Hamfara : Journal of Islamic Economic Studies
Volume 2 Number 1, March (2026), 1-24.

Asset Quality, Non-Performing Financing, and Early-Warning Indicators of Operational Stress in Islamic Banking Systems: Evidence from SSA

Abdallah Mambo Dallu[1]*, Michael Njoroge Njogo[2], Fiona Jepkosgei Korir[3]

[1,2,3]KCA University, Nairobi, Kenya
Email Correspondence: abdhallamambo@gmail.com

Kata Kunci :

Perbankan Syariah; Kualitas Aset; Efisiensi Operasional; Stabilitas Keuangan

Abstrak

Penelitian ini mengkaji apakah Non-performing Finance (NPF) berfungsi sebagai indikator peringatan dini terhadap tekanan operasional pada bank syariah yang beroperasi di Sub-Sahara Afrika. Dalam konteks stabilitas perbankan syariah, studi ini berangkat dari pandangan bahwa kualitas aset memiliki peran penting dalam mendeteksi tekanan internal yang belum sepenuhnya tercermin dalam indikator kehati-hatian konvensional. Tujuan penelitian ini adalah untuk mengidentifikasi peran NPF sebagai pemicu awal tekanan operasional dengan memandang efisiensi operasional sebagai manifestasi diagnostik dari transmisi tekanan internal, bukan sebagai ukuran kinerja manajerial. Metode penelitian menggunakan kerangka Data Envelopment Analysis dua tahap Simar–Wilson untuk menghasilkan skor efisiensi yang telah dikoreksi bias pada panel seimbang bank syariah penuh selama periode 2010–2024, yang selanjutnya dianalisis menggunakan regresi panel fixed effects dua arah untuk menilai peran peringatan dini NPF yang dilag. Hasil penelitian menunjukkan bahwa peningkatan NPF secara sistematis mendahului penurunan efisiensi operasional, yang mengindikasikan bahwa penurunan kualitas aset ditransmisikan melalui peningkatan biaya pemantauan, restrukturisasi, dan tata kelola syariah. Temuan ini menegaskan implikasi penting bagi regulator dan otoritas moneter dalam memperkuat kerangka peringatan dini perbankan syariah.

Keywords :

Islamic Banking, Asset Quality, Operational Efficiency, Financial Stability

Abstract

This study examines whether Non-Peforming Finance (NPF) functions as an early-warning indicator of operational stress in Islamic banks operating in SSA. Departing from conventional efficiency-determinant approaches, the study conceptualises operational efficiency as a diagnostic manifestation of internal stress transmission rather than a measure of managerial performance. The analysis employs a Simar–Wilson two-stage Data Envelopment Analysis framework to generate bias-corrected efficiency scores for a balanced panel of fully fledged Islamic banks over the period 2010–2024, followed by two-way fixed-effects panel regression to assess the early-warning role of lagged NPF.

The results show that increases in NPF systematically precede subsequent declines in operational efficiency, indicating that asset quality deterioration is transmitted internally through higher monitoring, restructuring, and Sharīʿah governance costs. The findings further reveal that such asset-quality-induced operational stress is persistent and more pronounced in structurally constrained banking environments. By reframing NPF as a forward-looking supervisory trigger and efficiency as a stress indicator, the study provides novel evidence for regulators and monetary authorities seeking to enhance early-warning frameworks in Islamic banking systems globally today.

INTRODUCTION

Islamic banking has burgeoned over the past two decades, becoming a key feature of financial systems in Muslim-majority and minority countries. Based on Sharīʿah principles that emphasize asset-backed financing, risk-sharing, and the prohibition of interest, Islamic banks are often regarded as inherently more stable than their conventional counterparts (Ullah et al., 2023). This view is normatively grounded in the Qur'ānic injunction against ribā, which establishes a financial order rooted in real economic activity, justice, and the avoidance of exploitative debt-based relations (Qur'an 2:278–279).

يَا أَيُّهَا الَّذِينَ آمَنُوا اتَّقُوا اللَّهَ وَذَرُوا مَا بَقِيَ مِنَ الرِّبَا إِن كُنتُم مُّؤْمِنِينَ ۝ فَإِن لَّمْ تَفْعَلُوا فَأْذَنُوا بِحَرْبٍ مِّنَ اللَّهِ وَرَسُولِهِ

"O you who believe! Fear Allah and give up what remains of interest, if you are believers. And if you do not, then be informed of a war from Allah and His Messenger."

Islamic finance aims to limit the risk of excessive leverage and speculation that is a key aspect of financial instability by prohibiting interest-based transactions and anchoring financial claims in tangible assets and productive ventures (Kateb et al., 2023; Prati et al., 2024). But those principles promise stability, which is often conditional. Islamic banks are still susceptible to the degradation of asset quality in practice (Anggraeni & Berniz, 2022; Kuria et al., 2024), especially under conditions with weak legal enforcement, limited Sharīʿah-compliant liquidity instruments, and underdeveloped financial markets. Thus, to comprehend stress and how it manifests in Sharīʿah-compliant institutions, one must go beyond normative assertions of stability in order to investigate the operational effects of impaired Islamic financing.

Nevertheless, lessons from emerging markets indicate that Islamic banks are not immune to asset quality deterioration, operational stress, and balance-sheet fragility (Gathara et al., 2023)—especially in environments characterised by weak legal enforcement, shallow financial markets, and limited Sharīʿah-compliant liquidity infrastructure (Muhammad et al., 2025). Islamic banking is small in Sub-Saharan Africa (SSA), but plays a crucial role in ensuring financial inclusion and in ethical finance. However, Islamic banking in the region suffers from significantly entrenched structural obstacles such as underdeveloped Islamic capital markets, constrained

lender-of-last-resort facilities, and evolving supervisory frameworks (Ayagre et al., 2024; Gondwe et al., 2024). These conditions increase the degree of banks' exposures to credit risk and complicate the task of financial soundness maintenance, so that the early detection of operational stress has emerged as a top concern for regulators and monetary authorities.

Asset quality is one of the fundamental building blocks of the soundness of banks and their finances (Mathuva, 2025; Velliscig et al., 2023). In conventional banking, non-performing loans (NPLs) act as a common early warning for distress, providing a sign of loss of intermediation quality and approaching insolvency or economic dysfunction. Islamic banking, on the other hand, is in the context of NPF that it serves to showcase the value of the assets and it is derived from Shariah-compliant contracts (*murabaha, ijara, musharakah,* and *mudarabah*)(Fahmi et al., 2023; Hidayat et al., 2012). Because these contracts fundamentally differ from conventional debt instruments in aspects such as allocation of risk, loss recognition strategies, and enforcement mechanisms, we now suggest that the dynamics and consequences of NPF also differ from those of conventional NPLs (Abdo et al., 2022; Suzuki et al., 2020). Despite the centrality of asset quality to Islamic banking stability, existing empirical research largely treats NPF as one of a number of balance-sheet characteristics that can explain profits or efficiency outcomes (Widarjono & Rudatin, 2021). A good deal of the literature concentrates on mature Islamic banking markets in the Middle East and Southeast Asia. Structurally constrained environments such as SSA have been little studied (Ayagre et al., 2024). Additionally, asset quality is often treated as a contemporaneous driver of performance instead of a leading indicator of emerging operational stress (Mathuva, 2025; Velliscig et al., 2023). This creates an important gap in knowledge regarding whether increasing NPF ratios of Islamic banks are precursors to more profound inefficiencies and vulnerabilities that are currently not detectable in traditional performance measures.

Under such circumstances, operational efficiency allows a certain view in which to look for stress (Karki & Rajbhandari, 2020). Rather than treating efficiency as a measure only of managerial effectiveness, falling efficiency could be indicative of an increasing array of operational tensions, higher cost of monitoring and recovery, and misallocation of resources as the quality of assets declines. The cost effect of NPF may be more severe in Islamic banks due to the greater monitoring of contracts, Sharīʿah governance costs, and the limited availability of secondary markets for troubled Islamic financial assets (Afkar, 2024; Salsabilla & Jaya, 2024). As a result, deterioration in efficiency can come before more obvious signifiers of financial distress, and for supervisors it can serve as a useful early-warning signal. From an Islamic economic perspective, financial stability is not an end in itself but a means to preserving wealth (*ḥifẓ al-māl*), ensuring justice (*ʿadl*), and preventing harm (*rafʿ al-ḍarar*) (Azizov, 2025; Harahap et al., 2023). Sharīʿah-compliant finance is normatively structured to promote these objectives through risk-sharing and asset-backed transactions, yet their realization depends critically on asset quality and institutional capacity. Persistent

deterioration in NPF undermines these maqāṣid by eroding operational efficiency, increasing governance and monitoring costs, and weakening the ability of Islamic banks to channel funds productively (Azizov, 2025). In this context, operational inefficiency is not merely a managerial shortcoming but a manifestation of internal stress that signals a deviation from the maqāṣid-consistent functioning of Islamic financial intermediation (Dewaya, 2025).

In this context, the focus of this study is on whether NPF has an operational stress early-warning indicator in Islamic banks operating in SSA (Karki & Rajbhandari, 2020). Instead of considering asset quality as a standard factor determining efficiency, this study has posited an increasing presence of NPF ratios which can be seen as a precursor of a loss of efficiency, corresponding to increasing operational pressure on Islamic banking firms. Through this, efficiency is viewed not as a measure of end-performance, but as a diagnosing function, indicating that credit stress has been transmitted to the inner workings of banks (Mathuva, 2025; Velliscig et al., 2023).

The study adds three key contributions to Islamic banking and financial stability literature. Firstly, it offers a scarce cross-national empirical case in SSA, an area that is still under-represented in Islamic banking literature despite its emerging policy importance. Second, it contributes to literature by reframing the relationship between asset quality and efficiency, positioning NPF as an early-warning and supervisory monitoring tool rather than a fixed determinant for performance. Third, the study provides policy-relevant knowledge for Islamic banking supervisors and regulators, demonstrating how efficiency-based indicators may complement traditional prudential metrics as a means to identify emerging vulnerabilities in Sharīʿah-compliant banking systems. In contrast to previous research that highlights a contemporaneous association between asset quality and performance, we present NPF as a forward-looking supervisory trigger, and operational efficiency here is seen less as a performance goal but as an indicator of internal stress.

LITERATURE REVIEW

Background Theory

In theory, Islamic banking has been considered a form of banking that promotes financial stability because of the unique operating principles – focus on asset-backed transactions, risk-sharing, minimal risk taking, the avoidance of over-leveraging and market speculation on transactions (Azmat et al., 2021; Chen et al., 2019). Conventional banks give an interest on account of the interest paid (Abdo et al., 2022; Bakour, 2023). Islamic banks have a mutual profit-and-loss sharing based structure, which include the benefits of depositors along with bank profits. The aim is to align incentives, tighten up the markets and deter reckless risk-play. Moreover, Islamic banks are also not allowed to deal in interest-based trading and speculate on risky financial securities, which also limits them from excessive accumulation of risk (Azizov, 2025; Dewaya, 2025). Interest-free banking when properly implemented with genuine profit-loss

sharing arrangements, demands more level transparency, disclosure, and ex ante assessment of financed projects (Putra & Al-Banna, 2025). These features are anticipated to reduce moral hazard, deter reckless lending and strengthen resilience of the financial system.

From an intuitive, theoretical perspective, close and direct relationship between Islamic banks' transactions and the real economy indicates that Islamic banks, to a higher extent than their peers, are more capable to withstand financial shocks (Riani, 2022). This is being buttressed by a developing literature that emphasizes that Islamic banking instruments are instrumental in shaping financial stability and economic efficiency by counterbalancing leverage-based frailty and speculation excesses. Islamic and conventional banking instrument comparisons have also indicated that Sharīʿah-compliant financial schemes could contribute to system resilience by connecting financial claims with tangible assets and productive activities (Bakour, 2023; Suzuki et al., 2020). Financing contracts like *murābaḥah, ijārah, mushārakah,* and *muḍārabah* contain risk-sharing and asset-backing elements that, on a theoretical basis, diminish the probability of destabilising credit booms (Ak & Harunoğullari, 2023; Azizah & Mukaromah, 2020). Some empirical research supports the relative robustness of Islamic banking instruments, particularly during periods of financial stress (Selim, 2025). Although such theoretical arguments centre around stability and shock absorption, they do not sufficiently incorporate how stress manifests in Islamic banks when asset quality is reduced. Specifically, the ways in which impaired Sharīʿah-compliant financing may be converted into operational strain have remained under-researched, particularly in emerging markets (Asiamah & Badu, 2023), where institutional and legal constraints may disrupt the stabilising attributes theorised (Akinbowale et al., 2025).

Previous Studies on Risk, Stability, and Islamic Banking

There is a large and complex literature that investigates the degree or risk level of Islamic banking system in relation to conventional banking system which is either being higher or lower. Most of this literature has also expanded after the Global Financial Crisis (GFC), yielding mixed and sometimes context-dependent findings. Farooqi and O'Brien (2019) found that Islamic banks in Gulf countries had a lower operating risk and higher market risk compared to conventional banks. In contrast, Mohammad et al. (2020) and Abdel Megeid (2017) have documented a higher liquidity risk for Islamic banks consistent with limitations in liquidity management tools and market infrastructure. In terms of credit risk, Islamic banks demonstrated lower credit risk with conservative lending practices and asset-backed contracts (Chowdhury et al., 2023; Kusnandar, 2022). In contrast, Lassoued (2018) contends that Islamic banks can be exposed to greater credit and insolvency risk especially in less mature markets owing to the lack of diversification and operational rigidities. Also, there seems to be no statistically significant difference in credit risk between Islamic and conventional banks; implying also convergence in their risk-taking behaviours in comparable

regulatory environments (Chowdhury et al., 2023; Kusnandar, 2022).

These divergent results apply to investigations investigating performance of Islamic versus conventional banks in times of financial adversity. Islamic banks are found to be better performing in the GFC and showing resilience (Abdo et al., 2022; Suzuki et al., 2020). Others claim there is no difference when controlling for size, capitalization and country effects (Bakour, 2023). A different line of research is related to the stabilizing effect of Islamic banks in dual banking systems. This study is a first to argue, that Islamic banks maintain higher liquidity buffers, do less speculative activities and stay better connected to the real economy as well as contribute to the broader structural stability of the. Others argue that, in small Islamic banks, this stabilising effect is more evident, but smaller size and complexity of the institutions can erode it as they grow (Gržeta et al., 2023; Świtała et al., 2020). For some reason, however, Islamic banks do not increase stability systematically and even tend to perform worse than traditional banks at those times of acute financial distress (Bakour, 2023).

Asset Quality and NPF in Islamic Banking

The position of asset quality is unique among Islamic banking on account of the contractual and institutional features in Sharīʿah-compliant finance. Unlike traditional banking, where non-performing loans (NPLs) primarily reflect a borrower's default on debt obligations (Bakour, 2023; Suzuki et al., 2020), it is NPF in Islamic banks, which arises from impairments in asset-backed and risk-sharing contracts, including murābaḥah, ijārah, mushārakah, and muḍārabah, among others (Ak & Harunoğullari, 2023; Azizah & Mukaromah, 2020). These collateralized contracts embed varying methods of risk-sharing, loss-recognition, and enforcement, signifying that asset quality degradation in Islamic banking can have operational and governance impacts that are dissociable from conventional credit risk. Differentiating between the two is the operational burden on bank operation of impaired Sharīʿah-compliant financing (Bakour, 2023). The NPF resolution may also include further monitoring, contract renegotiation, asset restructuring, and Sharīʿah governance review, which further increases internal operating costs.

Unlike traditional debt restructuring, Islamic banks have constraints and restrictions imposed by both the prohibition of interest (ribā) and excessive uncertainty (gharār), which limit the extent of permissible tools of recovery to be used (Kateb et al., 2023; Prati et al., 2024). As such, asset impairment in Islamic banking will more likely result in long-standing operational inefficiencies than short-term balance-sheet enhancements (Anggraeni & Berniz, 2022; Kuria et al., 2024). Current empirical research often also uses NPF as a control variable in performance or profitability analyses, treating it as a contemporaneous driver, not as a dynamic index of risk as it continues to materialize (Kuria et al., 2024; Prati et al., 2024). Further, the Islamic banking asset quality literature often centers on mature markets in the Middle East and Southeast Asia (Mateev & Nasr, 2023), where robustness of economic and legal

enforcement mechanisms and Sharīʿah-compliant liquidity infrastructure is relatively advanced. There have been fewer recent studies on structurally constrained environments, and the impact of weak recovery mechanisms and limited secondary markets for Islamic financial assets could compound the operational consequences of impaired financing (Ak & Harunoğullari, 2023; Azizah & Mukaromah, 2020; Selim, 2025). This gap is relevant to the study focus on the dynamic link between asset quality and operational efficiency of Islamic banks subject to institutional barriers.

Contagion, Stress Transmission, and Early-Warning Perspectives

Partial contagion of Islamic and conventional financial markets is identified by Rizvi, Arshad, and Alam (2015) who report reduced financial exposure of Islamic markets to financial risk in the period before the GFC. Kenourgios, Naifar, and Dimitriou (2016) and Hkiri et al. (2017) found that Islamic markets could decouple from conventional ones in times of turmoil and so diversification is a positive feature. Nevertheless, other studies support and refute the hypothesis of decoupling and establish substantial interdependence between Islamic and conventional markets (Abdo et al., 2022; Suzuki et al., 2020) Agent-based models (ABMs) have also started to be used in the larger studies, exploring financial contagion, systemic risk, and the spread of shocks through interbank networks; the impact of contagion extends beyond market-level analyses. These studies model liquidity hoarding, asset price contagion, and counterparty risk as a means of capturing the endogenous elements of financial distress (Kuria et al., 2024). Based on this literature, systemic vulnerability is not just due to individual bank characteristics but also related to network structure and connectivity and behavioural reactions to shocks.

Although these studies provide important insight into the dynamics of financial stability and contagion (Mateev & Nasr, 2023; Mathuva, 2025), they often abstract away from bank-level operational stress and do not directly reflect on how decline of asset quality within Islamic banks is manifested internally. Of particular note, the important monitoring role of NPF in early warning is rarely addressed in empirical studies, despite the centrality of these indicators for supervisory scrutiny and for prudential regulation (Widarjono & Rudatin, 2021). In addition, most empirical evidence is extrapolated from mature Islamic banking markets, leaving structurally constrained environments such as SSA underexplored.

Hypotheses Development

The early-warning framework emphasizes early warnings for those indicators which need to be identified before there is any overt financial distress. The indicators of asset quality and non-performing exposures are identified as being in the forefront of those indicators of instability in conventional banking systems (Afkar, 2024; Salsabilla & Jaya, 2024). In Islamic banking the NPF is the impairment in Sharīʿah-compliant contracts that typically means more monitoring, more restructuring, and more compliance costs(Azizah & Mukaromah, 2020). These traits imply that rising

NPF may exert delayed but persistent pressure on banks' internal operations. Instead of treating asset quality as a contemporaneous determinant of performance, this study treats NPF in the bank as a leading indicator of operational stress, as indicated by subsequent deterioration in efficiency. Deterioration in efficiency is seen as a diagnostic outcome indicating the transmission of credit stress into banks' cost structures and operational processes (Gržeta et al., 2023; Mai et al., 2023). Accordingly, the study advances the following hypotheses:

H1: Increases in NPF are associated with subsequent deterioration in operational efficiency in Islamic banks.

H2: The negative effect of NPF on operational efficiency persists over time in Islamic banks.

H3: The early-warning effect of NPF on operational efficiency is stronger in structurally constrained Islamic banking systems.

Islamic Economic Framework

Islamic banking, as applied to financial institutions, is part of the broader framework of Islamic economic policy, which focuses on achieving the goals of the Islamic legal system, primarily wealth protection *(ḥifẓ al-māl)*, justice *(ʿadl)*, and harm prevention *(rafʿ al-ḍarar)*(Azizov, 2025; Dewaya, 2025). In this approach, financial stability is not pursued as an end in itself but is considered a prerequisite for equitable wealth distribution and sustainable activity among financial mediums (Azizov, 2025; Harahap et al., 2023). Islamic finance and financial systems serve these objectives through asset-backed transactions, risk-sharing, and the prohibition of interest income (such as from a bank account), all aimed at curbing excessive leverage and speculative behavior (Azizah & Mukaromah, 2020; Selim, 2025). However, fulfilling these normative requirements critically depends on the quality of the financed assets and the institutional context in which Islamic banks operate. Deterioration in NPF adversely impacts Islamic banks and poses a risk because it disrupts objectives-oriented intermediation, reducing the banks' capacity to protect depositor and investor money (Widarjono & Rudatin, 2021).

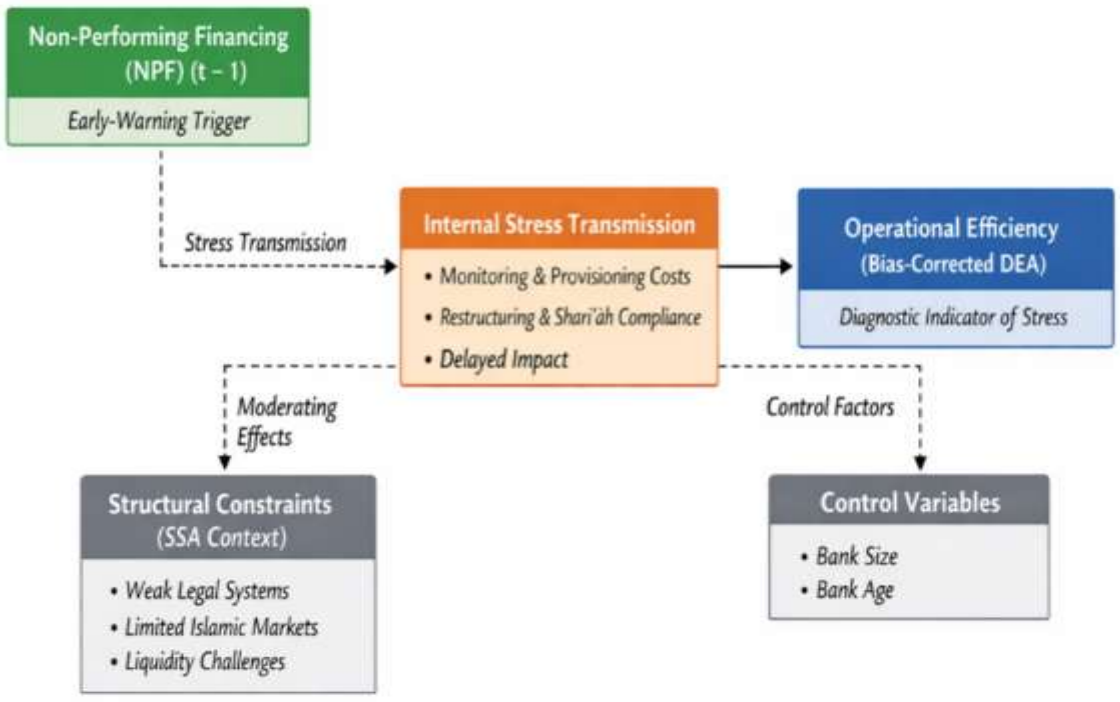
In reality, increased NPF adds to the monitoring, restructuring, and Islamic law governance burden for the banks and their operations (Chowdhury et al., 2023; Salsabilla & Jaya, 2024). When these pressures persist, they erode operational performance and thus the ability of Islamic banks to fulfill their ethical and developmental mandates. Operational efficiency plays a diagnostic role rather than merely reflecting managerial performance from an Islamic economic perspective (Afkar, 2024). Negative efficiency signals internal transmission of asset-quality stress and emerging threats to wealth preservation and financial justice. In structurally restricted settings—where legal enforcement, recovery mechanisms for Islamic law-compliant contracts, and Islamic liquidity instruments are underdeveloped (Akinbowale et al., 2025; Azizov, 2025)—these impacts are compounded. Therefore, the relationship between NPF and operational efficiency can help identify early signs

of stress in Islamic banking systems before systemic vulnerabilities escalate into a financial stability crisis, through an objectives-consistent lens that supervisory authorities may use to prevent such crises.

Conceptual Framework

The conceptual framework underpinning this study is as shown in Figure 1. The framework conceptualises NPF as an early-warning trigger of operational stress in Islamic banks rather than as a contemporaneous determinant of performance. Increases in NPF reflect deterioration in Sharīʿah-compliant financing contracts, which transmit stress internally through higher monitoring costs, restructuring expenses, and Sharīʿah governance burdens (Salsabilla & Jaya, 2024). These internal frictions are manifested through subsequent declines in operational efficiency, which is interpreted as a diagnostic outcome of stress transmission rather than a measure of managerial performance (Afkar, 2024). The framework further recognises that this transmission mechanism is conditioned by structural constraints prevalent in SSA, including weak legal enforcement, shallow Islamic financial markets, and limited recovery mechanisms (Gondwe et al., 2022; Mateev et al., 2021). Bank size and bank age are included as control variables to isolate the early-warning role of asset quality from scale and institutional maturity effects.

Figure 1. Conceptual Framework: Non-Performing Financing as an Early-Warning Indicator of Operational Stress in Islamic Banks



METHODOLOGY

Data and Sample Selection

This study used a balanced panel dataset comprising 35 fully-fledged Islamic banks operating in SSA; in this dataset, 525 bank–year observations were made over the period 2010–2024. The sample included jurisdictions with formally recognised Islamic banking frameworks such as Nigeria, Kenya, Senegal, Sudan, Djibouti, and South Africa (Gondwe et al., 2024). Islamic banking windows were excluded in order to reflect the operational realities of fully Sharīʿah-compliant institutions and to evaluate asset quality recognition and financing structures. Financial data at the bank level were sourced from audited annual reports, the IMF Financial Soundness Indicators database, IFSB website and national supervisory publications. It covers multiple regulatory phases, macroeconomic cycles, and episodes of financial stress, enabling an assessment of NPF dynamics beyond short-term fluctuations. The balanced panel structure provided consistent estimates of efficiency and minimized distortions from incomplete reporting or bank entry and exit.

Measurement of Operational Efficiency as an Indicator of Stress

Whereas efficiency has been a measure of managerial performance used in previous applications, in this study operational efficiency was considered a diagnosis of the propagation of internal stress within Islamic banks. From a Shariah perspective, decreasing efficiencies show rising costs of impaired asset management, contract restructuring, and Shariah governance which together prevent the protection of wealth of stakeholders *(ḥifẓ al-māl)* (Anggraeni & Berniz, 2022; Kateb et al., 2023; Kuria et al., 2024; Prati et al., 2024). Hence the DEA framework was not employed for ranking banks in a competitive manner but for revealing the hidden operational vulnerabilities which are critical for the safety of Islamic banking supervision and early-warning monitoring.

Operational efficiency was assessed using an output-oriented Data Envelopment Analysis (DEA) framework under variable returns to scale (VRS) (Simar & Wilson, 2020). Islamic banks in SSA were treated as financial intermediaries converting resources into Sharīʿah-compliant income. The output-oriented approach suits SSA's structural constraints affecting cost minimization while allowing income generation through resource utilization (Mai et al., 2023). Input variables included personnel, administrative expenses, and other non-interest operating costs, highlighting the resource-intensive nature of Islamic banking. These inputs were pivotal for pinpointing efficiency issues from asset quality stress, as rising NPF increases related costs (Afkar, 2024; Azizah & Mukaromah, 2020). Output variables encompassed non-interest income, fees, and other Sharīʿah-compliant earnings, indicative of Islamic banks' revenue from activities like Murābaḥah and Ijārah (Azizah & Mukaromah, 2020; Selim, 2025). Prioritizing non-interest income is vital since Islamic banking relies on asset performance rather than interest margins.

Table 1: The inputs and outputs variables used to measure the efficiency score, and partition variables

Variable name	Description
Input variables:	
Administrative Expenses	Total Administrative expense of each bank per year
Non-Interest expenses	Non-Interest expense of each bank per year
Personnel Expenses	Total Personnel Expenses to each bank per year
Output variables:	
Net Operating Income	The total income from core banking operations including fees & Commissions of each bank per year.
Net Fees and Commission	Net Fees and Commission of each bank per year
Total other income	Total other income including foreign exchange income, Gain on investment revaluation, Rental income, Dividend income and Other non-operating Shariah-compliant income of each bank per year

The DEA approach supports the study's early-warning framework, interpreting operational efficiency as a sign of internal stress rather than managerial optimization (Mai et al., 2023; Uddin et al., 2025). Deterioration in efficiency signals operational burden from asset quality shocks rather than inefficiencies due to scale or strategy. Bias-corrected efficiency scores were computed using the Simar–Wilson bootstrap procedure to enhance reliability in efficiency-based diagnostics (Simar & Wilson, 2020).

NPF and Asset Quality Indicators

Asset quality was operationalised as NPF ratios, defined as impaired or non-performing Sharīʿah-compliant financing relative to total financing. Contrary to conventional NPLs, NPF identifies impairments resulting from Islamic contracts like *murābaḥah, ijārah, mushārakah*, and *muḍārabah*, which involve distinct loss-recognition and enforcement mechanisms (Azizov, 2025). To develop an early-warning system, the study used lagged NPF indicators, allowing asset quality deterioration to precede observed changes in operational efficiency. Such temporal ordering was of paramount significance to avoid reverse causality and to bring the analysis into line with supervisory monitoring approaches (Salsabilla & Jaya, 2024), which in practice use asset quality indicators to anticipate future stress rather than explain contemporaneous outcomes.

Empirical Strategy: Early-Warning Framework

The empirical strategy was designed to test whether increases in NPF serve as leading indicators of operational stress, reflected through subsequent efficiency deterioration. The baseline econometric specification was expressed as follows:

$$\mathrm{EFF}_{i,t} = \alpha + \beta\,\mathrm{NPF}_{i,t-1} + \gamma\mathbf{X}_{i,t} + \mu_i + \lambda_t + \varepsilon_{i,t}$$

where:

- $\mathrm{EFF}_{i,t}$ - denotes the bias-corrected VRS efficiency score for bank $i$in year t, interpreted as an indicator of operational stress,
- $\mathrm{NPF}_{i,t-1}$ - represents lagged non-performing financing, capturing the early-warning effect of asset quality deterioration,
- $\mathbf{X}_{i,t}$ - is a vector of control variables included solely to isolate the asset quality channel,
- μ_i - captures unobserved, time-invariant bank-specific effects,
- λ_t - controls for common time effects, including macroeconomic shocks and regulatory changes, and
- $\varepsilon_{i,t}$ - is the idiosyncratic error term.

The coefficient β measured whether increases in NPF preceded declines in operational efficiency, consistent with the early-warning hypothesis.

Control Variables and Model Specification

In a parsimonious introduction, control variables were introduced in such a way to avoid lapses into financial soundness determinants. These included bank size (log of total deposits) and bank age, which would capture scale effects and institutional maturity that could influence the transmission of asset quality shocks into operational stress. Liquidity and capital ratios were not regarded as key explanatory variables, as the study was concerned with the stress-signalling role of NPF, rather than comprehensive soundness assessment. All models were estimated with two-way fixed-effects panel regression with robust standard errors to compensate for heteroskedasticity and serial correlation within banks. The fixed-effects specification was used, due to theoretical considerations and formal specification tests, ensuring that unobserved heterogeneity across banks did not bias the estimated early-warning relationship.

Persistence and Structural Constraint Analysis

To analyse the persistence of asset quality-induced stress, the study further developed the baseline model by adding longer lag structures of non-performing financing. Persistence was inferred when lagged NPF coefficients remained statistically significant over multiple periods, indicating prolonged operational strain following asset quality deterioration. Moreover, to account for the impact of structural constraints in SSA Islamic banking systems, the analysis examined whether the magnitude of the early-warning effect differed across institutional contexts characterised by weaker financial infrastructure. This allowed the empirical approach to align with supervisory concerns regarding heterogeneous vulnerability across emerging Islamic banking markets. This study departed from traditional efficiency-determinant models and positioned operational efficiency as a supervisory diagnostic

tool by combining bias-corrected efficiency estimation with a lagged early-warning regression framework. The methodology specifically acknowledged the temporal transmission of asset quality stress into internal bank operations, providing regulators and monetary authorities with a practical framework for monitoring emerging vulnerabilities in Islamic banking systems.

RESULTS AND DISCUSSION

Descriptive Patterns of DEA Inputs and Outputs

Table 2 summarises the descriptive statistics of the DEA input and output variables based on 525 bank–year observations, revealing substantial heterogeneity in operational costs and income generation among Islamic banks in SSA.

Table 2. Descriptive statistics of the inputs and outputs

Statistic	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis
Non-Interest Expenses	13250.75	4441.75	522356.	0	36743.8	8.644	98.211
Total Operating expenses	18874.5	11046.6	794811	5.73	43156.8	12.66	210.35
Net Impairment charges on financing	2698.1	1000.98	60773.9	0	5532.53	5.602	44.266
Non-Interest Income	16566.2	8961.96	467314	0	29639.5	8.102	107.916
Net Fees Commission	6377.4	3017.5	141884	0	11279	5.388	48.554
Total Other Income	11882.5	4527.98	279319	0	21772.3	5.702	54.725

On the input side, non-interest expenses and total operating expenses were similarly widely dispersed, with means of USD 13,250.75 and USD 18,874.5, respectively, and standard deviations far exceeding their means. Loans and advances of impairment carried wide variation, in line with diverse asset quality characteristics and provisioning behavior among banks. High dispersion was also observed in output variables. Non-interest income: there were significant fluctuations between minimum and maximum values for non-interest income, net fees and commission and total other income, suggesting less diversified income streams and reliance on fee-based income. The consistently high positive skewness and excess kurtosis across all variables indicates that a small number of relatively large Islamic banks made a rather large contribution to the operational costs and income. From an early-warning perspective, the observed imbalance between cost inputs and income outputs provides important

signals of emerging operational stress. Banks that exhibit rising operating and impairment-related expenses without corresponding growth in non-interest ***income are more likely to experience pronounced efficiency erosion over time. These*** distributional patterns support the use of bias-corrected DEA as an appropriate tool for capturing latent internal stress within banks, while the Simar–Wilson framework helps mitigate the influence of scale heterogeneity and extreme observations on efficiency estimates (Mai et al., 2023; Simar & Wilson, 2020)

Descriptive Statistics and Baseline Stress Conditions

Table 3 reports descriptive statistics based on 525 bank–year observations from 35 fully-fledged Islamic banks over the period 2010–2024.

Table 3. Descriptive Statistics of Study Variables: *(35 Islamic banks, 525 bank–year observations, 2010–2024)*

Variable	Mean	Std. Dev.	Min	Max	Between SD	Within SD
Bias-corrected VRS Efficiency	0.318	0.191	0.037	0.782	0.136	0.136
Impaired Financing / Equity (%)	56.445	35.216	0.602	280.05	25.224	24.879
Liquidity Ratio (%)	28.454	11.183	4.236	57.313	7.479	8.403
Net Profit Margin (%)	28.117	20.564	0.022	97.919	16.72	12.28
Log of Deposits (Bank Size)	11.484	2.328	0.154	16.47	2.187	0.873
Bank Age (years)	20.139	13.705	0	65	13.197	4.282

The VRS efficiency score — an average of 0.318 bias-corrected, with a minimum of 0.037 and a maximum of 0.782 — implies that Islamic banks in SSA operate at less than a third of the estimated efficiency frontier on average. These low levels of efficiency and wide dispersion indicated that operational frictions were both persistent and heterogeneous, rather than isolated managerial shortcomings. It shows that latent stress was evident in asset quality indicators. The impaired financing-to-equity ratio averaged 56.4 percent, with extreme values reaching 280 percent, indicating that in some institutions, Sharīʿah-compliant financing impairments substantially exceed equity buffers.

The high level of dispersion indicated uneven vulnerability across banks, potentially hindering timely recognition and resolution of credit impairment. Crucially, the coexistence of high impaired financing and low efficiency, as documented in Table 3, suggests that operational stress in SSA Islamic banks was structural rather than episodic. Even in the absence of immediate solvency deterioration, banks appeared to bear substantial internal costs associated with managing impaired financing, supporting the study's premise that efficiency can serve as an early diagnostic signal.

DEA Efficiency Results and Operational Stress Patterns

Table 4 presents the average DEA efficiency scores under constant returns to scale (CRS) and variable returns to scale (VRS).

Table 4. Summary DEA Efficiency Scores (2010–2024)

Efficiency Measure	Mean
CRS Technical Efficiency	**0.287**
VRS Technical Efficiency	**0.417**
Scale Efficiency	**0.751**

Interpretation notes: Inefficiency is primarily managerial/operational rather than scale-driven.

The mean CRS efficiency was 0.287 and mean VRS efficiency was 0.417, with a scale efficiency of 0.751, suggesting that inefficiency is mainly management and operational-based and not size-related. From the perspective of supervision this finding is significant in that it implies inefficiency may be an effect of internal frictions rather than because the bank size was not ideal. Bias correction serves to better clarify that interpretation. As Table 5 shows, the average VRS efficiency droped from 0.417 to 0.318 following the application of the Simar–Wilson bootstrap procedure, thus indicating that operational efficiency was significantly overstated in conventional DEA estimates. Even in later years, when nominal efficiency seemed to improve, the bias-corrected efficiency still remained below 0.40, with highest value reached at 0.396 in 2023.

Table 5. Bias-Corrected VRS Efficiency Scores

Year	VRSTE	Bias Corrected VRSTE
2010	0.392	0.300
2011	0.384	0.298
2012	0.398	0.300
2013	0.386	0.299
2014	0.380	0.291
2015	0.366	0.278
2016	0.348	0.265
2017	0.415	0.317
2018	0.385	0.299
2019	0.357	0.281
2020	0.425	0.334
2021	0.499	0.374
2022	0.475	0.360
2023	0.528	0.396
2024	0.515	0.377
Average	**0.417**	**0.318**

Note: Bias correction follows Simar–Wilson (2007).

The existence of low bias-corrected efficiency scores suggests embedded operational stress, not short-term inefficiency. This was an aggregation burden, especially in Islamic banking, as contract monitoring and recovery efforts become a cumulative burden as well as Sharīʿah governance requirements that take on more weight upon impairment of financing. That is, these findings supported a view on efficiency deterioration as a sign of underlying stress, not signs of bad management (Salsabilla & Jaya, 2024; Widarjono & Rudatin, 2021)

NPF as an Early-Warning Signal

The central evidence for early warning is presented in Table 6, which shows the fixed-effects regression analysis based on bias-corrected VRS efficiency serving as the dependent variable.

Table 6. Fixed-Effects Regression Results (Early-Warning Specification): *(Dependent variable: Bias-corrected VRS efficiency)*

Variable	**Coefficient**	**Robust Std. Error**	**t-statistic**	**p-value**
Lagged NPF (NPF_{t-1})	**−0.001**	0.0002	−5.00	<0.01 ***
Bank Size (log deposits)	−0.013	0.007	−1.86	0.064 *
Bank Age	0.00004	0.00002	1.72	0.086 *
Constant	Included	—	—	—
Bank Fixed Effects	Yes			
Time Fixed Effects	Yes			
Model Statistics				
R-squared				0.026
Adjusted R-squared				−0.081
F-statistic				3.165 (p < 0.01)

Significance: **** p<0.01, ** p<0.05, * p<0.10*

The coefficient of lagged NPF_{t-1} was negative and statistically significant ($\beta = -0.001$, $p < 0.01$), which implies that increases in impaired financing occur before decreases in operational efficiency. This result was the study's main empirical contribution. The findings were of key significance for the Islamic economy in thought and practice. The persistence of efficiency erosion following asset quality deterioration suggests that adherence to Sharīʿah alone does not guarantee maqāṣid-consistent outcomes in the absence of supportive legal and financial infrastructure (Azizov, 2025). Weaknesses in recovery mechanisms for Sharīʿah-compliant contracts lead to the accumulation of operational stress that compromises the social and economic objectives of Islamic banking. This highlights the need for regulators to complement doctrinal compliance with institutional reforms that enable Islamic banks to fulfil their developmental and ethical mandates.

Unlike traditional efficiency-determinant models—where asset quality is assessed contemporaneously—the lagged specification generated a temporal ordering similar to supervisory monitoring practice(Simar & Wilson, 2020). Notably, deterioration of asset quality does not immediately signify inefficiency but rather manifests over time through higher provisioning costs, intensified monitoring, renegotiation of Sharīʿah-compliant contracts, and increased governance-related expenses. Despite the small coefficient magnitude, its economic importance becomes very evident when we consider that the mean value and dispersion of NPF is quite high (Table 3). For banks that maintain long-standing high impaired financing ratios, even small increases in NPF accumulate into large efficiency losses, confirming NPF as a leading indicator of internal operational stress (Afkar, 2024).

Persistence of Asset-Quality-Induced Stress

The evidence from both Table 5 (efficiency dynamics) and Table 6 (regression results) suggests that asset-quality-induced operational stress was persistent. Even after 2020 nominal efficiency improved slightly, bias-corrected efficiency remained well below the frontier, with indicators suggesting banks were not yet able to recover operational normalcy once asset quality deteriorates. The persistence mirrored structural traits of the SSA Islamic banking systems (Akinbowale et al., 2025). Weak legal enforcement, lack of insolvency and recovery mechanisms for Sharīʿah-compliant contracts, and the absence of secondary markets for distressed Islamic assets constrain the ability of banks to efficiently resolve the problem of impaired financing (Mateev et al., 2021; Mathuva, 2025). Hence, asset quality shocks created enduring operational inefficiencies, rather than being swiftly absorbed. This finding matters in terms of financial stability. A chronic erosion of efficiency implies that unresolved credit problems over time can gradually erode the ability of institutions to remain resilient even in the absence of immediate capital shortfalls, supporting the importance of early supervisory action.

Heterogeneity and Structural Constraints

Table 7 documents substantial cross-country heterogeneity in bias-corrected efficiency scores.

Table 7: Average Bias-Corrected Efficiency Scores Across countries

Country	Num_Banks	Num_Observations	Avg_CRS_Efficiency	Avg_VRS_Efficiency	Avg_Scale_Efficiency	Avg_VRS_Efficiency_
Cote D'Ivore	1	15	0.373	0.725	0.582	0.562
Burkina Faso	1	15	0.339	0.766	0.448	0.556
Seychelles	1	15	0.236	0.621	0.368	0.43
Mali	1	15	0.358	0.487	0.751	0.386
Sudan	19	285	0.323	0.451	0.768	0.336
Senegal	1	15	0.255	0.368	0.764	0.308

South Africa	1	15	0.313	0.366	0.869	0.301
Mauritius	1	15	0.093	0.384	0.252	0.300
Kenya	3	45	0.278	0.318	0.852	0.257
Tanzania	1	15	0.241	0.261	0.909	0.22
Nigeria	2	30	0.18	0.245	0.769	0.204
Niger	1	15	0.209	0.217	0.962	0.188
Togo	1	15	0.138	0.200	0.726	0.163
Mauritania	1	15	0.169	0.174	0.966	0.149

According to Table 7, there was considerable heterogeneity in the operational efficiency of Islamic banks in SSA across countries, reflecting the varying levels of institutional maturity, market structure, and regulatory capacity. VRS efficiency scores adjusted for bias diverge between jurisdictions that highlight the uneven uptake of asset quality stress by banks. Islamic banks, particularly those in small or single-bank markets, were somewhat more efficient. Côte d'Ivoire (0.562) and Burkina Faso (0.556) had the highest bias-corrected efficiency scores respectively, followed by Seychelles (0.430), and finally Mali (0.386). The implications of these results suggest that simpler market structures and reduced complexity of governance may blunt operational effects of non-performing financing (Mateev et al., 2021; Velliscig et al., 2023). However larger, or more complex systems were less efficient.

A dominant sample (19 banks) and Sudan had an average efficiency of 0.336 despite being relatively scale efficient (0.768), suggesting that the inefficiency was mainly operational as opposed to scale-based. The same was true in Kenya (0.257) as well as Nigeria (0.204), where dual banking systems and competitive pressures seem to exacerbate operational impacts of asset quality deterioration. Middle-of-the-road countries like South Africa (0.301), Senegal (0.308), or Mauritius (0.300), demonstrated relatively robust legal systems but also low Islamic financial market depth. Lowest efficiency scores were noted in Tanzania (0.220), Niger (0.188), Togo (0.163), and Mauritania (0.149).

The high scale efficiency at the high level in certain of these jurisdictions does not necessarily lead to high operational efficiency and demonstrates limitations due to weak recovery mechanisms and deficiencies in Islamic financial infrastructure as a financial management. This evidence suggests that structural and institutional constraints are important mediating factors between NPF and stress (Afkar, 2024; Azizah, 2023). Weak legal enforcement, absence of Sharīʿah-compliant liquidity products and fragmented supervision in regions contribute to a greater erosion of operational efficiency, suggesting the need to have context-specific early-warning systems instead of a uniform threshold for supervision of Islamic banking across SSA countries.

Discussion

Relationship to Research Objectives and Hypotheses

This study aimed to investigate the extent to which asset quality (as measured by non-performing financing) acts as an early-warning indicator of operational stress for Islamic banks in SSA. These empirical results are a direct response to this aim as they show that declines in operational efficiency are systematically preceded by increases in non-performing financing. This finding is consistent with the study's key idea that deterioration in the quality of assets is transmitted internally through the operational structures of Islamic banks, rather than manifesting immediately as solvency or liquidity distress. The findings confirm the significance of asset quality as a forward-looking supervisory signal in Sharīʿah-compliant banking systems by establishing a temporal relationship between NPF and efficiency erosion.

Interpretation of Findings and Stress Transmission Mechanism

The institutional and contractual characteristics of Islamic banking can clarify the observed relationship. Compared to traditional debt-based banking, impaired Sharīʿah-compliant financing requires higher levels of monitoring, reformulation of contracts, and enhanced Sharīʿah governance oversight, which ultimately increases operating costs in the long term. These built-up burdens decelerate operational performance even in the absence of immediate balance-sheet deterioration. The continued erosion in efficiency also shows that asset quality shocks in Islamic banks are not readily assimilated in the context of fragile recovery mechanisms and immature Islamic financial infrastructure. From this point of view an increasingly low efficiency is symptomatic of internal stress transmission, not a lack of managerial performance.

Comparison with Previous Studies

These results are largely consistent with previous research documenting the relevance of asset quality to bank performance and stability, and in addition, they build on the literature by reframing NPF as a leading rather than contemporaneous indicator of stress. Most existing Islamic banking literature adopts NPF to be a control in the perspective of profitability or efficiency regressions; however, our study illustrates that its implications change dynamically and systematically over time. The findings support studies by focusing on more mature Islamic banking markets and importantly, the results bring a perspective to structural constraints in such contexts as SSA as these are more complex and institutional constraints contribute to the impact of asset impairments upon bank performance. In this vein, the results are at variance with studies that report quick adaptation and/or resilience in Islamic banks operating under stronger legal and market conditions.

Broader Implications and Future Research

In a wider arena, the findings accentuate the requirement for Islamic banking supervisors to consider more than traditional early warnings focusing only on capital and liquidity. To facilitate quick identification of emerging vulnerabilities for Sharīʿah-compliant banking systems, integrated efficiency-based diagnostics linked to asset quality could be employed. The results also imply that doctrinal compliance with Islamic principles does not automatically ensure operational resilience in the absence of supportive institutional frameworks. Future research could develop this early-warning paradigm through supplementing it with liquidity stress measures, Sharīʿah governance measures, or comparative analyses across regions to examine differences in the spread of asset-quality-induced stress in mature and emerging Islamic banking systems.

CONCLUSION

The study aimed to find out if asset quality, represented by non-performing financing, acts as an early-warning signal of operational stress in Islamic banks, operating in SSA. The results reveal that declines in asset quality come before losses in operational efficiency and show that stress due to credit is transmitted in-house through Islamic banking operational structures, as opposed to appearing immediately in conventional solvency or liquidity indicators. Thus, the paper directly answers its main objective by using NPF as a forward-looking supervisory signal in Sharīʿah-compliant banking systems. In addition to establishing empirical associations, this study advances Islamic banking literature by redefining operational efficiency as a diagnosis of internal stress and not as a measure of managerial performance. The findings indicate that compliance with Sharīʿah guidelines alone is not sufficient to guarantee resilience against adverse asset quality declines, especially in institutionally constrained settings. Chronic loss of efficiency is indicative of the accumulated burden of monitoring, restructuring, and Sharīʿah governance costs associated with impaired Islamic financing contracts. This finding adds to previous research on stability and efficiency by explaining the role that asset quality management plays in carrying out ethical and economic goals of Islamic banking. This research also allows multiple potential avenues for future efforts. First, additional research could add liquidity stress indicators or Sharīʿah governance measures to a general early-warning framework for capturing other stress transmission channels. Second, it would be interesting to compare studies in different regions to see if the asset quality–efficiency relationship varies between mature and emerging Islamic banking systems. Finally, a future study could investigate the extent to which the presence of developed Islamic capital and liquidity markets alleviates the persistence of operational stress despite asset quality deterioration.

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