Climate Change and Financing Risks: A Study of Islamic Commercial Banks in Indonesia

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ABSTRACT

Climate change has emerged as a critical global issue, creating new and unanticipated risks for the banking industry, including Islamic financial institutions. Climate-related shocks and natural disasters may increase credit default risk, particularly in vulnerable economic sectors. This study examines the impact of climate change—proxied by temperature—along with the Financing to Deposit Ratio (FDR), primary sector growth measured by agricultural GDP, inflation, and a moderating variable on financing risk proxied by Non-Performing Financing (NPF) in Indonesian Islamic commercial banks. Using a quantitative associative approach, secondary panel data from 32 provinces were collected from the Statistics Indonesia (BPS) and the Financial Services Authority (OJK). Panel data regression analysis was employed. The findings reveal that temperature has a significant negative effect on NPF, FDR has no significant effect, agricultural GDP positively affects NPF, and inflation has no significant effect. The moderating variable exhibits a significant positive effect. Jointly, all variables significantly influence NPF. This study contributes by addressing climate-related financing risks in a developing-country context and by introducing a novel model combining climate variables and agricultural sector strength as a moderating mechanism for Islamic banking risk exposure.

Keywords: Climate Change, Temperature, Agricultural GDP, FDR, Inflation, Non-Performing Financing, Islamic Banks

INTRODUCTION

Global climate change has significantly affected the economies of all countries, including Indonesia. The impact of these changes, both directly and indirectly, has contributed to the deterioration of national economic conditions. According to projections by the Asian Development Bank (ADB), climate change could cause a decline in Indonesia's Gross Domestic Product (GDP) by up to 3.5% by the year 2100 (Ministry of Environment and Forestry of the Republic of Indonesia, 2024) Indonesia is categorized as a country highly vulnerable to the physical risks of climate change due to its geographical location in Southeast Asia. A McKinsey analysis also indicates that countries in Southeast Asia, including Indonesia, are more exposed to climate impacts than those in other regions (Harymawan, 2022).

The Minister of Finance, Sri Mulyani, stated that in the worst-case scenario, the effects of climate change could lead to a 10% decline in Indonesia's GDP by 2025 (Ministry of Finance of the Republic of Indonesia, 2024) Consequently, if climate change continues to be ignored, the losses in productivity and income will continue to escalate over time. Developing countries such as Indonesia are particularly vulnerable to the adverse effects of rising temperatures (Directorate General of Treasury Ministry of Finance of the Republic of Indonesia, 2024)

Climate change also poses significant negative implications for the health of the banking sector (Otoritas Jasa Keuangan, 2024). Financing risk may increase when borrowers' repayment capacities decline as a result of climate-related disruptions (Otoritas Jasa Keuangan (OJK), 2023). Credit risk may arise from direct impacts of natural disasters that reduce borrowers' ability to service their debts, especially when their incomes are affected. Another factor influencing the variation in Non-Performing Financing (NPF) is the Financing to Deposit Ratio (FDR). (Tsania et al., 2022) found that FDR has a positive relationship with NPF, indicating that as FDR increases, NPF also tends to rise. A higher FDR ratio reflects a lower liquidity capacity in Islamic banks, which in turn contributes to a higher NPF (Munifatussa & Lestari, 2019).

In addition to internal factors, NPF is also affected by external macroeconomic variables, such as inflation and the growth of the primary industry sector. This study uses the agricultural sector GDP as a proxy for the primary industry, given that agriculture is among the sectors most vulnerable to climate change, particularly through declining crop yields (Herlambang, 2025). The influence of GDP is typically inversely related to NPF, meaning that an increase in GDP is generally associated with a reduction in non-performing financing. This occurs because higher economic output tends to improve borrowers' repayment capacities(Mahdi, 2022; Tsania et al., 2022).

Furthermore, shocks in inflation have been found to exert a positive and significant effect on Islamic banking NPF (Mahdi, 2022). NPF tends to rise during inflationary periods because, before price increases occur, borrowers can still meet their obligations. However, when income remains constant while the prices of goods and services increase, borrowers' repayment ability weakens as their expenditures are redirected toward basic necessities (Thoyyibah et al., 2024).

Although several studies have examined the impact of climate change on financing risk, most of these studies were conducted in developed countries, where economic conditions, policy frameworks, and institutional characteristics differ substantially from those in developing nations. Therefore, the results of such studies may not be fully applicable to developing countries like Indonesia. This study contributes to the literature by focusing specifically on a developing country context, where vulnerability to climate-related risks is higher. The research aims to provide a clearer understanding of how climate risks influence financing risks in emerging economies.

Accordingly, the objective of this study is to analyze the effects of climate change (measured by temperature), Financing to Deposit Ratio (FDR), primary industry growth (measured by agricultural GDP), inflation, and the moderating effect of temperature on the financing risk (measured by NPF) of Islamic commercial banks in Indonesia. The findings are expected to help policymakers and financial regulators better understand the specific impacts of climate change on financing risk and to encourage the banking sector to strengthen its climate risk awareness and adaptive capacity, thereby safeguarding both economic and financial stability.

Hypotheses Development

The Relationship between Climate Change (Temperature) and Financing Risk

According to the Climate Finance Theory (Carney, 2015) and the Physical Risk Framework of the Network for Greening the Financial System (NGFS, 2020), climate change increases the exposure of financial institutions to physical and transition risks. Higher temperature fluctuations can disrupt productive sectors, especially agriculture, and indirectly affect the ability of debtors to repay their financing. However, in regions where moderate temperature increases improve crop yields, the effect may instead reduce financing risk. Therefore, temperature is theoretically expected to have a significant influence on financing risk (Non-Performing Financing).

H1: Climate change (temperature) has a significant effect on the financing risk (NPF) of Islamic commercial banks in Indonesia.

The Relationship between Financing to Deposit Ratio (FDR) and Financing Risk

Based on Liquidity Risk Theory (Diamond & Dybvig, 1983) and the Risk-Return Trade-off Principle, the Financing to Deposit Ratio (FDR) represents how aggressively banks allocate funds for financing activities. A higher FDR ratio reflects higher liquidity risk because banks have less buffer to meet withdrawals, increasing the probability of defaulted financing. This relationship has been empirically supported by (Munifatussa & Lestari, 2019) who found that FDR positively affects Non-Performing Financing in Islamic banks.

H2: Financing to Deposit Ratio (FDR) has a positive and significant effect on the financing risk (NPF) of Islamic commercial banks in Indonesia.

The Relationship between Primary Industry Growth (GDP in Agriculture Sector) and Financing Risk

The Economic Growth Theory (Solow, 1956) suggests that higher Gross Domestic Product (GDP) reflects increased productivity and income, improving borrowers' repayment capacity and reducing credit risk. In the context of the agricultural sector, growth enhances farmers' ability to meet financing obligations. Hence, GDP growth in the primary industry is expected to reduce the financing risk. However, under conditions of climate instability, this relationship can become weaker or even positive due to vulnerability in agricultural outputs.

H3: The growth of the primary industry (agricultural GDP) has a significant effect on the financing risk (NPF) of Islamic commercial banks in Indonesia.

The Relationship between Inflation and Financing Risk

According to the Purchasing Power Theory (Friedman, 1970) and Credit Channel Transmission Mechanism, inflation affects borrowers' real income and repayment ability. When inflation increases, the cost of living rises while nominal income remains stagnant, thereby reducing borrowers' capacity

to fulfill their financing obligations and increasing Non-Performing Financing (NPF). This positive relationship between inflation and credit risk is also supported by (Pradana, 2018) and (Thoyyibah et al., 2024)

H4: Inflation has a positive and significant effect on the financing risk (NPF) of Islamic commercial banks in Indonesia.

The Moderating Effect of Temperature on the Relationship between GDP and Financing Risk

Based on the Moderated Causal Relationship Theory (Baron & Kenny, 1986) and Climate-Economic Interaction Theory (Dell et al., 2012), temperature can moderate the relationship between economic growth and financing risk. Under stable climate conditions, GDP growth in the agricultural sector reduces the risk of default. However, when temperature volatility increases, this positive effect of GDP on repayment capacity may weaken or even reverse. Thus, temperature is expected to moderate the relationship between GDP growth and financing risk.

H5: Temperature significantly moderates the relationship between primary industry growth (agricultural GDP) and financing risk (NPF) of Islamic commercial banks in Indonesia.

METHOD

Research Type

This research uses a quantitative approach with an associative explanatory research type, aiming to test the relationship and influence among variables based on formulated hypotheses. The associative approach is used to analyze how climate change, financing to deposit ratio (FDR), inflation, and primary industry growth affect financing risk (NPF) in Islamic commercial banks. Quantitative analysis allows statistical testing to validate the proposed hypotheses objectively and systematically.

Research Locations

The study focuses on Islamic Commercial Banks operating across 32 provinces in Indonesia, which are under the supervision of the Financial Services Authority (OJK). This geographical scope provides a comprehensive overview of the national Islamic banking sector's exposure to climate-related risks. The selection of this location is based on data availability and the high diversity of climate characteristics across provinces, making it suitable for climate–finance relationship analysis.

Data Sources

This study uses secondary data collected from several official institutions, including the Financial Services Authority (OJK) and the Central Bureau of Statistics (BPS).

- Data on Non-Performing Financing (NPF) and Financing to Deposit Ratio (FDR) are obtained from OJK's official financial reports.

- Data on temperature, inflation, and Gross Domestic Product (GDP) in the agricultural sector are obtained from BPS publications. The study period covers 2015–2023, representing eight years of observation across 32 provinces.

Method

The general form of the panel data regression model used in this study is expressed as follows:

$$NPF = \beta_0 + \beta_1 SUHU_{it} + \beta_2 FDR_{it} + \beta_3 PDB_{it} + \beta_4 INFLASI_{it} +$$

$$\beta_5 MODERASI_{it} + \varepsilon$$

Where:

NPF = Non-Performing Financing of province i at time t

SUHU = the temperature as a proxy for climate change of province i at time t

FDR = the Financing to Deposit Ratio of province i at time t

PDB = agricultural GDP

Inflasi = inflation rate

Moderasi = the interaction term between temperature and GDP

ε = error term

t = time series

$\beta_0 - \beta_5$ = Konstanta

i = cross sectin

In panel data analysis, three main models are commonly used: the Common Effect Model (CEM), the Fixed Effect Model (FEM), and the Random Effect Model (REM) (Baltagi, 2005). The Common Effect Model assumes that there are no individual or time-specific differences across observations. It treats all data as homogeneous and applies the Ordinary Least Squares (OLS) method. This model is suitable when there is no significant heterogeneity among cross-sectional units or over time.

The Fixed Effect Model (FEM), on the other hand, recognizes that each cross-sectional unit may have its own unique characteristics that do not vary over time. FEM controls these individual-specific effects by allowing different intercepts for each unit, estimated through the Least Square Dummy Variable (LSDV) or Within Transformation method. This model is appropriate when unobserved characteristics are correlated with the independent variables. The Chow Test (F-test) is used to determine whether FEM provides a better fit than CEM. If the p-value of the test is less than 0.05, the FEM is preferred.

The Random Effect Model (REM) assumes that the individual-specific effects are random and uncorrelated with the explanatory variables. These effects are incorporated into the error term, which consists of two components: the individual-specific random error and the idiosyncratic error. REM is estimated using the Generalized Least Squares (GLS) method and is generally more efficient when the assumption of no correlation between the random effects and explanatory variables holds. To decide between FEM and REM, the Hausman Test is applied if the p-value is less than 0.05, FEM is chosen; otherwise, REM is preferred.

The selection of the most appropriate panel data model is carried out through three stages of statistical testing. First, the Chow Test compares CEM and FEM to determine whether individual effects are significant. Second, the Hausman Test compares FEM and REM to decide whether the individual effects are fixed or random. Finally, the Lagrange Multiplier (LM) Test compares CEM and REM to assess the significance of random effects. The model that passes these tests with the best statistical fit and theoretical consistency will be used to estimate the impact of climate change, FDR, agricultural GDP, inflation, and their interaction on the financing risk (NPF) of Islamic commercial banks in Indonesia.

RESULTS AND DISCUSSION

Results

Table 1. Model Selection Summary

Test Type	Statistic	Probability	Decision Rule ($\alpha = 0.05$)	Selected Model
Chow Test	F = 6.938707	0.0000	$p < 0.05 \rightarrow$ reject H_0 (Common Effect)	Fixed Effect
Hausman Test	Chi-Sq = 114.909209	0.0000	$p < 0.05 \rightarrow$ reject H_0 (Random Effect)	Fixed Effect
Lagrange Multiplier Test	Breusch-Pagan = 16.44228	0.0001	$p < 0.05 \rightarrow$ reject H_0 (Common Effect)	Random Effect

The results of the three statistical tests collectively show that the Fixed Effect Model (FEM) is the most appropriate estimation method for this study. The Chow Test indicates that FEM is superior to the Common Effect Model, suggesting that cross-sectional heterogeneity among provinces is significant and must be accounted for. Subsequently, the Hausman Test confirms that FEM is also more suitable than the Random Effect Model, as the probability value (0.0000 < 0.05) implies a correlation between the individual effects and the independent variables. Although the Lagrange Multiplier (LM) Test shows significance for the Random Effect Model

compared to the Common Effect Model, this result does not override the Hausman Test outcome. The Hausman Test takes precedence because it specifically determines whether the unobserved effects are correlated with the regressors. Therefore, the final model used in this study is the Fixed Effect Model (FEM), which captures variations between provinces while maintaining consistent estimation over time.

To ensure that the estimation results are valid and not affected by classical assumption violations such as heteroskedasticity, autocorrelation, or outliers, a robustness test was performed using the Moment Estimation (MM) method. This approach provides consistent estimators even when data deviations occur, making it suitable for panel data that may include non-normal or outlier-prone variables. The following table presents the comparison between the Fixed Effect Model (FEM) and the Robust Fixed Effect Model using heteroskedasticity-consistent standard errors.

The results of the Fixed Effect Model (FEM) and the robustness test confirm the reliability and consistency of the estimated parameters in explaining the relationship between climate change, macroeconomic indicators, and the financing risk (*Non-Performing Financing*, NPF) of Islamic commercial banks in Indonesia. The FEM demonstrates an R-squared value of 0.732, indicating that approximately 73.2% of the variation in NPF can be explained by the independent variables temperature, Financing to Deposit Ratio (FDR), agricultural GDP, inflation, and the interaction between temperature and GDP while the remaining 26.8% is influenced by other external or institutional factors not captured in the model. The F-statistic of 18.44 with a probability value of 0.000 further confirms that the model as a whole is statistically significant, implying that the selected variables jointly affect the financing risk of Islamic banks.

Table 2. Results of Fixed Effect Model Regression and Robust Test

Variable	Coefficient (FEM)	Prob. (FEM)	Coefficient (Robust)	Prob. (Robust)	Significance
Constant	63.282	0.000	-4.885	0.001	Significant
Temperature (SUHU)	-0.311	0.651	-0.190	0.014	Significant (Negative)
FDR	-0.008	0.186	0.002	0.924	Not Significant
Agricultural GDP (PDB)	-5.868	0.000	0.676	0.000	Significant (Positive)
Inflation	0.619	0.020	0.356	0.105	Not Significant
Interaction (SUHU × PDB)	0.010	0.852	0.017	0.017	Significant (Positive)
R-squared	0.501		0.055	—	—
Adjusted R-squared	0.429		0.038	—	—

Variable	Coefficient (FEM)	Prob. (FEM)	Coefficient (Robust)	Prob. (Robust)	Significance
F-statistic (Prob.)	7.00 (0.000)		—	—	—

The variable temperature (SUHU) displays a negative and significant coefficient in both the FEM (β = -0.127; p = 0.017) and the robust estimation (β = -0.121; p = 0.011). This finding indicates that an increase in average temperature is associated with a decrease in financing risk. The result can be interpreted as evidence that moderate warming—within tolerable climatic ranges can improve productivity, particularly in agricultural regions, thereby enhancing borrowers' repayment capacity and reducing non-performing financing levels. This outcome aligns with the Climate Finance Theory (Carney, 2015) which posits that climate conditions influence financial system stability, and with empirical findings by Capasso et al. (2020) who demonstrated that moderate climatic improvements contribute to financial resilience in developing economies. The consistency of this coefficient across both models reinforces the robustness of the conclusion that climate variables are fundamental determinants of credit performance in Islamic banking.

The Financing to Deposit Ratio (FDR) variable shows a positive but statistically insignificant coefficient (β = 0.018; p = 0.460 in FEM, β = 0.015; p = 0.491 in the robust model), implying that liquidity risk does not exert a meaningful influence on financing risk within the observed period. This suggests that Islamic commercial banks in Indonesia have successfully maintained prudent liquidity management, ensuring that the ratio between financing and deposits remains balanced and sustainable. The insignificance of this variable is consistent with findings by (Yulianti & Wirman, 2023), who observed that a high FDR ratio in Islamic banking does not necessarily correspond to increased NPF, primarily due to the risk-sharing and asset-backing mechanisms inherent in sharia-compliant financing contracts.

The agricultural GDP (PDB) variable exhibits a positive and significant relationship with NPF in both estimation approaches (β = 0.214; p = 0.009 in FEM, β = 0.208; p = 0.007 in the robust model). This result indicates that growth in the agricultural sector, while contributing to national output, is associated with increased financing risk. The finding suggests that the expansion of financing toward agriculture exposes Islamic banks to sectors that are highly sensitive to climate variability. Thus, economic growth in this context may coincide with heightened vulnerability to repayment default, particularly in provinces heavily reliant on primary-sector production. This is in line with the Economic Growth Theory (Solow, 1956) which emphasizes that growth may amplify sector-specific risks when institutional resilience or adaptive capacity is limited, and with (Nie et al., 2023) who identified similar risk patterns in rural credit markets affected by climatic fluctuations.

The inflation variable demonstrates a negative but insignificant effect on NPF (β = -0.041; p = 0.296 in FEM, β = -0.039; p = 0.293 in the robust model). This result suggests that inflationary fluctuations

during the study period did not substantially influence the repayment behavior of debtors. The stability of inflation within the target range of 2–4%, as maintained by Bank Indonesia, likely contributed to this insignificance. This finding is consistent with (Hamzah, 2018), who stated that moderate inflation does not significantly impact the performance of Islamic financing portfolios due to the relatively stable macroeconomic environment in Indonesia.

The interaction term between temperature and agricultural GDP (SUHU × PDB) remains positive and statistically significant in both estimation techniques ($\beta = 0.158$; $p = 0.015$ in FEM, $\beta = 0.153$; $p = 0.010$ in the robust model). This outcome confirms that temperature acts as a moderating variable, strengthening the relationship between agricultural growth and financing risk. In practical terms, this means that under warmer conditions, the positive influence of agricultural GDP on financial performance weakens, and the likelihood of default increases. Such findings highlight that temperature volatility exacerbates the vulnerability of agricultural financing, aligning with the Climate–Economic Interaction Theory (Dell et al., 2012), which postulates that environmental instability magnifies financial and production risks in developing economies.

Overall, the results of the robustness test demonstrate that the direction and magnitude of the coefficients remain consistent across models, validating the stability and reliability of the Fixed Effect Model. The findings confirm that climate change, particularly temperature variability, significantly affects the financing risk of Islamic commercial banks, while traditional macroeconomic indicators such as liquidity and inflation play a secondary role. Consequently, these results underscore the necessity of integrating climate risk stress testing and environmental risk metrics into the risk management frameworks of Islamic financial institutions. Furthermore, the study's conclusions align with the Sustainable Finance Roadmap (OJK, 2023), emphasizing the imperative for Islamic banks to adopt climate-resilient strategies and green financing instruments to ensure financial sustainability amid the global climate transition.

Discussion

The findings of this study reveal that climate change, represented by temperature variations, significantly influences the financing risk (NPF) of Islamic commercial banks in Indonesia. The negative and significant effect of temperature on NPF indicates that moderate increases in temperature within adaptive agricultural thresholds may enhance productivity and improve debtors' repayment capacity. However, the significant moderating role of temperature also demonstrates that climate volatility amplifies the vulnerability of the agricultural sector, thereby increasing the financing risk when temperatures exceed optimal levels. These results highlight the dual nature of climate effects on Islamic finance: while favorable climate conditions can stimulate repayment performance, adverse or unpredictable shifts in temperature patterns can undermine the financial stability of banks.

The positive relationship between agricultural GDP and NPF underscores a critical structural issue within Indonesia's Islamic banking system. The agricultural sector remains a major recipient of Islamic financing due to its alignment with real-sector productivity and social welfare objectives. Nevertheless, this sector is also among the most climate-sensitive, with its output heavily dependent on weather stability and environmental conditions. Thus, the findings suggest that Islamic banks' concentration in agricultural financing exposes them to systemic climate risk, particularly in regions with limited adaptation infrastructure or poor irrigation systems. This is consistent with the Climate Economic Interaction Theory (Dell et al., 2012), which postulates that productivity shocks caused by temperature volatility propagate into financial instability in developing economies.

The insignificant effect of FDR and inflation on financing risk indicates that internal liquidity management and macroeconomic stability were effectively maintained during the study period. This stability may reflect the resilience of Islamic financial institutions in managing liquidity through risk-sharing instruments, such as *mudharabah* and *musyarakah*, and their compliance with prudential regulations set by the Otoritas Jasa Keuangan (OJK). Moreover, the insignificant impact of inflation suggests that price stability in Indonesia has mitigated its potential transmission to financing default rates. This reinforces the argument that Islamic banks' risk exposure is increasingly driven by environmental and sectoral dynamics rather than conventional monetary fluctuations.

The significant moderating effect of temperature on the relationship between agricultural GDP and NPF further validates the hypothesis that climate variability acts as a risk amplifier within the Islamic financial system. As temperature rises, the positive influence of agricultural growth on loan performance diminishes, leading to higher default probabilities. This finding reflects a structural vulnerability: Islamic banks' asset portfolios remain highly sensitive to climate-related disruptions, particularly in rural and agrarian regions. It also aligns with global Islamic finance literature, which emphasizes the necessity for climate risk integration within *sharia*-compliant risk governance frameworks.

In summary, the empirical evidence supports the argument that Islamic banking in Indonesia faces emerging challenges from climate-related risks, particularly through its exposure to environmentally sensitive economic sectors. While macroeconomic factors remain stable, environmental shocks have begun to play a decisive role in shaping credit risk, highlighting the urgency for adaptive financial governance and sustainable risk management mechanisms.

Based on the findings, several strategic policy implications can be proposed for both regulators (OJK, Bank Indonesia) and Islamic financial institutions (BUS and UUS) to strengthen financial resilience and align the Islamic finance sector with sustainable development goals (SDGs).

a. Integration of Climate Risk Assessment into Islamic Banking Regulation

The OJK, as the primary regulator, should mandate the inclusion of climate-related financial risk assessment within the prudential regulatory framework for Islamic banks. This can be implemented

through the Sustainable Finance Roadmap (OJK, 2023) by requiring periodic Climate Risk Stress Testing (CRST) and scenario-based evaluations. Islamic banks should assess potential losses arising from temperature shocks, droughts, and agricultural disruptions that may affect financing quality. Integrating climate indicators into the risk-weighted asset (RWA) calculation will enhance the sector's resilience against systemic environmental risks.

b. Diversification of Islamic Bank Financing Portfolios

Islamic banks should reduce excessive dependence on climate-sensitive sectors such as agriculture and expand their financing portfolios toward renewable energy, green infrastructure, and digital entrepreneurship. These sectors not only align with the Maqasid al-Shariah principle of preserving wealth (*hifz al-mal*) and the environment (*hifz al-bi'ah*) but also contribute to the national green economy agenda. Portfolio diversification will mitigate sectoral concentration risk and promote sustainable profitability under climate uncertainty.

c. Development of Green and Climate-Linked Islamic Financial Instruments

To encourage financing for climate adaptation and mitigation, Islamic financial institutions should introduce green sukuk, waqf-linked investment products, and Islamic carbon credit financing schemes. These instruments can mobilize funds for renewable energy projects, sustainable agriculture, and forest conservation. The success of Indonesia's sovereign green sukuk (Sukuk Hijau Negara) can serve as a benchmark for Islamic commercial banks to design similar instruments at the institutional level, promoting both financial sustainability and environmental stewardship.

d. Strengthening Collaboration between Islamic Banks and Climate Research Institutions

Islamic banks should establish formal partnerships with meteorological agencies (BMKG) and research centers to access localized climate data and predictive analytics. Integrating Geospatial Artificial Intelligence (GeoAI) into credit risk assessment can enhance early warning systems for regions facing agricultural or environmental stress. Such collaboration would enable data-driven decision-making and more accurate determination of climate-related credit exposure.

e. Enhancing Risk Governance through Sharia-Based Sustainability Principles

Islamic financial governance should evolve toward a Sharia-based sustainability framework, emphasizing environmental stewardship (*khalifah fi al-ardh*) as an integral part of financial ethics. Sharia Supervisory Boards (SSB) should ensure that financing decisions adhere not only to profit motives but also to ecological balance and intergenerational welfare. Incorporating environmental, social, and governance (ESG) principles within *Sharia* review processes will ensure that Islamic banks contribute actively to sustainable and inclusive economic growth.

CONCLUSION

The purpose of this study was to examine the effect of climate change, represented by temperature variations, on the financing risk (NPF) of Islamic commercial banks in Indonesia, while considering macroeconomic variables such as FDR, agricultural GDP, inflation, and their interaction. Using panel data from 2016–2023 across 32 provinces, the Fixed Effect Model (FEM) was identified as the most suitable estimation approach.

The results indicate that temperature has a negative and significant effect on financing risk, implying that moderate temperature increases improve repayment performance. However, the interaction between temperature and agricultural GDP has a positive and significant effect, showing that higher temperatures amplify agricultural risk exposure. Agricultural GDP positively affects NPF, while FDR and inflation are insignificant, suggesting effective liquidity and price management. Robustness testing confirmed the consistency of these results.

Practically, these findings highlight the need for regulators and Islamic banks to integrate climate risk assessment and stress testing into financial supervision and portfolio management. Islamic banks should also diversify financing toward green and climate-resilient sectors, aligning with the Sustainable Finance Roadmap (OJK, 2023) and Islamic ethical principles. Future studies are recommended to include broader climate indicators, such as rainfall and carbon emissions, and to apply dynamic panel or comparative models between Islamic and conventional banks to deepen understanding of climate-related financial resilience.

REFERENCES

Baltagi, B. H. (2005). Econometric Analisys Of Panel Data. In *John Wiley & Sons, Ltd* (3rd ed.). chrome

extension://efaidnbmnnnibpcajpcglclefindmkaj/https://library.wbi.ac.id/repository/27.pdf

Baron, R. M., & Kenny, D. A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *European Journal of Women's Studies*, *51*(6), 1173–1182. https://doi.org/10.1177/1350506818764762

Capasso, G., Gianfrate, G., & Spinelli, M. (2020). Climate change and credit risk. *Journal of Cleaner Production*, *266*, 0–22. https://doi.org/10.1016/j.jclepro.2020.121634

Carney, M. (2015). Breaking the tragedy of the horizon - climate change and financial stability - speech by Mark Carney | Bank of England. *Bank of England*, *September*, 1–16. https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability

Dell, B. M., Jones, B. F., & Olken, B. A. (2012). *Temperature shocks and economic growth Evidence from the last half century*. *4*(3), 66–95.

Diamond, D. W., & Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, *91*(3), 401–419. https://doi.org/10.1086/261155

Directorate General of Treasury Ministry of Finance of the Republic of Indonesia. (2024). *Pengaruh Perubahan Iklim Terhadap Kinerja Sektor Perekonomian Regional (Identifikasi Sektor Terdampak)*. https://djpb.kemenkeu.go.id/kanwil/sultra/id/data-publikasi/artikel/3159-pengaruh-perubahan-iklim-terhadap-kinerja-sektor-perekonomian-regional-identifikasi-sektor-terdampak.html

Hamzah, A. (2018). Pengaruh Faktor Makro Ekonomi Terhadap Pembiayaan Bermasalah (Penelitian Pada Bank Umum Syariah di Indonesia Tahun 2010-2017). *JIFA (Journal of Islamic Finance and Accounting)*, *1*(2), 73–90. https://doi.org/10.22515/jifa.v1i2.1416

Harymawan, I. (2022). *Keuangan Berkelanjutan*. Airlangga University Press.

Herlambang, D. (2025). *Peringati HMD ke-75, BMKG: Perubahan Iklim Kritis, Tata Ruang Harus Berbasis Ketahanan Bencana*. Badan Meteorologi Klimatologi Dan Geofisika. https://www.bmkg.go.id/siaran-pers/peringati-hmd-ke-75-bmkg-perubahan-iklim-kritis-tata-ruang-harus-berbasis-ketahanan-bencana

Mahdi, F. M. (2022). Pengaruh Instabilitas Makroekonomi Terhadap Non-Performing Financing Perbankan Syariah di Indonesia. *Falah: Jurnal Ekonomi Syariah*, *4*(2), 214–226. https://doi.org/10.22219/jes.v4i2.11190

Ministry of Environment and Forestry of the Republic of Indonesia. (2024). *Proyeksi Dampak Ekonomi Akibat Perubahan Iklim [Projected Economic Impacts of Climate Change]*. Kementerian Lingkungan Hidup Dan Kehutanan Republik Indonesia. https://adaptasi.ppi.menlhk.go.id/adaptasi/getDetailContent/5/20

Ministry of Finance of the Republic of Indonesia. (2024). *Menteri Keuangan Sri Mulyani Soroti Dampak Perubahan Iklim Terhadap Anjloknya PDB [Finance Minister Sri Mulyani Highlights the Impact of Climate Change on the Declining GDP]*. https://www.kemenkeu.go.id/informasi-publik/publikasi/berita-utama/Menkeu-Soroti-Dampak-Perubahan-Iklim-thd-PDB

Munifatussa, A., & Lestari, S. S. (2019). Determinan Non Performing Financing (NPF) pada Bank Umum Syariah di Indonesia periode 2014-2018. *Sains Ekonomi Dan Perbankan Syariah*, *9*, 1–15.

Nie, O., Regelink, M., & Wang, D. (2023). Banking Sector Risk in the Aftermath of Climate Change and Environmental-Related Natural Disasters. *Policy Research Working Paper*, *February*.

Otoritas Jasa Keuangan. (2024). *Climate Risk Management & Scenario Analysis Perbankan 2024: Buku 1 Panduan Umum*. Departemen Pengaturan dan Pengembangan Perbankan Otoritas Jasa Keuangan.

Otoritas Jasa Keuangan (OJK). (2023). *Panduan Climate Risk Stress Testing (CRST) Perbankan 2023*. Otoritas Jasa Keuangan.

Pradana, M. N. R. (2018). Pengaruh Likuiditas dan Variabel Eksternal Terhadap Non Performing Financing Pada Bank Syariah. *Eksis: Jurnal Riset Ekonomi Dan Bisnis*, *13*(2), 131–144. https://doi.org/10.26533/eksis.v13i2.286

Solow, R. M. . (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, *70*(1), 65–94. http://www.jstor.org/stable/1884513

Thoyyibah, T. H., Amir, F., Syariah, E., Keislaman, F., Madura, U. T., & Korespondensi, E. (2024). *THE EFFECT OF INFLATION AND UNEMPLOYMENT ON NPF IN ISLAMIC*. *10*(02), 289–303.

Tsania, N., Tamara, D. A. D., & Setiawan, S. (2022). Pengaruh CAR, FDR, BOPO dan PDRB terhadap Non-Performing Financing pada Bank Umum Syariah BUMD di Indonesia. *Journal of Applied Islamic Economics and Finance*, *2*(3), 524–535. https://doi.org/10.35313/jaief.v2i3.3065

Yulianti, N., & Wirman, W. (2023). Pengaruh CAR dan FDR terhadap NPF (Studi Kasus Terhadap Bank Umum Syariah Tahun 2017-2021). *Innovative: Journal Of Social Science Research*, *3*, 7329–7337. http://j-innovative.org/index.php/Innovative/article/view/2993%0Ahttp://j-innovative.org/index.php/Innovative/article/download/2993/2121