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Climate risk and credit risk: The role of corporate social responsibility – a system GMM analysis of MENA banks

Mohamed Ali Khemiri[1]
Soumaya Saidi[2+]
Hanen Dhaouadi[3]

[1,2]*Faculty of Law, Economics and Management of Jendouba, University of Jendouba, Tunisia.*
[1]*Email: mohamedalikhemiri20@yahoo.com*
[2]*Email: soumayasaidi@esc.u-manouba.tn*
[3]*Higher Institute of Accounting and Business Administration, University of Manouba, Tunisia.*
[3]*Email: hanen.dhaouadi@iscae.uma.tn*

(+ Corresponding author)

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ABSTRACT

The current study explored whether Corporate Social Responsibility (CSR) can moderate the association between climate risk and bank credit risk in the Middle East and North Africa (MENA) region. To achieve this objective, we used a sample of 70 conventional banks from 12 MENA countries over the period 2010-2022. This paper employs the System Generalized Method of Moments (SGMM) as an empirical approach to assess the effect of climate risk (CRI) on credit risk, the impact of Corporate Social Responsibility (CSR) on the credit ratio, and the effect of CSR on the link between climate risk and credit risk. The empirical results show that climate risk increases credit risk, while Corporate Social Responsibility significantly reduces the level of credit risk for MENA banks, measured by the non-performing loans (NPLs) ratio and the loan loss provisions (LLP) to total assets (TA) ratio. Furthermore, findings support evidence that the interaction between climate risk and Corporate Social Responsibility significantly decreases the level of credit risk, a conclusion consistent across the two different measures of credit risk. The findings of this study offer valuable implications for bank managers, regulators, and policymakers seeking to improve credit risk management in the face of climate-related financial risks.

Contribution/Originality: This study makes a new contribution to the existing literature on the relationship between climate risk and credit risk by exploring the moderating effect of CSR. Moreover, it provides valuable findings illustrating the significant role played by CSR in mitigating the detrimental effects of climate risk on banking credit risk.

1. INTRODUCTION

Ecological degradation and climate change are two major concerns that require special attention to protect the entire world from their harmful effects. International efforts such as the 2015 Paris Agreement, COP26, and COP28 have contributed significantly to mobilizing economic resources by implementing effective measures to reduce greenhouse gas emissions and promote sustainable growth. Additionally, the controversy surrounding the relationship between governance and climate change has intensified public discourse on the interconnections between environmental policies and institutional responsibility. This growing controversy has also prompted financial institutions to prioritize green finance investments, which include various products such as green bonds and sustainability-related loans that direct funding toward environmentally aligned projects. Conversely, green investments aim to promote sustainable development by supporting investments in renewable energy, clean

technologies, and green infrastructure. According to Al Mamun et al. [1] and Cepni et al. [2], these innovations are a gradual change in financial markets. They are increasingly aligning with climate objectives to guide global economic practices toward sustainability.

The banking sector plays a key role in stimulating economic growth by providing capital to support economic activities and facilitate business development. Therefore, Hakimi et al. [3] concluded that identifying the determinants of bank profitability and stability is a crucial task. Climate change is one of the essential determinants of banking stability in several ways. As significant financial intermediaries, banks face increasing climate-related risks through their lending portfolios, investments, and business operations. To adapt to the transition towards a sustainable economy, banks must redefine their risk exposure and strategic goals, especially for industries most vulnerable to climate impacts.

Therefore, policymakers, practitioners, and scholars now see it as fundamental to comprehend the relationship between climate risk and credit risk [4-7]. Climate change may have diverse effects on the credit risk of banks. Due to their loan books, investment exposures, and operational exposures, banks, as large financial intermediaries, are increasingly vulnerable to climate risks. These can result in increased defaults by borrowers, a decline in asset values, and business disruptions. To mitigate these threats, banks are integrating climate risk analysis into credit models, stress-testing portfolios, and green finance. Regulatory requirements for greater disclosure are also leading to the development of novel risk management instruments, enabling banks to evolve, safeguard financial stability, and support a sustainable economy. Therefore, policymakers, practitioners, and scholars today believe it is crucial to understand how credit risk is connected to climate risk [8, 9].

The conceptual framework that relates corporate social responsibility (CSR), climate risk, and credit risk is based on stakeholder theory Freeman [10] and risk management theories Cagli et al. [11]. Stakeholder theory suggests that firms have responsibilities beyond shareholders, including environmental and social responsibilities. Through the adoption of CSR practices, banks and firms anticipate both environmental and social risks, which can help reduce the adverse effects of climate-related events. Climate risk, encompassing both physical risks (such as natural disasters) and transition risks (such as policy changes toward low-carbon economies), could significantly impact the financial stability of borrowers and the quality of the loan portfolio. Elevated climate risk increases credit risk by raising the probability of default among environmentally exposed customers. However, companies that integrate CSR into their overall strategy are more likely to manage environmental risks effectively, demonstrate greater transparency, and build long-term trust with stakeholders, thereby helping to reduce credit risk. Therefore, CSR can serve as a buffer that mitigates the negative impact of climate risk on creditworthiness.

Against the background of increasing focus on CSR, its intervening effect on the climate risk-credit risk nexus in banks has not been extensively researched, especially in emerging economies with unique climatic and economic issues. This research examines whether CSR initiatives would mitigate the positive impact of climate risk on credit risk. The findings aim to inform banks, regulators, and policymakers about the strategic role that CSR plays in mitigating climate issues and facilitating financial sustainability. The current study aims to answer the following research questions: *Does climate risk affect the MENA bank's credit risk? Does CSR moderate the impact of climate risk on bank credit risk?*

The primary objectives of this research are threefold. First, it examines the direct impact of climate risk on credit risk. Second, it analyzes the role of corporate social responsibility in influencing credit risk. Third, it explores whether corporate social responsibility moderates the relationship between climate risk and credit risk. By addressing these objectives, this study contributes to the literature on climate risk, CSR, and banking sector stability, offering both theoretical insights and practical policy implications.

This study investigates the relationship between climate risk, corporate social responsibility, and credit risk in the context of the MENA region. The MENA region may be considered a suitable case study for several reasons.

First, climate risks in the MENA region are a top priority, given the geographical and socio-economic vulnerabilities of this area. Furthermore, this region is among the hottest on Earth and is warming much faster than the rest of the planet. Projections for average temperature rise under the high-emission scenario indicate an increase of 2-4°C by the end of this century. The MENA region is the most water-scarce part of the planet, with over 60% of the population experiencing water stress. Secondly, over the last decade, CSR has evolved moderately in the MENA region due to a combination of regulatory changes, international requirements, and increasing public awareness of environmental and societal concerns. CSR in the MENA region typically combines traditional values with modern practices aligned with global sustainability standards.

The sample for this study consists of 70 MENA banks from 10 MENA countries. Banks have been monitored from 2010 to 2022. The SGMM is an empirical method used in this article. Empirical findings demonstrate that corporate social responsibility has a significant negative impact on the credit risk of MENA banks, but climate risk has a positive effect on credit risk. Findings also suggest that CSR and climate risk interact to significantly reduce credit risk. This conclusion is consistent across two different measures of credit risk: the nonperforming loans (NPLs) ratio and the ratio of loan loss provisions (LLP) to total assets (TA).

This research contributes several important insights to the literature. First, while previous studies have examined the influence of climate risk or CSR individually on bank performance, few have examined how climate risk and CSR interact in their effects on credit risk, particularly in the MENA region, where exposures to climate vulnerabilities and financial system fragility are elevated. This paper addresses this gap by investigating the effect of climate risk on credit risk in the MENA region, considering the moderating effect of corporate social responsibility. In bridging this gap, it significantly enriches the banking literature in the MENA region. Second, although there is substantial evidence investigating credit risk and climate risk in developed or international contexts, our study adds to the current literature on credit risk and climate risk in the MENA region. Third, there are limited empirical studies that have established a connection between CSR and credit risk in the MENA region. By examining this association, the research contributes to the CSR literature from the regional banking perspective. In conclusion, the results provide crucial recommendations to policymakers and bankers on credit portfolio restructuring and the establishment of conducive regulatory frameworks, supporting sustainable banking practices and mitigating climate-related financial risks.

The remainder of this paper is organized as follows: Section 2 presents the literature review and outlines the development of hypotheses. Section 3 describes the sample, the empirical approach, model specification, and variable selection. Section 4 discusses the analysis and empirical results. Finally, Section 5 provides the conclusion and some policy recommendations.

2. LITERATURE REVIEW AND HYPOTHESES DEVELOPMENT

The literature review and hypotheses development section discusses relevant prior studies that focus on credit risk, providing mixed results. Firstly, we examine the academic literature that focuses on the relationship between climate risk and credit risk. Secondly, we discuss recent literature that has developed a link between corporate social responsibility and credit risk. Finally, we summarize studies that explore how corporate social responsibility moderates the link between climate risk and credit risk.

2.1. Climate Risk and Credit Risk

In recent years, the concept of climate risk encompasses physical risks such as extreme weather events and rising sea levels, as well as transition risks such as policy and technological changes, which are widely recognized as significant financial threats. Theoretical models suggest that climate risk can undermine banking financial stability

and other financial institutions by increasing the likelihood of loan defaults and, consequently, non-performing loans (NPLs).

Empirical research highlights the rising influence of climate risk on banking systems, with its influence following an upward trend. According to Nie et al. [12], natural disasters caused by climate variability deteriorate economies and consequently reduce borrowers' ability to repay their loans by exacerbating risks in the banking system. Similarly, Zhang et al. [13] suggest that, in a Chinese context, climate shocks significantly deteriorate the credit quality of regional commercial banks. They concluded that industrial and geographical exposure are its main risk transmission channels. In the same context, Brik [8] shows that climate risk undermines financial stability by increasing NPL ratios for banks with weak governance systems. Furthermore, Khemiri [14] tests the relationship between climate risk, economic policy uncertainty, and credit risk in the MENA region. He found that high climate vulnerability exacerbates the volume of non-performing loans, harming sustainable development. Fan et al. [15] provided additional evidence for the Chinese context. They suggested that climate change amplifies NPL ratios, with regional variations highlighting the need for adaptive policy responses. These papers underline the urgency of integrating climate risk into credit risk management practices to make banking systems more resilient worldwide.

It effectively captures the dual nature of climate risk, including transition risks and physical risks, and how these risks can destabilize banking systems through an increase in non-performing loans (NPLs). Recent literature has strengthened the argument by demonstrating the relationship between climate risk and financial stability at both the global and regional levels [12, 16]. However, the paragraph can be improved by providing a more thorough critique of the weaknesses and gaps present in the existing literature. For instance, while it emphasizes the empirical evidence, it does not address potential flaws in the methodology of the cited studies, such as data limitations, local biases, or challenges in isolating climate risk from other economic drivers. Additionally, the paragraph could discuss other perspectives or counterarguments, such as the contribution of or risk hedging instruments in financial innovation towards neutralizing the negative effects of climate risk. Furthermore, although the conclusion is convincing, it could be made even more sophisticated by acknowledging that integrating climate risk into credit risk management necessarily involves reconciling a myriad of complicating factors, including regulatory intricacies, the lack of normative measures, and potential resistance from banks.

Although the literature connecting climate risk and NPLs is nascent, theoretical and empirical studies have provided valuable insights. Climate risk, in its various forms, can threaten bank stability by significantly elevating the possibility of loan defaults. Such connections have been empirically proven to be valid across geographical locations, industries, and types of financial institutions, underscoring the need to integrate climate risk into financial decision-making.

H_1: Climate risk increases credit risk.

2.2. Corporate Social Responsibility and Credit Risk

Empirical and theoretical literature have explored the relationship between corporate social responsibility (CSR) and credit risk, presenting evidence on how socially responsible actions assist in achieving financial stability. Theoretically, CSR is described as enhancing a firm's reputation, promoting stakeholder trust, and improving risk management, thereby indirectly reducing the likelihood of loan default. By prioritizing ethical behavior, ecological sustainability, and social welfare, companies can develop closer relationships with customers, workers, and regulators, which can help minimize operational and financial risks. Several empirical studies have documented a negative association between CSR practices and the volume of NPLs, although results vary across regions. Some studies have not found a significant relationship between CSR and NPLs. According to Boussaada et al. [17], higher CSR scores were associated with lower levels of NPLs in the European area. They concluded that CSR practices contribute to enhancing risk management and lending practices. In the context of Mongolian banks, Ho et al. [18] demonstrate

that banks with better CSR performance tend to have lower NPLs, suggesting that CSR engagement and credit quality are positively correlated.

However, Razafindrambinina and Grace [19] focused on the ASEAN banking industry, and they found no substantial relationship between CSR and NPLs. This result highlighted the effect of the regional disparities on the effectiveness of CSR initiatives and underscored the importance of contextual factors in determining the impact of CSR on NPLs. According to Nguyen and Nguyen [20], CSR activities reduce bank risk-taking in Vietnamese banks, particularly in financially constrained institutions. These suggest that CSR practices can serve as a buffer against financial instability by mitigating credit risk. They are often viewed as strategic approaches to promote prudent lending practices and enhance risk assessment capabilities.

The relationship between CSR and credit risk is complex. Although it contributes to reducing non-performing loans and enhancing financial stability, its effectiveness varies across banking sectors and is influenced by various factors, including regional context, financial constraints, and institutional quality. To optimize the role of CSR in credit risk management, it is important for policymakers and bank managers to consider all these factors when designing CSR strategies.

H_2: Corporate social responsibility reduces credit risk.

2.3. Corporate Social Responsibility, Climate Risk and Credit Risk: Moderating Role

According to the literature, corporate social responsibility (CSR) can play an important moderating role in the relationship between credit risk and climate risk. It can potentially reduce the harmful effects of climate-related uncertainties on financial performance. CSR practices can serve as strategic measures to enhance the resilience and sustainability of companies facing climate uncertainties, particularly those operating in high-carbon-emission sectors and possessing strong corporate governance and financial flexibility. Moreover, other factors such as national culture, religiosity, and corporate governance structures can influence the moderating role of CSR in the relationship between climate risk and credit risk.

The integration of corporate social responsibility, as part of green growth initiatives, in the relationship between climate risk and credit risk highlights how proactive environmental strategies can reduce financial risks related to climate change and, consequently, improve the stability of banking systems. Empirical evidence from the literature emphasizes the role played by green and sustainability financing initiatives in moderating the relationship between climate risk, credit risk, and banking stability. Busch et al. [21] concluded that CSR activities provide an "*insurance-like*" benefit, which helps companies manage the long-term risks associated with climate change and negative externalities such as greenhouse gas emissions. More recently, Mohy-ud-Din et al. [22] have shown that companies that integrate robust CSR practices are more likely to reduce the harmful effects of climate change and political uncertainty, thus improving the company's sustainability and value creation. Ozkan et al. [23] suggest that cultural factors play a role in how CSR is perceived and implemented. They concluded that its effectiveness in mitigating climate risk is more pronounced in countries with low individualism and high religiosity. Vo et al. [24] add that strong corporate governance and financial flexibility strengthen the proactivity of companies in CSR activities. This helps to mitigate the negative impact of climate policy uncertainty on financial performance. According to Chen et al. [25], climate transition risks promote corporate ESG performance, with CSR acting as a moderating factor that enhances this relationship, especially in non-state-owned enterprises and those with diverse boards.

It is important to consider that, although CSR acts as a solution to mitigate the negative impacts of climate risk on financial performance, the effectiveness of its moderating role may differ across contexts and industries. Furthermore, the effectiveness of CSR initiatives can be enhanced by the presence of sustainability committees and ecological audits. Overall, a holistic approach to CSR and governance is crucial for effectively managing financial risks related to climate change.

H_5: Corporate social responsibility can moderate the relationship between climate risk and credit risk.

3. EMPIRICAL DESIGN

3.1. The Sample

To explore how climatic risk impacts credit risk, considering ESG scores as a moderating variable, we used data from 70 banks in the MENA region over the period 2010-2022. Our study applies filtering criteria to ensure data availability and sample homogeneity. We relied on the World Bank [26] definition, which considers the MENA region to include 21 countries, and on the United Nations Statistics, which added Turkey. Given that a large part of this nation is geographically located within the MENA region [27], it was included in our analysis. However, several countries, namely Syria, Iraq, Libya, Sudan, Somalia, Djibouti, and Yemen, were excluded due to macroeconomic and political instability that could introduce bias into our results.

Our initial sample size was 181 banks, but due to a lack of data, particularly regarding non-performing loans, it was reduced to only 70 conventional banks. We exclude banks that have missing data for more than three years (See Table 1).

Table 1. Distribution of the sample by country.

Middle East and North Africa countries		
Countries	**Number of banks**	**%**
Egypt	3	4.28%
Jordan	4	5.71%
Lebanon	1	1.43%
Morocco	2	2.86**%**
Tunisia	10	14.28%
Turkey	8	11.43%
Saudi Arabia	10	14.28%
Bahrain	2	2.86%
United Arab Emirates	11	15.71%
Kuwait	7	10%
Qatar	7	10%
Oman	5	7.14%
Total	70	100%

The bank-specific data, such as NPLs, LLPTA, and ESG score (composite environmental, social, and governance score), as well as control variables, were obtained from the Refinitiv Eikon database. The data on the climatic risk index were collected from Germanwatch. Furthermore, data on macroeconomic variables, bank concentration, and institutional quality were obtained from the World Bank database, specifically the World Bank Indicators (WDI), Global Financial Development (GFD), and Worldwide Governance Indicators (WGI).

3.2. Empirical Approach and Model Specification

In this study, we used the SGMM model, which is more appropriate for exploring the relationships between CSR and bank risks [28]. According to Hakimi and Khemiri [29] and Boussaada et al. [17], this approach is appropriate for resolving endogeneity and heterogeneity problems. Moreover, given the structure of our panel data, with a larger cross-sectional dimension (i = 70 banks) relative to the time dimension (T = 13 years), SGMM is the most appropriate method. This econometric technique is well-suited for dynamic panel models, as it accounts for the lagged dependent variable, thereby capturing the persistence of banks' risk-taking behavior over time.

We followed the moderator effects analysis approach of Sharma et al. [30] and Ping [31], which is based on two main steps. The first step consists of analyzing the main effects of the explanatory variables on the dependent variable.

The second step aims to explore the interaction effects. Figure 1 presents the empirical strategy applied based on three models.

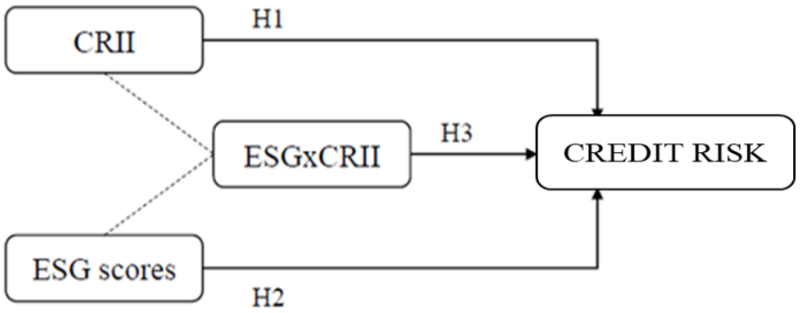

Figure 1. The moderating role of ESG score on the climate risk-credit risk relationship.

In the first model, we assess the effect of climate risk on credit risk. The econometric model to be tested is represented by the following Equation 1.

$$\text{Credit risk}_{i,t} = \beta_0 + \beta_1\text{Credit risk}_{i,t-1} + \beta_2\text{CRII}_i + \beta_3\text{TAILLE}_{i,t} + \beta_4\,\text{CAP}_{i,t} + \beta_5\text{ROA}_{i,t} + \beta_6\text{LTD}_{i,t} + \beta_7\text{NII}_{i,t} + \beta_8\text{PIB}_i + \beta_9\text{INF}_i + \beta_{10}\text{DCTPS} + \beta_{11}\text{CHOMAGE}_i + \beta_{12}\text{CONC}_{i,t} + \beta_{13}\,\text{QI\_index}_i + \beta_{14}\text{CA\_index}_{i,t} + \varepsilon_{i,t} \quad (1)$$

The second model consists of investigating the effect of the ESG score on credit risk. The econometric model is presented in the following Equation 2.

$$\text{Credit risk}_{i,t} = \beta_0 + \beta_1\text{credit risk}_{i,t-1} + \beta_2\text{ESG}_{i,t} + \beta_3\text{TAILLE}_{i,t} + \beta_4\,\text{CAP}_{i,t} + \beta_5\text{ROA}_{i,t} + \beta_6\text{LTD}_{i,t} + \beta_7\text{NII}_{i,t} + \beta_8\text{PIB}_i + \beta_9\text{INF}_i + \beta_{10}\text{DCTPS} + \beta_{11}\text{CHOMAGE}_i + \beta_{12}\text{CONC}_{i,t} + \beta_{13}\,\text{QI\_index}_i + \beta_{14}\text{CA\_index}_{i,t} + \varepsilon_{i,t} \quad (2)$$

In the last model, we introduced the interaction term (ESGxCRI) to explore the moderating role of the ESG score on the climate risk and credit risk relationship. Equation 3 presents the econometric model to be tested.

$$\text{Credit risk}_{i,t} = \beta_0 + \beta_1\text{Credit risk}_{i,t-1} + \beta_2\text{ESGxCRII}_{i,t} + \beta_3\text{TAILLE}_{i,t} + \beta_4\,\text{CAP}_{i,t} + \beta_5\text{ROA}_{i,t} + \beta_6\text{LTD}_{i,t} + \beta_7\text{NII}_{i,t} + \beta_8\text{PIB}_i + \beta_9\text{INF}_i + \beta_{10}\text{DCTPS} + \beta_{11}\text{CHOMAGE}_i + \beta_{12}\text{CONC}_{i,t} + \beta_{13}\,\text{QI\_index}_i + \beta_{14}\text{CA\_index}_{i,t} + \varepsilon_{i,t} \quad (3)$$

3.3. Variable Selection and Theoretical Justification

3.3.1. Dependent Variable: Credit Risk

This study extends the literature by examining the moderating role of the ESG score on the relationship between climatic risk and credit risk. The dependent variable is non-performing loans, which are critical indicators of financial health and act as "financial pollution" that hinders sustainable economic growth [32]. NPLs are measured by the ratio of bank non-performing loans to total loans [29] and are considered non-performing when the repayment exceeds at least 90 days [33]. We introduced the loan loss provision ratio as a second measure of credit risk [34, 35]. We measured this ratio (LLPTA) as the ratio of loan loss provisions (LLP) to total assets (TA).

3.3.2. Main Explanatory Variable: Climate Risk

The Climate Risk Index (CRI), published annually since 2006 by Germanwatch, assesses the extent to which countries are affected by climate-related extreme weather events. It captures the impacts of realized climate risks on national economies and societies. Since lower CRI scores indicate higher climate vulnerability, the index was transformed into its inverse and rescaled to a range between 0 and 1, where 0 represents lower climate risk and 1 represents higher climate risk. The inverse score is presented in Equation 4.

$$\text{CRII} = \frac{1}{\text{CRI}} \quad (4)$$

3.3.3. Other Explanatory Variable: Corporate Social Responsibility

The study applies, according to Boussaada et al. [17], a composite Environmental, Social, and Governance (ESG) index. This is an index that comes in the form of a pillar score that provides a general and balanced indication of the performance of a firm based on environmental, social, and governance dimensions. While the ESG score was the moderating variable [13, 17, 36].

3.3.4. Control Variables

For the control variable, we employed three categories. The first one included variables specific to the bank, such as bank size, capital, liquidity risk, bank performance, and bank diversification. In bank literature, there is no agreement on the impact of those variables on NPLs. The bank size significantly reduces the level of NPLs [37-40], while Chaibi and Ftiti [41] and Goczek and Malyarenko [42] found a positive association between them.

The relationship between capital and NPLs is ambiguous. More recently, Kryzanowski et al. [43] found that banks with strong capital quality and high equity ratios are more likely to control the level of NPLs during the COVID-19 crisis. In addition, Alnabulsi et al. [44] and Phung et al. [45] confirm these findings. In contrast, Hasan and Ashfaq [46] showed that the NPLs ratio rises significantly with higher bank capital, while Jabbouri et al. [38] and Radivojević et al. [47] did not find a significant relationship.

The relationship between liquidity risk and NPLs is causal and reciprocal. Saliba et al. [48], Alnabulsi et al. [44], and Kumar and Kishore [49] proved an inverse association between liquidity ratio and NPLs. However, Anastasiou et al. [50] found a positive effect of liquidity risk on NPLs.

Several studies have shown that bank performance negatively affects NPLs [38, 44, 51], whereas Kumar and Kishore [49] found a negative but insignificant relationship.

Three opposing results exist in the literature regarding the effect of bank diversification on NPLs. Saliba et al. [48] and Ghosh [52] concluded that increased diversification is beneficial for reducing non-performing loans (NPLs). Nevertheless, Alnabulsi et al. [44] and Canh et al. [53] proved that diversification increases the NPLs ratio, whereas others have found a non-significant link [39, 41].

In the second category, we introduced macroeconomic variables. The literature considers economic growth as another essential factor of NPLs. Jabbouri et al. [38] and Chaibi and Ftiti [41] demonstrated that when economic conditions improve, the NPLs ratio decreases, but Radivojević et al. [47] found an inverse effect.

For inflation, Hakimi and Khemiri [29] and Karismaulia et al. [40] highlighted a positive relationship, explained by the fact that inflation leads to a decrease in consumer incomes, making loan repayment more difficult.

Naili and Lahrichi [39] and Chaibi and Ftiti [41] observed a positive relationship between unemployment and NPLs. A high unemployment rate decreases borrowers' ability to meet financial obligations, worsening the issue of loan defaults. Moreover, low-income borrowers experience higher interest rates due to uncertainty regarding their employment, which further diminishes their ability to repay loans.

Some other studies have examined the impact of domestic credit to the private sector (DCTPS) on NPLs and have found mixed results [3, 48].

The final category is bank concentration, which significantly reduces NPL levels [44, 54]. More recently, Hakimi and Khemiri [29] demonstrated that rigorous monitoring and close surveillance of the sector enable quick intervention to implement corrective measures if a potential problem arises. However, Canh et al. [53] concluded that more concentrated banks take a higher credit risk.

In this study, two indices (CA_index and QI_index) were constructed through two main steps. Following Goyal et al. [55], we applied empirical normalization and weighting using equal coefficients (1/N). Once the indices are calculated, the resulting values will range from 0 to 1. According to Goyal et al. [55], the institutional quality index (QI_index) is composed of the six Worldwide Governance Indicators developed by Kaufmann. The board

characteristics index (CA_index) includes the following characteristics: board size (number of directors on the board), board independence (proportion of independent directors), duality (a dummy variable equal to 1 if the CEO also serves as Chair of the Board, and 0 otherwise), board gender diversity (percentage of women on the board), board tenure (average length of board members' terms), and board compensation (total remuneration of directors in U.S. dollars relative to total assets). Table 2 provides definitions for all variables.

Table 2. Definition of variables.

Variables	Definitions	Measurements
NPLs	Non-performing loans	Non-performing loans/ Total loans (%)
LLPTA	The loan loss provisions to total assets ratio	The loan loss provisions/ Total assets ratio.
ESG	ESG score	Composite environmental/ Social/Governance score
CRII	Climate risk index	Climate risk index (CRI) of German Watch
ROA	Bank performance	Net income/Total assets
LTD	Liquidity risk	Loans to deposit ratio (%)
CAP	Bank capital	Capital adequacy ratio
SIZE	Bank size	Natural logarithm of total assets
NII	Bank diversification	The ratio of noninterest income
GDPG	Economic growth	The annual growth rate of GDP (%)
INF	Inflation	The consumer price index (%)
DCTPS	Domestic credit to the private sector	Domestic credit to private sector (% of GDP)
UNEMP	Unemployment	The unemployment rate (%)
CONC	Bank concentration	Bank concentration (%)
QI_index	Institutional quality index	Composite index of WGI indicator.
CA_index	Board characteristics index	Composite index of board characteristics.

4. ANALYSIS AND RESULTS

In this section, firstly, we provide summary statistics regarding the data used in this study and check for the multicollinearity problem between independent variables. Secondly, we discuss the empirical results of the SGMM approach.

Table 3. Descriptive statistics.

Variable	Mean	Std. dev.	Min.	Max.
NPLS	0.076	0.118	0.04	2.61
ESG	39.52	16.986	5.92	90.891
CRII	0.012	0.006	0.006	0.059
SIZE	23.632	1.226	20.942	26.512
CAP	0.169	0.087	.035	2.115
ROA	0.014	0.008	-0.038	0.063
LTD	1.596	5.744	0.014	98.763
NII	38.678	17.041	9.552	96
GDPG	3.12	4.07	-21.4	19.592
INF	4.833	10.958	-3.749	171.205
DCTPS	66.143	22.215	3.706	138.858
UNEMP	7.032	5.793	0.1	19.837
CONC	81.64	14.143	56.035	100
QI_index	0.676	0.176	0.171	0.971
CA_index	0.316	0.107	0.06	0.623

4.1. Summary Statistics and Correlation Matrix

Table 3 presents descriptive statistics that provide additional information about the data used in this study. The statistics show that the mean value of the credit risk, measured by the NPL ratio, is 7.6%, with the highest level being 261%, indicating that banks in the region suffer from poor asset quality.

For the main independent variables, the average ESG score is 39.52%, with a maximum score of 90.98, indicating that most MENA banks are socially responsible. For climatic risk, the average inverse score of climatic risks is 1.2%, with the highest score of 5.9%, indicating that the region suffers from climate change. Concerning size, bank capital, and bank performance (ROA), their mean values are 23.632, 16.9%, and 1.4%. The highest level of liquidity risk reached 98.763%, while the lowest level was 1.4%. Banks in the MENA region are diversified, with an average of 17.041%, and a maximum of 96. For macroeconomic factors, the mean values of economic growth, inflation rate, and unemployment are 3.12%, 4.833%, and 7.032%, respectively. The banking sector in the MENA region has an average concentration of 81.64, with a maximum of 100 and a minimum of 56.35. The average institutional quality and board of directors' scores were 67.6% and 31.6, respectively, with the highest scores of 97.1% and 62.3%.

According to Kervin [56], the absence of multicollinearity is ensured when the correlation coefficients between independent variables are below 70%. The results in Table 4 confirm that our model does not suffer from multicollinearity.

Table 4. Correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) ROA	1.000													
(2) ESG	0.047	1.000												
	(0.170)													
(3) CRII	0.031	-0.130*	1.000											
	(0.356)	(0.000)												
(4) LTD	0.095*	0.164*	-0.002	1.000										
	(0.005)	(0.000)	(0.948)											
(5) CAP	0.082*	0.000	-0.061	0.019	1.000									
	(0.014)	(0.994)	(0.068)	(0.570)										
(6) SIZE	0.181*	0.286*	-0.130*	-0.031	0.201*	1.000								
	(0.000)	(0.000)	(0.000)	(0.394)	(0.000)									
(7) NII	-0.055	0.014	-0.091*	0.083*	0.144*	0.299*	1.000							
	(0.108)	(0.680)	(0.008)	(0.015)	(0.000)	(0.000)								
(8) GDPG	0.308*	0.052	0.062	0.057	0.036	0.074*	0.110*	1.000						
	(0.000)	(0.127)	(0.061)	(0.090)	(0.283)	(0.041)	(0.001)							
(9) INF	0.122*	0.215*	-0.043	0.073*	-0.056	0.005	-0.086*	0.028	1.000					
	(0.000)	(0.000)	(0.195)	(0.030)	(0.093)	(0.893)	(0.012)	(0.398)						
(10) DCTPS	-0.269*	0.154*	-0.167*	0.016	-0.016	-0.031	-0.066	-0.335*	-0.035	1.000				
	(0.000)	(0.000)	(0.000)	(0.650)	(0.633)	(0.399)	(0.056)	(0.000)	(0.295)					
(11) UNEMP	-0.058	0.215*	0.071*	0.036	-0.283*	-0.401*	-0.124*	-0.072*	0.173*	0.016	1.000			
	(0.088)	(0.000)	(0.037)	(0.292)	(0.000)	(0.000)	(0.000)	(0.032)	(0.000)	(0.641)				
(12) CONC	-0.037	-0.269*	0.058	-0.121*	0.237*	0.182*	0.024	-0.031	-0.264*	-0.044	-0.745*	1.000		
	(0.265)	(0.000)	(0.079)	(0.000)	(0.000)	(0.000)	(0.479)	(0.344)	(0.000)	(0.197)	(0.000)			
(13) QI_index	0.010	-0.229*	-0.106*	-0.029	0.131*	0.237*	0.071*	0.090*	-0.389*	0.162*	-0.652*	0.517*	1.000	
	(0.762)	(0.000)	(0.001)	(0.392)	(0.000)	(0.000)	(0.038)	(0.006)	(0.000)	(0.000)	(0.000)	(0.000)		
(14) CA_index	-0.022	0.305*	-0.018	0.063	-0.054	-0.088*	-0.043	-0.005	0.023	0.083*	0.444*	-0.370*	-0.131*	1.000
	(0.542)	(0.000)	(0.611)	(0.078)	(0.126)	(0.019)	(0.226)	(0.896)	(0.522)	(0.020)	(0.000)	(0.000)	(0.000)	

Note: * p<0.1.

To further validate the results in Table 4, we performed a Variance Inflation Factor (VIF) test for multicollinearity, which measures how much the variance of estimated regression coefficients is inflated due to correlations among predictors. A VIF value of 1 indicates no correlation; values between 1 and 5 suggest moderate correlation, and values greater than 5 indicate potentially severe multicollinearity.

Results in Table 5 present the mean VIF for the first model, investigating the influence of climate risk on banking credit risk, which is approximately 1.63. This indicates no severe multicollinearity among the variables and demonstrates a moderate correlation across all values. Second, Table 5 shows the mean VIF of 1.70 for the second model, which analyzes the effect of corporate social responsibility on bank credit risk. Again, this confirms the absence of severe multicollinearity, with moderate correlations between the variables. Finally, Table 5 presents the mean VIF value of 1.66 for the third model, which examines the interaction effect of both corporate social responsibility and climate risk on credit risk. Similar to the two previously discussed models, no severe multicollinearity is expected, although a moderate correlation between the variables is observed.

Table 5. Variance inflation factor (VIF).

Model 1			Model 2			Model 3		
	VIF	1/VIF		VIF	1/VIF		VIF	1/VIF
UNEMP	3.982	0.251	UNEMP	3.979	0.251	UNEMP	3.988	0.251
CONC	2.695	0.371	CONC	2.693	0.371	CONC	2.707	0.369
QI_index	2.274	0.44	QI_ index	2.275	0.44	QI_ index	2.34	0.427
SIZE	1.477	0.677	SIZE	1.768	0.566	SIZE	1.549	0.645
CA_ index	1.359	0.736	ESG	1.531	0.653	CA_ index	1.388	0.72
INF	1.316	0.76	CA_ index	1.431	0.699	INF	1.301	0.769
ROA	1.237	0.808	INF	1.322	0.757	ROA	1.242	0.805
DCTPS	1.215	0.823	DCTPS	1.253	0.798	ESGxCRI	1.23	0.813
NII	1.19	0.84	ROA	1.245	0.803	DCTPS	1.218	0.821
PIB	1.184	0.845	NII	1.203	0.831	NII	1.196	0.836
CAP	1.117	0.896	PIB	1.193	0.838	PIB	1.195	0.837
CRII	1.094	0.914	CAP	1.112	0.9	CAP	1.116	0.896
LTD	1.054	0.949	LTD	1.083	0.924	LTD	1.07	0.934
Mean VIF	1.63		Mean VIF	1.70		Mean VIF	1.66	

4.2. Discussion of the Empirical Findings

The empirical approach section of this paper begins by examining the influence of climate risk, proxied by CRII, on bank credit risk in the MENA region, where credit risk is measured by non-performing loans (NPLs). Empirical results are presented in Table 6. Diagnostic tests, including the Sargan test for over-identifying restrictions and the Arellano-Bond test for serial correlation, support the validity of the model. In particular, the p-values of both the Sargan test and the AR(2) test are greater than 5%, indicating that the null hypotheses of valid over-identifying restrictions and no serial correlation cannot be rejected.

Table 6. Estimation results.

NPLs	MODEL 1		MODEL 2		MODEL 3	
	Coef.	Z	Coef.	Z	Coef.	Z
NPLs (-1)	0.13	128.24***	0.124	130.05***	0.131	181.14***
SIZE	-0.082	-31.04***	-0.07	-19.19***	-0.083	-33.05***
CAP	-0.003	-3.14***	0.001	0.86	-0.001	-1.22
ROA	-1.421	-13.30***	-1.239	-12.84***	-1.462	-15.05***
LTD	0.000	-0.72	-0.001	-3.15***	-0.001	-1.55
NII	-0.002	-26.45***	-0.002	-19.09***	-0.002	-35.67***
GDPG	-0.001	-10.81***	-0.001	-6.19***	-0.001	-8.08***
INF	0.0001	7.69***	0.000	6.31***	0.000	4.56***
DCTPS	-0.001	-10.73***	-0.001	-5.57***	-0.001	-10.66***

NPLs	MODEL 1		MODEL 2		MODEL 3	
	Coef.	Z	Coef.	Z	Coef.	Z
UNEMP	0.000	-1.28	0.001	4.14***	-0.001	-1.51
CONC	0.000	4.49***	0.001	3.70***	0.000	5.10***
QI_index	- 0.474	-31.58***	-0.418	-23.48***	-0.445	-25.62***
CA_index	-0.108	-16.91***	-0.134	-14.740***	-0.114	-13.54***
CRII	**0.213**	**4.10*** **				
ESG			**-0.002**	**-24.04*** **		
ESGxCRII					**-0.02**	**-12.24*** **
Constant	1.833	29.41***	1.603	18.02***	1.879	29.85***
obs	627		623		620	
AR (1)	-1.3651		-1.4094		-1.3712	
PROB	0.1722		0.1587		0.1703	
AR (2)	-0.73986		-1.0438		-1.0227	
PROB	0.4594		0.2966		0.3065	
SARGAN TEST	59.87676		61.00408		60.26944	
PROB	0.9129		0.8947		0.9068	

Note: *** p<.01.

Table 6 presents results with a positive and significant contribution from a lagged dependent variable (NPLs (-1)). These findings imply that the credit risk from the previous year, calculated as NPLs, has a positive impact on the emergence of the same credit risk in the current year.

Results related to the first model (MODEL 1) indicate that the coefficient of climate risk (CRII) is positively and significantly associated with the dependent variable (NPLs), suggesting that an increase in the climate risk index significantly raises the credit risk for banks in the MENA region. Climate risk elevates NPLs by exposing banks to various vulnerabilities: physical, economic, and financial. Physical risks include flooding, drought, and other extreme weather events that can damage assets, disrupt operations, and reduce incomes factors that hinder borrowers' ability to repay loans. Transition risks stem from the shift toward low-carbon economies, which may strain industries reliant on fossil fuels, leading to financial distress and defaults. Additionally, disrupted supply chains due to climate issues can devalue collateral assets and increase costs, further impairing borrowers' repayment capacity. Increased insurance premiums and macroeconomic effects, such as reduced economic activity and higher unemployment, also contribute to financial stress. Regions with vulnerable climates, such as the MENA region, are particularly affected by these factors, resulting in increased credit risk. Despite the intensification of climate risks, banks in this region are experiencing a rise in non-performing loans. Therefore, our results confirm the work of Khemiri [14], Zhang et al. [13], and Brik [8], and validate the hypothesis, H1.

The results regarding corporate social responsibility reveal a negative and significant impact on the NPLs ratio at 1% in the MENA region. A 1% increase in CSR commitment can reduce non-performing loans by 0.2%. CSR commitment enhances stakeholder relations, improves banking reputation, promotes ethical banking, strengthens risk management, increases financial literacy, and boosts borrower creditworthiness. It emphasizes the importance of responsible lending, meaning it encourages banks to finance financially sound and socially compliant businesses. Consequently, it can foster customer loyalty and trust by reducing default risks and encouraging prompt loan repayments. Furthermore, CSR initiatives supporting sustainable business practices also enable borrowers to effectively manage their financial resources. As a result, CSR practices reduce the volume of non-performing loans to ensure the financial stability of the banking sector. Our results corroborate those of Boussaada et al. [17] and Ho et al. [18]. Based on this negative relationship, we confirm the second hypothesis, H2.

In the third step, we investigated the role played by CSR in influencing the relationship between climate risk and non-performing loans. In other words, we explored how CSR commitment moderates the climate risk-NPLs relationship in the MENA region. The results of the MODEL 3 are presented in Table 6.

The results indicated that corporate social responsibility (CSR) plays a moderating role in the relationship between climate risk and non-performing loans (NPLs). The interaction term ESGxCRII shows a negative and significant sign at 1% in the MENA region. In other words, CSR commitment enhances the environmental resilience of banks and improves credit risk management. Climate risk adversely affects the financial health of borrowers due to extreme weather events and environmental degradation, which can reduce income and increase insolvency behavior. However, authentic CSR policies encourage banks to support green financing and environmentally friendly companies, as well as to adhere to environmental loan policies to mitigate the harmful effects of climate change on repayment ability. Banks motivated by CSR are more likely to incorporate climate-related risks into their lending decisions, ensuring loans are directed toward companies with effective environmental risk management frameworks. Furthermore, CSR fosters customer trust and financial literacy over time, reducing default rates even during climate-induced economic shocks. Therefore, CSR acts as a stabilizer, weakening the adverse impact of climate risk on loan performance and promoting financial stability. The results confirm the third hypothesis (H3).

The findings in Table 6 indicate that the NPLs ratio significantly decreases under the bank-specific conditions. The coefficient of bank size is negative and significant. An increase in bank size by 1% leads to a significant decrease in the level of NPLs by 8.2%. Larger banks are less exposed to non-repayment of NPLs because they are more likely to have access to advanced technologies, as well as more qualified managers and diversified tools that can effectively evaluate the quality of their credit portfolios. This finding corroborates the works of Naili and Lahrichi [39] and Jenkins et al. [51].

Similarly, the capital adequacy ratio significantly reduces the NPL ratio in the MENA region. A 1% increase in the capital ratio leads to a 0.3% decrease in the level of NPLs. Banks with higher capital ratios implement effective control systems to manage information asymmetries and adverse selection, thereby reducing loan defaults. As a result, this helps preserve the bank's capital reserves. This finding agrees with the findings of Kryzanowski et al. [43] and Makri et al. [32]

Concerning bank performance and bank diversification, findings reveal a negative and significant impact on NPLs. Increasing the ROA by 1% significantly reduced the volume of NPLs by 142.1%. Profitable financial institutions often have a diverse lending portfolio, which helps mitigate their risks. It is typical for high-performing banks to have sufficient provisioning reserves to cover possible losses in the event of payment default. Our findings agree with those of Jabbouri et al. [38] and Jenkins et al. [51].

The increase in bank diversification by 1% significantly reduced the volume of NPLs by 142.1% and 0.2%, respectively. Banks with greater diversification generate higher non-interest income, which enhances their performance. They aim to maximize their stable, risk-free revenues. In this context, it becomes essential for them to accurately assess and manage the risks associated with different asset categories to prevent credit risks and ensure their financial stability. These findings corroborate the results of Saliba et al. [48] as well as those of Ghosh [52].

For the macroeconomic factors, GDP growth negatively and significantly impacts NPLs in the region. NPLs significantly decrease by 0.1% when GDP growth increases by 1%. Credit risk tends to decline as the economic environment improves. Our results confirm those of Hakimi et al. [57], who concluded that higher economic growth strengthens the ability of borrowers to repay their loans, ensuring their solvency.

Looking at the effect of inflation rates, it has a positive and significant impact on non-performing loans. As these increase by 0.01%, the inflation rate increases by 1%. This positive relationship confirms the conclusions of Karismaulia et al. [40], who found that an inflationary situation weakens consumers' financial capacity due to price increases and consequently makes it more difficult to repay loans.

Domestic credit to the private sector (DCTPS) in the MENA region is a key factor in mitigating credit risk. A 1% increase in DCTPS significantly decreases the ratio of non-performing loans by 0.1%. The agreement of substantial domestic credit to the private sector aims to support creditworthy borrowers, stimulate investments, and

promote economic growth. Private sector financing through creditor loans seeks to improve the profitability of businesses by increasing household incomes and, consequently, ensuring increased repayment capacity. As a result, this dynamic not only reduces the volume of NPLs but also improves the quality of bank loan portfolios. This result aligns with the results of Hakimi et al. [3].

The bank concentration (CONC) has a positive and significant effect on non-performing loans (NPLs) at the 1% significance level in the region. Dominant banks operating in highly concentrated banking markets receive a larger share of credit applications. To handle most requests, they can grant credit with insufficient guarantees and adopt more flexible borrower selection processes, thereby increasing non-performing loans. This result contradicts those of Hakimi et al. [57], who found a negative association between concentration and NPLs.

Regarding the institutional quality index (QI_index), it significantly reduces the NPL ratio in the MENA region. The more the quality of the institutional environment improves by 1%, the more the ratio of NPLs weakens by 47.4%. Establishing a transparent, credible, and higher-quality institutional environment signals positively to solvent investors. It ensures an economic environment with greater political stability, compliance with regulations, and the application of laws while protecting the rights of lenders and borrowers. A well-reputed institutional framework helps to strengthen trust between lenders and borrowers, which supports the development of the financial sector. Moreover, it benefits the economic and financial situation of borrowers, improves household profitability, and consequently reduces the risk of default. This negative association confirms the conclusions of Goyal et al. [55].

Finally, according to the results presented in Table 6, an effective board of directors contributes to reducing the NLPs ratio in the MENA region. The results indicate a negative association between the CA_index and NPLs, or a 1% improvement in the Board of Directors Characteristics Index (CA_index) significantly reduces the non-performing loan ratio by 10.8%. Establishing a well-structured Board of Directors promotes transparency and accountability within the organization. Additionally, establishing an effective Board of Directors improves the skills of its members, ensuring the presence of administrators better equipped to develop risk management strategies in response to economic changes. A balanced composition of the Board of Directors enhances the decision-making process, strengthens the supervision of managerial activities, and leads to the rapid resolution of potential credit problems. This finding confirms the conclusions of Hakimi et al. [57].

5. SENSITIVE CHECK

To draw relevant conclusions, it is essential to validate the robustness of our empirical results. To achieve this, we maintained the same empirical approach (SGMM) while incorporating a new credit risk measure into our initial models. More precisely, we measured credit risk by the loan loss provision ratio [34, 35]. According to Jia [58] and Lee et al. [59], this ratio refers to the amount a bank must reserve to cover anticipated credit losses in its loan portfolio. Wang et al. [60] mentioned that the loan loss provisions to total assets ratio is a key indicator of bank loan reserve adequacy. It reflects both the strength of banking practices in risk management and their ability to control the level of exposure. In this study, the LLPTA ratio is determined by the ratio between loan loss provisions (LLP) and total assets (TA), represented by the following equation:

$$LLPTA_{i,t} = \frac{LLP_{i,t}}{TA_{i,t}}$$

Furthermore, loan loss provisions are of particular importance to regulators and banking supervisors. Underestimating these provisions could indeed prove insufficient to cover expected credit losses, thereby increasing the vulnerability of banks [61]. For this reason, banking regulatory and supervisory bodies pay close attention to this indicator [62].

The literature establishes a positive relationship between the non-performing loans (NPLs) ratio and the loan loss provision (LLP) ratio, suggesting that banks increase their provisions when they anticipate higher credit losses

[63-65].

Table 7 presents the results of the robustness tests, using the loan loss provisions to total assets ratio as the dependent variable and SGMM as the econometric approach. Both p-values for the Sargan test and the AR(2) test exceed the 5% threshold, confirming the validity of the over-identification restrictions and the absence of second-order autocorrelation. Furthermore, the lagged value of the loan loss provisions to total assets ratio significantly increases its current value at the 1% level. The following results largely confirm those found by the non-performing loans.

Following the empirical results displayed in MODEL 1, climate risk significantly increases the loan loss provision in the MENA region. Climate risk directly affects borrowers' repayment capacity as well as the quality of bank assets. Companies operate in economic environments that are increasingly influenced by extreme climate changes. These events disrupt business continuity, thereby reducing borrowers' financial capacity. When borrowers' incomes are affected, the probability of default increases. In response, banks raise their loan loss provisions to protect themselves against potential losses resulting from a rise in non-performing loans.

Table 7. Estimation results.

LLPTA	MODEL 1		MODEL 2		MODEL 3	
	Coef.	Z	Coef.	Z	Coef.	Z
LLPTA (-1)	0.721	454.41***	0.73	493.90***	0.725	515.56***
SIZE	0.012	42.76***	0.012	44.89***	0.012	41.09***
CAP	0.001	2.23**	0.002	1.85*	0.001	1.27
ROA	-0.384	-19.88***	-0.384	-18.12***	-0.358	-18.34***
LTD	0.000	0.80	0.000	1.06	0.000	0.83
NII	-0.0001	-22.48***	-0.0001	-28.68***	-0.0001	-23.40***
GDPG	-0.001	-59.13***	-0.001	-49.86***	-0.001	-70.24***
INF	0.000	5.44***	0.000	5.68***	0.000	4.50***
DCTPS	0.000	20.58***	0.000	22.45***	0.000	23.86***
UNEMP	0.000	3.19***	0.000	1.62	0.000	2.21**
CONC	-0.0003	-29.11***	-0.0003	-41.00***	-0.0003	-47.05***
QI_index	0.053	45.98***	0.049	47.70***	0.05	36.04***
CA_index	-0.02	-17.38***	-0.02	-20.93***	-0.024	-24.13***
CRII	0.188	11.76***				
ESG			-0.00003	-5.90***		
ESGxCRII					-0.002	-9.07***
Constant	-0.277	-38.81***	-0.258	-39.31***	-0.274	-36.37***
Obs.	586		584		582	
AR (1)	-2.0162		-2.0223		-2.0205	
PROB	0.0438		0.0431		0.0433	
AR (2)	-0.25574		-0.30303		-0.29362	
PROB	0.7982		0.7619		0.7691	
SARGAN TEST	66.23522		66.37552		66.10225	
PROB	0.3997		0.3950		0.4041	

Note: *** p<0.01, ** p<0.05, * p<0.1.

Concerning the effect of the ESG score on the loan loss provisions to total assets ratio, the findings in MODEL 2 confirm the robustness of the results obtained for NPLs. The results show that banks with higher engagement in social responsibility tend to reduce the volume of loan loss provisions. In particular, banks that actively participate in CSR initiatives are more likely to adopt prudent lending practices and foster stronger relationships with stakeholders, which in turn enhance credit portfolio quality and reduce the need for high provisions.

Model 3 presents the results of the interaction term ESGxCRII on the loan loss provisions to total assets ratio. The results confirm that CSR moderates the relationship between climate risk and credit risk. Specifically, the greater a bank's engagement in CSR practices, the weaker the impact of climate risk on loan loss provisions. CSR stimulates

investment in projects supporting the green economy by adopting proactive, sustainable, and ethical practices, thereby acting as a buffer against exposure to climate risk. Strategic integration of an authentic CSR policy by banks leads to the implementation of proactive risk management strategies that limit the financing of high-environmental-risk projects. A deep commitment to CSR enhances the selection of borrowers with low climate risk, thereby mitigating the negative effects of climate change on project profitability. This strategy ultimately reduces the volume of non-performing loans (NPL) and, consequently, the volume of provisions for loan losses.

As expected, bank size, bank capital, domestic credit to the private sector, unemployment, and better institutional quality are the main traditional determinants of credit risk in the MENA region. Thus, all these control variables have a significant positive relationship with the volume of loan loss provisions. Large and well-capitalized banks estimate a higher level of provisions to cover potential losses due to their financial capacity to ensure stricter regulatory oversight or risk prevention strategies. Similarly, a better quality of the institutional framework encourages banks to adopt more transparent and rigorous risk management practices by estimating and provisioning for potential losses more quickly. Additionally, increased credit to the private sector and a high unemployment rate reflect a poorer financial and economic situation for borrowers, leading to a higher level of default risk. Consequently, banks increase their volume of provisions.

6. CONCLUSION

To contribute to the debate on bank credit risk issues, this study aims to test how corporate social responsibility can moderate the relationship between climate risk and credit risk. To assess this moderating role, we used a dataset of 70 banks operating in the MENA region over the years 2010-2022, and the SGMM as an empirical approach. For this purpose, the main independent variable is climate risk, which was proxied by the Global Climate Risk Index (CRII). Similarly, we measured corporate social responsibility by the Environmental, Social, and Governance score (ESG). Credit risk was measured through two proxies: non-performing loans and the loan loss provision ratio. The empirical findings indicate a negative and significant correlation between climate risk and non-performing loans in the MENA region. We found that corporate social responsibility improves bank stability by reducing the level of NPLs. Furthermore, findings support evidence that the interaction between climate risk and corporate social responsibility significantly increases the level of bank stability in the MENA region. The results of the robustness check show that CRII increases both portfolio and leverage risks, while corporate social responsibility significantly lowers risk. We also found that MENA banks benefit from an interaction between CRII and CSR since it significantly reduces the loan loss provisions to total assets ratio.

The findings of this study carry significant policy implications for both policymakers and bankers. First, policymakers should promote policies that encourage banks to embrace CSR within their risk management, particularly by supporting sustainable lending and green finance initiatives. They can achieve this through tax incentives, subsidies, or mandatory ESG reporting indicators. Financial institutions and central banks should also enhance their climate risk analytical capabilities to ensure that the banking sector adequately incorporates environmental considerations into their loan guidelines. Second, from the perspective of bankers, adopting CSR-driven strategies has the potential to improve the credit quality of loan portfolios through responsible lending and by catering to businesses with sound environmental risk mitigation methods. To reduce borrowers' exposure to climate shocks, banks are required to invest in climate-resilient financial literacy and sustainable business growth. Finally, by integrating CSR into banking operations, both regulators and bankers can help ensure a more stable and resilient banking system in the MENA region.

The current study focuses on the relationship between climate risk, non-performing loans, and CSR in the MENA region and has some limitations. Firstly, the available CSR data lacks sufficiency in both quantity and quality due to the absence of standardized CSR reporting standards in most MENA banks. This lack of standardization can lead to

measurement inconsistencies, undermining the robustness of the results. Second, the MENA region comprises a diverse group of countries with distinct characteristics, including natural and economic resources. This study primarily focuses on the overall climate risk score and does not examine climate risk specific to each country, particularly sectoral issues. Third, although a moderating effect of CSR is observed, this study does not consider potential endogeneity issues, such as the possibility that banks with higher NPL levels may be more capable of adopting CSR initiatives.

In future research, it is crucial to analyze the different dimensions of CSR separately, specifically the environmental, social, and governance dimensions, to deepen the analysis and improve conclusions. The MENA region encompasses both Islamic and conventional banks, operating under different regulatory frameworks. Therefore, conducting a comparative study between Islamic and conventional banks would provide more detailed information on the moderating relationship between CSR, climate risk, and non-performing loans (NPLs). Additionally, a comparative international study including European and American regions would be beneficial to explain how local conditions, such as financial development and regulatory regimes, influence these relationships.

Furthermore, research on the impact of international climate policies combined with recent advancements in financial technologies, such as fintech and blockchain, can provide valuable insights into how to optimize climate risk management and apply CSR within regional economies.

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