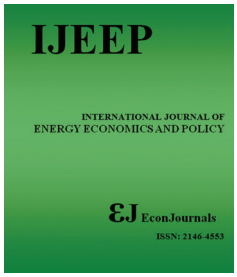

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Climate Risk and Bank Profitability in the MENA Region: The Moderating Role of Financial Development

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ABSTRACT

This study pursues three key objectives: First, to examine the impact of climate risk on bank profitability, measured by return on assets (ROA) and return on equity (ROE); second, to assess the role of financial development (FD) in influencing bank profitability; and third, to determine whether financial development moderates the relationship between climate risk and bank profitability. Using a sample of 68 conventional banks in the MENA region (2005-2020) and employing the SGMM methodology, we split the MENA region in two sub-regions. The first block contains the Gulf Cooperation Council (GCC) countries with a sample of 33 banks and, the second covers the non-GCC countries with a sample of 35 banks. Results reveal that climate risk reduces bank profitability, while financial development enhances it. Additionally, financial development mitigates the negative effect of climate risk on profitability. However, sub-sample results differ: for GCC banks, FD shows a positive impact, climate risk a negative one, and their interaction a positive effect, whereas for non-GCC banks, climate risk and its interaction with FD are insignificant.

Keywords: Climate Risk, Financial Development, Profitability, MENA Banks, SGMM
JEL Classifications: G21; Q54

1. INTRODUCTION

Climate change and ecological degradation are indeed critical issues that need urgent attention. The Paris Agreement of 2015, COP26, and COP28 are notable global initiatives aimed at mobilizing financial resources to implement effective strategies for mitigating greenhouse emissions and working towards sustainable development (UNFCC, 2015; UNFCC, 2021 and UNFCC, 2023).

Climate risk refers to the possible harm that climate change might do to multiple areas of society, particularly the economy. There is an increasing interest from governments and financial sector authorities all over the world regarding the implications of climate change and associated hazards on economies and financial systems. The physical deterioration and financial losses that are linked to climate change have an impact on the stability of the financial system. The physical impacts of climate-related shocks, such as extreme weather events, can affect financial institutions and the global economy (Dietz et al., 2016; Bolton et al., 2020).

Banks are regarded as one of the key providers of funding for economies. Through encouraging investment and corporate activity, the banking system contributes significantly to economic growth. Therefore, it is essential to identify the elements that ensure bank stability and promote profitability. Considering the role that banks play in the financial system and how they affect economic expansion, it is critical to recognize the critical role that banking institutions play in managing climate-related risks in emerging nations. Due to issues like poverty, poor infrastructure, and ineffective administration, these economies are typically more susceptible to the effects of climate change (Levine, 2005; Battiston et al., 2017).

Bank profitability may be impacted by climate change in a number of ways. First of all, the stock performance of banks

is negatively impacted by climate change concerns, potentially resulting in financial losses. Second, how banks handle climate change may have an impact on their profits. Although banks are aware of the effects of climate change, they have not yet fully implemented climate change management strategies in their operations. Profitability, however, may benefit from overall climate change management and disclosure quality. Furthermore, banks restrict credit extension to more polluted provinces by adjusting their credit supply in areas with higher vulnerability to climate concerns. This means that banks should take into account the risks associated with climate change and modify their loan provisioning appropriately. Moreover, businesses in areas more vulnerable to climate change pay greater spreads.

Extreme weather events, such as hurricanes, floods, and wildfires, may be more frequent because of climate change. Such events could cause damage to infrastructure and property, leading to insurance claims and debt defaults. Banks may face higher credit risks and lower asset values in regions affected by climate-related disasters. To mitigate these risks and foster long-term profitability, banks can incorporate climate risk assessment and management practices into their business models. This includes stress testing portfolios to evaluate their vulnerability to climate-related risks, integrating environmental factors into lending and investment decisions, and participating in sustainable finance initiatives.

The following inquiries will be addressed in this study: Does climate risk have an impact on MENA banks' profitability? How important is financial development in this area?

This study investigates the relationship between climate risk, financial development, and bank profitability in the context of the MENA area. The MENA area might be considered a suitable case study for a number of reasons. First, climate risks in the MENA region are a high-urgency issue, bearing in mind both geographical and socio-economic vulnerabilities of the region. The MENA region is one of the hottest regions in the world, and it is warming up at a speed much faster compared to the rest of the world. The projections for average temperature rise under the high-emission scenario show an increase of 2-4°C by the close of this century. In fact, MENA stands as the most water-scarce region in the world, with over 60% of its population already exposed to water stress. Second, the financial development in the MENA region is a mixed picture, influenced by diverse economic structures and varying levels of institutional strength, together with geopolitical dynamics. Furthermore, financial systems across most MENA countries are heavily bank-based, as banks dominate savings mobilization and credit supply. Consequently, it will be very useful to study the connection between climate risk, financial development and bank profitability in this region.

The sample of 68 MENA banks from 10 MENA nations served as the basis for our study, which was conducted between 2005 and 2020. The System Generalized Method of Moments (SGMM) is an empirical method used in this article. We divided the MENA area into two sub-regions in order to obtain more accurate findings and a better understanding of how financial development and climate risk affect bank profitability. 33 banks from the Gulf Cooperation Council (GCC) nations are included in the first block, while 35 banks from the non-GCC countries are included in the second.

The empirical findings indicate that while financial growth considerably boosts MENA banks' profitability, climate risk lowers bank profitability. Additionally, results corroborate the notion that FD and climate risk combine to greatly boost bank profitability. The two sub-samples have different disaggregated analytical outcomes. Regarding the favorable impact of FD, the negative impact of climate risk, and the positive impact of the interactional link, the results for the GCC nations support the same conclusions. Regarding the impact of climate risk and the interactional link for the non-GCC nations, no significant effect was discovered.

This study makes several key contributions to the existing literature. First, it assesses the impact of climate risk on bank profitability in the relatively under-researched MENA region using comprehensive analysis; second, it brings in the moderating role of financial development that provides a new look at how regional financial systems are likely to influence the nexus between climate risk and bank performance. Third, as part of a sensitivity analysis, the study divides the sample into GCC and non-GCC banks, enabling a comparative analysis between the two sub-regions and facilitating the development of region-specific recommendations. Finally, the findings offer valuable insights for policymakers and bankers, providing guidance on restructuring credit portfolios and creating innovative lending products to enhance bank profitability.

The rest of this paper is organized as follows: Section 2 presents the literature review. Section 3 outlines the sample and explains the empirical methodology. Section 4 discusses the empirical findings. Finally, Section 5 provides the conclusion and offers policy recommendations.

2. RELEVANT LITERATURE AND HYPOTHESES DEVELOPMENT

The relationship between climate risk and bank profitability is reviewed at the beginning of this section, followed by a presentation of recent research on the connection between financial development and bank profitability, and a summary of studies on the moderating influence of financial development on the relationship between climate risk and bank profitability.

2.1. Climate Risk and Bank Profitability

Natural catastrophes have the potential to seriously affect the stability and profitability of banks. Several studies document the negative effects that natural catastrophes exert on bank stability, profitability, and deposit ratios. For example, Walker et al. (2023) examined the performance and solvency effects of natural catastrophes on US banks, finding that these are likely to result in reduced profitability and solvency metrics such as the equity ratio and the net-income-to-assets ratio.

Similarly, Noth and Schüwer (2023) investigated the relationship between bank stability and natural catastrophes. Their findings indicate that natural disasters caused by weather in the United

States significantly undermine the financial stability of banks operating in affected regions. This is demonstrated by increased default probabilities, reduced z-scores, higher ratios of non-performing assets, higher foreclosure ratios, lower returns on assets, and lower equity ratios during the period succeeding a natural disaster.

Nguyen et al. (2023) had investigated the Asian context. They investigated how natural catastrophes affect commercial bank performance and how financial integration influences this connection using a sample of East Asian banks from 1999 to 2014. The study's key conclusions show that while natural catastrophes have no direct correlation with liquidity, credit risk, profitability, or default risk, they do considerably reduce deposit ratios. Disasters have also been shown to have a delayed effect, with deposits rising and liquidity falling a year following the incident. Additionally, international banking claims more especially, those made by regional Asian lenders help to mitigate the drop in deposits following natural catastrophes.

Caby et al. (2022) used a sample of 137 banks from 36 developed and emerging economies between 2011 and 2019 to investigate the impact of climate change management on bank profitability. Nevertheless, banks appear aware of the consequences of climate change on their business to the point that they have transformed the issue into a strategic matter relevant for the board of directors. The empirical findings support a positive impact on profitability with respect to the general quality of climate change management and disclosure, as well as the ex-post justification of relevance of the topic to the board. Considering that new banking rules are being enacted, the correlation between climate change management practices and financial success is still at a rather poor level; thus, banks should pay more attention to these practices in order to protect their future profits.

Barth et al. (2022) investigated the effect of natural disasters on bank performance in 2022. The authors used a sample of US banks between 2000 and 2017 to do this. The results indicate that community and non-community banks drive the results without any evidence of price gouging. Furthermore, they are located in disaster areas and help such communities recover from natural disasters.

To investigate the impact of natural disasters on banks, Blickle et al. (2021), used a sample of US banks. They found that it's important to note that the effects of natural disasters on banks can vary based on the size and diversification of the banks, with larger banks being able to offset losses and even boost profits due to increased loan demand, while local banks may experience more negative stability effects. In the same context, Bos et al. (2022), using a sample of US commercial banks, studied the impact of natural disasters on bank asset portfolios. Results show that banks' asset diversification strategy helps clients' smooth consumption and supports local recovery.

The literature on the relationship between climate risk and bank profitability highlights an emerging consensus that climate-related risks pose serious challenges to financial institutions, while empirical evidence remains mixed and context-dependent. It has been indicated that physical risks and transition risks-which originate from the transition to a low-carbon economy-can have a negative impact on bank profitability by increasing loan defaults, reducing asset values, and raising operational costs. However, other studies have put forward that the impacts might be diminished for banks with strong risk management frameworks and diversified portfolios or even exploited as an opportunity through green financing. Much of the literature also lacks detail in terms of differentiating between short-run and long-run impacts, with significant reliance on macroeconomic models that do not capture bank-specific vulnerabilities. Moreover, regional inequalities in climate risk exposure and regulatory responses are not well explored, which limits the generalization of the findings. Overall, although the literature emphasizes that integrating climate risk into financial decision-making is important, further empirical research is needed to disentangle the complex mechanisms through which climate risk influences bank profitability across different contexts and time horizons. This paper examines how climate risk affects bank profitability in the MENA area by drawing on theoretical and empirical insights from relevant literature. The following hypothesis is specifically tested by the study:

H_1: Climate risk decreases bank profitability

2.2. Financial Development and Bank Profitability

Financial development is typically defined as the growth and sophistication of financial markets, institutions, and instruments in an economy. It includes improving access to capital, enhancing risk management, increasing financial inclusion, and diversifying investment options. Bank profitability, on the other hand, often refers to the ability of banks to generate returns for their shareholders, commonly measured by metrics like Return on Assets (ROA) and Return on Equity (ROE).

The relation between financial development and bank profitability is complicated and has shifted across different regions and contexts. A literature review on the relationship between financial development and bank profitability would typically cover how the changes in financial systems, availability of financial resources, and financial regulations influence the profitability of banking institutions. Though some studies indicate the positive impact of financial development on profitability, other studies point to a negative correlation in certain environments.

Demirguç-Kunt and Huizingha (1999) examine the effects of financial development and financial structure on bank profitability using bank-level data for a number of developed and developing countries from 1990 to 1997. They discover that because financial development increases competition, which in turn implies reduced bank profitability; it has a negative impact on bank performance.

Ting (2017) discusses the influence of government intervention in banks and financial development on bank profitability during the 2008 global financial crisis. The findings show that during the 2008 global financial crisis, both government involvement and financial development positively influenced the profitability of banks. In addition, the positive effect of financial development was relatively higher for banks with lower government involvement compared to those with higher government involvement.

From 2002 to 2016, Le and Ngo (2020) look into the factors that affect bank profitability in 23 different countries. They measure financial development by looking at the stock market capitalization to GDP ratio. They discovered that the growths of the capital market and bank profitability are positively correlated.

According to Ozili and Ndah (2021), the profitability of Nigerian banks is negatively correlated with the financial system deposits to GDP ratio, which is an indicator of financial development. Recently, Bashiru et al. (2023) examined the influence of financial development on bank profitability in Sub-Saharan Africa. From this study, it was discovered that the extent of financial development has a negative significant impact on the banking sector profitability.

The link between bank profitability and financial development is influenced by economic conditions, regulatory frameworks, and market structure. Financial development may boost profitability by increasing efficiency and allocating resources more effectively, but this connection may be impacted by issues with competitiveness, systemic risk, and economic cycles. In order to guarantee both long-term bank profitability and general financial stability, the literature recommends a balanced strategy to financial development.

The literature on the relationship between financial development and bank profitability is wide-ranging and complex; studies have shown a wide range of perspectives depending on the theoretical framework and empirical setting. On one hand, financial development has been supported by substantial evidence to have a positive effect on bank profitability with deeper capital markets, improved regulatory frameworks, and increased access to financial services that reduce information asymmetries, lower transaction costs, and enable better resource allocation. On the other hand, some literature indicates that finance that is more developed means there will be greater competition within the banking sector; therefore, it squeezes interest margins and undermines profitability, especially for smaller banks or those that are less efficient. Even more critically, most of the studies tend to center around aggregate measures of financial development, disregarding heterogeneous effects particular to such dimensions as institutional quality, technological advancement, or financial inclusion. Most studies currently remain concentrated for developed economies, leaving many gaps in how this relationship works in emerging or low-income economies where financial systems are less mature, with large variations in the institutional environment. The literature while contributing useful insights, is not well converged and lacks contextual specificity. This implies the need for more granular, cross-country, and longitudinal studies to be conducted in order to clearly understand the mechanism and conditions under which financial development influences bank profitability. This research uses the theoretical and empirical insights gained in the relevant literature to investigate the effect of financial development on bank profitability in the MENA region. In particular, the study examines the following hypothesis:

H_2: Financial development improves bank profitability

2.3. The Moderating Role of Financial Development in the Climate Risk -Bank Profitability Relationship

The interplay between financial development, climate risk, and bank profitability is increasingly recognized in economic literature. This relationship is influenced by various factors, including the maturity of financial systems, the nature of climate risks, and the overall economic environment.

The literature exploring the role of financial development as a moderator in the relationship between climate risk and bank profitability is relatively recent, according to Afzal et al. (2024), financial development, particularly through green banking initiatives, can mitigate these effects. For instance, the adaptation of green technologies in banking has been shown to enhance profitability and reduce credit risks, suggesting that banks that embrace sustainable practices can better navigate climate-related challenges. As stated by Lee et al. (2024), banks that implement green policies can improve their profitability while managing climate risks effectively.

Hunjra et al. (2022) investigate the role of financial policy uncertainty in climate change risk and show that financial policy uncertainties play a significant role in climate-change risk in 42 developing economies from 1991 to 2020. The authors found that financial development facilitates better risk assessment and management practices, enabling banks to navigate climate risks more effectively.

Liu et al. (2024) examine the connection between bank risk-taking and climate transition risk (CTR), concentrating on Chinese commercial banks between 2010 and 2020. The results highlight how crucial it is that banks use digital transformation as a strategy to successfully manage the risks associated with the climate transition. This demonstrates why banks must give digital projects top priority in order to improve their capacity for risk management in the face of climate change.

According to the study of Alogoskoufis et al. (2021), developed financial markets frequently have stricter regulatory frameworks that incentivize banks to implement climate risk mitigation strategies, which might eventually stabilize profitability. In summary, financial development may moderate the relationship between climate risk and bank profitability in several ways: More developed financial systems typically possess better risk management tools and frameworks, allowing banks to better absorb shocks from climate-related risks.

Literature on financial development as a moderator in the relationship between climate risk and bank profitability is at foundational stages and hence comes up with a few but very insightful literature pieces. Though studies agree on how climate risk negatively impacts bank profitability through mechanisms such as increased loan defaults, asset devaluations, and higher operational costs, the mitigating or aggravating role played by financial development has generally been less explored. While some studies indicate that, in financially developed economies, banks might be better positioned to absorb climate-related shocks due to advanced risk management systems, diversified portfolios, and access to innovative financial instruments such as green bonds or climate-resilient investments, other studies propose that higher financial development might amplify negative effects from climate risk. This is through increasing market sensitivity to environmental

shocks or by fostering overexposure to climate-vulnerable sectors. A critical gap exists in literature as far as empirical studies on differential impacts across regions of financial development go, especially in the developing economies whose financial systems are less robust and where their climate risks are sometimes more acute. Further, under most literature lies the interaction issue of financial development with regulatory frameworks that could considerably shape how banks could respond to risks emanating from climate change. In sum, while some research has been conducted, there is still an urgent need for more comprehensive and context-specific studies to completely understand the moderating role of financial development in shaping the nexus between climate risk and bank profitability. This paper examines the moderating impact of financial development in the relationship between climate risks and bank profitability in the MENA area, building on the theoretical and empirical insights produced in the relevant literature. The following hypothesis is specifically tested by the study:

H_3: Financial development moderates the climate risk –bank profitability relationship

3. SAMPLE, EMPIRICAL APPROACH AND MODEL SPECIFICATION

3.1. The Sample

The moderating role of financial development in the relationship between climate risk and bank profitability is investigated using a sample of conventional banks from 10 MENA countries over the period 2005-2020. This period was chosen for several reasons: First, it covers major global and regional events such as the 2008 global financial crisis and the adoption of the Paris Agreement in 2015, which have heightened awareness of climate risks. This period is long enough to estimate the dynamic relationship between climate risk, financial development and bank profitability. The dataset included an initial number of 109 banks; however, due to limitations in data availability and continuity, the final sample was narrowed to 68 conventional banks. In order to provide more profound insights and reliable results on the impact of financial inclusion on bank stability, the MENA region was divided into two sub-regions based on the International Monetary Fund's World Economic Outlook classification. The first group comprises GCC countries, represented by a sample of 33 banks, while the second group includes non-GCC countries, represented by 35 banks (Table 1).

3.2. Variable Selection and Theoretical Justification

The dependent variable is bank profitability proxied by return on assets and return on equity, as seen in prior studies such as Goddard et al. (2004), and Hakimi et al. (2023). The independent variable is climate risk proxied by the climate risk index as in Kreft and Eckstein, (2014). The moderating variable, financial development is measured using the IMF's financial development index from Svirydzenka (2016). Control variables include bank-specific factors, such as size, capital adequacy, and loan-to-deposit ratio, as well as macroeconomic factors like GDP growth and inflation. These variables were selected based on their theoretical relevance and prior empirical evidence.

3.2.1. Dependent variable: Bank profitability

In this paper, we extend the literature by investigating the effect of climate risk and financial development on banking profitability. To capture this relationship, the dependent variable is the profitability measured by the (ROA) and (ROE) ratio. Referring to Goddard et al. (2004), and Hakimi et al. (2023), we employ two metrics that represent different dimensions of bank performance. The ROA reflects a bank's efficiency in generating income with its assets and is calculated as the ratio of net income to total assets. The net income-to-total equity ratio is referred to as return on equity, or ROE.

3.2.2. Main explanatory variable: Climate risk

As explanatory variables, according to Kreft and Eckstein (2014), we use the Global Climate Risk Index (CRI) compiled and published by Germanwatch to measure climate risk by country. The index aims to demonstrate the adverse effects that climate change has had on many different countries. These include climatologically events like wildfires, hydrological events like floods, and meteorological happenings like storms. Low climatic risk is indicated by a high index score, and a lower score on the index is an indication of a higher climate risk.

3.2.3. Other explanatory variable: Financial development

Beck and Levine (2005) highlighted various indicators of financial development that capture the size, activity, and efficiency of the financial sector. Commonly used proxies in empirical studies include the ratio of financial depth or stock market capitalization to GDP and the ratio of credit to the private sector (bank loans to private enterprises) to GDP. However, the aggregate index of financial development introduced by the IMF (Svirydzenka, 2016) offers a more comprehensive measure, encompassing multiple dimensions of the financial system. In this study, we utilize the IMF's financial development index, which integrates three key components: Depth (the size and liquidity of financial markets), access (the ability of individuals and businesses to obtain financial services), and efficiency (the capacity of institutions to deliver financial services cost-effectively, sustainably, and with active capital markets).

3.2.4. Control variables

As outlined, our econometric model incorporates several control variables. The first category pertains to bank-specific factors, including bank size (BS), which is used to explain variations in bank performance (Anginer et al., 2018), and the capital adequacy ratio (CAR), a key determinant of bank performance (Molyneux and Thornton, 1992). The second category relates to industry-specific variables, such as bank concentration (CONC) and bank

Table 1: Distribution of the sample by country

GCC		NON GCC	
Countries	**Number of banks**	**Countries**	**Number of banks**
Kuwait	5	Egypt	4
Oman	3	Morocco	4
Qatar	4	Tunisia	10
Saudi Arabia	8	Jordan	13
United Arab Emirates	13	Lebanon	4
Number of banks	33	Number of banks	35
Whole sample		68 banks	

competition (LERN), both recognized as significant drivers of bank profitability (Hakimi et al., 2023). The third category encompasses macroeconomic conditions, represented by the GDP growth rate (GDPG), inflation rate (INF), the 2008 global financial crisis (CRISIS), and the unemployment rate (UNEM) (Hakimi et al., 2023; Abreu and Mendes, 2001).

Bank-level data, including financial and accounting variables, were sourced from the Thomson Reuters database and the annual reports of individual banks. Country-level data, reflecting industry-specific and macroeconomic conditions, were gathered from two primary sources: The Global Financial Indicators database and the World Bank Indicators database. Climate Risk Index (CRI) data were obtained from Germanwatch, while data on the Financial Development Index (FDI) were retrieved from the IMF's Financial Access Survey.

3.3. Empirical Approach and Model Specification

The empirical approach employed in this study is thus based on the SGMM methodology. A number of reasons underscore the appropriateness of the SGMM approach in the present study. First, the dynamic nature of bank profitability can be considered by including the lagged dependent variables as regressors. The second is that it reduces endogeneity issues through the use of internal instruments, like lagged values of independent variables. Third, it gives consistent and efficient estimates in the presence of heteroscedasticity and autocorrelation. Moreover, omitted variables bias and measurement errors are two problems that are consistently faced by OLS and fixed- and random-effect (FE and RE) models. To this end, we used the SGMM approach, recommended by Blundell and Bond (1998) in this study. Results are more reliable and useful in the SGMM method (Zhou et al., 2014; Teixeira and Queirós, 2016; Danisman and Tarazi 2020; Hakimi et al., 2023).

The empirical approach in this work is based on three phases. First, we explore the relationship between climate risk and bank profitability. Equation (1) presents the econometric to be tested in this step:

$$PROF_{i,t} = \beta_0 + \beta_1 PROF_{i,t-1} + \beta_2 CRI_{i,t} + \beta_3 BS_{i,t} + \beta_4 CAR_{i,t} + \beta_5 CONC_{i,t} + \beta_6 LERN_{i,t} + \beta_7 GDPG_{i,t} + \beta_8 INF_{i,t} + \beta_9 CRISIS_{i,t} + \beta_9 UNEM_{i,t} + \varepsilon_{i,t} \quad (1)$$

We looked into how financial development affected bank profitability in the second stage. The following equation (2) presents the econometric model:

$$PROF_{i,t} = \beta_0 + \beta_1 PROF_{i,t-1} + \beta_2 FDI_{i,t} + \beta_3 BS_{i,t} + \beta_4 CAR_{i,t} + \beta_5 CONC_{i,t} + \beta_6 LERN_{i,t} + \beta_7 GDPG_{i,t} + \beta_8 INF_{i,t} + \beta_9 CRISIS_{i,t} + \beta_9 UNEM_{i,t} + \varepsilon_{i,t} \quad (2)$$

The third phase is determining if the link between climate risk and bank profitability is mediated by financial development. In order to capture the interplay between climate risk and financial development, we incorporate an interactional variable into the econometric model. Equation (3) provides the econometric model to be tested:

$$PROF_{i,t} = \beta_0 + \beta_1 PROF_{i,t-1} + \beta_2 CRI*FDI_{i,t} + \beta_3 BS_{i,t} + \beta_4 CAR_{i,t} + \beta_5 CONC_{i,t} + \beta_6 LERN_{i,t} + \beta_7 GDPG_{i,t} + \beta_8 INF_{i,t} + \beta_9 CRISIS_{i,t} + \beta_9 UNEM_{i,t} + \varepsilon_{i,t} \quad (3)$$

All variables' definitions are given in Table 2.

4. ANALYSIS AND RESULTS

4.1. Summary Statistics and Correlation Matrix

Table 3 presents descriptive statistics for the variables used in our analysis. It outlines the key characteristics of this dataset. The table details, for each variable, the mean, standard deviation, minimum, and maximum value. These statistics summarize the variables used in the SGMM model.

Bank profitability, as expressed by Return on Assets or (ROA), stands at an average of 1.954, while a maximum value of 101.432 and a minimum value of −10.304 were registered by a Tunisian

Table 2: Definition and measurement of variables

Variables	Definitions	Measures
Dependent variables (PROF)		
ROA	Return on assets	Net income after tax to total assets
ROE	Return on equity	Net income after tax to total equities
Climate risk		
CRI	Climate risk index	Climate risk index (CRI) of German watch
Financial development		
FDI	Financial development index	the financial development index developed by the IMF
Interaction variables		
CRI*FDI	Interactional variable	The interaction between CRI and FDI
Bank specifics		
BS	Bank size	Natural logarithm of total assets
CAR	Capital adequacy ratio	Bank capital to total assets (%)
Industry specifics		
CONC	Bank Concentration	Bank concentration (%)
LERN	Bank competition	The Lerner index
Macroeconomic conditions and financial environment		
GDPG	The growth rate of GDP	Annual growth rate of GDP (%)
INF	The inflation rate	Consumer price index (%)
CRISIS	Global financial crisis of 2008	Dummy variable that takes 0 before the crisis of 2008 and 1 after
UNEM	The unemployment rate	The unemployment rate (%)

bank (UIB) on 2010. The Return on equity (ROE) ranges between −135.9, registered by a Kuwait bank (Gulf Bank) on 2008, and 59.3 with an average value of 13.713. For conventional banks, the Climate Risk Index (CRI) oscillates at an average value of 100.830, while the maximum achieved is 173.670. While calculating the Financial Development Index (FDI), its average worked out to 0.390, ranging from 0.578 to the maximum value and 0.167 for the minimum.

BS means bank size, and the average is relatively small at 9.887, ranging from 2.660 to 18.080. The (CAR) stands for Capital Adequacy Ratio, which averages 14.869, ranging from 1.256 to 40.350. Industry-specific factors are that the average bank concentration (CONC) is 67.906, with a maximum of 100.000 and a minimum of 40.218. Bank competition is measured by (LERN), averaging 0.423, ranging from 0.098 to 0.615.

Macroeconomic conditions, represented by the GDP growth rate (GDPG) and inflation rate (INF). The GDPG has an average 3.225, with a maximum of 26.170 and a minimum of −21.464 registered by Lebanon on 2020. The inflation rate averages 3.955, ranging from −4.863, registered by Qatar on 2009, to 84.864. Finally, the unemployment rate (UNEM) has an average of 7.999, with a maximum of 18.5 and a minimum of 0.11.

Table 3: Descriptive statistics

Variable	Mean	Standard deviation	Min	Max
ROA	1.954	3.505	−10.304	101.432
ROE	13.713	13.204	−135.9	59.3
CRI	100.830	31.404	12.250	173.670
FDI	0.390	0.104	0.167	0.578
BS	9.887	2.660	5.045	18.080
CAR	14.869	4.941	1.256	40.350
CONC	67.906	19.267	40.218	100.000
LERN	0.423	0.109	0.098	0.615
GDPG	3.225	4.465	−21.464	26.170
INF	3.955	6.403	−4.863	84.864
CRISIS	0.812	0.390	0	1
UNEM	7.999	5.397	0.11	18.5

The correlation matrix gives the strength and type of relationships between the variables by calculating the coefficients of linear correlations between the variables. The correlation matrix for all variables in this study is presented in Table 4.

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. The VIF value of 1 indicates no correlation; values between 1 and 5 suggest moderate correlation, and values >5 indicate potentially severe multicollinearity.

Results from Table 5, for example, present the mean VIF for the first model-that is, investigating the influence of climate risk on the profitability of banks to be around 1.54, thereby indicating no severe multicollinearity among the variables and thus showing a good moderate correlation across all values. Second, Table 6 shows the mean VIF of 1.95 for the second model, which analyzes the effect of financial development on bank profitability. Again, this confirms no severe multicollinearity, with moderate correlations between the variables. Finally, Table 7 presents the mean VIF value of 1.67 for the third model that probes the interaction effect of both financial development and climate risk on bank profitability. Thus, similar to the two previously discussed models, no severe multicollinearity would be expected, though this would show a moderate correlation between the variables.

4.2. Results of the Aggregate Analysis: The Whole Sample

4.2.1. Findings of the effect of climate risk on bank profitability

Testing the effect of climate risk, as determined by the Climate Risk Index (CRI), on bank performance in the MENA area, as determined by the ROA and ROE, is the first stage of the empirical approach used in this article. The empirical results are shown in Table 8.

The results of the Sargan and serial correlation diagnostic tests indicate that the null hypothesis, which assumes the validity of

Table 4: Correlation matrix

	CRI	FDI	BS	CAR	CONC	LERN	GDPG	INF	CRISIS	UNEM
CRI	1.0000									
FDI	0.2238*	1.0000								
	0.0000									
BS	−0.0112	0.0761*	1.0000							
	0.7110	0.0121								
CAR	0.1654*	0.4606*	0.0073	1.0000						
	0.0000	0.0000	0.8091							
CONC	0.0684*	0.3027*	−0.1930*	0.0556	1.0000					
	0.0240	0.0000	0.0000	0.0668						
LERN	0.0127	0.4544*	−0.2379*	0.2359*	0.1586	1.0000				
	0.7457	0.0000	0.0000	0.0000	0.0000					
GDPG	0.1114*	0.1874*	−0.0843*	0.0304	0.0101	−0.0022	1.0000			
	0.0002	0.0000	0.0054	0.3168	0.7398	0.9562				
INF	0.0602	−0.070*	0.0820*	−0.0904*	0.1356*	−0.2422*	−0.1157*	1.0000		
	0.0529	0.0228	0.0083	0.0037	0.0000	0.0000	0.0002			
CRISIS	−0.2932*	−0.0173	0.1239*	−0.0648*	0.0733*	0.1573*	−0.3571*	−0.032	1.0000	
	0.0000	0.5693	0.0000	0.0327	0.0155	0.0001	0.0000	0.3009		
UNEM	−0.1158*	−0.590*	−0.3580*	−0.2391*	−0.0581	−0.4822*	−0.1384*	0.0817*	0.0150	1.0000
	0.0001	0.0000	0.0000	0.0000	0.0555	0.0000	0.0000	0.0086	0.6217	

*, indicate level of significance at 5%

Table 5: Variance inflation factor (VIF), model 1: The effect of climate risk on bank profitability

Variable	VIF	1/VIF
UNEM	2.19	0.456
LERN	2.03	0.492
BS	1.76	0.568
GDPG	1.40	0.712
CONC	1.35	0.742
CRISIS	1.31	0.762
CRI	1.30	0.768
CAR	1.30	0.769
INF	1.19	0.839
Mean VIF	1.54	

Table 6: Variance inflation factor (VIF) model 2: The effect of financial development on bank profitability

Variable	VIF	1/VIF
FDI	3.49	0.286
LERN	2.38	0.419
UNEM	2.34	0.428
CONC	2.21	0.452
BS	1.88	0.533
CAR	1.41	0.706
GDPG	1.31	0.762
INF	1.31	0.764
CRISIS	1.25	0.799
Mean VIF	1.95	

Table 7: Variance inflation factor (VIF), model 3: the interactional effect of climate risk and financial development on bank profitability

Variable	VIF	1/VIF
UNEM	2.25	0.444
LERN	2.08	0.480
CRI*FDI	2.06	0.486
BS	1.76	0.568
CONC	1.52	0.659
GDPG	1.43	0.697
CAR	1.36	0.737
CRISIS	1.29	0.772
INF	1.26	0.791
Mean VIF	1.67	

over-identifying restrictions and the absence of correlation, cannot be rejected. This conclusion is supported by P-values for both the Arellano and Bond AR (2) test and the Sargan test, which exceed the 5% threshold.

From the results of Table 8, it is observed that the lagged dependent variable has significantly a positive coefficient which indicates that for both ROA and ROE profitability in this current year, bank profitability in preceding year is positively as well as highly affects.

Overall, the empirical results for the whole sample from Table 8 show a positive correlation between climate risk and profitability. For MENA banks, a rise in the climate risk index dramatically boosts profits. This results indicate that climate risk have a negative effect on bank profitability through increased credit risk, market risk, or operational risk with increasing frequency and severity of extreme weather events. On the other hand, regulatory pressures

Table 8: Results of the effect of CRI on bank profitability (the whole sample)

ROA	ROA		ROE	ROE	
	Coef.	Z		Coef.	Z
ROA (−1)	0.290	24.65***	ROE (−1)	0.360	46.81***
CRI	0.001	4.65***	CRI	0.017	0.000***
BS	0.098	2.01**	BS	0.096	0.41
CAR	0.037	10.04***	CAR	0.045	1.88*
CONC	0.001	0.51	CONC	−0.079	−3.12***
LERN	2.024	6.39***	LERN	23.49	9.49***
GDPG	−0.000	−0.05	GDPG	0.008	0.29
INF	−0.018	6.77***	INF	0.045	1.45
CRISIS	−0.536	−7.92***	CRISIS	−4.166	−11.45***
UNEM	−0.202	20.790***	UNEM	−1.187	11.05***
_cons	−2.496	−5.07***	_cons	−3.495	−0.94***
AR (1)	−1.944			−1.267	
Prob	0.051			0.204	
AR (2)	1.874			1.321	
Prob	0.060			0.186	
Sargan test	55.189			50.936	
Prob	0.100			0.189	
Obs	547			547	

*** P<0.01, ** P<0.05, * P<0.1

may increase as governments mandate more stringent norms and requirements related to climate change. Compliance costs could increase, while one major reputational risk may be associated with finance extended to projects that damage the environment. This result is confirmed for both ROA and ROE. This finding is in line with the works of Caby et al. (2022). Therefore, we accept H1.

Empirical results show that the coefficient of bank size is positively and significantly associated with the dependent variable ROA. This might be explained by a fact that larger banks generate more often than small-sized banks. Moreover, one may say that the economies of scale favor big banks. The following findings of this study relate to Košak and Čok (2008) and Adusei (2015) accordingly.

The findings also show that banks with enough capital make greater profits. Both ROA and ROE corroborate this outcome. For ROA, the capital adequacy ratio coefficient is positive and significant at the 1% level, while for ROE, it is positive and significant at the 10% level. Rising equity yields a reduced cost of capital that boosts profitability. A bank capital surge may also yield a higher estimated cost and a financial distress cost. Higher capital reduces the incentives for shareholders to undertake unduly risk and practice speculation. High-rated banks that have enough amount of capital impact loan price reduce operation cost and enhance bank profitability. Capital through monitoring channels may have a positive effect on bank profitability: The shareholders will be motivated more to monitor and require efficiency in order not to incur losses, enhancing bank profitability. This result is consistent with the research of Mehran and Thakor (2011), Berger et al. (2000), Goddard et al. (2004), Molyneux and Thornton (1992), and Bourke (1989).

It is shown that the profitability of banks in the MENA area is more susceptible to an increase in bank concentration. An increase of 1% of the bank Concentration, decreases bank profitability by 7.9% for ROE. In a concentrated market, dominant banks may engage

in aggressive pricing practices to capture a larger share of the market. This can result in narrower interest rate spreads, reducing the profitability of banks. Additionally, larger banks might offer more attractive terms to customers, making it harder for smaller banks to attract deposits or lend at favorable rates. This result is in line with Li et al. (2023) and Mateev et al. (2023).

Additionally, we discovered that in the MENA area, bank profitability for both ROA and ROE is favorably and considerably impacted by increased bank rivalry as indicated by the Lerner index. A more competitive banking environment would encourage speculative activity, which would impact bank profits. This result is consistent with the research of Rakshit (2022) and Yuanita (2019).

The results also show that while the inflation rate has a negative and substantial impact on both ROA and ROE, economic growth has a positive and large impact on bank profitability as assessed by ROA. The level of growth economic is a key factor influencing bank profitability. When the macroeconomic environment is steady and the economy is doing well, loans become better, which increases the ability of borrowers to honor their obligations. As a result, there is a greater chance of solvency and a reduction in the amount of non-performing loans, both of which boost bank profitability. This result is in line with Athanasoglou et al. (2008), Calza et al. (2003), Hamdi et al. (2017), Hakimi et al. (2020).

These findings reveal that inflation has a statistically significant negative effect on ROA, proving that every increase in the inflation rate highly diminishes bank profitability. As observed, higher inflation rates would add to the operating costs and financial expenses that wear down profitability. It increases the cost of capital and thereby reduces borrowers' repayment capacity. This reduction in the quality of loans, coupled with an increased proportion of NPLs, weakens profitability further. These findings confirm the results obtained by Revell (1979); Perry (1992); Athanasoglou et al., (2006); Pasiouoras and Kosmidou, (2007); Alexiou and Sofoklis (2009); Hamdi et al. (2017); and Hakimi et al. (2020).

The global financial crisis of 2008 was found to bear significant negative influence on the banks' profitability, thereby diminishing both ROA and ROE. During a crisis, borrowers face reduced capacity to meet their financial obligations, leading to deteriorated loan portfolio quality and increased nonperforming loans, a critical challenge to bank profitability. Furthermore, banks move to more conservative lending practices, which decrease loan issuance and lower interest income, and, subsequently, profitability decreases. The results confirm those found in the studies of Hamdi et al. (2017), Hakimi et al. (2020), and Zaiane and Moussa (2021).

Our analysis indicates that, indeed, unemployment is in a negative relationship with bank profitability, as shown by the coefficients for both ROA and ROE that are statistically significant. Indeed, higher unemployment rates, as seen in the MENA region, increase the non-performing loans and decline the demand for new credit from the non-governmental sector, resulting in enormous banking losses and affecting the bottom line of the banking system in general. These findings are consistent with the results obtained by Clair (2004) for Singaporean banks, Heffernan and Fu (2008) for Chinese banks, Abreu and Mendes (2001) for the Spanish, German, and French banking systems, and Pesola (2005) for Nordic European countries.

4.2.2. Findings of the effect of financial development on bank profitability (the whole sample)

Examining whether bank profitability in the MENA area gains from financial development is the second phase in the empirical strategy. Stated differently, we looked into the relationship between increased financial development and increased bank profitability. Table 9 presents the empirical results.

Results indicate that financial development (FD) significantly increase bank profitability measured by ROA and ROE. The coefficient FD is positive and statistically significant at the level of 1% for both ROA and ROE. This result is an indication that, as financial systems in the region become more advanced, offering a wider array of services, improved access to credit, or greater financial stability, banks benefit via increased profitability. Greater financial development improves bank profitability in the MENA region. This result is in line with Le and Ngo, (2020). Therefore, we accept H2.

For the effect of bank specifics, no significant changes with comparison to the results discussed in Table 8. Regarding industry specifics, their signs and significances are similar to the results of the climate risk on bank profitability measured by ROA and ROE. As financial environment, the signs and the significances of GDPG, INF, CRISIS and UNEM are similar the results discussed in Table 8.

4.2.3. Findings of the interactional effect of climate risk and financial development on bank profitability (the whole sample)

Exploring how financial development and climate risk interact with bank profitability is the third phase in the empirical approach. To

Table 9: The effect of FD on bank profitability (the whole sample)

ROA	ROA		ROE	ROE	
	Coef.	Z		Coef.	Z
ROA (−1).	0.282	33.25***	ROE (−1).	0.356	53.65***
FDI	0.756	3.39***	FD	9.573	4.14***
BS	0.081	1.80*	BS	0.448	1.68*
CAR	0.037	8.61***	CAR	−0.038	−1.34
CONC	0.000	0.24	CONC	−0.129	−5.36***
LERN	1.737	5.83***	LERN	20.45	8.64***
GDPG	0.004	1.28	GDPG	0.048	1.68*
INF	−0.012	4.74***	INF	0.043	1.12
CRISIS	−0.492	−6.27***	CRISIS	−4.224	−9.39***
UNEM	−0.200	20.84***	UNEM	−1.113	9.13***
_cons	−2.299	−5.00***	_cons	−3.577	−0.98
AR (1)	−1.891			−1.257	
Prob	0.058			0.208	
AR (2)	1.964			1.410	
Prob	0.051			0.158	
Sargan test	52.817			46.579	
Prob	0.145			0.327	
Obs	547			547	

***P<0.01, **P<0.05, *P<0.1

put it another way, we looked into whether FD and climate risk combine to improve bank profitability in the MENA area. Table 10 presents empirical findings.

Results in Table 10 indicate that the interaction between financial development and climate risk *(CRI*FDI)* is positively and significantly associated with the level of bank profitability. This implies that financial development, influenced by climate risks, can positively impact bank profitability. Climate risks could also force financial systems to innovate and build better tools for risk assessment and pricing, like climate risk insurance or green bonds. These innovations improve financial stability and profitability for those banks that manage the risks. This result is in line with Alogoskoufis et al. (2021). Therefore, we accept H3.

Table 10: The interactional effect of financial development and climate risk on bank profitability (the whole sample)

ROA	ROA		ROE	ROE	
	Coef.	Z		Coef.	Z
ROA (−1).	0.284	25.85***	ROE (−1).	0.360	45.30***
CRI*FDI	0.004	6.56***	CRI*FD	0.048	6.38***
BS	0.100	2.06**	BS	0.203	0.87
CAR	0.037	10.46***	CAR	−0.049	−1.96**
CONC	0.001	0.81	CONC	−0.084	−3.39***
LERN	2.233	7.78***	LERN	24.82	10.10***
GDPG	−0.001	−0.30	GDPG	0.006	0.23
INF	−0.015	5.37***	INF	0.030	0.97
CRISIS	−0.543	−8.30***	CRISIS	−4.126	−11.57***
UNEM	−0.204	20.33***	UNEM	−1.179	9.97***
_cons	−2.671	−5.59***	_cons	−4.698	−1.23
AR (1)	−1.940			−1.269	
Prob	0.052			0.204	
AR (2)	1.878			1.315	
Prob	0.060			0.188	
Sargan test	55.215			49.879	
Prob	0.100			0.218	
Obs	547			547	

***P<0.01, **P<0.05, *P<0.1

Regarding the effects of bank-specific factors, industry characteristics, and macroeconomic conditions, there are no significant changes compared to the results presented in Tables 8 and 9.

4.3. Results of the Disaggregate Analysis: GCC Countries VS Non-GCC Countries

Although the nations of MENA belong to the same bloc, one should not go into the research without mentioning the fact that there was macroeconomic heterogeneity among them in the first place. Indeed, a number of the MENA nations have quite advanced financial infrastructure and sectors, such as the United Arab Emirates and Saudi Arabia, which, over the years, have grown into large financial centers themselves. In contrast, a number of the other countries in the same bloc have poor infrastructure and a still outdated banking system. Thus, we segmented the MENA region into two sub-regions according to the International Monetary Funds' World Economic Outlook classification to get an enhanced understanding and reliable results about the impact of financial development along with climatic risk on bank profitability. First is the bloc including the Gulf Cooperation Council. While the remaining nations make up the second.

4.3.1. Findings of the effect of Climate risk on bank profitability (GCC vs. non GCC countries)

We used a similar empirical approach for disaggregated analysis, considering the GCC and non-GCC countries. First, we considered the impact of climate risk on bank profitability. Second, we looked at the impact of financial development on bank profitability, using both ROA and ROE as measures. Finally, we investigated the interaction effect between financial development and climate risk on bank profitability. The results of the first analysis which is climate risk to bank profitability are presented in the following table, Table 11.

We will focus more on how climate risk affects bank profitability as shown by ROA and ROE in the disaggregated study. The model's output has yielded two distinct findings, which are as follows:

Table 11: Results of the effect of climate risk on bank profitability (GCC vs. non GCC countries)

PROF	GCC countries				Non GCC countries			
	ROA		ROE		ROA		ROE	
	Coef.	Z	Coef.	Z	Coef.	Z	Coef.	Z
Prof (−1)	0.293	27.14***	0.178	59.49***	0.316	3.51***	0.984	23.91***
CRI	0.001	10.60***	0.036	16.96***	−0.001	−0.41	−0.015	−0.93
BS	−0.108	−4.88***	−0.440	−1.21	0.470	0.52	3.744	1.24
CAR	0.014	5.36***	0.111	−2.70***	0.033	1.27	0.350	0.42
CONC	−0.023	−9.72***	0.238	−8.38***	0.000	0.03	−0.124	−0.46
LERN	4.805	26.88***	49.123	20.59***	1.518	0.37	22.329	0.58
GDPG	0.001	0.63	−0.014	−0.94	−0.013	−0.58	−0.292	−1.03
INF	0.010	3.25***	0.101	5.04***	0.106	1.81*	0.072	0.13
CRISIS	−0.833	−16.05***	−7.918	−26.98***	−0.238	−1.26	−3.528	−1.56
UNEM	−0.086	12.56***	−0.638	12.59***	0.039	0.57	−0.052	−0.14
_cons	1.784	4.72***	12.050	2.29**	−4.835	−0.72	−31.03	−0.89
AR (1)	−1.696		−1.125		−1.383		−1.709	
Prob	0.089		0.260		0.166		0.087	
AR (2)	1.347		0.926		1.789		1.807	
Prob	0.178		0.354		0.073		0.070	
Sargan test	44.790		42.603		8.147		11.012	
Prob	0.396		0.488		1.000		1.000	
Obs	253		253		294		294	

***P<0.01, **P<0.05, *P<0.1

In contrast to the aggregate analysis, which confirms a positive relationship between climate risk and bank profitability, the disaggregated analysis reveals regional differences between GCC and non-GCC countries. As shown in Table 11, climate risk has a positive and significant impact on bank profitability in GCC countries, as measured by both ROA and ROE. However, for non-GCC countries, climate risk does not exhibit a significant effect on bank profitability for either ROA or ROE.

For the GCC countries, climate risk has a positive and significant impact on bank profitability measured by both ROA and ROE. GCC economies are highly dependent on oil and gas. Climate risks and the global push for decarbonization can destabilize these economies, reducing bankable opportunities and increasing credit risks. Moreover, Policies promoting green energy transitions may lead to stranded assets in fossil fuel sectors, which dominate GCC economies.

Unlike the first bloc, for the case of non-GCC countries. Climate risk does not exert any significant effect of bank profitability measured by both ROA and ROE. Although these countries may have more diversified economies, with less direct dependence on climate-vulnerable sectors. Furthermore, banks of non-GCC countries may have smaller loan portfolios tied to industries severely affected by climate risks.

4.3.2. Findings of the effect of financial development on bank profitability (GCC vs. non GCC countries)

Investigating whether more financial development in GCC and non-GCC nations results in higher bank profitability is the second phase of the empirical approach. The empirical results are shown in Table 12.

While the aggregate analysis confirms the positive effect of financial development on bank profitability for both ROA and ROE, the disaggregated analysis highlights regional differences between GCC and non-GCC countries. In fact, according to Table 12, the effect of FD on bank profitability in GCC countries is statistically significant and positive for both ROA and ROE. In countries other than GCC, the relationship of FD is positively and significantly related with ROA, but no significant impact is seen on bank profitability if measured by ROE.

More financial development significantly increases the level of bank profitability. Financial development enables a broader population and businesses to access credit, investments, and other financial products, increasing the demand for banking services and boosting profitability. Advanced financial systems often come with technological innovations (e.g., digital banking, fintech) that reduce operational costs and improve service delivery, leading to higher profit margins. Financial development fosters economic growth by supporting business expansion, infrastructure development, and entrepreneurship, thereby increasing the demand for loans and the interest income of banks.

4.3.3. Findings of the interactional effect of climate risk and financial development on bank profitability (GCC vs. non GCC countries)

Assessing how financial development and climate risk combine to affect bank profitability in GCC and non-GCC nations is the third phase in the empirical approach. Table 13 presents the empirical findings.

In contrast to the aggregate analysis, which confirms a positive impact of the interaction between financial development and climate risk on bank profitability, the disaggregated analysis reveals regional differences between GCC and non-GCC countries. As shown in Table 13, this interaction has a positive and significant effect on bank profitability in GCC countries, measured by both ROA and ROE. However, in non-GCC countries, the interaction does not have any significant effect on bank profitability for either ROA or ROE.

Table 12: Results of the effect of financial development on bank profitability (GCC vs. non GCC countries)

PROF	GCC countries				Non GCC countries			
	ROA		ROE		ROA		ROE	
	Coef.	Z	Coef.	Z	Coef.	Z	Coef.	Z
Prof (−1)	0.303	32.94***	0.171	47.91***	0.338	2.77***	0.959	26.23***
FDI	0.923	3.47***	17.68	12.54***	11.236	1.96**	31.47	0.76
BS	−0.131	−5.41***	−0.987	−2.87***	0.643	0.59	−0.566	−0.20
CAR	0.018	6.77***	−0.026	−0.72	0.094	5.14***	0.552	1.65*
CONC	−0.025	−10.67***	−0.280	−10.01***	−0.002	−0.12	0.151	0.62
LERN	4.334	19.98***	40.53	15.35***	−3.359	−0.42	−24.04	−0.63
GDPG	0.009	3.59***	0.092	7.37***	−0.015	−0.69	0.096	0.25
INF	0.006	2.59***	0.036	2.15**	0.055	0.51	−0.294	−0.51
CRISIS	−0.727	−10.57***	−7.804	−20.21***	−0.241	−1.20	−0.640	−0.26
UNEM	−0.084	10.69***	−0.494	7.41***	−0.035	−0.20	−0.108	−0.24
_cons	1.979	7.25***	19.56	3.87***	−6.720	−1.48	−3.820	−0.12
AR (1)	−1.681		−1.109		−1.272		−1.687	
Prob	0.092		0.267		0.203		0.091	
AR (2)	1.603		1.278		1.123		1.580	
Prob	0.108		0.201		0.261		0.114	
Sargan test	39.390		37.266		31.835		7.499	
Prob	0.628		0.717		0.895		1.000	
Obs	253		253		294		294	

***P<0.01, **P<0.05, *P<0.1

Table 13: Results of the effect of the interactional effect of climate risk and financial development on bank profitability (GCC vs. non GCC countries)

PROF	GCC countries				Non GCC countries			
	ROA		ROE		ROA		ROE	
	Coef.	Z	Coef.	Z	Coef.	Z	Coef.	Z
Prof (−1)	0.288	30.38***	0.175	56.97***	0.299	2.61***	0.952	19.04***
CRI*FDI	0.004	11.63***	0.092	18.07***	−0.002	−0.49	0.037	0.31
BS	−0.107	−4.72***	−0.362	−1.00	0.422	0.54	2.454	1.20
CAR	0.014	5.03***	−0.090	−2.49**	0.040	2.07**	0.280	0.81
CONC	−0.022	−9.15***	−0.222	−7.88***	−0.000	−0.000	0.317	0.59
LERN	4.862	25.91***	50.80	16.85***	2.958	1.27	15.48	0.45
GDPG	0.001	0.53	−0.004	−0.36	−0.009	−0.42	0.200	0.40
INF	0.007	2.43***	0.045	2.50**	0.110	1.46	0.022	0.02
CRISIS	−0.809	−14.95***	−7.847	−25.76***	−0.182	−1.00	−1.025	−0.38
UNEM	−0.087	11.79***	−0.660	12.31***	0.061	0.65	0.446	0.76
_cons	1.671	4.38***	8.487	1.76*	−5.270	−1.15	−50.80	−1.95*
AR (1)	−1.690		−1.137		−1.388		−1.766	
Prob	0.091		0.255		0.165		0.077	
AR (2)	1.391		0.969		1.819		1.725	
Prob	0.164		0.332		0.068		0.084	
Sargan test	43.704		42.097		8.118		10.373	
Prob	0.441		0.510		1.000		1.000	
Obs	253		253		294		294	

***P<0.01, **P<0.05, *P<0.1

This result reveals an interesting divergence between the GCC (Gulf Cooperation Council) countries and non-GCC countries in how the interaction between financial development and climate risk affects bank profitability. GCC countries have well-developed financial systems with abundant capital, enabling banks to adapt to climate risks effectively. This may include offering climate-resilient financial products or diversifying portfolios. Unlike GCC countries, non-GCC economies may not have substantial investment in climate adaptation or green sectors, leading to fewer profitable opportunities for banks.

5. CONCLUDING REMARKS AND POLICY RECOMMENDATIONS

The paper tries to answer whether financial development bolsters bank profitability in the MENA region. Precisely, this paper investigates the role of financial development in moderating the relationship between climate risk and bank profitability. The empirical estimation based on the SGMM has used data from 68 conventional banks over the period 2005-2020. The empirical findings derived through the estimation show that, across the full sample, bank profitability is negatively affected by climate risk. However, greater financial development is found to enhance bank profitability. Moreover, the interaction between financial development and climate risk further improves bank profitability in the MENA region. This implies that more developed financial systems typically possess better risk management tools and frameworks, allowing banks to better absorb shocks from climate-related risks.

In order to obtain further insights and more reliable results about the impact of climate risk on bank profitability, we divided the MENA region into two sub-regions using the classification of the International Monetary Fund. The first group consists of GCC countries, while the second group includes the remaining countries. The disaggregated analysis shows that, in GCC countries, financial development has a positive effect on bank profitability, while climate risk is negative, and the interaction term of financial development and climate risk positively influences profitability. Conversely, in non-GCC countries, neither climate risk nor its interaction with financial development shows a significant effect on bank profitability.

Overall, findings suggest that climate risk significantly affects bank profitability, with bigger consequences reported in non-GCC countries. This underlines the susceptibility of banks in less financially developed nations to environmental shocks. By improving resilience via improved resource allocation and risk management, financial development has a moderating role in reducing the negative consequences of climate risk. These results demonstrate how urgently governments in the MENA area must give financial development top priority when formulating more comprehensive plans for climate adaptation.

The findings of this study carry significant policy implications for both policymakers and bankers. First, Policymakers should develop a green financial market by providing sufficient incentives toward green financing. The incentives could range from tax exemption for green bonds to subsidy arrangements for banks used in the financing of renewable energy projects, consequently promoting financial growth and reducing climatic hazards. Furthermore, regulatory bodies may integrate climate change risk into bank regulations to build resilience within sectors. Second, the growth in investment in climate-resilient infrastructure will decrease the exposure to environmental shocks and, hence, provide a stable environment wherein the financial systems can perform well. Policymakers in non-GCC countries should tap public-private partnerships for such project financing, guaranteeing proper use of resources and sustainability. Third, regional cooperation

can enhance the climate resilience across the MENA region. Policymakers should establish climate funds to assist non-GCC countries in implementing climate adaptation strategies, while fostering knowledge-sharing platforms to disseminate best practices in financial development and climate risk management. Fourth, Governments should create market-based mechanisms, like carbon trading systems, which would incentivize banks and corporations to go green. Besides, targeted support for startups and enterprises focused on climate solutions may stimulate much-needed innovation for sustainable economic growth.

Although these results are useful for policymakers, there are some limitations that need to be considered. First, this study relies on the financial development index as the proxy for financial development; other indicators could be used in place of this one for the purpose of robustness checks regarding the relationship between financial development and bank performance. Secondly, the sample of MENA banks has been restricted to conventional banks; it excludes other forms of financial institutions.

In this respect, future research on the subject should be directed towards incorporating other indices of financial development. Increasing the sample size by adding Islamic banks would enable the analysis to present a comparison of Islamic and conventional banks within the MENA region, offering further insights into the relationship between climate risk and performance, as well as the moderating role of financial development. The addition of governance and institutional quality variables would also be extremely useful.

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