicating that average provisioning is relatively low but varies considerably across banks and over time. The distance between the minimum and maximum values is also large, with a minimum of -0.1397 and a maximum of 0.9986, suggesting that LLPR is skewed. To ensure that the conclusions are not driven by extreme observations and to enhance the reliability of empirical inference, the study reports marginal effects at selected percentiles of CCPI and uses the alternative transformed measure asinh(LLP) to test whether the results are stable under a less skewed provisioning measure.

The scale variable also shows substantial stratification across banks. DP has a mean of 1.88 × 10^11, a standard deviation of 4.46 × 10^11, and a maximum of 4.78 × 10^12. This indicates strong right-skewness and substantial differences in deposit bases and operating scale across banks. Log-transforming size-related variables is therefore appropriate to reduce skewness and limit the influence of extremely large banks on the estimates.

In terms of capital strength, the mean EA is 0.096, but it ranges from -0.042 to 0.455. This suggests that the sample includes observations with negative equity, potentially reflecting periods of stress or restructuring, as well as highly capitalized banks. Finally, NIM has a mean of 0.0295, approximately 2.95%, and ranges from -0.115 to 0.217,

implying that interest income performance is generally positive but that periods of negative interest margins are also present. This reflects the sensitivity of bank profitability to market conditions and funding costs.

Table 2. Correlation matrix

	LLPR	ESG	DP	EA	NIM	CCPI
LLPR	1.000	0.067***	-0.010	0.191***	0.009	0.109***
ESG	0.067***	1.000	0.332***	-0.227***	0.008	0.239***
DP	-0.010	0.332***	1.000	-0.292***	-0.215***	0.108***
EA	0.191***	-0.227***	-0.292***	1.000	0.520***	-0.193***
NIM	0.009	0.008	-0.215***	0.520***	1.000	-0.005
CCPI	0.109***	0.239***	0.108***	-0.193***	-0.005	1.000

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

The correlation matrix shows that pairwise correlations among LLPR, ESG, DP, EA, NIM and CCPI are generally low to moderate, suggesting that multicollinearity is unlikely to be a major concern in the regression model. The largest correlation appears between NIM and EA ($r = 0.5200$, $p < 0.01$), indicating a positive association between net interest margin and capitalization. The remaining correlations are below approximately 0.35, including ESG-DP ($r = 0.3317$, $p < 0.01$), DP-EA ($r = -0.2923$, $p < 0.01$), ESG-EA ($r = -0.2270$, $p < 0.01$), and CCPI-ESG ($r = 0.2392$, $p < 0.01$). These patterns reflect heterogeneity in bank size, balance-sheet structure, ESG performance, and national policy context.

Main Empirical Results

System GMM Regression Results

Table 3. System GMM estimation results

Variable	Coefficient
L1.LLPR	-0.36606*
L1.ESG	-0.00088**
L1.logDP	0.0038850***
L1.EA	0.043254
L1.NIM	0.2034538*
L1.CCPI	-0.00074**
L1.ESG × CCPI	0.0000197**
Constant	-0.0117685
AR(2) p-value	0.182
Hansen p-value	0.136

Note: *, ** and *** denote significance at the 10%, 5% and 1% levels, respectively.

The diagnostic tests indicate that the model satisfies the basic requirements concerning instrument validity and residual structure. Specifically, the AR(2) test has a p-value of 0.182, suggesting no evidence of second-order serial correlation in the differenced residuals. The Hansen test has a p-value of 0.136, indicating that the null hypothesis of instrument validity is not rejected at conventional significance levels. The System GMM estimates can therefore be used to interpret the dynamic relationship among ESG, CCPI, and loan loss provisioning.

The coefficient on the lagged dependent variable, L1.LLPR, is negative and statistically significant at the 10% level (beta = -0.36606). This suggests that loan loss provisioning tends to adjust downward following periods of elevated provisioning. The result reflects the dynamic adjustment of loan loss provisions: when provisions are high in the previous period, banks tend to reduce provisions in the subsequent period, whereas periods of low provisioning may be followed by subsequent adjustments. This finding is consistent with the literature on bank provisioning, which

argues that provisions reflect not only realized credit losses but also the credit cycle, loss-recognition discipline, and balance-sheet adjustment over time (Laeven & Majnoni, 2003; Beatty & Liao, 2011; Bushman & Williams, 2012).

The coefficient on lagged ESG is negative and statistically significant at the 5% level (beta = -0.00088). Because the model includes the ESG × CCPI interaction term, this coefficient should be interpreted as a conditional effect at the reference value of CCPI rather than as an unconditional ESG effect. Substantively, the negative coefficient is consistent with the risk-mitigation mechanism developed in the literature review: ESG may reflect stronger governance quality, greater transparency, more rigorous borrower screening and more effective post-lending monitoring. Accordingly, ESG can help banks reduce information asymmetry, mitigate adverse selection and improve loan portfolio quality. The economic interpretation is therefore completed by the marginal-effect analysis reported in **Table 4**.

The coefficient on lagged CCPI is negative and statistically significant at the 5% level (beta = -0.00074). Economically, this suggests that, under certain conditions, a clearer climate policy and response environment may be associated with lower provisions because banks operate in an institutional environment that supports better identification, governance, and pricing of climate-related risks. This interpretation is consistent with Network for Greening the Financial System (2019) and the Basel Committee on Banking Supervision (2022), which emphasize that climate risk should be incorporated into banks' governance, strategy, internal controls, and risk management processes.

The central result of the model is the positive and statistically significant interaction between ESG and CCPI (beta = 0.0000197, $p < 0.05$). This coefficient indicates that national climate policy and response performance significantly alters the effect of ESG on loan loss provisioning. Specifically, as CCPI increases, the negative ESG-provisioning association weakens and may turn positive. This supports the hypothesis regarding the moderating role of CCPI and is consistent with the risk-identification mechanism. In clearer climate policy and response environments, transition risks such as carbon pricing, emissions-reduction requirements, climate disclosure obligations, and supervisory pressure become more visible. Banks with stronger ESG performance may then be better able to use sustainability information to identify loans vulnerable to deterioration and to recognize loan loss provisions more prudently. This finding is consistent with Ehlers, Packer and de Greiff (2021), who show that carbon risk is reflected in credit conditions when transition risk becomes more visible and more readily priced.

Regarding the control variables, the coefficient on logDP is positive and statistically significant at the 1% level (beta = 0.0038850), indicating that banks with larger deposit bases are associated with higher provisions. This may reflect a portfolio-size effect: banks with larger funding bases typically have larger balance sheets and credit operations, which generate greater provisioning needs. The coefficient on NIM is positive and statistically significant at the 10% level (beta = 0.2034538), suggesting that banks with higher net interest margins tend to recognize higher loan loss provisions. The coefficient on EA is not statistically significant, indicating that, after controlling for deposit size, profitability, ESG, and the climate policy and response context, the equity-to-assets ratio does not exhibit a clear independent effect on the loan loss provision ratio.

Marginal Effects of ESG across CCPI Percentiles and the Turning Point

Table 4. Marginal effects of ESG on LLPR at selected CCPI values

CCPI level	CCPI value	ME(ESG|CCPI)	p-value
P25 (low)	37.39	-0.0001466	0.111
P50 (median)	45.90	0.000021	0.638
P75 (high)	52.93	0.0001595	0.005
Pmax (very high)	76.67	0.0006271	0.005

Source: Authors' calculation

Table 4 shows that the effect of ESG on LLPR varies with CCPI. At P25 (37.39), the marginal effect is negative but insignificant (−0.0001466, p = 0.111), while at P50 (45.90) it is close to zero and insignificant (0.000021, p = 0.638). At P75 (52.93), the effect becomes positive and significant (0.0001595, p = 0.005), increasing further at Pmax (76.67)

(0.0006271, p = 0.005). These results indicate that ESG is associated with higher provisioning only in stronger climate policy and response environments, supporting the risk-identification mechanism. The marginal-effect results are consistent with Laeven and Majnoni (2003), Beatty and Liao (2011), and Bushman and Williams (2012), who show that bank provisions reflect not only current losses but also expected losses, risk-recognition discipline, and cyclical adjustment behavior. The results also align with the literature on climate risk pricing in credit markets, particularly Ehlers, Packer and de Greiff (2021), by showing that carbon and transition risks are more clearly reflected in credit decisions when the policy environment makes those risks more visible and more readily priced.

Given the negative coefficient on ESG and the positive coefficient on the ESG × CCPI interaction, the turning point of the ESG effect is estimated at a CCPI threshold of approximately 44.67. When CCPI is below this threshold, the marginal effect of ESG tends to be negative; when CCPI exceeds this threshold, the marginal effect turns positive. However, the percentile results show that the marginal effect becomes statistically significant only when CCPI is high, namely at P75 and Pmax. Thus, the turning point identifies the direction of change in the ESG effect, while the statistical significance of this effect becomes evident in stronger climate policy and response environments. Because the threshold is close to the sample median of CCPI, the change in the role of ESG is not confined to extreme cases; it reflects an economically meaningful moderating mechanism within the data distribution. This reinforces H3, which states that national climate policy and response performance positively moderates the relationship between ESG and loan loss provisioning.

Robustness Check

Table 5. Robustness check

Variable	Model_asinh(LLP)	Model_LLPR
L1.asinh(LLP)	-0.4103984*	
L1.LLPR		-0.3660628*
L1.ESG	-0.0009127**	-0.00088**
L1.logDP	0.0040418***	0.0038850***
L1.EA	0.0411841	0.043254
L1.NIM	0.2186491*	0.2034538*
L1.CCPI	-0.0007661**	-0.00074**
L1.ESG × CCPI	0.0000203***	0.0000197**
Constant	-0.0121293	-0.0117685
AR(2) p-value	0.165	0.182
Hansen p-value	0.142	0.136

Note: *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The robustness results show that the main conclusions remain unchanged when LLPR is replaced with asinh(LLP), an alternative provisioning measure. This supports the robustness of the main inference to an alternative measurement of provisioning. In both specifications, lagged ESG is negative and statistically significant (Model_asinh(LLP): beta = -0.0009127; Model_LLPR: beta = -0.00088).

At the same time, the moderating role of the climate policy and response environment in the ESG-provisioning relationship is further supported. Specifically, L1.CCPI is negative and significant in both models (Model_asinh(LLP): -0.0007661; Model_LLPR: -0.00074), whereas the interaction term L1.ESG × CCPI is positive and significant in both models (Model_asinh(LLP): 0.0000203; Model_LLPR: 0.0000197). These results show that, as CCPI increases, the negative provisioning effect of ESG weakens and may shift toward more prudent provisioning behavior.

Finally, the lagged provisioning variables are negative and statistically significant at the 10% level (L1.asinh(LLP) = -0.4104; L1.LLPR = -0.3661), reflecting the mean-reverting adjustment of provisions over time. This dynamic feature is not dependent on a particular provisioning measure.

Conclusion

The empirical results show that banks' ESG performance is significantly associated with the loan loss provision ratio, but that this relationship is not linear and homogeneous across all contexts. In the baseline model, the ESG coefficient is negative and statistically significant, implying that ESG may reflect stronger governance capacity, information transparency, and credit discipline, thereby being associated with lower provisions. This result is consistent with the risk-mitigation mechanism developed in the literature review, according to which banks with stronger ESG practices are better able to screen borrowers, monitor loans, and manage credit portfolios.

The most important evidence, however, concerns the moderating role of CCPI. The ESG × CCPI interaction term is positive and statistically significant, indicating that as national climate policy and response performance increases, the negative effect of ESG on provisions weakens and may become positive. The marginal-effect results reinforce this interpretation: at low and median CCPI levels, the effect of ESG on LLPR is not statistically clear, whereas at high and very high CCPI levels, ESG has a positive and statistically significant effect on provisions. This finding suggests that in clearer climate policy and response environments, ESG operates not only as a risk-mitigation mechanism but also as a risk-identification capability. It reflects banks' capacity to identify climate-related, legal, and low-carbon transition risks earlier, thereby promoting more prudent provisioning behavior.

The findings indicate that ESG serves as an organisational capability for both credit risk mitigation and early risk identification. In stronger climate-policy environments, high-ESG banks may recognise climate-related and transition risks more promptly; therefore, higher loan loss provisions may reflect prudent, forward-looking risk recognition rather than poorer loan portfolio quality.

The study contributes by identifying loan loss provisioning as a channel linking bank-level ESG capabilities to national climate-policy conditions. Banks should integrate ESG into credit assessment, expected credit loss estimation, and portfolio monitoring, while supervisors should align ESG disclosure with climate risk management, stress testing, and provisioning guidance.

Limitations and Dimensions for Future Research

The study has several limitations that future research may address. First, ESG is measured using an aggregate ESG score, whereas the environmental, social, and governance pillars may have different effects on provisioning behavior. Second, CCPI is a country-level index and therefore does not fully capture sectoral, regional, or borrower-level exposures within individual bank loan portfolios. Third, loan loss provisions jointly reflect asset quality, expected losses, and accounting policies. Future studies could incorporate non-performing loans, loan charge-offs, expected credit loss measures, or portfolio-level carbon exposure data to test the transmission mechanisms more directly. These extensions would further clarify the role of ESG in bank credit risk management in the context of climate change and the transition to a low-carbon economy.

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