

ESG activities and bank risk-taking: The mediating role of liquidity creation and the moderating role of bank funding structure in ASEAN-5

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Abstract

This paper investigates how ESG activities shape bank risk-taking in ASEAN-5, focusing on liquidity creation (LC) as a transmission channel and bank funding structure (BFS) as a conditioning environment. Using an unbalanced panel of 62 banks over 2015–2024, the study measures ESG activities with Refinitiv ESG scores, bank risk-taking (BRT) with non-performing loans, and LC with the loan-to-deposit ratio. The empirical strategy combines static estimators (pooled OLS, fixed and random effects) with dynamic System GMM and LSDVC estimators to address persistence, endogeneity and unobserved heterogeneity. Mediation is assessed through a Baron and Kenny procedure in the dynamic setting, while moderation is examined via the $ESG \times BFS$ interaction term. ESG engagement significantly reduces BRT, confirming a risk-disciplining role. ESG also increases LC, and higher LC is associated with lower BRT, supporting partial mediation of the ESG-risk link through LC. The $ESG \times BFS$ interaction is negative and statistically significant, indicating that stable, deposit-based funding strengthens the risk-reducing impact of ESG. Results are robust across static, System GMM and LSDVC estimators. This study advances ASEAN-5 banking research by examining the intermediation channel through which ESG activities affect BRT, specifically LC mediation and BFS moderation, within a unified dynamic framework. By doing so, it complements prior ASEAN-5 evidence on the ESG-AI digital-capability channel and links sustainability policies, intermediation behaviour, and liability structure in emerging ASEAN economies.

Keywords Environmental, social, and governance (ESG), Bank risk-taking, Liquidity creation, Bank funding structure, ASEAN banking, Dynamic panel estimation

Paper type Research article

1. Introduction

Across the ASEAN-5 banking systems, environmental, social, and governance (ESG) considerations are increasingly being incorporated into risk management, governance, and capital allocation frameworks. This shift reflects the bank-dominated structure of these economies, where credit intermediation remains the principal channel through which firms and households access finance. In response, regional regulators have moved to embed sustainability expectations into supervisory practice through environmental risk guidance, taxonomy-based classification systems, sustainable finance frameworks, and enhanced disclosure requirements. Although the specific instruments differ across jurisdictions, the overall regulatory direction is

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clear: ESG considerations are no longer peripheral disclosures, but are increasingly linked to prudential oversight, portfolio steering, and market discipline within ASEAN banking ([Monetary Authority of Singapore \(MAS\), 2020, 2022](#); [Bank Negara Malaysia \(BNM\), 2021](#); [Bangko Sentral ng Pilipinas \(BSP\), 2020, 2024](#); [Otoritas Jasa Keuangan \(OJK\), 2017](#); [Securities and Exchange Commission Thailand \(SEC Thailand\), 2021](#)).

This policy shift has occurred alongside uneven market development. ASEAN thematic bond issuance fell by about 32% in 2022, even though issuance remained substantially above 2020 levels, while credit-risk conditions also continued to vary across banking systems, underscoring the region's heterogeneous sustainability and risk environment ([Climate Bonds Initiative, 2023](#); [OJK, 2021](#); [Reuters, 2024](#)).

The research problem emerges from the fact that bank risk-taking remains a central determinant of financial stability and the cost of capital in ASEAN's predominantly bank-based financial systems, yet the channels through which ESG activities shape daily intermediation decisions remain insufficiently specified and empirically tested. Existing evidence generally suggests that stronger ESG performance is associated with lower bank risk, including lower non-performing loan (NPL) ratios and stronger stability indicators, whereas ESG controversies tend to increase risk exposure. However, these relationships vary across ESG pillars, disclosure quality, and institutional environments, leaving the causal process contested rather than settled ([Liu *et al.*, 2023](#); [Galletta *et al.*, 2023](#)). Recent ASEAN evidence further suggests that ESG intensity is associated with stronger risk discipline and improved financial performance, implying that ESG effects may operate through internal banking processes rather than through reputational signalling alone ([Salem *et al.*, 2024](#)).

Two unresolved issues are particularly important in the ASEAN context. First, prior work rarely specifies how ESG programmes reshape the intermediation process through which banks generate risk, especially through changes in asset composition, contingent commitments, and portfolio monitoring. Second, limited attention has been given to the possibility that the effect of ESG on risk depends on the bank's funding profile, despite the fact that liability structure materially affects lending behaviour, liquidity management, and vulnerability under stress ([Salem *et al.*, 2025](#)). These omissions matter in ASEAN because banks remain the dominant allocators of capital, ESG data infrastructures are still maturing, and supervisory expectations increasingly emphasise scenario analysis, governance alignment, and risk-sensitive portfolio adjustment ([MAS, 2022](#); [BNM, 2021](#); [BSP, 2020](#)).

To address the first gap, this study adopts a liquidity-creation perspective. Liquidity creation provides an operational lens for understanding how ESG activity may alter credit origination, covenant design, monitoring intensity, and, ultimately, bank risk-taking; the full theoretical and empirical basis for this channel is developed in [Section 2](#) ([Salem *et al.*, 2024](#); [Shahimi *et al.*, 2024](#)). To address the second gap, the study incorporates funding structure as a moderating condition. Differences between stable deposit-based funding and more volatile market-based liabilities may change how ESG-induced intermediation adjustments translate into risk outcomes, a logic that is elaborated in the literature review and later tested empirically ([Dagher and Kazimov, 2015](#); [Craig and Dinger, 2013](#)).

Prior literature relevant to this study converges around three themes. First, sustainability-oriented banking regulation is expanding across ASEAN, with growing emphasis on board oversight, environmental and social risk integration, scenario analysis, and more structured disclosure practice ([MAS, 2020, 2022](#); [BNM, 2021](#); [BSP, 2020](#); [Salem and Shahimi, 2025](#)). Second, cross-market empirical evidence generally links stronger bank-level ESG performance with lower insolvency, leverage, liquidity, and credit risk, although these effects weaken under low disclosure quality, controversy exposure, and measurement inconsistency, all of which remain salient in emerging ASEAN settings ([Liu *et al.*, 2023](#); [Galletta *et al.*, 2023](#)). Third, the banking literature shows that liquidity creation is sensitive to shocks, capital buffers, and liability composition, making it a plausible mechanism through which ESG choices may influence risk discipline and portfolio outcomes ([Dagher and Kazimov, 2015](#)).

The theoretical foundation of the study integrates stakeholder theory, the resource-based view (RBV), and the banking intermediation perspective. Stakeholder theory suggests that banks respond to the claims of regulators, depositors, borrowers, investors, and other salient actors by strengthening transparency, accountability, and risk control. RBV complements this by treating ESG-related data, routines, and analytical capabilities as strategic resources that can improve discipline in screening, pricing, and monitoring when embedded in credit processes (Freeman, 1984; Barney, 1991). The intermediation perspective then identifies the operational arena in which those capabilities become consequential, namely the transformation of bank balance-sheet and off-balance-sheet activities into liquidity for the real economy. Funding structure serves as an important boundary condition because it shapes the bank's capacity to absorb risk and sustain lending behaviour under different liability configurations.

This study makes three contributions. First, it examines the intermediation channel through which ESG activities influence bank risk-taking in ASEAN-5 by modelling liquidity creation as a mediating mechanism and bank funding structure as a moderating condition. This framing complements prior ASEAN-5 evidence on the ESG-AI digital-capability channel by shifting the mechanism from information-processing capability to balance-sheet intermediation and liability stability (Salem *et al.*, 2026). Second, it explains why similar ESG profiles may generate different risk outcomes across banks with different funding structures. Third, it situates the analysis within ASEAN-5, where supervisory reforms, evolving taxonomies, and uneven market development create a policy-relevant setting for testing how ESG practices affect bank risk in transitional financial systems.

2. Literature reviews

2.1 ESG activities, bank risk-taking, and liquidity creation: a review of the literature

The literature on ESG activities, bank risk-taking, and intermediation has expanded quickly, but the evidence remains dispersed across regions and empirical designs. Overall, the dominant pattern suggests that stronger bank-level ESG performance is associated with lower risk exposure and stronger financial outcomes, whereas ESG controversies or weak disclosure environments tend to intensify risk-taking and weaken the consistency of these effects (Liu *et al.*, 2023; Galletta and Mazzù, 2023; Gangwani *et al.*, 2024). In ASEAN, the evidence points in the same general direction but is more uneven. Existing studies indicate that ESG engagement can support profitability and stability, yet differences in disclosure quality, measurement practices, and institutional maturity across countries make causal interpretation less straightforward and reinforce the need for mechanism-based inquiry beyond aggregate ESG scores (Nguyen, 2024; Do *et al.*, 2024a, b; WWF, 2019; Maybank IBG, 2022).

A particularly relevant mechanism is bank liquidity creation. Berger and Bouwman (2009, 2014, 2017) show that banks create liquidity by transforming illiquid assets and off-balance-sheet commitments into liquid claims, and that this process is highly sensitive to financial conditions. This makes liquidity creation a credible transmission channel through which ESG initiatives may affect risk-taking: ESG-driven shifts in lending composition, covenant design, sector exposure, and monitoring intensity can alter the structure of intermediation and, in turn, the bank's risk posture. Consistent with this logic, evidence from China shows that stronger ESG performance reduces bank liquidity risk, while ASEAN evidence suggests that ESG intensity is linked to stronger risk discipline and better performance (Liu *et al.*, 2023; Salem *et al.*, 2024).

The present article is positioned against prior ASEAN-5 evidence showing that artificial intelligence adoption acts as a digital-capability channel through which ESG activities are translated into lower bank risk-taking (Salem *et al.*, 2026). That evidence explains how ESG information becomes risk discipline through AI-enabled monitoring, credit-quality assessment, compliance automation, and data-driven governance. The present study tests a different mechanism by examining whether ESG affects bank risk-taking through the banking-intermediation channel of liquidity creation and whether this channel is conditioned by bank

funding structure. The two studies are therefore complementary: prior evidence explains a digital-capability pathway, whereas the present study explains an intermediation and liability-structure pathway within the same ASEAN-5 banking setting.

2.2 Research gap/novelty

Despite growing evidence that ESG activities are associated with bank stability and performance, two important gaps remain in the ASEAN context. First, most prior studies rely on static risk indicators and do not explain the operational channel through which ESG practices influence bank risk-taking, particularly through changes in lending structure, monitoring intensity, and liquidity creation. Second, existing research usually treats bank funding structure as a control variable rather than as a condition that may strengthen or weaken the risk implications of ESG-related intermediation choices, despite evidence that liability composition affects both the scale and fragility of bank liquidity creation (Craig and Dinger, 2013; Dagher and Kazimov, 2015).

This study makes three contributions. It identifies liquidity creation as the intermediation mechanism linking ESG activity to bank risk-taking, thereby making the specific channel explicit rather than presenting ESG as a reduced-form risk predictor. It further introduces bank funding structure as a moderating factor that conditions how ESG-related changes in intermediation translate into risk outcomes. Finally, it provides ASEAN-5 evidence that complements the ESG-AI digital-capability channel documented by Salem et al. (2026), while shifting the analytical focus to liquidity creation, deposit-based funding stability, and prudential intermediation.

2.3 Conceptual framework

Grounded in stakeholder theory and the resource-based view, the conceptual framework proposes that ESG activities function as capability bundles that reshape banks’ incentives, information systems, and control processes, thereby influencing risk-taking both directly and indirectly through liquidity creation. As shown in Figure 1, ESG is expected to reduce bank risk-taking directly by strengthening governance, board accountability, screening standards, and monitoring discipline (Freeman, 1984; Barney, 1991; MAS, 2020; BNM, 2021; BSP, 2020). ESG is also expected to alter liquidity creation by redirecting origination, covenant design, and early-warning systems toward borrowers and sectors with more resilient cash-flow profiles. In turn, changes in liquidity creation are expected to transmit ESG effects to

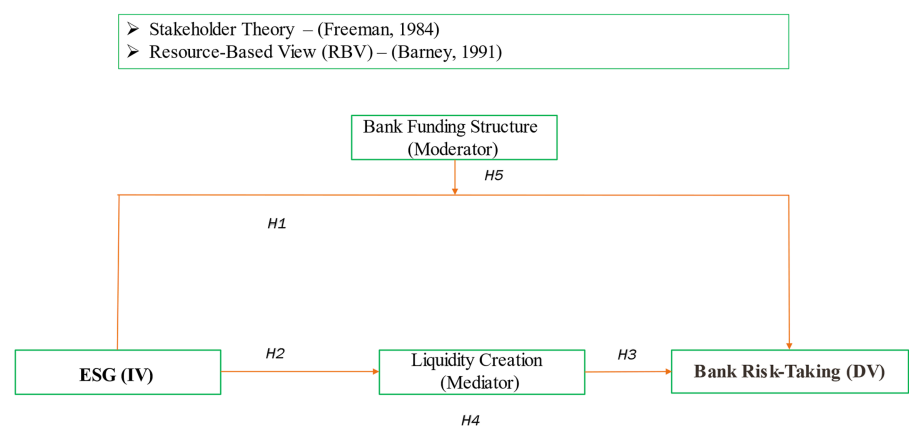


Figure 1. Conceptual framework

observable risk outcomes because the scale and composition of liquidity transformation shape exposure to default, rollover, and valuation risk. Finally, bank funding structure is treated as a boundary condition: stable deposit funding should reinforce the risk-reducing effect of ESG, whereas heavier reliance on wholesale funding may weaken it (Craig and Dinger, 2013; Dagher and Kazimov, 2015).

2.4 Hypothesis development

2.4.1 ESG activities and bank risk-taking. Stronger ESG activity is generally expected to discipline bank risk-taking by improving governance quality, strengthening screening and monitoring routines, and reducing exposure to environmental, social, and conduct-related vulnerabilities. Recent international banking evidence broadly supports this expectation. Higher ESG performance has been associated with lower non-performing loans and stronger stability indicators, while ESG controversies and weak sustainability conduct have been linked to greater risk-taking and weaker risk outcomes (Liu, 2023; Galletta and Mazzù, 2023). Evidence from emerging and ASEAN-related settings points in the same direction, showing that institutionalised ESG practices can support stability and performance, although the magnitude of the association varies across jurisdictions and depends on disclosure quality, measurement choices, and the maturity of sustainability governance arrangements (Do et al., 2024a, b; Nguyen, 2024; Salem et al., 2026).

This relationship, however, is unlikely to be automatic in all banking environments. In capacity-constrained settings, ESG-related investments, reporting demands, and compliance requirements may increase operating costs and compress short-run efficiency, thereby weakening some immediate intermediation gains (Do et al., 2024a, b; Verma and Kashiramka, 2025). Where monitoring and verification are weak, ESG signalling may also become symbolic, creating greenwashing, reputational risk, and conduct risk that dilute the intended stabilising effect (Galletta et al., 2024). At the pillar level, recent banking evidence further indicates that governance often exerts the strongest disciplinary influence because it directly shapes board oversight, internal controls, and risk appetite, whereas environmental and social effects are more context-dependent (Biswas et al., 2025; Lee et al., 2024; Safiullah et al., 2022). For ASEAN-5 banks, where disclosure regimes and taxonomy structures remain uneven, a direct empirical test of the aggregate ESG-risk relationship remains a necessary starting point.

H1. ESG activities are associated with bank risk-taking in ASEAN-5.

2.4.2 ESG activities and liquidity creation (LC). In bank-based financial systems, ESG activities may also affect the bank's core intermediation function by shaping liquidity creation. Credible sustainability programmes can strengthen depositor confidence, improve reputational standing, and support more stable funding conditions, while ESG-informed lending may expand credit in ways that are accompanied by stronger borrower screening and monitoring. Recent Asian evidence is consistent with this logic, reporting a positive association between ESG performance and liquidity creation, with stronger effects in riskier institutional settings where governance and confidence channels are especially valuable (Lee et al., 2024). Related evidence also shows that stronger ESG performance is associated with lower liquidity risk, suggesting that sustainability practices may enhance balance-sheet resilience as well as the capacity to transform liabilities into credit provision (Liu et al., 2024).

At the same time, the ESG-LC relationship is not necessarily uniform across conditions. Some evidence indicates that during periods of financial stress, banks with stronger CSR or ESG commitments may behave more conservatively and temporarily restrain liquidity creation, implying that ESG can reinforce prudence rather than mechanically increase intermediation in every period. This does not overturn the broader expectation of a positive linkage under normal operating conditions, but it does indicate that the relationship is context-sensitive. As noted in Section 1, ASEAN regulators have increasingly integrated environmental and social considerations into governance, product design, pricing, and

disclosure frameworks; however, direct bank-level evidence on the ESG-liquidity creation nexus in ASEAN-5 remains limited. Accordingly, this study tests whether ESG activities are associated with liquidity creation in the region's bank-dominated systems.

H2. ESG activities are associated with liquidity creation (LC) in ASEAN-5.

2.4.3 Liquidity creation (LC) and bank risk-taking (BRT). Liquidity creation is a defining banking function, yet its implications for risk-taking depend on the quality of balance-sheet transformation. When liquidity creation is supported by stable funding, sound screening, and disciplined portfolio management, it can reflect effective intermediation rather than excessive risk accumulation. Recent empirical evidence supports this stabilising interpretation, showing that higher liquidity creation can be associated with lower bank-level and systemic risk, particularly where banks maintain stronger internal discipline and portfolio diversification (Davydov *et al.*, 2021). Nevertheless, the relationship remains conditional rather than mechanical. Competitive pressures, supervisory intensity, and liability fragility may turn aggressive liquidity creation into a risk-enhancing process, especially when credit expansion is funded by unstable sources or accompanied by weaker screening (Tran and Nguyen, 2024; Thakor, 2024).

Regionally relevant evidence broadly supports the view that liquidity creation can be stabilising under normal conditions. Asia-Pacific findings suggest that liquidity creation improves bank stability and that the relationship becomes more pronounced in settings characterised by stronger ESG or disclosure discipline (Gupta and Kashiramka, 2024). Evidence from Vietnam, a transition economy with institutional features relevant to ASEAN banking, likewise indicates that higher liquidity creation is associated with lower risk-taking (Vuong *et al.*, 2023). Even so, ASEAN-specific bank-level evidence remains limited, and existing work rarely evaluates this relationship within a unified dynamic framework that simultaneously accounts for funding composition and macro-financial controls. This justifies a direct empirical test of whether liquidity creation is associated with bank risk-taking in ASEAN-5.

H3. Liquidity creation is associated with bank risk-taking in ASEAN-5.

2.4.4 ESG activities and bank risk-taking: mediating role of liquidity creation (LC). Beyond their direct association, ESG activities may influence bank risk-taking indirectly through liquidity creation. If stronger ESG engagement improves the quality of screening, monitoring, covenant design, and portfolio discipline, it should also enhance the intermediation process through which banks create liquidity. Existing evidence provides initial support for each segment of this pathway. On one hand, stronger ESG performance has been linked to higher liquidity creation and lower liquidity risk in Asian banking samples (Lee *et al.*, 2024; Liu *et al.*, 2024). On the other hand, stronger liquidity creation has been associated with lower risk-taking and greater stability in Asia-Pacific and ASEAN-relevant contexts (Gupta and Kashiramka, 2024; Vuong *et al.*, 2023). Taken together, these results suggest that liquidity creation may serve as a meaningful transmission channel through which ESG activity affects bank risk outcomes (Salem *et al.*, 2026).

The mediation proposition is particularly relevant for ASEAN-5 because existing regional evidence largely documents reduced-form associations, while bank-level tests of the full ESG → LC → BRT sequence remain scarce. This gap is important because the banking systems of the region remain heavily reliant on intermediation, and sustainability-related reforms are increasingly expected to alter product design, governance routines, and portfolio steering in operational rather than purely symbolic ways (Salem *et al.*, 2026). If liquidity creation does function as a channel, the direct ESG-risk association should weaken once LC is introduced into the empirical specification. This study therefore tests whether liquidity creation carries part of the effect of ESG activities on bank risk-taking within a dynamic panel framework tailored to ASEAN-5 banks.

- H4. Liquidity creation mediates the relationship between ESG activities and bank risk-taking, such that ESG increases LC, and higher LC is associated with lower BRT, yielding a negative indirect effect in ASEAN-5.

2.4.5 ESG activities and bank risk-taking: moderating role of bank funding structure (BFS).

The risk implications of ESG activities are also unlikely to be uniform across banks because they depend partly on the structure and stability of funding. Where banks rely more heavily on stable retail and transactional deposits, ESG-related improvements in screening, pricing, and monitoring are more likely to translate into lower risk-taking because those banks face less funding fragility and can sustain intermediation adjustments more effectively (Salem, 2026a). By contrast, banks that depend more on wholesale or market-based liabilities may face tighter liquidity pressures under stress, making the disciplinary effect of ESG weaker or less durable (Salem, 2026b). This expectation is consistent with evidence showing that stronger ESG performance is associated with lower funding costs and cheaper deposit acquisition, implying stronger depositor confidence and more favourable liability conditions (Andrieş *et al.*, 2023). It is also consistent with evidence on wholesale funding fragility, which shows that run-like shocks in instruments such as certificates of deposit can transmit liquidity stress across banks and undermine stability (BIS Working Paper No. 1263, 2025).

This moderating perspective is especially relevant in ASEAN-5, where traditional deposit-based banking remains dominant but coexists with meaningful variation in liability composition across institutions and countries. In such settings, similar ESG profiles may produce different risk outcomes because banks do not operate under identical funding constraints. Rather than treating liability structure as a background control, this study treats it as a conditioning factor that may amplify or weaken the effect of ESG on risk-taking. This approach responds directly to the limited regional evidence on how sustainability-related intermediation changes interact with funding stability in bank-dominated systems. It therefore allows the ESG-risk relationship to be evaluated under a more realistic institutional lens.

- H5. Bank funding structure moderates the ESG-bank risk-taking relationship such that the negative association between ESG activities and bank risk-taking is stronger for banks with more stable, deposit-based funding and weaker for banks more reliant on wholesale funding.

3. Methodology

3.1 Sampling

This study investigates how ESG activities affect bank risk-taking in ASEAN-5 banks, with liquidity creation as a mediator and bank funding structure as a moderator. Using purposive sampling, the analysis covers 62 listed banks from 2015 to 2024, selected for consistent ESG disclosure, Refinitiv/LSEG coverage, and financial transparency. Indonesia contributes 23 banks, followed by Thailand (15), Malaysia (11), the Philippines (10), and Singapore (3). The period captures accelerated ESG integration after the 2015 SDGs, the COVID-19 shock, and the rise of sustainable finance in ASEAN, allowing assessment of structural and crisis-related shifts in bank risk dynamics [1]. The country distribution of the sampled banks is presented in Table 1.

The data-cleaning procedure was designed specifically for the present LC mediation and BFS moderation model. First, bank-year observations were extracted from Refinitiv/LSEG Eikon and cross-checked against banks' annual reports, sustainability reports, and regulatory disclosures where necessary. Second, duplicate observations and banks lacking the core ESG, BRT, LC, BFS, and control-variable information required for the dynamic specifications were removed. Third, ESG, risk-taking, liquidity creation, funding-structure, and bank-specific financial variables were matched at the bank-year level using consistent bank identifiers and country-year classifications. Fourth, observations with missing values in the focal variables

Table 1. Sample banks

ASEAN-5 country	Number of listed banks
Indonesia	23
Malaysia	11
Philippines	10
Singapore	3
Thailand	15
<i>Total Banks</i>	62

were excluded on a model-specific basis before lag construction, System GMM estimation, and LSDVC robustness checks. This produces an independent unbalanced panel tailored to the intermediation-channel design of this article.

3.2 Variables definition and measurement

3.2.1 *Dependent variable.* The dependent variable is bank risk-taking (BRT), measured using two complementary indicators: the non-performing loans (NPL) ratio and the z-score. The NPL ratio, defined as non-performing loans divided by total gross loans, captures realised credit-risk exposure and remains one of the most widely used supervisory indicators of asset-quality deterioration in banking research (Louzis *et al.*, 2012). Although NPLs should be interpreted as an ex post outcome rather than a pure behavioural choice, because they also reflect borrower conditions and macroeconomic shocks, they remain the most direct and policy-relevant proxy for realised credit risk in bank-based systems, particularly in emerging markets where loan portfolios are the dominant transmission channel of financial vulnerability (Laeven and Valencia, 2018; Demirgüç-Kunt *et al.*, 2020). Higher NPL ratios therefore indicate greater credit-risk materialisation and a weaker risk posture.

To complement this credit-risk measure, the study also employs the z-score, calculated as the sum of return on assets (ROA) and the capital-to-assets ratio divided by the standard deviation of ROA. The z-score captures distance to default and thus provides a broader solvency-based perspective on bank fragility (Laeven and Levine, 2009; Čihák and Hesse, 2010). Together, NPL and z-score offer a more robust assessment of BRT by combining realised credit deterioration with overall insolvency risk. Both measures are sourced from Refinitiv Eikon and enter the dynamic specification in lagged form to capture persistence in risk behaviour and reduce simultaneity with the explanatory variables (Arellano and Bond, 1991; Wintoki *et al.*, 2012).

3.2.2 *Independent variable.* The principal independent variable is the Environmental, Social, and Governance (ESG) score obtained from Refinitiv (LSEG), measured on a 0–100 scale, where higher values indicate stronger disclosure-based ESG performance. This measure is widely used in banking and finance research because it offers standardised and cross-country comparable coverage for listed firms. According to LSEG’s methodology, the score is derived from publicly available and auditable disclosures selected from a broader database of more than 800 ESG data points and aggregated into ten categories covering the Environmental, Social, and Governance pillars. Environmental and Social indicators are benchmarked against industry peers using the TRBC classification, whereas Governance indicators are benchmarked at the country level to account for institutional differences across jurisdictions (LSEG, 2024). Because the score reflects disclosure intensity rather than absolute sustainability outcomes, cross-country interpretation may still be affected by differences in reporting mandates and enforcement. To limit this concern, the empirical models control for country-level heterogeneity. ESG is also introduced in lagged form to reflect annual disclosure

cycles, mitigate simultaneity, and strengthen temporal ordering between ESG activity and bank risk-taking (Ehlers *et al.*, 2022, 2023; Arellano and Bond, 1991).

3.2.3 Mediating variable. The mediating variable is liquidity creation (LC), which captures the bank's intermediation capacity and liquidity position. LC is proxied by two complementary indicators from Refinitiv Eikon. The first is the loan-to-deposit ratio (LDR), defined as total loans divided by total deposits, which reflects the extent to which banks transform deposit funding into credit. Higher LDR values indicate more intensive intermediation and potentially greater liquidity pressure. The second is the liquidity coverage ratio (LCR), which measures the stock of high-quality liquid assets relative to expected short-term net cash outflows in line with Basel III standards (BCBS, 2013a, b). Higher LCR values indicate stronger short-run liquidity resilience. Together, LDR and LCR capture both intermediation intensity and liquidity-buffer strength. LC enters the model in lagged form to reflect the dynamic nature of balance-sheet adjustment and to reduce simultaneity between liquidity conditions and current risk outcomes (Arellano and Bond, 1991).

3.2.4 Moderating variable. The moderating variable is bank funding structure (BFS), which captures the composition and stability of bank liabilities. BFS is measured as the ratio of customer deposits to total funding liabilities using Refinitiv Eikon data. A higher ratio indicates a more stable, deposit-based funding structure and lower refinancing risk, whereas a lower ratio implies greater dependence on wholesale or market-based funding and greater exposure to liquidity shocks and rollover pressure (Demirgüç-Kunt and Huizinga, 2010). BFS enters the model both as an independent covariate and as an interaction term with ESG. This allows the analysis to test whether the disciplinary effect of ESG on bank risk-taking is stronger when banks rely on stable deposit funding and weaker when liability structures are more fragile.

3.2.5 Control variables. The study includes a set of bank-specific and macroeconomic controls to account for heterogeneity across institutions and national environments. At the bank level, size (SIZE), measured as the natural logarithm of total assets from Refinitiv Eikon, controls for scale, diversification capacity, and possible too-big-to-fail effects (Nizam *et al.*, 2019; Velte, 2017). Capital adequacy (CAP), measured as total capital divided by total assets, captures solvency buffers and shock-absorption capacity (Platonova *et al.*, 2018; Sinueia *et al.*, 2019). At the macroeconomic level, GDP growth (GDP), measured as annual real GDP per capita growth, captures cyclical conditions affecting borrower repayment capacity, while inflation (INF), proxied by the annual change in the GDP deflator, captures monetary conditions that may influence credit quality (Demirgüç-Kunt and Huizinga, 1999; Bikker and Hu, 2002; Athanasoglou *et al.*, 2008). A COVID-19 dummy (DCOVID) is included to capture the systemic disruption associated with the pandemic (OECD, 2021; Duan *et al.*, 2021). Finally, private credit by deposit banks to GDP (BC) controls for the scale of bank intermediation, while a bank-based financial system indicator (BNK), coded as 1 when private credit to GDP exceeds stock market capitalisation to GDP and 0 otherwise, captures the extent to which national financial systems remain bank-dominated, which is particularly relevant in ASEAN. As a sensitivity check, the analysis may be replicated using the LSEG ESG Combined Score (ESGC), which adjusts the baseline ESG Score for material controversy events. Because controversy measures may be more mechanically related to adverse bank outcomes, the baseline specification relies on the ESG Score to isolate disclosure-based ESG assessment. ESGC equals ESG when no controversies are recorded (LSEG, 2024).

3.3 Empirical model

3.3.1 Mediation model. For mediation analysis, this study adopts the Baron and Kenny (1986) mediation model, which is a widely used approach for examining the indirect effect of an independent variable (IV) on a dependent variable (DV) through a mediator. It involves a sequence of regression equations designed to assess whether the relationship between the IV and the DV is explained, at least partially, by the mediator. In the context of this study, ESG activities (IV) may influence bank BRT (DV) through their effect on LC (the mediator). The mediation process is tested by first confirming that the IV affects the DV, then demonstrating

that the IV influences the mediator, and finally verifying that the mediator affects the DV. If the direct effect of the IV on the DV diminishes or becomes insignificant when the mediator is included, full mediation is supported, whereas a partial reduction indicates partial mediation (Baron and Kenny, 1986). This approach has been widely applied in various fields, including economics and finance, to examine complex relationships.

3.3.2 Mediation estimation procedures.

Step 1: A statistically significant relationship must exist between the independent variable (ESG) and the dependent variable (BRT). This step determines whether ESG significantly influences BRT ($ESG \rightarrow BRT$) before the inclusion of the mediator.

$$\begin{aligned} BRT_{it} = & \alpha_0 + \alpha_1 BRT_{it-1} + \alpha_2 ESG_{it-1} + \alpha_{3-4} \sum Bank\ Specific\ Factors_{it} \\ & + \alpha_{5-6} \sum Macroeconomic\ Factors_{it} + \alpha_{7-8} \sum Financial\ Development\ Factors_{it} \\ & + \alpha_9 DCOVID + \eta_i + \varepsilon_{it} \end{aligned} \quad (Eq. 1)$$

Step 2: The independent variable (ESG) has an impact on the mediator (LC), i.e. ESG influences LC ($ESG \rightarrow LC$). At this point, the mediator is regarded as an outcome variable.

$$\begin{aligned} LC_{it} = & \alpha_0 + \alpha_1 LC_{it-1} + \alpha_2 ESG_{it-1} + \alpha_{3-4} \sum Bank\ Specific\ Factors_{it} \\ & + \alpha_{5-6} \sum Macroeconomic\ Factors_{it} + \alpha_{7-8} \sum Financial\ Development\ Factors_{it} \\ & + \alpha_9 DCOVID + \eta_i + \varepsilon_{it} \end{aligned} \quad (Eq. 2)$$

Step 3: The mediator (LC) has an influence on the dependent variable (BRT), i.e. LC influences BRT ($LC \rightarrow BRT$).

$$\begin{aligned} BRT_{it} = & \alpha_0 + \alpha_1 BRT_{it-1} + \alpha_2 LC_{it-1} + \alpha_{3-4} \sum Bank\ Specific\ Factors_{it} \\ & + \alpha_{5-6} \sum Macroeconomic\ Factors_{it} + \alpha_{7-8} \sum Financial\ Development\ Factors_{it} \\ & + \alpha_9 DCOVID + \eta_i + \varepsilon_{it} \end{aligned} \quad (Eq. 3)$$

Step 4: The impact of the independent variable (ESG) on the dependent variable (BRT) diminishes or change in the presence of the mediator (LC) (Eq. 3).

$$\begin{aligned} BRT_{it} = & \alpha_0 + \alpha_1 BRT_{it-1} + \alpha_2 ESG_{it-1} + \alpha_3 LC_{it-1} + \alpha_{4-5} \sum Bank\ Specific\ Factors_{it} \\ & + \alpha_{6-7} \sum Macroeconomic\ Factors_{it} + \alpha_{8-9} \sum Financial\ Development\ Factors_{it} \\ & + \alpha_{10} DCOVID + \eta_i + \varepsilon_{it} \end{aligned} \quad (Eq. 4)$$

- (1) If all conditions in Steps 1–3 are fulfilled and the effect of the independent variable (ESG) on the dependent variable (BRT) becomes negligible in the presence of the mediator (LC), the mediator fully mediates the effect of the independent variable. ·

- (2) Nevertheless, if the effect of the independent variable remains substantial in the presence of the mediator (LC), the mediator partially mediates the effect of the independent variable.

3.3.3 Moderation model. The specification in Equation (5) incorporates bank funding structure (BFS) as a moderating variable to capture how liability composition conditions the effect of ESG activities on bank risk-taking (BRT). The interaction term ($ESG \times BFS$) allows the model to test whether the risk implications of ESG engagement differ between banks that rely more heavily on stable retail deposits versus those more exposed to wholesale or market-based funding. This approach is consistent with prior evidence that funding stability shapes both the scale and risk of liquidity creation, thereby amplifying or dampening the impact of ESG-driven changes in origination and monitoring on portfolio risk (Arellano and Bond, 1991; Wintoki et al., 2012).

$$\begin{aligned} BRT_{it} = & \alpha_0 + \alpha_1 BRT_{it-1} + \alpha_2 ESG_{it-1} + \alpha_3 BFS_{it} + \alpha_4 (ESG_{it-1} \times BFS_{it}) \\ & + \alpha_{5-6} \Sigma Bank\ Specific\ Factors_{it} + \alpha_{7-8} \Sigma Macroeconomic\ Factors_{it} \\ & + \alpha_{9-10} \Sigma Financial\ Development\ Factors_{it} + \alpha_{11} DVOVID + n_i + \varepsilon_{it} \quad (Eq. 5) \end{aligned}$$

3.4 Estimation method

This study adopts a staged identification and robustness strategy rather than a comparison of competing estimators. Static panel models are first employed to establish the baseline sign and magnitude of the relationships among ESG activities, liquidity creation, funding structure, and bank risk-taking. Specifically, pooled ordinary least squares (OLS), fixed effects (FE), and random effects (RE) models are estimated with bank-specific and macroeconomic controls, while model selection is guided by the Breusch-Pagan Lagrange Multiplier test, the F -test for fixed effects, and the Hausman test (Breusch and Pagan, 1980; Hausman, 1978; Wooldridge, 2010). Diagnostic tests for multicollinearity, heteroskedasticity, serial correlation, and cross-sectional dependence are also applied.

The analysis then proceeds to a two-step System GMM framework to address persistence in bank risk-taking and potential endogeneity arising from the joint determination of ESG activities, liquidity creation, and funding structure over time (Arellano and Bond, 1991; Blundell and Bond, 1998). Within this dynamic setting, the Baron and Kenny (1986) mediation approach is used to test the mediating role of liquidity creation, while moderation is examined through the $ESG \times BFS$ interaction term. For robustness, the findings are cross-validated using the LSDVC estimator, which reduces finite-sample bias in dynamic fixed-effects panels (Kiviet, 1995; Bruno, 2005a, b), and by re-estimating the models excluding pandemic years.

4. Results and discussion

4.1 Descriptive statistics

Table 2 indicates substantial cross-sectional variation across the ASEAN-5 banking sample, supporting the suitability of the panel for empirical estimation. Bank risk-taking (BRT) records a mean of 3.48 (SD = 1.26), with values ranging from 0.90 to 7.20, suggesting marked heterogeneity in asset quality, credit exposure, and solvency conditions. ESG scores average 58.3 (SD = 12.4), spanning from 26 to 86, which reflects uneven degrees of sustainability integration across banks, from relatively limited adoption to more mature ESG implementation (Refinitiv, 2022a, b; Nizam et al., 2019). Liquidity creation averages 32.5 (SD = 6.8), while bank funding structure (BFS) averages 71.5 (SD = 9.5), indicating the continued predominance of deposit-based intermediation in the region (Craig and Dinger, 2013). The sample is composed primarily of large listed banks, with an average log of total

Table 2. Descriptive statistics of key variables

Variable	Mean	Std. Dev	Min	Max
BRT (NPL)	3.48	1.26	0.90	7.20
ESG	58.30	12.40	26.00	86.00
LC (LDR)	32.50	6.80	15.00	49.00
BFS	71.50	9.50	45.00	90.00
SIZE	16.72	1.06	14.05	19.70
CAP	11.35	2.76	5.60	18.40
GDP	4.05	2.30	−3.80	8.40
INF	2.60	1.65	0.10	6.60
BC	75.10	11.50	50.00	97.00

Note(s): Std. Dev. = standard deviation. Min/Max = sample bounds

assets of 16.72, while mean capital adequacy of 11.35% suggests generally sound solvency positions. Macroeconomic indicators also reflect a relatively stable environment, with average GDP growth of 4.05%, inflation of 2.6%, and private credit provision of 75.1% of GDP. Preliminary diagnostics showed that z-score and LCR series were less stable across the panel; accordingly, NPL and LDR were retained as the more consistent proxies for BRT and LC, respectively.

4.2 VIF test

The Variance Inflation Factor (VIF) diagnostics presented in [Table 3](#) confirm the absence of multicollinearity among the explanatory variables. All predictors exhibit VIF values well below the conservative threshold of 5, with the highest recorded for ESG (2.85) and a mean VIF of 2.05 across the model. Following the guidelines of [Hair et al. \(2010\)](#), VIF values between 1 and 3 indicate a low and acceptable level of collinearity, while values exceeding 10 are typically considered indicative of severe multicollinearity. Accordingly, the inclusion of bank-specific, macroeconomic, and ESG-related variables in the regression framework is methodologically sound, with minimal risk of variance inflation or distortion of standard errors due to linear dependence among regressors.

4.3 Pearson correlation matrix

[Table 4](#) shows that ESG performance is moderately and negatively associated with bank risk-taking ($r = -0.3152$), indicating that stronger sustainability engagement is linked to lower risk exposure. Liquidity creation also exhibits a negative correlation with risk ($r = -0.2880$),

Table 3. Variance inflation factor (VIF) diagnostics for model predictors

Variable	VIF
SIZE	2.45
CAP	1.82
GDP	1.65
INF	1.41
BC	2.10
ESG	2.85
LC	2.20
BFS	1.95
Mean VIF	2.05

Table 4. Pearson correlation matrix

Variable	BRT	ESG	LC	BFS	SIZE	CAP	GDP	INF	BC	BNK	DCOVID
BRT	1.0000										
ESG	-0.3152	1.0000									
LC	-0.2880	0.6125	1.0000								
BFS	-0.2651	0.5348	0.4289	1.0000							
SIZE	-0.2764	0.5582	0.4710	0.4467	1.0000						
CAP	-0.1842	0.2719	0.1986	0.2351	0.3227	1.0000					
GDP	-0.1423	0.2324	0.1860	0.1904	0.1642	0.1228	1.0000				
INF	0.1276	-0.2042	-0.1738	-0.1592	-0.1660	-0.1383	-0.5195	1.0000			
BC	-0.1629	0.3035	0.2678	0.2459	0.3392	0.2165	0.2311	-0.1815	1.0000		
BNK	-0.1092	0.1420	0.1184	0.1275	0.1762	0.0968	0.1520	-0.1064	0.3295	1.0000	
DCOVID	0.0956	-0.0521	-0.0415	-0.0724	-0.0758	-0.0289	-0.2638	0.3397	-0.1213	-0.0897	1.0000

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suggesting that more disciplined intermediation is associated with improved risk outcomes. Similarly, bank funding structure is inversely related to risk ($r = -0.2651$), implying that greater reliance on stable deposit funding supports lower risk-taking (Craig and Dinger, 2013; Dagher and Kazimov, 2015). Larger size, stronger capital adequacy, and higher GDP growth are likewise associated with lower risk, while inflation shows a small positive association.

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4.4 Static models

Table 5 shows that the focal variables perform consistently across all static specifications. ESG performance is negatively and significantly associated with bank risk-taking in pooled OLS, fixed effects, and random effects models, indicating that stronger sustainability engagement is linked to lower risk exposure and more disciplined risk governance (Cornett et al., 2016; Nizam et al., 2019). Liquidity creation also carries a negative and statistically significant coefficient, supporting the view that more disciplined intermediation is associated with lower bank risk. Likewise, bank funding structure is negatively associated with risk-taking, suggesting that greater reliance on stable deposit-based funding strengthens resilience relative to more fragile liability structures (Craig and Dinger, 2013; Dagher and Kazimov, 2015). Overall, the static results provide coherent initial evidence that ESG, liquidity creation, and funding stability operate as complementary channels of bank risk discipline in the ASEAN-5 banking context.

4.5 Mediation results of liquidity creation (LC)

In Table 6, the mediation analysis follows the Baron and Kenny (1986) framework within a dynamic two-step System GMM specification. In the first step, Environmental, Social, and Governance (ESG) engagement shows a negative and statistically significant association with bank risk-taking, confirming a meaningful total effect and establishing the basis for mediation. In the second step, ESG positively and significantly predicts Liquidity Creation (LC),

Table 5. Pooled OLS, fixed effects (FE), and random effects (RE) models

Variable/Item	Pooled OLS	Fixed effects (FE)	Random effects (RE)
Constant	0.694** (0.031)	1.183*** (0.006)	0.903** (0.013)
ESG	−0.006** (0.041)	−0.007** (0.024)	−0.007** (0.028)
LC	−0.005*** (0.008)	−0.004** (0.020)	−0.005** (0.016)
BFS	−0.003** (0.037)	−0.003* (0.089)	−0.003** (0.046)
SIZE	−0.775*** (0.000)	−0.693*** (0.004)	−0.742*** (0.001)
CAP	−0.028 (0.351)	−0.045* (0.076)	−0.049** (0.021)
GDP	0.019 (0.242)	−0.017 (0.328)	−0.018 (0.298)
INF	0.019 (0.493)	0.036*** (0.010)	0.038*** (0.007)
BC	0.001 (0.772)	−0.002 (0.715)	−0.001 (0.942)
BNK	−0.009 (0.528)	−0.013 (0.334)	−0.011 (0.421)
DCOVID	−0.795** (0.042)	−0.309* (0.087)	−0.326* (0.069)
F stats	18.12***	12.67***	14.01***
R-squared	0.6810	0.5347	0.5786
Banks (i)	62	62	62
Panel data model	Breusch-Pagan LM: Pooled vs. RE: $\chi^2(1) = 251.84***$	F-test: Pooled vs. FE: $F = 12.67***$	Hausman test: FE vs. RE: $\chi^2 = 1.215$
statistical tests			
Panel data model selection	Reject H_0 : Pooled OLS inappropriate (panel effects exist)	Reject H_0 : Pooled OLS inappropriate (unit effects exist)	Fail to reject H_0 : No significant difference between FE and RE; thus, Random Effects (RE) is appropriate

Note(s): *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Numbers in parentheses are *p*-values

Table 6. GMM estimation results for mediation steps for ESG, (LC), (BRT)

Mediation steps	Step 1 (ESG → BRT)	Step 2 (ESG → LC)	Step 3 (LC → BRT)	Step 4 (ESG → BRT, controlling for LC)
SPC	Eq. (1)	Eq. (2)	Eq. (3)	Eq. (4)
BRT _{it-1}	0.472* (0.091)	N/A	0.363* (0.052)	0.508*** (0.004)
ESG _{it-1}	−0.022** (0.032)	0.060*** (0.003)	N/A	−0.015* (0.082)
LC _{it-1}	N/A	0.422* (0.072)	−0.113** (0.039)	−0.136** (0.021)
SIZE	−0.482** (0.013)	0.538*** (0.005)	−0.323 (0.151)	−0.469* (0.060)
CAP	−0.100 (0.135)	0.139 (0.143)	0.150** (0.019)	−0.110** (0.025)
GDP	−0.025 (0.885)	0.088* (0.077)	0.028 (0.563)	−0.030 (0.385)
INF	0.016 (0.483)	0.055 (0.252)	0.039 (0.508)	0.010 (0.650)
BC	−0.018** (0.026)	0.032 (0.122)	−0.025 (0.218)	−0.005 (0.772)
BNK	1.274* (0.068)	2.813** (0.018)	0.802 (0.142)	0.597* (0.052)
DCOVID	0.105 (0.842)	0.470 (0.433)	−0.206 (0.403)	−0.473 (0.308)
AR(1) <i>p</i> -value	0.045	0.013	0.016	0.014
AR(2) <i>p</i> -value	0.602	0.271	0.537	0.511
Hansen Test (<i>p</i> -value)	0.294	0.809	0.694	0.608
Sargan Test (<i>p</i> -value)	0.248	0.720	0.618	0.459
Wald Test (<i>p</i> -value)	0.000	0.000	0.000	0.000
N	62	62	62	62

Note(s): Dependent variable varies by equation (BRT in Steps 1, 3, 4; LC in Step 2). Standard errors robust to heteroskedasticity. *, **, and *** denote significance at 10%, 5%, and 1% levels respectively

indicating that banks with stronger ESG engagement tend to exhibit more disciplined and resilient intermediation practices. This finding is consistent with the view that ESG-related improvements in screening, monitoring, and portfolio structuring enhance liquidity transformation capacity.

In the third step, LC is negatively and significantly associated with bank risk-taking, showing that more effective liquidity creation is linked to lower observed risk. In the fourth step, once LC is introduced into the model, LC remains negative and significant, while the direct ESG effect weakens and becomes only marginally significant. This pattern supports partial mediation, implying that part of ESG's risk-reducing effect operates through the liquidity creation channel, while a residual direct effect remains. These results are reinforced by the diagnostic properties of the System GMM model. The presence of AR(1), absence of AR(2), and an acceptable Hansen test indicate a valid specification with no serious evidence of residual serial correlation or instrument invalidity (Blundell and Bond, 1998; Roodman, 2009).

4.6 Moderation results of bank funding structure (BFS)

In Table 7, across the fixed effects (FE), random effects (RE), and two-step System GMM specifications, the focal variables exhibit a consistent and theoretically coherent pattern. Environmental, Social, and Governance (ESG) engagement is negatively and significantly associated with bank risk-taking, while Liquidity Creation (LC) also retains a negative and significant effect, indicating that stronger sustainability engagement and more disciplined intermediation are both linked to lower bank risk. Bank Funding Structure (BFS) is likewise negative and significant, suggesting that greater reliance on stable, deposit-based funding reduces risk exposure relative to more fragile liability structures. Most importantly, the $ESG \times BFS$ interaction term remains negative and statistically significant across the panel estimators, showing that funding stability strengthens the risk-reducing effect of ESG. In substantive terms, the marginal effect of ESG becomes more negative as BFS improves, implying that ESG operates more effectively when supported by a stronger deposit base rather

Table 7. Moderation of ESG by bank funding structure (BFS) on bank risk-taking (BRT)

Variables	FE	RE	Sys-GMM
BRT it-1 (lagged only for GMM)	–	–	0.501*** (0.006)
ESG it-1 (lagged only for GMM)	–0.007** (0.028)	–0.007** (0.035)	–0.008** (0.030)
LC it-1 (lagged only for GMM)	–0.004** (0.033)	–0.004** (0.027)	–0.005** (0.021)
BFS	–0.003* (0.089)	–0.003** (0.046)	–0.003** (0.040)
ESG × BFS	–0.000** (0.029)	–0.000** (0.042)	–0.000** (0.032)
SIZE	0.681*** (0.005)	0.731*** (0.002)	0.700*** (0.004)
CAP	–0.043* (0.079)	–0.047** (0.026)	–0.051** (0.018)
GDP	–0.017 (0.339)	–0.018 (0.311)	–0.019 (0.293)
INF	0.035*** (0.010)	0.036*** (0.007)	0.037*** (0.006)
BC	–0.002 (0.730)	–0.001 (0.944)	–0.001 (0.885)
BNK	–0.012 (0.354)	–0.010 (0.443)	–0.012 (0.321)
DCOVID	–0.298* (0.093)	–0.317* (0.076)	–0.499** (0.038)
AR(1) <i>p</i> -value	–	–	0.015
AR(2) <i>p</i> -value	–	–	0.521
Hansen J (<i>p</i> -value)	–	–	0.611

Note(s): Dependent variable is BRT. FE and RE estimations include ESG, LC, BFS, and controls. Sys-GMM treats ESG, LC, BFS, and the interaction ESG × BFS as endogenous, with lagged instruments collapsed and limited. Standard errors are robust; *p*-values in parentheses. *, **, *** denote significance at 10%, 5%, and 1% levels

than volatile wholesale funding, consistent with established interaction logic and prior banking evidence on liability structure and risk discipline (Aiken and West, 1991; Brambor *et al.*, 2006; Demirgüç-Kunt and Huizinga, 2010). The dynamic results further reinforce this interpretation: the lagged dependent variable is significant, confirming persistence in bank risk-taking, while standard diagnostics support model validity through the presence of AR(1), absence of AR(2), acceptable Hansen statistics, and a collapsed instrument set (Blundell and Bond, 1998; Roodman, 2009). Taken together, the results indicate that ESG, LC, and BFS function as complementary channels of bank risk discipline in ASEAN-5 banking.

4.7 LSDVC results vs. GMM (LSDVC steps vs. GMM four steps)

This section evaluates the robustness of the mediation mechanism by comparing the System GMM results with three bias-corrected LSDVC variants (AH, AB, and BB) as reported in Table 8. The objective is to determine whether the mediation pathway remains stable across estimators that address different econometric concerns, notably finite-sample bias in dynamic fixed-effects panels and endogeneity in dynamic banking models (Nickell, 1981; Bruno, 2005a, b; Blundell and Bond, 1998; Roodman, 2009). Overall, the results are highly consistent across methods, strengthening confidence in the reliability of the mediation findings. In the first step, ESG shows a negative and statistically significant association with bank risk-taking (BRT) across all LSDVC variants and System GMM, confirming a robust total effect.

In the second step, ESG positively and significantly predicts Liquidity Creation (LC) in all specifications, indicating that stronger ESG engagement is consistently associated with more disciplined liquidity transformation. In the third step, LC remains negatively and significantly associated with BRT across all estimators, supporting the view that stronger liquidity creation is linked to lower bank risk-taking. In the fourth step, when LC is included in the ESG-BRT equation, LC remains negative and significant, while the direct effect of ESG weakens and becomes only marginally significant. This pattern supports partial mediation, indicating that part of ESG's risk-reducing effect is transmitted through LC, while a residual direct effect remains. Taken together, the convergence of LSDVC and System GMM results indicates that the ESG → LC → BRT pathway is not estimator-specific and can therefore be regarded as methodologically robust.

Table 8. Mediating Role of LC between ESG and BRT: LSDVC vs. System GMM

	Step 1 ESG → BRT				Step 2 ESG → LC				Step 3 LC → BRT				Step 4 ESG → BRT, controlling LC				
Spec	AH	AB	BB	Sys GMM	AH	AB	BB	Sys GMM	AH	AB	BB	Sys GMM	AH	AB	BB	Sys GMM	
BRT _{it-1}	0.4446** (0.0125)	0.4598** (0.0118)	0.5861*** (0.009)	0.4715 * (0.0913)	NA	NA	NA	NA	0.3421** (0.012)	0.2810*** (0.004)	0.4392*** (0.001)	0.3628 * (0.0524)	0.3363* (0.076)	0.3419* (0.064)	0.4363* (0.059)	0.5082 *** (0.0041)	
ESG _{it-1}	-0.0198** (0.032)	-0.0211** (0.030)	-0.0207** (0.029)	-0.0217 ** (0.0315)	0.0554*** (0.005)	0.0587*** (0.004)	0.0601*** (0.003)	0.0598 *** (0.0034)	NA	NA	NA	NA	-0.0129* (0.081)	-0.0135* (0.079)	-0.0141* (0.076)	-0.0149 * (0.0821)	
LC _{it-1}	NA	NA	NA	NA	0.3244** (0.0423)	0.2257* (0.0674)	0.3653* (0.0923)	0.4215* (0.0723)	-0.0983** (0.024)	-0.1061** (0.020)	-0.1119** (0.019)	-0.1126 ** (0.0389)	-0.1215** (0.021)	-0.1243** (0.020)	-0.1310** (0.018)	-0.1362 ** (0.0212)	
SIZE	-0.4417* (0.062)	-0.4572* (0.059)	-0.4633* (0.058)	-0.4824 ** (0.0126)	0.5211*** (0.008)	0.5326*** (0.006)	0.5398*** (0.006)	0.5376 *** (0.0052)	-0.3075 (0.161)	-0.5138 (0.155)	-0.4181 (0.150)	-0.3227 (0.1514)	-0.3024* (0.060)	-0.4118* (0.058)	-0.4221* (0.057)	-0.4693 * (0.0597)	
CAP	-0.1031 (0.132)	-0.1076 (0.129)	-0.1098 (0.127)	-0.0995 (0.1351)	0.1378 (0.146)	0.1412 (0.143)	0.1427 (0.141)	0.1385 (0.1426)	-0.1492** (0.019)	-0.1510** (0.018)	-0.1518** (0.018)	-0.1497 ** (0.0192)	-0.1095** (0.024)	-0.1112** (0.023)	-0.1118** (0.023)	-0.1096 ** (0.0247)	
GDP	-0.0261 (0.887)	-0.0272 (0.881)	-0.0278 (0.876)	-0.0248 (0.8853)	0.0863* (0.078)	0.0881* (0.076)	0.0888* (0.076)	0.0879 * (0.0765)	-0.0292 (0.562)	-0.0295 (0.560)	-0.0297 (0.559)	-0.0281 (0.5629)	-0.0307 (0.386)	-0.0313 (0.381)	-0.0315 (0.379)	-0.0304 (0.3854)	
INF	0.0148 (0.493)	0.0151 (0.490)	0.0155 (0.488)	0.0161 (0.4827)	-0.0551 (0.254)	-0.0558 (0.253)	-0.0561 (0.252)	-0.0551 (0.2520)	0.0383 (0.507)	0.0387 (0.506)	0.0389 (0.505)	0.0385 (0.5076)	0.0101 (0.649)	0.0105 (0.647)	0.0106 (0.647)	0.0103 (0.6499)	
BC	-0.0168** (0.027)	-0.0171** (0.026)	-0.0173** (0.025)	-0.0181 ** (0.0259)	0.0317 (0.123)	0.0321 (0.122)	0.0324 (0.121)	0.0318 (0.1217)	-0.0245 (0.217)	-0.0247 (0.215)	-0.0248 (0.215)	-0.0247 (0.2184)	-0.0047 (0.771)	-0.0049 (0.769)	-0.0049 (0.768)	-0.0048 (0.7716)	
BNK	1.2673* (0.070)	1.2761* (0.069)	1.2815* (0.068)	1.2743* (0.0684)	2.8212** (0.018)	2.8269** (0.018)	2.8285** (0.018)	2.8129 ** (0.0181)	0.8072 (0.141)	0.8084 (0.140)	0.8091 (0.139)	0.8024 (0.1420)	0.5975* (0.051)	0.5980* (0.050)	0.5981* (0.050)	0.5968* (0.0521)	
DCOVID	0.1075 (0.832)	0.1081 (0.831)	0.1086 (0.835)	0.1046 (0.8422)	0.4712 (0.434)	0.4725 (0.432)	0.4741 (0.431)	0.4697 (0.4328)	-0.2064 (0.401)	-0.2070 (0.400)	-0.2074 (0.400)	-0.2055 (0.4026)	-0.4692 (0.306)	-0.4698 (0.305)	-0.4701 (0.305)	-0.4729 (0.3084)	
AR(1) p-value	-	-	-	0.0453	-	-	-	0.0128	-	-	-	0.0159	-	-	-	0.0138	
AR(2) p-value	-	-	-	0.6021	-	-	-	0.2714	-	-	-	0.5372	-	-	-	0.5110	
Hansen (p-value)	-	-	-	0.2941	-	-	-	0.8092	-	-	-	0.6936	-	-	-	0.6078	
Sargan (p-value)	-	-	-	0.2479	-	-	-	0.7198	-	-	-	0.6182	-	-	-	0.4587	
Wald Test (p-value)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
N (banks)	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	

4.8 Discussion of main findings

This section presents each set of analytical results, providing detailed explanations, comparative insights, and theoretical justifications. Findings are interpreted in light of prior research to support the arguments and ensure a thorough, evidence-based discussion.

These findings should be read as complementary to prior ASEAN-5 evidence showing that AI adoption partially transmits the effect of ESG activities and ESG pillars into lower bank risk-taking by strengthening information processing, monitoring, and compliance capabilities (Salem *et al.*, 2026). The present results do not re-test that digital-capability channel. Instead, they show that ESG also operates through balance-sheet intermediation: ESG strengthens liquidity creation, liquidity creation reduces BRT, and stable deposit-based funding amplifies the ESG-risk discipline relationship. This distinction matters because ASEAN-5 banks operate in bank-based systems where risk discipline depends not only on digital analytics, but also on how sustainability practices reshape credit transformation and liability stability.

4.8.1 Static models discussion. Across pooled OLS, fixed effects, and random effects models, the core relationships remain stable and statistically significant. Higher ESG engagement is associated with lower bank risk-taking (BRT), while greater liquidity creation (LC) and a more stable bank funding structure (BFS) are likewise linked to reduced risk. The ESG-BRT association suggests that stronger sustainability orientation is accompanied by better credit discipline, tighter screening, and more effective monitoring, consistent with evidence that stronger ESG performance supports more prudent banking conduct and better financing conditions (Cornett *et al.*, 2016; Goss and Roberts, 2011). The negative LC-BRT relationship also aligns with liquidity-creation theory, which holds that when intermediation is supported by stronger screening, pricing, and monitoring, resulting liquidity is less fragile and portfolio risk is lower. Similarly, the inverse BFS-BRT association reflects the stabilising role of deposit-based funding in reducing rollover risk and limiting procyclical balance-sheet pressures (Demirgüç-Kunt and Huizinga, 2010; Huang and Ratnovski, 2011; BCBS, 2013a, b). Taken together, the static results provide consistent cross-sectional evidence that ESG activity, LC, and BFS operate as complementary channels of bank risk discipline. Future research may examine whether these relationships are nonlinear.

4.8.2 Mediation discussion. The two-step System Generalized Method of Moments (GMM) results confirm the dynamic persistence of bank risk-taking and show that Environmental, Social, and Governance (ESG) engagement reduces risk both directly and indirectly through its positive effect on Liquidity Creation (LC). The four Baron-Kenny conditions are satisfied: ESG is negatively associated with bank risk-taking (BRT), ESG positively predicts LC, LC is negatively associated with BRT, and the direct ESG effect weakens after LC is introduced, indicating partial mediation. This suggests that ESG engagement strengthens screening, monitoring, and portfolio discipline in ways that improve intermediation quality and, in turn, reduce risk exposure. These findings are consistent with prior literature showing that stronger liquidity creation supported by sound monitoring reduces fragility, while better ESG performance is associated with more disciplined lending and improved financing conditions (Cornett *et al.*, 2016; Goss and Roberts, 2011). As discussed in Section 2.3, this mediation pattern is consistent with the study's theoretical foundation.

4.8.3 Moderation discussion. The interaction term between Environmental, Social, and Governance (ESG) engagement and Bank Funding Structure (BFS) is consistently negative and statistically significant across fixed effects, random effects, and System GMM models, while the direct effect of BFS on bank risk-taking (BRT) also remains negative and significant. This indicates that a more stable, deposit-based liability structure strengthens the risk-reducing effect of ESG by providing a more supportive setting for governance improvements, stronger monitoring, and more disciplined risk pricing. Existing evidence supports this interpretation: stable retail deposits reduce rollover risk and weaken procyclical leverage pressures, while stable funding buffers banks against liquidity stress and funding shocks (Demirgüç-Kunt and Huizinga, 2010; Huang and Ratnovski, 2011; BCBS, 2013a, b). In this context, ESG practices appear to generate their strongest risk-disciplining effect when supported by liability structures

that anchor funding stability and enable banks to embed credit discipline into day-to-day operations. As outlined in [Section 2.3](#), this result is also consistent with the study's theoretical logic.

4.9 Implications

The results carry practical implications for the main actors involved in ASEAN's bank-based financial systems. Overall, the evidence indicates that ESG engagement, liquidity creation, and funding stability should not be treated as separate policy agendas, but as interconnected drivers of credit discipline, portfolio quality, and resilience. Accordingly, the implications are most usefully understood in terms of how banks, regulators, and investors respond to the ESG-LC-BRT relationship identified in this study.

For banks, the findings imply that ESG should be embedded directly into underwriting, pricing, monitoring, and portfolio steering rather than confined to disclosure or reputational positioning. The ESG → LC → BRT channel suggests that sustainability practices become most effective when translated into observable intermediation discipline through stronger screening, earlier warning signals, and more stable funding structures. Operationally, this requires more reliable risk-data architecture, stronger internal controls, and funding policies that preserve liquidity resilience under stress, consistent with BCBS 239 and Basel liquidity standards such as the LCR and NSFR ([BCBS, 2013a, b, 2014](#)). Where banks use AI or digital tools to support ESG-linked decisions, governance should ensure explainability, validation, and accountability in line with principles such as FEAT and the NIST AI Risk Management Framework ([MAS, 2018](#); [NIST, 2023](#)).

For regulators and supervisors, the findings support a prudential approach that connects sustainability oversight to balance-sheet discipline rather than treating ESG as a stand-alone disclosure exercise. Regulatory priorities should therefore include stronger convergence in ESG disclosure, greater interoperability of taxonomies, and wider use of scenario analysis in supervisory review, particularly in jurisdictions where reporting quality and enforcement remain uneven. Alignment with ISSB reporting standards, the ASEAN Taxonomy, NGFS scenario pathways, and Basel climate-risk principles can strengthen comparability, improve risk visibility, and reduce supervisory fragmentation across ASEAN markets ([BCBS, 2022](#); [ASEAN Taxonomy Board, 2023](#); [ISSB, 2023a, b](#); [NGFS, 2023](#)).

For investors and other market participants, the findings indicate that ESG signals are most informative when supported by credible funding structures and disciplined liquidity creation. Transparent, comparable, and decision-useful ESG disclosures can reduce information asymmetry and improve the pricing of bank risk, while weak disclosure or fragile liability structures may dilute the market value of sustainability claims. In this sense, investors should assess ESG performance together with liquidity discipline and funding stability, while non-financial borrowers and fintech or regtech providers should anticipate tighter ESG-linked underwriting, stronger data requirements, and greater demand for auditable sustainability information across the credit process ([Cornett et al., 2016](#); [ISSB, 2023a, b](#)).

5. Conclusions

The primary objective of this study is to examine how Environmental, Social, and Governance (ESG) practices influence bank risk-taking (BRT) in the ASEAN-5, with particular attention to the mediating role of Liquidity Creation (LC) and the moderating effect of Bank Funding Structure (BFS). Using static panel models, two-step System Generalized Method of Moments (GMM), and robustness checks based on Least Squares Dummy Variable Correction (LSDVC), the study provides empirical evidence on the channels through which ESG shapes bank risk outcomes in emerging-market banking systems.

The findings are consistent across estimation techniques. First, ESG engagement significantly reduces BRT, confirming its role as a risk-disciplining mechanism. Second,

LC operates as a partial mediating channel: ESG activity strengthens liquidity creation, which in turn reduces risk. Third, BFS significantly moderates this relationship, with the risk-reducing effect of ESG becoming stronger in banks supported by more stable, deposit-based funding structures. These results remain robust under LSDVC estimation, reducing concerns over small-T bias and estimator-specific distortion.

The study makes three main contributions. Theoretically, it places ESG within a dynamic mediation-moderation framework of bank risk governance. Empirically, it extends the ESG-risk literature into the ASEAN-5 context, where evidence remains more limited than in developed markets. From a policy and managerial perspective, the results show that ESG integration, disciplined liquidity creation, and stable funding structures operate as complementary pillars of banking resilience.

For banks, the findings imply that ESG should be embedded into credit screening, pricing, monitoring, and portfolio management. For regulators, the results support stronger disclosure quality, greater alignment with the ASEAN Taxonomy and ISSB-oriented reporting practices, and continued attention to liquidity standards such as the Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR). For investors and other stakeholders, the evidence indicates that banks combining credible ESG practices with stable funding profiles are associated with lower risk and more sustainable long-term value.

The study is limited to listed ASEAN-5 banks, which may restrict generalizability to smaller or unlisted institutions, and risk-taking is proxied mainly through non-performing loans, which primarily capture credit risk. Future research may incorporate broader risk measures, climate-related and macroprudential stress scenarios, and cross-regional comparisons to assess whether the ESG-LC-BRT mechanism is distinctive to ASEAN banking or more broadly generalizable.

Ethical approval

Approved by the Universiti Kebangsaan Malaysia (UKM) Research Ethics Committee, Clearance No.: JEP-2024-569.

Consent to participate

Informed consent was obtained from all Banks representatives before participation, with assurances of confidentiality and anonymity.

Consent to publish

Not applicable; the manuscript reports only aggregate, de-identified findings.

Data availability statement (DAS)

The datasets generated and analysed during the current study are not publicly available because the full bank-year panel forms part of an ongoing ASEAN-5 ESG-banking research programme and includes licensed data obtained from Refinitiv/LSEG Eikon. However, the GMM and LSDVC estimation syntax, together with variables that can be cross-verified through LSEG and related public disclosures, are available from the corresponding author upon reasonable request. The underlying raw commercial data remain subject to database access conditions. The study received ethical approval from the Universiti Kebangsaan Malaysia (UKM) Research Ethics Committee (Clearance No.: JEP-2024-569), and informed consent was obtained from all organizational representatives prior to data collection.

Notes

1. Although this article belongs to the same broader ASEAN-5 ESG-banking research programme as [Salem et al. \(2026\)](#), the final estimation dataset is constructed independently for the present liquidity-creation mediation and bank-funding-structure moderation model. Differences in descriptive statistics therefore reflect model-specific data cleaning, variable availability, missing-value treatment, and lag construction.

Supplementary material

The supplementary material for this article can be found online.

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