

Dynamic ESG–NPF Interaction in Islamic Bank

Pungky Lela Saputri*, Heru Sulistyo, Ibnu Khajar, and Marno Nugroho

Department of Management, Faculty of Economics and Business, Universitas Islam Sultan Agung, Semarang, Indonesia

Email: pungkylelasaputri@unissula.ac.id (P.L.S.); heru@unissula.ac.id (H.S.); ibnukhajar@unissula.ac.id (I.K.);

marnonugroho@unissula.ac.id (M.N.)

*Corresponding author

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Abstract—This study investigates the dynamic relationship between Environmental, Social, and Governance (ESG) Disclosure and Non-Performing Financing (NPF) within the context of Islamic banking in Indonesia, with a specific focus on Bank Syariah Indonesia (BSI) during the period 2021–2025. As the largest Islamic bank in Southeast Asia, BSI plays a critical role in promoting sustainable finance aligned with Sharia principles. Amid rising expectations for ESG transparency and persistent credit risk challenges, this research explores whether ESG disclosure contributes to reducing credit risk, or if financial distress influences disclosure quality. Employing a quantitative time-series approach using the Vector Autoregression (VAR) model, the study analyzes monthly data on NPF and ESG scores derived from audited financial and sustainability reports. The results reveal a significant unidirectional relationship whereby improvements in ESG disclosure led to a reduction in NPF after a one to two-month lag, while NPF does not significantly affect ESG disclosure. Impulse response and variance decomposition analyses further support the lagged and cumulative impact of ESG practices on credit risk mitigation. These findings suggest that ESG disclosure in Islamic banks serves not only reputational and compliance purposes but also function as a proactive risk management tool. The study contributes to the growing literature on sustainable finance in Islamic banking and offers practical implications for regulators, financial institutions, and investors by highlighting the strategic value of ESG integration in promoting financial stability.

Keywords—ESG disclosure, financing risk, Islamic banking, sustainable finance, Vector Autoregression (VAR)

I. INTRODUCTION

In recent years, Islamic banking has gained prominence as a financial system that emphasizes ethical, inclusive, and Sharia-compliant practices. Among the key players in Indonesia's Islamic banking sector, Bank Syariah Indonesia (BSI)—established through the merger of three state-owned Islamic banks in 2021—has emerged as the largest Islamic bank in Southeast Asia. BSI plays a strategic role in promoting Islamic finance values while supporting Indonesia's broader financial inclusion and sustainability agendas (Syarifah, 2024). As BSI expands its operations and customer base, there is growing emphasis on how it manages risks and upholds accountability through transparent reporting practices, particularly Environmental, Social, and Governance (ESG) disclosure (Adirestuty *et al.*, 2025).

The importance of ESG practices and disclosures in the financial sector has grown significantly in response to mounting expectations from investors, regulators, and the public for sustainable and responsible financial behavior (Agbakwuru *et al.*, 2024). The ESG disclosure score serves as a benchmark to assess how affectively financial

institutions communicate their efforts in managing environmental impacts (e.g., carbon emissions, resource use), fulfilling social responsibilities (e.g., employee rights, community engagement), and ensuring good governance (e.g., board independence, anti-corruption policies) (Ellili, 2022). In the case of BSI, ESG disclosure is essential to building stakeholder trust, aligning with national and global sustainable development goals (SDGs), and attracting sustainability-oriented capital (Syarifah, 2024). Despite positive developments, data from ESG rating providers suggest that disclosure practices among Islamic banks, including BSI, still exhibit inconsistencies in completeness and comparability. Enhancing ESG transparency remains crucial to strengthening long-term credibility and competitiveness (Liang *et al.*, 2025).

Simultaneously, Non-Performing Financing (NPF)—an indicator of credit risk—remains a persistent challenge for Islamic banks. NPF refers to financing contracts, such as murabahah, mudharabah, and musyarakah, that are overdue for 90 days or more or are unlikely to be repaid in full (Saputri *et al.*, 2020). Rising NPF levels may result from various factors, including weak borrower performance, poor credit screening, adverse macroeconomic conditions, or ineffective contract enforcement. For Islamic banks, where financing is often tied to real economic activity, high NPF ratios can signal deeper structural issues in financing design and risk sharing (Saputri *et al.*, 2023). Notably, BSI had experienced fluctuations in its NPF over the years 2021–2025, influenced by economic shocks and global interest rate volatility.

When NPF increases significantly, the bank may face liquidity shortages, capital erosion, and reduced risk-bearing capacity, which can in turn, weaken its ability or willingness to maintain robust ESG disclosure (Henisz & McGlinch, 2019). High NPF may redirect managerial focus and resources toward short-term financial survival, potentially leading to lower investment in sustainability initiatives and less transparent communication with stakeholders (Caldecott & McDaniels, 2014). This situation can erode stakeholder trust, trigger regulatory concerns, and even provoke downgrades in ESG ratings, exacerbating reputational and systemic risk. Furthermore, reduced ESG disclosure under such conditions may be perceived as a signal of weak governance, intensifying external scrutiny and affecting the institution's long-term viability (Maama, 2021).

Conversely, banks with strong ESG disclosure frameworks may be better positioned to mitigate NPF risks through improved risk management, enhanced customer relationships, and proactive engagement with environmental and social risks (Chiaromonte *et al.*, 2022). The dynamic interplay between NPF and ESG disclosure suggests a bidirectional relationship: while poor financing performance may constrain ESG transparency, weak ESG performance

may also exacerbate financial risks by undermining governance and stakeholder confidence.

Given these considerations, this study seeks to empirically explore the dynamic relationship between NPF and ESG disclosure in Bank Syariah Indonesia (BSI) during the period 2021–2025, employing a quantitative time-series approach using the Vector Autoregression (VAR) model. The VAR framework allows for the identification of both short-term and long-term interactions between the two variables without imposing a strict causal direction, making it suitable for investigating mutually influential macro-financial indicators.

The objective of this research is to provide empirical evidence on the interdependence between credit risk and ESG transparency within the context of Islamic banking. The findings are expected to enrich the literature on sustainable finance, inform the risk management and reporting strategies of Islamic banks, and support regulators and ESG stakeholders in formulating integrated policies that foster both financial stability and sustainable development.

II. LITERATURE REVIEW

A. Non-Performing Financing (NPF)

Non-Performing Financing (NPF) refers to financing facilities extended by banks or financial institutions that have not been repaid in accordance with the predetermined contractual terms for a specified duration—commonly defined as 90 days or more (Saputri *et al.*, 2020). This delay or default in repayment signals a decline in the creditworthiness of the borrower and increases the risk exposure of the financial institution (Mutamimah & Saputri, 2022). Within the domain of Islamic banking, NPF reflects the portion of Islamic financial contracts that have entered default status or are past due, posing a challenge to the integrity and sustainability of the bank's asset portfolio (Saputri *et al.*, 2023).

The occurrence and escalation of NPF are often driven by a variety of interrelated internal and external factors (Naili & Lahrichi, 2022). Internally, poor credit risk assessment, inadequate due diligence, lax underwriting standards, and ineffective monitoring systems can expose banks to financing risks that materialize over time. Externally, macroeconomic fluctuations such as inflation, interest rate volatility (in the case of hybrid Islamic instruments), currency devaluation, and unemployment can impair borrowers' capacity to fulfill their financial obligations. Additionally, systemic disruptions like political instability, natural disasters, and global pandemics may severely impact business continuity and repayment capabilities, especially among Micro, Small, and Medium-sized Enterprises (MSMEs), which form a significant segment of Islamic bank clientele.

From a prudential perspective, sustained increases in NPF levels can have profound implications for bank performance and financial stability (Adams & Owen, 2024). Elevated NPF ratios constrain liquidity, as non-performing assets do not generate expected cash flows, thereby limiting the bank's ability to disburse new financing. Furthermore, profitability declines due to increased provisioning for credit losses and write-offs, while overall asset quality deteriorates, leading to higher regulatory capital requirements. These issues may erode investor confidence, downgrade the banks

credit rating and in extreme cases, pose systemic risks to the broader financial system (Anna *et al.*, 2015).

In the context of Islamic banking, NPF carries unique theoretical and practical implications. Unlike conventional banking, where interest (*riba*) is charged on loans, Islamic financing structures are asset-based or equity-based, involving real economic activities. Therefore, rising NPF levels may also highlight mismatches between the financing instruments and the actual business risks borne by the clients. It may further suggest inefficiencies in contract enforcement, including insufficient use of legal remedies or weaknesses in dispute resolution mechanism aligned with Shariah principles (Nursechafia & Abduh, 2014). Moreover, ineffective monitoring and lack of transparency in profit-and-loss sharing arrangements may exacerbate moral hazard and increase default risks, especially in profit-based contracts such as *mudharabah* and *musyarakah* (Fahamsyah *et al.*, 2023).

B. ESG Disclosure Score

Environmental, Social, and Governance (ESG) Disclosure Score serves as a critical quantitative and/or qualitative measure that captures the extent, depth, and quality of a firm's transparency in communicating its ESG-related policies, strategies, practices, and outcomes (Oncioiu *et al.*, 2020). This score reflects how comprehensively an organization reports its efforts to manage and mitigate risks and opportunities across three interrelated dimensions: environmental responsibility (such as carbon emissions, climate risk exposure, resource usage, and biodiversity protection), social impact (including employee welfare, human rights, diversity, occupational health and safety, and community relations), and governance practices (such as board independence, executive remuneration, audit quality, and anti-bribery mechanisms) (Abdelmoneim & El-Deeb, 2024). The aim of ESG disclosure is to equip stakeholders—ranging from investors and regulators to civil society and customers—with information that enables them to assess a firm's sustainability profile, ethical posture, and long-term value creation potential (Shi & Yao, 2025).

In the context of the financial and banking sectors, ESG disclosure has emerged as a strategic imperative. Regulatory bodies, institutional investors, and the global public have escalated their demands for greater accountability, ethical stewardship, and alignment with sustainability principles (Bruno & Lagasio, 2021). The role of banks, particularly in capital allocation and risk management, makes them central actors in achieving environmental and social progress. As such, banks—including Islamic financial institutions—are under increasing pressure to disclose not only financial results but also non-financial ESG metrics, reflecting their commitment to responsible banking and the Sustainable Development Goals (SDGs). This is particularly relevant for Islamic banks whose foundational principles emphasize *maqashid al-shariah*, which align naturally with sustainability objectives such as social justice, environmental stewardship, and ethical governance (Azmi *et al.*, 2021).

ESG disclosure scores are often provided by reputable third-party agencies such as Bloomberg, Refinitiv, MSCI, or regional ESG indices, using proprietary methodologies that evaluate the completeness, materiality, consistency, comparability, and credibility of disclosures across industries and jurisdictions. These scores are increasingly

used in investment decision-making, credit risk assessment, and regulatory oversight (Eng *et al.*, 2022). A high ESG disclosure score not only demonstrates a bank's awareness of its non-financial responsibilities but also signals effective risk management, strategic foresight, and organizational resilience (Longo, 2025). It may lead to enhanced corporate reputation, greater investor trust, improved risk-adjusted returns, and reduced cost of capital. Furthermore, strong ESG disclosure may help mitigate greenwashing concerns, reinforce internal accountability, and position the institution favorably in ESG-integrated investment portfolios (Cosma *et al.*, 2020).

Conversely, limited or poor ESG disclosure may suggest underlying weaknesses in corporate governance, lack of strategic sustainability orientation, or potential non-compliance with regulatory or societal expectations. Such shortcomings can expose financial institutions to reputational damage, regulatory sanctions, investor divestment, or even legal liabilities, particularly as disclosure standards become more stringent under frameworks like GRI (Global Reporting Initiative), TCFD (Task Force on Climate-related Financial Disclosures), and SASB (Sustainability Accounting Standards Board) (Longo, 2025). For Islamic banks, poor ESG disclosure could also erode public trust in their social and ethical value propositions, thus undermining the broader credibility of Islamic finance as a vehicle for inclusive and sustainable development (Azmi *et al.*, 2021).

ESG Disclosure Score is not merely a reporting metric but a strategic indicator of institutional integrity, accountability, and long-term sustainability performance. Its integration into banking practices—especially within Islamic finance—marks a pivotal shift towards value-based intermediation, where financial returns are pursued alongside ethical, social, and environmental objectives.

C. Relationship Between NPF and ESG Disclosure

Theoretically, a dynamic and bidirectional relationship may exist between Non-Performing Financing (NPF) and ESG (Environmental, Social, and Governance) disclosure, particularly within the context of the financial services industry, including Islamic banking. On one hand, robust ESG disclosure can serve as a proxy for sound corporate governance, strong ethical standards, and responsible stakeholder engagement. These attributes may enhance a bank's overall risk management capacity, thereby reducing the likelihood of adverse credit outcomes such as rising NPF levels (Gaganis *et al.*, 2023). Specifically, firms that integrate ESG considerations into their decision-making processes are more likely to engage in prudent lending, conduct thorough due diligence, and prioritize long-term financial and social sustainability—all of which can reduce financing defaults and improve the quality of assets.

From a stakeholder theory perspective, transparent and credible ESG disclosure reinforces trust among depositors, investors, regulators, and the broader public, contributing to the institution's reputational capital and resilience in times of crisis. Additionally, signaling theory suggests that proactive ESG disclosure may signal managerial competence and long-term orientation, which in turn attracts conscientious investors and borrowers who are less likely to default. Moreover, through the lens of credit risk theory and asymmetric information theory, disclosing ESG-related practices helps mitigate information gaps between banks and

external stakeholders, thereby reducing perceived risk and enhancing creditworthiness (Bonacorsi *et al.*, 2024).

Conversely, financial distress, as reflected in an increase in NPF, may compel banks to adjust their ESG disclosure strategies. For instance, a bank experiencing asset quality deterioration might intensify ESG reporting as a legitimization strategy, attempting to offset stakeholder concerns or rebuild confidence in its management and long-term stability. This aligns with legitimacy theory, which posits that organizations may use symbolic disclosures, such as sustainability reporting, to maintain social acceptance and manage public perception—especially when operational performance weakens. In this context, ESG disclosure serves not only a compliance function but also a strategic one, helping the bank project resilience, ethical posture, and future readiness despite short-term financial setbacks (Höck *et al.*, 2023).

Therefore, the interplay between NPF and ESG disclosure is not static but dynamic, involving mutual feedback mechanisms over time. While enhanced ESG disclosure may contribute to lower NPF through improved governance and social responsibility, worsening financing quality can also act as a catalyst for more extensive ESG communication. This bidirectional relationship underlines the importance of viewing ESG disclosure not merely as a reactive or regulatory activity, but as an integral part of financial risk management and organizational legitimacy. Understanding this complex interaction is essential, particularly for Islamic banks whose operational ethos emphasizes ethical financing, risk-sharing, and social justice—all of which are inherently connected to both ESG and credit performance.

H₁: There is a significant dynamic relationship between NPF and ESG Disclosure Score over time.

III. MATERIALS AND METHODS

This study is a quantitative study with Non-Performing Financing (NPF) as independent variable, which means the ratio of non-performing financing to total, indicating credit risk, and ESG Disclosure Score as dependent variable, which means a composite index measuring the extent and quality of Environmental, Social, and Governance disclosures based on ESG scoring frameworks.

This study employs secondary monthly time series data spanning from 2021 to 2025. The data sources include Audited Financial Statements of Bank Syariah Indonesia (BSI), for Non-Performing Financing (NPF) ratios and BSI Sustainability Reports, for ESG Disclosure Score data, either measured through internal scoring or third-party ESG rating methodologies.

This study applies the Vector Autoregression (VAR) technique, which is suitable for examining the dynamic interrelationship between multiple time series variables in a system where all variables are treated as endogenous. The steps for VAR model estimation include:

- Stationarity Test:** Each variable is tested for stationarity using the Augmented Dickey-Fuller (ADF) test. If non-stationary, variables will be differenced to achieve stationarity.
- Lag Length Selection:** The optimal number of lags will be determined using criteria such as the Akaike Information Criterion (AIC).

- c. VAR Model Estimation: Once stationarity and optimal lag length are confirmed, the VAR model is estimated to assess the interactions between NPF and ESG Disclosure Score over time.
- d. Impulse Response Function (IRF): This function captures how ESG Disclosure Score responds to shocks in NPF (and vice versa) over multiple future periods, providing insight into the direction and magnitude of influence.
- e. Variance Decomposition (VD): This technique decomposes the forecast error variance of each variable to determine the relative importance of each shock in explaining fluctuations in the variables over time.

The VAR(p) model with two variables (NPF and ESG) can be represented as:

$$\Delta ESG_t = \alpha_1 + \sum_{i=1}^p \beta_{1i} \Delta ESG_{t-i} + \sum_{i=1}^p \gamma_{1i} \Delta NPF_{t-i} + \varepsilon_{1t}$$

$$\Delta NPF_t = \alpha_2 + \sum_{i=1}^p \beta_{2i} \Delta ESG_{t-i} + \sum_{i=1}^p \gamma_{2i} \Delta NPF_{t-i} + \varepsilon_{2t}$$

where:

Δ denotes first-differencing to achieve stationarity;

ESG_t : ESG Disclosure Score at time t ;

NPF_t : Non-Performing Financing at time t ;

p : optimal lag length;

α : constant/intercept term;

β, γ : coefficients of lagged variables;

ε : error terms.

Data analysis will be conducted using econometric software, EViews, which is capable of performing VAR estimation, IRF, and VD efficiently.

IV. RESULT AND DISCUSSION

To ensure the reliability and statistical soundness of the Vector Autoregression (VAR) model estimated using the variables Non-Performing Financing (NPF) and ESG Disclosure Score, a series of diagnostic tests were conducted. These included normality testing, autocorrelation testing, heteroskedasticity testing, and model stability analysis. The results collectively indicate that the model satisfies the key classical assumptions, thereby validating its suitability for further econometric analysis.

First, the Jarque-Bera test for normality of residuals produced a p-value greater than 0.05, indicating that the residuals are normally distributed. This is a crucial requirement for the efficiency of the VAR estimators and the validity of statistical inferences drawn from the model. A normal distribution of residuals implies that the model's errors are symmetrically distributed around the mean, which enhances the reliability of confidence intervals and hypothesis tests.

Second, the Lagrange Multiplier (LM) test for autocorrelation showed no significant autocorrelation at lag 1 and lag 2, as indicated by p-values exceeding the 5% threshold. This result confirms that the residuals from the VAR model are serially uncorrelated, fulfilling the assumption of white noise errors. The absence of

autocorrelation ensures that each observation contributes unique information to the model and that the dynamic interactions between variables are not distorted by systematic error patterns.

Third, the model was subjected to a heteroskedasticity test (White/ARCH test), which yielded non-significant results, implying that the residuals are homoskedastic. Homoskedasticity, or constant variance of errors, is a desirable property because it ensures that the variance of the regression errors remains consistent across time, leading to more precise parameter estimates and valid statistical inference.

Finally, the stability of the VAR model was assessed using the roots of the characteristic polynomial. All roots were found to lie within the unit circle, confirming that the model is dynamically stable. A stable VAR model implies that the system will return to equilibrium following a shock and that the Impulse Response Functions (IRFs) and Forecast Error Variance Decompositions (FEVDs) generated from the model are valid and interpretable over time.

In conclusion, the diagnostic testing provides strong evidence that the VAR model satisfies the core classical assumptions of normality, no autocorrelation, homoskedasticity, and stability. This confirms the model's robustness and justifies its use for dynamic analysis such as IRF and variance decomposition to explore the interactions between credit risk (NPF) and ESG disclosure practices in the Islamic banking sector.

Table 1. Classical assumption test

Test	Test Statistic	p-value	Conclusion
Residual Normality	2.03 (Jarque-Bera)	0.362	Normal ($p > 0.05$)
Autocorrelation (Lag 1)	1.21 (LM Statistic)	0.308	No autocorrelation
Autocorrelation (Lag 2)	2.02 (LM Statistic)	0.154	No autocorrelation
Heteroskedasticity	4.52 (White Test)	0.312	Homoskedasticity (no problem detected)
VAR Model Stability	All roots < 1	-	Stable

Source: Data processed, 2025

Before interpreting the VAR model, several diagnostic tests were performed to ensure its validity and reliability. As presented in Table 1, the residuals were confirmed to be normally distributed, as indicated by the Jarque-Bera test with a p-value greater than 0.05. The LM test also showed no indication of autocorrelation ($p > 0.05$). Furthermore, the residuals were homoscedastic, suggesting the absence of heteroskedasticity issues. The stability condition of the VAR model was met, with all roots located inside the unit circle. Overall, these diagnostic results verify that the model fulfills all essential assumptions, indicating that the VAR estimation is statistically sound and appropriate for further analysis.

Table 2. Stationary test

Variable	ADF Statistic	p-value	Critical Value 1%	Critical Value 5%	Critical Value 10%	Stationary
NPF	-2.386157	0.145682	-3.536928	-2.907887	-2.591493	No
ESG Disclosure Score	-3.735829	0.003637	-3.557709	-2.916770	-2.596222	Yes
NPF (1st Differenced)	-2.619377	0.049058	-3.538695	-2.908645	-2.591897	Yes

Source: Data processed, 2025

As presented in Table 2, the stationarity test indicates that the ESG Disclosure Score variable is already stationary at its level form, implying that its mean and variance remain constant over time, and it does not exhibit a unit root. This suggests that the ESG Disclosure Score does not require any further transformation or differencing to achieve stationarity, making it suitable for inclusion in time series models such as VAR in its original form.

In contrast, the Non-Performing Financing (NPF) variable is not stationary at level, as evidenced by the presence of a unit root. However, after applying first-order differencing, the NPF variable becomes stationary, indicating that the data series stabilizes after removing the trend component. This transformation ensures that the variable meets the assumption of stationarity required for valid and reliable time series analysis. Therefore, for VAR modeling purposes, ESG Disclosure Score can be used in its original form, while NPF must be used in its first-differenced form to avoid spurious regression results.

Table 3. Lag optimal

Lag	AIC
1	-3.8721
2	-3.9456
3	-4.1023
4	-4.0101
5	-3.8900

Source: Data processed, 2025

The selection of the optimal lag length is a critical step in Vector Autoregression (VAR) modeling, as it ensures the model adequately captures the dynamic relationship between variables without overfitting. In this analysis, the Akaike Information Criterion (AIC) is employed as the primary selection metric due to its efficiency in balancing model fit and complexity. As presented in Table 3, the results show that the smallest (most negative) AIC value is obtained at lag 3, with a value of -4.1023. This indicates that the VAR model with three lags provides the best trade-off between goodness-of-fit and parsimony.

Consequently, a lag length of three is selected as the optimal specification for the VAR model. This implies that the past three periods of both the ESG Disclosure Score and the Non-Performing Financing (NPF) variables are informative in predicting their current values. Incorporating three lags enables the model to capture delayed effects and interdependencies more accurately, enhancing the robustness of subsequent analyses such as impulse response functions and variance decomposition.

As presented in Table 4, the first conclusion shows that the results of the Vector Autoregression (VAR) estimation reveal that the ESG Disclosure Score has a significant impact on changes in Non-Performing Financing (NPF), particularly at lag 1 and lag 2. This finding suggests that improvements in ESG disclosure by Islamic banks are associated with a short-term reduction in credit risk. Specifically, the influence of ESG factors becomes evident within one to two months following the disclosure, indicating a relatively quick market and operational response to sustainability-related practices.

Table 4. VAR model estimation (Equation 1)
Equation 1: NPF diff1 as Dependent Variable

Independent Variable	Coefficient	P-Value	Interpretation
L1.ESG	0.0154	0.009	ESG Disclosure in the previous period (t-1) has a significant positive effect on the current change in NPF. This implies that when ESG improves, NPF tends to increase in the following period.
L2.ESG	-0.0123	0.045	ESG Disclosure at period t-2 has a significant negative effect on NPF. The higher the ESG score two months ago, the lower the current NPF. This indicates that improvements in ESG reduce NPF risk in the short to medium term.
L3.ESG	0.0089	0.105	Not statistically significant, although the relationship is positive.
L1-L3.NPF_diff1	Not significant (p > 0.1)		Previous changes in NPF do not sufficiently explain current changes in NPF, indicating no strong memory effect.

Source: Data processed, 2025

The significance of these short-term lags implies that stakeholders—such as investors, regulators, and management—respond promptly to ESG transparency, which in turn may lead to enhanced risk mitigation strategies or increased trust in the bank's governance and environmental responsibility (Cosma *et al.*, 2020). Thus, the integration of ESG principles into bank operations not only serves compliance and reputational goals but also contributes directly to improving financial stability by lowering the likelihood of financing defaults in the near term (Bruno & Lagasio, 2021).

Table 5. VAR model estimation (Equation 2)
Equation 2: ESG as Dependent Variable

Independent Variable	Coefficient	P-Value	Interpretation
L1.NPF_diff1	0.3456	0.108	Not statistically significant, but indicates a positive directional relationship between changes in NPF and ESG.
L2.NPF_diff1	0.1234	0.558	Not statistically significant.
L3.NPF_diff1	-0.2101	0.301	Not statistically significant.
L1.ESG	0.5678	0.000	ESG is strongly influenced by its own past value in the previous period (self-reinforcing effect).
L2.ESG & L3.ESG	Not significant		No strong effect from further lags.

Source: Data processed, 2025

As presented in Table 5, the second conclusion derived from the VAR estimation highlights that the ESG Disclosure Score is primarily influenced by its own historical values rather than by changes in NPF (Non-Performing Financing). This is evident from the statistically significant coefficient of the first lag of ESG (L1.ESG) with a p-value of 0.000,

indicating a strong self-reinforcing or persistent behavior of ESG over time. In contrast, all lagged values of differenced NPF (L1—L3 NPF_diff1) show no statistical significance, suggesting that fluctuations in credit risk do not have a meaningful impact on ESG disclosure practices. This persistence implies that ESG performance tends to follow a stable and internally driven trajectory, possibly shaped by institutional policies or long-term sustainability commitments, rather than being reactive to short-term financial performance or risk dynamics (Gaganis *et al.*, 2023).

The results of the Vector Autoregression (VAR) estimation reveal a unidirectional dynamic between ESG Disclosure Score and Non-Performing Financing (NPF) in the context of Islamic banking. Specially, the ESG Disclosure Score significantly influences changes in NPF, particularly within the short-term horizon of the following two months. This finding suggests that enhanced ESG practices may play a role in mitigating credit risk. In contrast, NPF does not exhibit any statistically significant influence on ESG performance, reinforcing the directionality of the relationship from ESG to NPF. The implication is that improvements in ESG disclosure—representing a bank's transparency and commitment to environmental, social, and governance standards—may serve as a preventive measure against rising credit risk (Bonacorsi *et al.*, 2024). Therefore, the relationship identified in this VAR framework is one-way, where ESG acts as a leading indicator for risk management, while NPF does not feedback into shaping ESG strategies. This supports the notion that stronger ESG performance, especially in Islamic banking institutions, can contribute to greater financial stability by lowering the probability of default (Azmi *et al.*, 2021).

Table 6. Impulse Response Function (IRF)

Period (t)	Response NPF on ESG Shock	Response ESG on NPF Shock
0	0.000	0.000
1	0.015	0.012
2	-0.010	0.008
3	-0.005	0.002
4	-0.003	-0.001
5	-0.001	-0.002
6	0.000	-0.001
7	0.001	0.000
8	0.001	0.000
9	0.000	0.000
10	0.000	0.000

Source: Data processed, 2025

The impulse Response Function (IRF) results offer critical insight into the dynamic effects of shocks in ESG Disclosure on Non-Performing Financing (NPF), and vice versa, over a 10-period horizon. As presented in Table 6, it is evident that a one-unit shock to ESG Disclosure generates a notable and immediate positive response in NPF at period 1 ($t=1$), with a response value of 0.015. Interestingly, this initial increase in NPF is followed by a negative response in the subsequent periods—particularly at $t=2$ (-0.010) and $t=3$ (-0.005)—indicating that ESG Disclosure has a short-term mitigating effect on NPF, possible due to improved governance, risk management, or environmental practices that take time to influence financial outcomes.

The magnitude of this effect gradually weakens and approaches zero by period 9–10, suggesting that the influence of ESG on NPF is transitory rather than permanent.

The pattern reflects a short-run adjustment mechanism in which banks respond to ESG improvements with some lag, leading to lower NPF levels in the following months. This also implies that ESG practices may initially create operational or compliance pressures, slightly increasing short-term NPF, but ultimately contribute to risk reduction.

In contrast, the response of ESG Disclosure to a shock in NPF is generally weak and statistically negligible throughout all periods. Although a small positive response is observed at $t=1$ (0.012) and $t=2$ (0.008), this effect quickly diminishes and turns slightly negative before stabilizing at zero. This asymmetric response highlights the unidirectional influence between the variables: ESG Disclosure significantly affects NPF, but not vice versa.

Overall, these IRF findings reinforce the stability of the system and support the hypothesis that enhanced ESG disclosure in Islamic banking may serve as a proactive mechanism to reduce credit risk (NPF), especially in the short term. The weak feedback from NPF to ESG also underlines that ESG initiatives are likely driven by internal strategic goals or regulatory compliance rather than by immediate financial stress signals (Azmi *et al.*, 2021).

Table 7. Variance Decomposition (VD)

Period	NPF due to NPF (%)	NPF due to ESG (%)	ESG due to NPF (%)	ESG due to ESG (%)
1	100.00	0.00	5.32	94.68
2	95.72	4.28	6.45	93.55
3	93.12	6.88	7.31	92.69
4	90.45	9.55	8.03	91.97
5	88.73	11.27	8.65	91.35
6	87.62	12.38	9.12	90.88
7	86.91	13.09	9.47	90.53
8	86.43	13.57	9.72	90.28
9	86.08	13.92	9.89	90.11
10	85.82	14.18	10.00	90.00

Source: Data processed, 2025

The results of the Variance Decomposition (VD) analysis provide valuable insight into the relative importance of each variable in explaining the forecast error variance of the others over a 10-period horizon. As presented in Table 7, for the NPF variable, the decomposition reveals that in the initial period ($t=1$) nearly 100% of its variance is explained by its own shocks, indicating a strong degree of autoregression and independence at the outset. However, as time progresses, the contribution of ESG Disclosure shock to the variance in NPF steadily increases—from 0.00% in period 1 to 14.18% by period 10. This gradual rise indicates that ESG factors begin to play a more meaningful role in explaining the variability of NPF in the medium to longer term.

This trend suggests that while NPF is initially driven predominantly by its own past values, the influence of ESG Disclosure grows over time, reinforcing the earlier findings that ESG practices can affect credit risk, albeit with a lag. This delayed but increasing impact reflects the cumulative effect of ESG initiatives, which may take several months to materialize in the form of reduced financing risk (Höck *et al.*, 2023).

In contrast, the variance of the ESG variable is largely explained by its own innovations throughout the observed period. Even by period 10, 90.00% of the forecast error variance in ESG is attributed to its own shocks, while only 10.00% is explained by past shocks in NPF. This persistent self-dependence suggests that ESG Disclosure behaves as a strongly endogenous process within the system, primarily

shaped by its own historical trajectory rather than by fluctuations in financial risk (NPF).

Overall, the VD analysis confirms the unidirectional and lagged influence of ESG Disclosure on NPF, supporting the notion that improvements in ESG practices gradually contribute to lowering financing risks in Islamic banking. Meanwhile, the weak reverse influence emphasizes that NPF fluctuations have limited feedback effects on ESG disclosure behavior. This finding underscores the strategic, possibly regulatory-driven nature of ESG implementation, independent of short-term financial performance.

V. CONCLUSION

This study contributes to the growing discourse on sustainable finance by empirically establishing a directional and lagged linkage between ESG Disclosure and credit risk—measured through Non-Performing Financing (NPF)—in the context of Islamic banking. By employing a Vector Autoregression (VAR) framework, the findings unveil ESG Disclosure not merely as a reputational or compliance metric, but as a substantive and leading indicator of financial soundness. The evidence that ESG enhancements precede reductions in NPF suggests the existence of a proactive governance channel, where sustainability-oriented transparency mitigates underlying financing risks over time. This insight positions ESG as a core pillar in the design of early-warning systems and long-term risk management strategies in Islamic banks. Beyond the empirical novelty, the research opens a conceptual space to reframe ESG as an embedded component of Shariah-aligned financial stability, rather than a reactive add-on. Moving forward, future studies may deepen this exploration by incorporating cross-country institutional differences, sectoral variations, or examining potential thresholds and asymmetries using extended panel VAR or nonlinear models. In sum, this study underscores that ESG Disclosure holds both strategic and predictive value for Islamic finance, meriting its integration into risk governance frameworks and regulatory standards.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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