



ORIGINAL ARTICLE


Citation: Musa, H., Rech, F., Grofčíková, J., & Cúg, J. (2026). ESG performance and bank financial stability: Global evidence. *Oeconomia Copernicana*, 17(1), 105–139. <https://doi.org/10.24136/oc.4174>

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Article history: Received: 14.12.2025; Accepted: 14.03.2026; Published online: 30.03.2026

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ESG performance and bank financial stability: Global evidence

JEL Classification: G21; G32; Q56

Keywords: ESG; bank financial stability; Z score; corporate governance; risk management

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Abstract

Research background: The link between environmental, social, and governance (ESG) performance and bank financial stability is of high academic and regulatory interest, yet global evidence is mixed. Clarifying this relation is important for resilient banking systems under rising sustainability pressures.

Purpose of the article: To examine the association between ESG performance and bank financial stability, assessing both composite scores and the individual pillars, and documenting heterogeneity across bank financial stability, ESG profiles, and economic conditions.

Methods: The analysis draws on a global panel of 4,466 bank-year observations from 688 banks across 84 countries over 2013–2024. ESG data come from MSCI ESG Ratings, and bank financial stability is measured using the natural logarithm of the Z-score. Baseline estimates use fixed effects with bank, country, and year effects. To account for persistence and potential endogeneity in bank financial stability, we additionally estimate dynamic panel models using the two-step Arellano–Bond GMM estimator.

Findings & value added: The composite ESG score is positively associated with bank financial stability, but the effect is economically and statistically negligible in fixed effects models. Pillars diverge: governance is positive and significant, social is negative, and environmental shows no clear link. Heterogeneity is pronounced, with ESG aligning with higher bank financial stability mainly among already stable banks, while fragile banks face adverse associations. During the COVID-19 period, the social pillar improves toward neutral or mildly beneficial, while the governance effect weakens. Dynamic GMM yields a stronger positive composite association and uniformly positive pillar effects, suggesting static models understate benefits due to endogeneity and persistence. The central contribution of this paper lies in its reconceptualization of the ESG–bank financial stability relationship as fundamentally state- and capacity-contingent. By demonstrating that ESG functions not as a universal remedy but as a conditional strategic asset that benefits financially robust institutions, and by revealing how pillar-specific effects exhibit distinct shifts during systemic crises, this paper provides a novel dynamic framework that advances both theoretical understanding and the practical design of risk management and prudential supervision in an era of escalating global uncertainty.

Introduction

In an era defined by climate change, social inequality, and recurrent financial crises, the principles of Environmental, Social, and Governance (ESG) have ascended from a niche concern to a central tenet of global finance. For banking institutions, which form the circulatory system of the modern economy, this shift is particularly consequential. Banks are not only under growing pressure to manage their own ESG footprints, but are also critical channels through which sustainability risks and opportunities are transmitted to the broader economy. Consequently, the relationship between a bank's ESG performance and its financial stability has become a subject of

intense academic and regulatory scrutiny (Aevoae *et al.*, 2023; Biswas *et al.*, 2025; Srairi & Kateb, 2025; Liaqat *et al.*, 2026).

A growing body of literature posits that superior ESG performance enhances bank financial stability through multiple channels. The risk-management channel suggests that high-ESG banks exhibit more prudent risk-taking and stronger controls, reducing insolvency risk and fragility, especially during crises (Gangwani & Kashiramka, 2024; Chiaramonte *et al.*, 2022; Wen *et al.*, 2025). Meanwhile, the credit quality channel links stronger ESG metrics to healthier loan portfolios and lower non-performing loans (Liu *et al.*, 2023; Tóth *et al.*, 2021; Cantero-Saiz *et al.*, 2024). Additionally, the funding cost channel proposes that banks with superior ESG benefit from cheaper debt and equity due to reduced information asymmetry and a lower perceived risk profile (Andrieş & Sprincean, 2023; Galletta *et al.*, 2023; Almulla *et al.*, 2025).

However, the relationship is not uniformly positive, with evidence of trade-offs, such as the finding that high ESG scores can reduce bank value even as they modestly lower risk and bank performance (Di Tommaso & Thornton, 2020; Curcio *et al.*, 2024; Philippas *et al.*, 2025). Furthermore, the effects vary starkly across ESG pillars. While governance (G) is consistently highlighted for risk mitigation (Aevoae *et al.*, 2023; Biswas *et al.*, 2025), the environmental (E) and social (S) pillars show ambiguous or mixed results (Chen *et al.*, 2025; Lupu *et al.*, 2022). This divergence implies that composite ESG scores can mask opposing underlying effects, potentially leading to a misleading aggregate result. Moreover, the context in which ESG operates appears to be crucial. The stabilizing effect of ESG is often found to be state-dependent, manifesting most strongly during periods of financial distress (Chiaramonte *et al.*, 2022). The global COVID-19 pandemic, for instance, served as a stark reminder that the value of different forms of capital can shift dramatically during systemic shocks.

Important gaps remain. Much of the literature is regional, with a concentration on Europe, the United States, or single emerging markets (Chiaramonte *et al.*, 2022; Lupu *et al.*, 2022; Liu *et al.*, 2023; Biswas *et al.*, 2025). Crucially, while some studies disaggregate ESG scores (Biswas *et al.*, 2025; Chen *et al.*, 2025), few provide a comprehensive, risk-stratified analysis that clarifies for which banks, under which conditions, and through which pillars ESG is most effective at promoting stability (Di Tommaso & Thornton, 2020). As a result, findings remain fragmented and often contradictory. Recent evidence documents sign reversals and non-linearities across re-

gions and institutional regimes. ESG engagement can reduce short-run stability in the Association of Southeast Asian Nations (ASEAN) banks (Do *et al.*, 2024), and regime-switching results in Europe show that ESG may be stabilizing or destabilizing depending on engagement intensity and capacity (Bouattour *et al.*, 2024). Cross-country dynamic analyses further reveal U-shaped ESG–risk relationships and institutional thresholds (Al Hashfi *et al.*, 2025), while sovereign ESG can display inverted-U effects on banking-system stability (Athari, 2024). Consequently, it remains unclear whether ESG acts as a universal stabilizer or a conditional one that depends on pillar composition, banks’ risk profiles, ESG quartile positioning, and institutional context.

We address these gaps using a global panel of 4,466 bank-year observations from 688 banks in 84 countries during 2012–2024. The aim of this paper is to provide a comprehensive global assessment of the comprehensive and pillar-specific relationship between banks’ ESG performance and financial stability. We estimate fixed-effects models and dynamic system-GMM specifications to address persistence, unobserved heterogeneity, and potential endogeneity between ESG and bank financial stability. Three results stand out. First, in static designs the composite ESG score has a statistically and economically negligible association with bank financial stability. Second, disaggregation reveals sharp pillar differences, with governance consistently positive, social negative in the short run, and environmental near zero at conventional horizons. Third, effects are heterogeneous and state-dependent. A capacity channel is present, whereby ESG aligns with greater bank financial stability for already robust banks, but not for fragile ones, and during COVID-19 the social pillar became beneficial while the governance effect weakened. Dynamic GMM indicates stronger long-run stabilizing effects, including for social.

The contribution of this paper is threefold. First, we provide the first comprehensive global evidence on the dynamic and pillar-specific ESG–bank financial stability relationship, bridging gaps left by regional samples and static designs. Second, we show that a bank’s *ex ante* financial health conditions the payoff to ESG. Stable institutions gain more from ESG, while fragile institutions can face lower bank financial stability if they expand too quickly, which helps reconcile mixed findings in the literature and explains why composite scores often mask offsetting forces. Third, we document that pillar effects are state-dependent and can shift during systemic stress, with social capital becoming stabilizing in crises and the governance pre-

mium moderating. Taken together, these results move the debate beyond aggregate indices toward actionable pillar evidence for bank financial stability assessment, and they underscore that static fixed-effects estimates provide lower bounds, whereas dynamic specifications recover longer-horizon benefits that accumulate as institutions and market conditions evolve. Our results hold significant implications for bank risk managers and prudential regulators, advocating for a nuanced, pillar-specific approach to integrating ESG into financial bank financial stability frameworks.

The remainder of the paper is structured as follows. Section 2 reviews the related literature and develops the research motivation. Section 3 describes the data, variables, and empirical methodology. Section 4 presents the main empirical results, including baseline estimates, robustness checks, and heterogeneity analyses. Section 5 discusses the findings and their implications for theory and policy. Section 6 concludes and outlines directions for future research.

Literature review

Research links banks' ESG performance to financial stability through three main channels. First, higher ESG aligns with stronger risk management and lower fragility, especially in stress. Emerging-market banks with stronger disclosure face lower insolvency, leverage, and liquidity risks (Gangwani & Kashiramka, 2024). European evidence shows that higher composite and pillar scores reduce fragility during crises (Chiaramonte *et al.*, 2022). Strong ESG also encourages proactive, value-enhancing risk-taking while limiting passive risk-taking through reputational capital, better credit structures, and lower information asymmetry, with the environmental pillar most influential (Wen *et al.*, 2025). However, Di Tommaso and Thornton (2020) find that while high ESG scores are associated with a modest reduction in risk-taking, they also lead to a simultaneous decrease in bank value, revealing a trade-off between bank financial stability and shareholder value. This pattern fits stakeholder and risk-management views and highlights the central role of governance, which reduces banks' systemic risk contributions (Aevoae *et al.*, 2023; Almulla *et al.*, 2025). In particular, governance quality often stands out. Aevoae *et al.* (2023) show that higher overall ESG,

and especially better corporate governance, reduces banks' contribution to systemic distress.

Second, credit quality is a key mechanism. For U.S. banks, higher composite and pillar scores are associated with fewer non-performing loans (Liu *et al.*, 2023). Tóth *et al.* (2021) similarly show ESG performance significantly lowers NPL ratios in EU banks. Porenta & Rant (2025) report that for development banks, ESG-related risks, especially poor social or governance scores, are significant predictors of weaker credit ratings, implying a close ESG–credit risk link. Recent work further suggests that pillar effects are asymmetric. Environmental performance can lift ratings, while social, governance, and the aggregate score show mixed results across markets and horizons (Chen *et al.*, 2025). Together, these studies suggest that stronger ESG improves asset quality by avoiding riskier sectors and borrowers.

Third, ESG can lower funding costs. The logic is that high-ESG banks may enjoy a lower cost of capital via cheaper debt or equity. This mechanism fits with a well-established pathway whereby sustainability increases transparency and reduces information asymmetry, which raises demand for banks' securities and lowers required returns and deposit rates (El Ghoul *et al.*, 2011; Ge & Liu, 2015; Hong & Kacperczyk, 2009). Bank-level evidence shows cheaper deposits and debt for higher-ESG institutions, driven largely by social and governance dimensions in larger banks and advanced economies, relieving liquidity and capital pressures (Andrieș & Sprincean, 2023). Strong stakeholder ties and moral capital can further reduce reputational and regulatory costs (Galletta *et al.*, 2023; Godfrey *et al.*, 2009). Higher ESG ratings operate as risk management that reduces idiosyncratic risk and yields cheaper funding relative to riskier peers (Andrieș & Sprincean, 2023; El Ghoul *et al.*, 2011). Conceptually, lower funding costs improve bank financial stability by easing liquidity and capital constraints. ESG may also reduce equity costs as socially conscious investors might bid up well-rated banks, while governments or regulators could favor them with lower capital surcharges (Odell & Ali, 2016).

Systemic perspectives confirm these links and highlight heterogeneity. Higher ESG, especially governance, reduces contributions to system-wide distress (Aevoae *et al.*, 2023). In India, ESG practices reduce default risk, with the governance pillar strongest and environmental weaker but beneficial (Biswas *et al.*, 2025). In Europe, Curcio *et al.* (2024) find ESG performance among non-financial firms transmits differently to banks and insurers. Their breakdown reveals that banks are systemically more vulnerable

to the riskiness of environmentally focused (green) companies, whereas insurers appear more exposed to the risk from firms in traditional brown industries like oil and gas. In addition, bank financial stability gains are state-dependent and most pronounced in periods of turmoil, as documented for European banks during COVID-19 (Chiaramonte *et al.*, 2022). The evidence indicates that reputational capital and disciplined risk management embedded in strong ESG act as buffers when market confidence is fragile. The literature also underscores significant methodological complexity. The relationship is not always linear or uniformly positive. Lupu *et al.* (2022) employ a cross-quantile approach to demonstrate that the ESG–bank financial stability link in European banking is more nuanced than standard linear models suggest, with the strength of the association varying meaningfully across the individual pillars.

Collectively, the literature confirms a material link between ESG and bank financial stability, but highlights profound contingencies regarding pillars, context, and potential trade-offs. To test these nuanced predictions on a global scale, we formulate the following hypotheses:

H1: *ESG scores influence bank financial stability.*

H2: *The impact of ESG scores on bank financial stability varies across the E, S, and G pillars and is different from the aggregated ESG score.*

Moving from conceptual channels to empirical identification, recent studies show that estimates of the ESG–bank stability relationship depend heavily on measurement choices, time horizon, and institutional context, contributing to mixed findings across samples (Chiaramonte *et al.*, 2022; Bouvatier *et al.*, 2023; Do *et al.*, 2024; Alessi *et al.*, 2024; Liaqat *et al.*, 2026). Composite ESG scores often mask offsetting pillar effects, while rating-provider disagreement introduces additional measurement error, leading recent work to emphasize pillar-level analysis (Lupu *et al.*, 2022; Biswas *et al.*, 2025; Chen *et al.*, 2025). On the outcome side, most cross-country studies rely on accounting-based Z-scores, yet alternative constructions and crisis-driven volatility can shift empirical inferences (Beck *et al.*, 2013; Chiaramonte *et al.*, 2016; Bouvatier *et al.*, 2023). Identification is challenging because ESG and bank financial stability may be jointly determined through funding costs, reputation, or regulatory expectations, and evidence increasingly points to non-linearities, regime shifts, and institutional

thresholds (Andrieş & Sprincean, 2023; Bouattour *et al.*, 2024; Athari, 2024; Al Hashfi *et al.*, 2025; Curcio *et al.*, 2024).

Data and methods

Data

The sample comprises a global panel of 4,466 bank–year observations for 688 banks over 2012–2024, constructed from consolidated annual financial statements. We use annual frequency to align with ESG reporting cycles and dampen seasonal noise. Financials are from Compustat North America (US) and Compustat Global (S&P Capital IQ), country-level macro controls from the World Bank, and ESG metrics from MSCI ESG Ratings. The sample primarily consists of commercial and universal banks and also includes Islamic banks where covered by the data. Standalone investment banks are largely absent, so the analysis is not stratified by bank type. We start in 2012 to coincide with the major restructuring of the MSCI ESG Ratings model (version 2.0 effective Jan 1, 2012), which enhanced cross-industry comparability of key issues; using a post-2012 window avoids mixing pre- and post-reform ESG constructs. We also adopt a post-crisis window because the relation between ESG and bank financial stability is state-dependent; ESG’s stabilizing effect on banks is most evident during periods of financial distress, so including the 2008–2009 crisis would risk confounding identification (Chiaramonte *et al.*, 2022).

Variable definition

Dependent variable: Bank financial stability

To empirically assess bank financial stability, we require a robust metric that captures a financial institution’s proximity to insolvency. Following a well-established tradition in the banking literature, we proxy bank financial stability using the Z-score, an accounting-based measure that synthesizes profitability, capitalization, and the volatility of returns (Beck *et al.*, 2013; Chiaramonte *et al.*, 2016; Laeven & Levine, 2009). A higher Z-score indicates a lower probability of insolvency and therefore greater bank financial stability. Because of provider coverage gaps, comparable mar-

ket-based proxies are unavailable for our global panel; using them would restrict the sample and impair cross-country comparability, so we rely on Z-score variables. Its robustness for panel data analyses has been reinforced by recent methodological refinements (Bouvatier *et al.*, 2023), and it remains widely used in contemporary banking studies, including those examining ESG performance (Biswas *et al.*, 2025; Han *et al.*, 2025).

To measure bank financial stability, we use the Z-score, a widely adopted proxy for a bank's financial stability that combines profitability, capitalization, and earnings volatility. Higher values indicate greater bank financial stability. To ensure robustness, we employ three variants of the Z-score that differ in how profitability and volatility are computed. These alternative constructions capture short-term and smoothed risk dynamics and are commonly used in panel studies of bank stability. All variants are log-transformed to reduce skewness and improve comparability across countries. Using this trio allows us to demonstrate that results do not hinge on a single construction of the Z-score, partially offsetting the absence of uniformly available market-based bank financial stability metrics in the global dataset. Detailed formulas and construction steps for the three Z-score variants are provided in Appendix.

Independent variables

Our primary independent variables are the bank's ESG performance scores, sourced from Morgan Stanley Capital International (MSCI) ESG Ratings, a provider widely utilized in contemporary financial research for its comprehensive and consistent methodology (Bonacorsi *et al.*, 2024; Cantero-Saiz *et al.*, 2024). While different rating agencies employ distinct methodologies, the high correlation in firm rankings across major providers suggests that our reliance on MSCI data does not critically limit the generalizability of our findings. The central variable is the comprehensive MSCI ESG Score, which we use in its raw logarithmic form and as an industry-adjusted logarithmic score, the latter calculated by deducting the annual global industry median to isolate a bank's relative ESG standing. To investigate the distinct effects of each sustainability dimension, we disaggregate the overall score into its three constituent pillars—Environmental (E), Social (S), and Governance (G)—also in logarithmic form, an approach strongly recommended by recent literature to uncover their divergent relationships with bank financial stability (Biswas *et al.*, 2025; Lupu *et al.*, 2022).

Control variables

To isolate the relationship between ESG performance and bank financial stability from other confounding factors, we include a comprehensive set of control variables informed by the established banking literature. Our selection is guided by the CAMEL framework, a widely adopted approach for assessing the financial health of banks, which encompasses capital adequacy, asset quality, management efficiency, earnings, and liquidity (Cole & White, 2012; Shaddady & Moore, 2019). These variables are included to ensure that the estimated association between ESG performance and bank financial stability is not driven by standard balance-sheet or macroeconomic determinants of risk. In particular, capitalization (ETA), asset quality (NPL), and cost efficiency (CIR) are expected to be most sensitive to ESG-related adjustments, as ESG engagement may influence risk-management practices, lending composition, and operating costs. The definition and calculation of all variables used in this paper are detailed in Table 1.

Descriptive statistics

Table 2 summarizes statistics. The three log Z-scores average about 1.3 and are almost perfectly correlated ($r > 0.98$). The third version is lower (mean 1.08, SD 0.35) due to its earnings-volatility component. Banks are well capitalized and profitable: ETA averages 10 percent with 3 percentage points dispersion; ROA averages 1 percent. Asset quality is heterogeneous: NPL averages 3 percent and reaches 27 percent. Cost efficiency centers on CIR near 65 percent. Macroeconomic conditions vary: GDP growth averages 2.6 percent (SD 2.9) and inflation 3.1 percent (SD 3.2), spanning expansions and downturns across countries. ESG varies substantially. The MSCI ESG log score has mean 1.65 (SD 0.20), about 5.2 unlogged. The industry-adjusted ESG log score centers at 1.63 (SD 0.44), with sector demeaning widening dispersion and placing some banks far from industry averages. Across pillars, governance is highest (mean log 1.78, about 5.9 unlogged), environmental lowest (mean log 1.17, minimum 0.00), and social in between (mean log 1.57, about 4.8; SD 0.32). Overall, banks score strongest on governance and weakest on environmental.

Econometric strategy

We examine ESG performance and bank financial stability with a multi-faceted design that addresses key econometric issues. We harmonize the panel, construct variables, winsorize at the 1st and 99th percentiles, then drop rows with any missing values per specification. Diagnostics show no problematic multicollinearity (Table 3). Because ESG pillars are highly correlated, we enter them separately while keeping the full control set fixed across models.

The primary estimation uses fixed-effects panel regressions with the following specification:

$$Z_{it} = \alpha + \beta ESG_{i,t-1} + \gamma X_{i,t-1} + \lambda_t + \delta_c + \varepsilon_{it}, \quad (1)$$

where Z_{it} represents one of the three log Z-score measures for bank i in year t , $ESG_{i,t-1}$ denotes the lagged ESG measure (either comprehensive or pillar-specific), and $X_{i,t-1}$ is a vector of lagged controls. Controls are lagged one year and follow the CAMEL framework plus macro variables: capital adequacy (*ETA*, *TLTA*), asset quality (*NPL*), management efficiency (*CIR*), earnings capacity (*ROA*, *NIOR*), liquidity and funding (*CDTA*), and macro conditions (real GDP growth and CPI inflation). The model includes bank, year, and country fixed effects. Standard errors are two-way clustered by bank and country. We run this baseline for each Z-score variant and each ESG proxy, yielding a compact, comparable grid.

Bank financial stability is inherently persistent, and including lagged dependent variables in fixed-effects models can create endogeneity and dynamic panel bias. Moreover, ESG performance and stability may be jointly determined. To address these concerns, we estimate dynamic panel models using the two-step Arellano–Bond GMM estimator, which allows the inclusion of lagged dependent variables and uses internal instruments to control for persistence and endogeneity. Robustness checks include Arellano–Bond dynamic panel GMM with deeper lag instruments, leave-one-country-out (LOCO) and leave-one-year-out (LOYO) influence checks, quadratic ESG terms and lead-lag tests for non-linearity and reverse causality, interactions with lagged bank financial stability quartiles, and structural break tests around the COVID-19 period. These address endogeneity, persistence, influence, and time- or country-specific shocks.

Results

Baseline fixed-effects results of ESG aggregates

Table 4 reports fixed-effects panel results on aggregate ESG and bank financial stability. Linear effects are absent. Coefficients on both raw and industry-adjusted composite ESG are positive, economically trivial, and statistically indistinguishable from zero across all three Z-score variants. This indicates that, conditional on bank, country, and time effects, overall ESG is not a reliable linear predictor of bank financial stability. The finding tempers optimistic claims of a straightforward positive ESG–bank financial stability link in Chiaramonte *et al.* (2022) and aligns with Di Tommaso and Thornton (2020), who emphasize trade-offs and non-linear or dimension-specific channels. Results are robust to alternative Z-score constructions and to the industry-adjusted ESG metric.

Model fit remains strong, with R-squared values ranging between 0.667 and 0.697, suggesting that the specification captures a substantial share of within-bank variation in bank financial stability. Control variables behave consistently with financial theory. Higher capitalization ETA raises bank financial stability. Deteriorations in asset quality NPL and cost efficiency CIR reduce bank financial stability. Inflation CPI loads negatively, consistent with macro volatility. The negative CDTA coefficient likely reflects heavier deposit funding among inherently riskier banks. The stability and theoretical coherence of the control coefficients reinforce the interpretation that the ESG null result is specific rather than an artifact of misspecification.

ESG pillars versus comprehensive scores

Table 5 shows a clear pillar-level divergence that explains the muted composite effect in Table 4. Governance loads positively on bank financial stability across all three Z-scores, with significance at 5 percent for Z-score 2 and 10 percent for Z-score 3, consistent with work highlighting governance as the primary risk-mitigation channel (Aevoae *et al.*, 2023; Biswas *et al.*, 2025) and consistent with stronger governance bolstering capital buffers and solvency resilience. The social pillar is negative and significant in every specification, consistent with a cost-and-attention channel in which expansive programs raise operating costs and divert managerial focus from pru-

dential targets, and with a business-mix channel in which inclusion-oriented lending shifts portfolios toward higher-risk, thinner-margin segments that modestly lower Z-scores despite social value.

The environmental pillar, meanwhile, is near zero and insignificant throughout. This neutrality is likely due to a fundamental mismatch in timing and risk measurement. The benefits of environmental investments are often long-term strategic gains. Conversely, the substantial costs of decarbonizing operations or portfolios are often incurred in the near term. Our primary bank financial stability measure, the Z-score, is an accounting-based metric of short-to-medium-term solvency risk. It is therefore ill-equipped to capture these long-horizon environmental risks and opportunities, which may explain the lack of a significant linear relationship in the static model. Together the pillar results support H2 and show that ESG effects on bank financial stability vary sharply across E, S, and G, and differ from the aggregate score.

Static sorting versus dynamic adjustment

Table 6 shows strong heterogeneity by initial bank financial stability, using interactions with lagged stability quartiles. Evidence supports a capacity channel in which the ESG effect reverses with ex ante risk. For the most fragile banks in the lowest quartile, higher ESG precedes significant declines in stability, consistent with binding resource trade-offs. For the most robust banks in the highest quartile, stronger ESG predicts significant bank stability gains because well-capitalized institutions can adopt these practices without eroding buffers. This reversal explains the net-neutral aggregate effect and makes pre-existing financial health a prerequisite for stabilizing benefits.

Table 7 contrasts dynamic and static views. Cross-sectional ranking on ESG within a year weakly predicts contemporaneous bank financial stability. Differences between top and bottom ESG quartiles are small and insignificant for the composite and the environmental pillar. Patterns that do appear are a slight but significant bank financial stability penalty for mid-tier social scores and a marginal benefit for the highest governance quartile. The divergence between weak cross-sectional sorting and strong dynamic effects implies that the primary mechanism is within-bank improvement over time, not static positioning.

Robustness to geographic and temporal influences

Global multi-year coverage could raise country- or time-driven concerns. Tables 8 and 9 provide influence diagnostics that reject them. Country checks show conclusions intact under extreme exclusions. Removing the most influential country shifts ESG coefficients by less than one baseline standard error and never flips pillar signs. Governance stays positive, social negative, environmental neutral. With equal country weights, the governance effect weakens and becomes insignificant, implying the link is strongest in large banking systems and systemically important centers.

Temporal diagnostics yield similarly stable conclusions. Dropping any single year produces only minor and statistically insignificant coefficient changes. The negative social and positive governance patterns persist across all subsamples, including the COVID-19 period and phases marked by evolving ESG disclosure standards. These robustness checks confirm that the results are not artifacts of sample composition, time clustering, or disproportionate influence from particular jurisdictions, but instead reflect stable structural patterns in the ESG–stability relationship.

Pandemic period changes

The COVID-19 shock serves as a natural experiment to test the state-dependent nature of the ESG–bank financial stability relationship. Table 10 reveals a significant realignment in which the relative effectiveness of ESG pillars shifted profoundly during the crisis.

The most striking finding is the divergent response of the Social and Governance pillars. The S pillar, negative in the full sample, became significantly beneficial during the acute phase (2020–2021), suggesting social capital provided a crucial bank financial stability buffer when trust was most strained, consistent with findings that stakeholder trust enhances resilience during crises (Lins *et al.*, 2017). Conversely, the stabilizing G pillar sharply deteriorated, indicating that governance structures designed for normal operations may have constrained flexibility during an unprecedented shock, reflecting potential rigidity costs. The E pillar showed modest but insignificant improvement. Null results from placebo tests confirm these shifts are genuinely pandemic-related.

This evidence fundamentally challenges a static view of ESG. The risk implications of ESG are state-contingent, with social dimensions gaining

critical importance during systemic crises, while governance's benefits recede.

Robustness checks

We address endogeneity from reverse causality and the dynamic persistence of bank financial stability using a two-step Arellano–Bond GMM estimator. The results in Table 11 reveal a substantially stronger positive ESG–bank financial stability link than the static fixed-effects baseline, indicating that the latter likely represents a lower bound. The composite ESG coefficient is economically meaningful, ranging from 0.381 to 0.388 across specifications. Consistent with Biswas *et al.* (2025), GMM amplifies the effects, with Governance remaining the strongest stabilizer.

Crucially, the pillar-level dynamics also change. The Social pillar flips from negative in static models to positive in the dynamic setting, indicating that its benefits materialize as long-run bank financial stability gains that outweigh short-run costs. The Environmental pillar, which was neutral in static models, also becomes a significant positive predictor in the dynamic framework. This pattern suggests that the financial effects of environmental commitments, such as strategic repositioning and managing transition risks, unfold over a longer horizon not captured by static models. Model diagnostics are sound, with the expected pattern of serial correlation and acceptable Hansen tests, confirming the validity of our instruments and a genuine long-run ESG–bank financial stability relationship.

Additional analysis

We subject the main results to a broad set of ancillary checks. First, Table 12 examines potential non-linearities by including quadratic ESG terms. Across all specifications, the squared terms are statistically insignificant, indicating no evidence of curvature in the ESG–bank financial stability relationship. This validates our linear specification and suggests that neither diminishing nor increasing returns characterize the marginal effect of ESG on bank financial stability within the observed data range.

Second, Table 13 addresses reverse causality concerns by including both contemporaneous and one-year lead ESG values. The lead terms are largely insignificant across specifications, providing little evidence that future bank financial stability predicts current ESG performance. The governance

pillar's coefficient remains positive and significant for contemporaneous values, while its lead is insignificant, reinforcing our interpretation of governance as a driver rather than a consequence of bank financial stability. While two specifications show marginal significance for social and industry-adjusted ESG leads, their economic magnitude is limited and directionally inconsistent, suggesting no systematic reverse-causality pattern.

Discussion

This study provides a globally comprehensive analysis of the relationship between ESG performance and bank financial stability, revealing a complex and contingent picture that challenges simplistic narratives. Our findings demonstrate that the composite ESG score exhibits a negligible association with bank financial stability in static models, a result that tempers overly optimistic claims in the literature and underscores the danger of relying on aggregated metrics that mask opposing underlying forces (Di Tommaso & Thornton, 2020). The core contribution lies in disentangling the pillar-level effects and documenting critical heterogeneity based on a bank's ex-ante financial health and the economic context.

The divergence across ESG pillars is striking. The consistently positive effect of the governance pillar aligns with its established role as the cornerstone of bank risk management, reinforcing internal controls and prudent decision-making (Aevoae *et al.*, 2023; Laeven & Levine, 2009). Conversely, the significant negative association of the social pillar in static models suggests potential short-term trade-offs, where stakeholder-oriented investments may increase operational costs or shift loan portfolios toward riskier segments, thereby straining capital buffers. The environmental pillar's neutrality in the short run likely stems from a temporal mismatch; the costs of decarbonization are immediate, while the strategic benefits of managing long-term transition risks, which are priced by financial markets (Bolton & Kacperczyk, 2021), materialize over a horizon that standard accounting-based Z-scores cannot capture.

Our results further highlight a pronounced “capacity channel.” The stabilizing effect of ESG is conditional on a bank's initial financial robustness, benefiting only those institutions with sufficient capital buffers to absorb potential short-run costs. For fragile banks, ESG engagement can be detrimental, a finding consistent with resource-based theories where financial

constraints bind (Froot *et al.*, 1993). This heterogeneity is compounded by state dependence, as vividly illustrated during the COVID-19 pandemic. The crisis-induced shift of the social pillar from negative to beneficial underscores the value of reputational and social capital during systemic shocks (Lins *et al.*, 2017), while the diminished effect of governance hints at the rigidity costs of established structures in unprecedented turmoil.

Methodologically, our analysis confirms that accounting for endogeneity and dynamic persistence is crucial. The significantly stronger, uniformly positive ESG–bank financial stability relationship estimated via dynamic panel GMM indicates that static fixed-effects models likely represent a lower bound. This suggests that the full financial benefits of ESG, particularly from social and environmental investments, are long-term in nature and are understated in cross-sectional or short-panel analyses (Wintoki *et al.*, 2012).

The regulatory and institutional backdrop is a critical contingency shaping the materiality of ESG factors for bank financial stability, and institutional and regulatory differences across countries may partly explain the heterogeneity observed in the global sample. International regulatory debates often treat ESG alignment as homogeneous, yet our evidence shows that its prudential relevance is pillar specific and state dependent. Composite ESG scores are negligible in fixed-effects models, while governance is stabilizing and social effects vary across horizons and bank financial stability. This suggests that international harmonization should focus on comparable definitions, disclosures, and risk taxonomies, while allowing proportional implementation across pillars and bank capacities. Evidence on climate transition risk indicates that bank losses are modest on average but can become systemic under stress or fire-sale dynamics, supporting targeted capital buffers rather than uniform add-ons (Alessi *et al.*, 2024). Cross-country research further shows that ESG–stability links depend on institutional and cultural contexts, implying that uniform global rules may be inefficient when they ignore national transmission channels and supervisory capacity (Liaquat *et al.*, 2026).

At the national level, ESG enters supervision through stress testing, Pillar 2 assessments, and systemic buffers. Our results show that ESG is most informative when treated by pillar rather than as a single score. Governance consistently acts as a near-term stabilizer, suggesting that supervisory focus on board oversight and risk management can provide clearer prudential signals, consistent with evidence linking stronger governance to

lower default risk (Biswas *et al.*, 2025). By contrast, the social pillar shows short-run costs but longer-run benefits, supporting differentiated treatment between buffer-eroding expansion and resilience-building investment. ESG characteristics can also affect system-wide tail risk, reinforcing a macroprudential view of ESG as a channel for externalities rather than a uniform risk metric (Curcio *et al.*, 2024).

For banks, ESG functions more as a strategic risk portfolio than a universal stabilizer. Stability gains are strongest for already resilient institutions and can be weaker for fragile banks, making capital planning and sequencing central. Governance reforms appear to deliver the most immediate stability benefits, while social and environmental initiatives are more effective when aligned with profitability and buffer capacity. Evidence from emerging markets shows that stronger ESG disclosure is associated with lower insolvency and liquidity risk but depends on existing governance quality (Gangwani & Kashiramka, 2024), while broader ESG-oriented strategies can also raise operating costs and create short-term trade-offs (Philippas *et al.*, 2025).

Conclusions

Leveraging a sample of 688 banks across 84 countries from 2013–2024, this paper offers a global benchmark for how ESG relates to bank financial stability without presuming a uniform effect. The main contribution is three-fold. First, it establishes the value of pillar-level analysis over composite scores by mapping when different ESG components matter for prudential outcomes. Second, it formalizes a capacity-contingent mechanism, clarifying why financially robust institutions are positioned to translate sustainability efforts into risk mitigation, while constrained peers are not. Third, it documents state dependence and shows how dynamic identification alters inference, underscoring that conclusions drawn from contemporaneous models can understate long-horizon effects.

Policy and practical implications are substantial. Our results caution against a one-size-fits-all approach to ESG regulation and risk management. For regulators and supervisors, the findings advocate for a granular, pillar-specific view when incorporating ESG into prudential frameworks. The strong, consistent performance of the governance pillar justifies its central role in supervisory assessments. The negative short-term social

effect warrants careful monitoring to distinguish between value-creating stakeholder engagement and value-destroying inefficiencies. For bank managers, the evidence suggests that pursuing ESG is not an immediate financial stabilizer for all. Banks should prioritize strengthening their governance structures as a direct bank financial stability measure. Investments in social and environmental dimensions should be viewed as long-term strategic commitments whose financial benefits may accrue over time, especially if the bank is already financially robust.

This paper is not without limitations. First, our analysis relies on MSCI ESG Ratings to ensure global coverage and comparability; however, results may differ when alternative ESG providers or scoring methodologies are used. Replicating the analysis across multiple ESG datasets would help assess the stability of the findings. Second, ESG rating disagreement across providers is well documented and introduces an additional layer of measurement uncertainty. Although we mitigate this by using both raw and industry-adjusted scores and by focusing on pillar-level effects, future research could explicitly examine how rating dispersion itself relates to bank risk and stability. Third, our stability proxy, the Z-score, is accounting-based and captures structural solvency risk rather than short-term market volatility. We mitigate this concern by employing three well-known alternative Z-score constructions. However, all variants remain balance-sheet-based. Future research could examine whether ESG effects differ when using market-based measures such as Merton distance to default, the Ohlson O-score, or equity-implied risk indicators.

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Funding information

The paper has been supported by the Scientific Grant Agency of Slovak Republic under project VEGA No. 1/0120/25 “Research of paradigms and determinant processes and ESG implementation in the context of the required financial performance of companies and changes resulting from the CSRD directive”. The authors would like to thank the Scientific Grant Agency of The Ministry of Education, Research, Development and Youth of the Slovak Republic for financial support of this research and publication.

Compliance with ethical standards

This article does not contain any studies with human participants or animals performed by the authors. Extracting and inspecting publicly accessible files (scholarly sources) as evidence, before the research began no institutional ethics approval was required.

Data availability statement

All data generated or analyzed are included in the published article. The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. The raw anonymized data can be provided by emailing the primary author.

Author contributions

All listed authors have made a substantial, direct and intellectual contribution to the work, and approved it for publication. The authors take full responsibility for the accuracy and the integrity of the source analysis.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Annex

Table 1. Variable definitions

Variable	Description
Dependent variables	
Ln (Z-score 1)	The natural logarithm of the sum of return on assets (ROA) and the equity-to-total-assets ratio, divided by the standard deviation of ROA.
Ln (Z-score 2)	The natural logarithm of the sum of the five-year moving average of ROA and the five-year moving average of the equity-to-total-assets ratio, divided by the standard deviation of ROA.
Ln (Z-score 3)	The natural logarithm of the sum of the five-year moving average of ROA and the five-year moving average of the equity-to-total-assets ratio, divided by the range (max-min) of ROA over the previous five years.
Independent variables	
Ln (ESG raw)	The natural logarithm of the comprehensive MSCI ESG Score.
Ln (ESG ind)	The natural logarithm of the MSCI ESG Score after deducting the annual global industry median.
Ln(E)	The natural logarithm of the Environmental pillar score from MSCI.
Ln(S)	The natural logarithm of the Social pillar score from MSCI.
Ln(G)	The natural logarithm of the Governance pillar score from MSCI.
Control variables (Bank-specific)	
ETA	The ratio of total equity to total assets.
TLTA	The ratio of total loans to total assets.
NPL	The ratio of non-performing loans to gross loans.
CIR	The ratio of operating expenses to operating income.
ROA	The ratio of net income to average total assets.
CDTA	The ratio of customer deposits to total assets.
NIOR	The ratio of net interest income to total operating revenue.
Control variables (Macroeconomic)	
GDP	The annual growth rate of real Gross Domestic Product.
CPI	The annual inflation rate based on the Consumer Price Index.

Table 2. Descriptive statistics

	Obs	Mean	Std. Dev.	Min	Max
Dependent variables					
Ln(Z-score 1)	4466	1.34	0.26	0.35	1.84
Ln(Z-score 2)	4466	1.34	0.25	0.44	1.84
Ln(Z-score 3)	4466	1.08	0.35	-0.33	1.70
Independent variables					
Ln(ESG raw)	4466	1.65	0.20	0.64	2.00
Ln(ESG ind)	4466	1.63	0.44	0.04	2.30
Ln(E)	4466	1.17	0.60	0.00	2.28
Ln(S)	4466	1.57	0.32	0.04	2.10
Ln(G)	4466	1.78	0.30	0.47	2.22
Control variables (Accounting):					
ETA	4466	0.10	0.03	0.04	0.21
TLTA	4466	0.61	0.14	0.15	0.86
NPL	4466	0.03	0.04	0.00	0.27
CIR	4466	0.65	0.15	0.33	1.24
ROA	4466	0.01	0.01	-0.01	0.05
CDTA	4466	0.68	0.16	0.18	0.91
NIOR	4466	0.29	0.14	-0.01	0.75
Control variables (Macroeconomic):					
GDP	4466	2.59	2.93	-7.81	9.69
CPI	4466	3.10	3.23	-1.12	18.45

Table 3. Correlation matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ln(Z-score 1)	1																
Ln(Z-score 2)	0.989	1															
Ln(Z-score 3)	0.981	0.992	1														
Ln(ESG raw)	-0.043	-0.047	-0.061	1													
Ln(ESG ind)	-0.042	-0.044	-0.059	0.462	1												
Ln(E)	-0.093	-0.1	-0.121	0.304	0.313	1											
Ln(S)	-0.066	-0.071	-0.087	0.353	0.266	0.214	1										
Ln(G)	0.129	0.134	0.139	0.21	0.184	-0.134	-0.123	1									
ETA	0.081	0.083	0.101	-0.087	-0.083	-0.236	-0.094	0.082	1								
TLTA	0.175	0.185	0.196	-0.091	-0.105	-0.23	-0.162	0.21	0.108	1							
NPL	-0.4	-0.414	-0.435	0.134	0.113	0.202	0.176	-0.162	0.051	-0.341	1						
CIR	-0.298	-0.295	-0.301	0.018	-0.025	0.082	0.072	-0.113	-0.213	-0.042	0.295	1					
ROA	0.016	0.007	0.017	0.059	0.069	-0.061	0.03	0.041	0.545	-0.067	0.063	-0.534	1				
CDTA	0.126	0.137	0.16	-0.146	-0.126	-0.326	-0.215	0.161	0.07	0.262	-0.252	-0.037	0.006	1			
NIOR	-0.048	-0.052	-0.064	0.156	0.158	0.299	0.196	-0.081	-0.202	-0.41	0.113	0.133	-0.028	-0.261	1		
GDP	-0.039	-0.047	-0.052	-0.082	0.033	-0.041	-0.024	-0.047	0.076	-0.034	0.009	-0.193	0.217	-0.004	-0.046	1	
CPI	-0.286	-0.294	-0.296	-0.044	0.013	-0.046	0.003	-0.113	0.072	-0.164	0.165	-0.097	0.358	-0.079	-0.061	0.218	1

Table 4. Multivariate fixed-effects panel regressions of bank financial stability on ESG scores

	Ln (Z-score 1)	Ln (Z-score 2)	Ln (Z-score 3)	Ln (Z-score 1)	Ln (Z-score 2)	Ln (Z-score 3)
Ln (ESG raw)	0.013 (0.012)	0.016 (0.011)	0.018 (0.016)			
Ln (ESG ind)				0.003 (0.010)	0.006 (0.010)	0.009 (0.014)
ETA	1.165*** (0.265)	1.201*** (0.274)	1.814*** (0.384)	1.160*** (0.266)	1.197*** (0.277)	1.811*** (0.387)
TLTA	0.166* (0.086)	0.185* (0.098)*	0.257* (0.139)	0.166* (0.086)	0.185* (0.097)	0.256* (0.138)
NPL	-0.896*** (0.195)	-0.869*** (0.215)	-1.228*** (0.327)	-0.897*** (0.196)	-0.869*** (0.216)	-1.226*** (0.329)
CIR	-0.255*** (0.087)	-0.271*** (0.080)	-0.374*** (0.106)	-0.256*** (0.087)	-0.271*** (0.080)	-0.375*** (0.106)
ROA	-0.652 (2.381)	-1.103 (2.32)	-1.111 (3.207)	-0.652 (2.369)	-1.109 (2.31)	-1.123 (3.194)
CDTA	-0.213** (0.095)	-0.200** (0.087)	-0.274** (0.111)	-0.213** (0.096)	-0.201** (0.089)	-0.276** (0.112)
NIOR	0.042 (0.049)	0.045 (0.053)	0.051 (0.069)	0.042 (0.049)	0.045 (0.053)	0.051 (0.069)
GDP	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.004)	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.004)
CPI	-0.009*** (0.003)	-0.011*** (0.003)	-0.014*** (0.004)	-0.009*** (0.003)	-0.010*** (0.003)	-0.014*** (0.004)
Num.Obs.	4400	4400	4400	4400	4400	4400
R2	0.667	0.675	0.696	0.667	0.675	0.697
RMSE	0.15	0.14	0.19	0.15	0.14	0.19

Notes: This table reports coefficients from regressions of log Z-score measures on ESG scores with additive bank, country, and year fixed effects. Standard errors (in parentheses) are two-way clustered by bank and country. Controls (lagged) include capital ratio (ETA), leverage (TLTA), non-performing loans (NPL), cost-income ratio (CIR), profitability (ROA), deposit funding (CDTA), net interest operating ratio (NIOR), and macro variables (GDP growth and CPI inflation). ESG variables are lagged and logged: “ESG (raw, ln)” is the unadjusted comprehensive score; “ESG (ind)” is demeaned within industry before logging. The dependent variables are log Z-score measures: Ln (Z-score 1), Ln (Z-score 2), and Ln (Z-score 3). RMSE is the root mean squared error. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. N = 4,400 bank-year observations.

Table 5. Multivariate fixed-effects panel regressions of bank financial on ESG pillars

	Ln (Z-score 1)	Ln (Z-score 2)	Ln (Z-score 3)	Ln (Z-score 1)	Ln (Z-score 2)	Ln (Z-score 3)	Ln (Z-score 1)	Ln (Z-score 2)	Ln (Z-score 3)
Ln (E)	-0.001 (0.013)	-0.003 (0.012)	-0.004 (0.016)						
Ln (S)				-0.016** (0.007)	-0.016** (0.007)	-0.024** (0.009)			
Ln (G)							0.023 (0.014)	0.029** (0.014)	0.036* (0.019)
ETA	1.159*** (0.275)	1.197*** (0.283)	1.810*** (0.394)	1.160*** (0.267)	1.194*** (0.277)	1.807*** (0.388)	1.151*** (0.266)	1.184*** (0.275)	1.794*** (0.384)
TLTA	0.165** (0.081)	0.182* (0.093)	0.253* (0.132)	0.167* (0.085)	0.186* (0.097)	0.259* (0.138)	0.168* (0.085)	0.188* (0.097)	0.260* (0.139)
NPL	- 0.899*** (0.198)	- 0.871*** (0.217)	- 1.230*** (0.330)	- 0.906*** (0.197)	- 0.879*** (0.218)	- 1.241*** (0.332)	- 0.886*** (0.195)	- 0.855*** (0.215)	- 1.210*** (0.328)
CIR	- 0.255*** (0.087)	- 0.271*** (0.079)	- 0.374*** (0.105)	- 0.254*** (0.086)	- 0.270*** (0.079)	- 0.373*** (0.104)	- 0.251*** (0.085)	- 0.266*** (0.078)	- 0.368*** (0.104)
ROA	-0.644 (2.379)	-1.094 (2.31)	-1.102 (3.197)	-0.623 (2.381)	-1.073 (2.319)	-1.07 (3.207)	-0.573 (2.344)	-1.001 (2.275)	-0.989 (3.146)
CDTA	-0.213** (0.094)	-0.199** (0.086)	-0.274** (0.110)	-0.213** (0.094)	-0.199** (0.087)	-0.274** (0.109)	-0.217** (0.095)	-0.205** (0.088)	-0.280** (0.111)
NIOR	0.043 (0.05)	0.046 (0.054)	0.052 (0.07)	0.043 (0.05)	0.046 (0.054)	0.052 (0.07)	0.041 (0.049)	0.043 (0.053)	0.048 (0.068)
GDP	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.004)	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.004)	-0.003 (0.003)	-0.003 (0.003)	-0.004 (0.004)
CPI	- 0.009*** (0.003)	- 0.011*** (0.003)	- 0.014*** (0.004)	- 0.009*** (0.003)	- 0.010*** (0.003)	- 0.014*** (0.004)	- 0.009*** (0.003)	- 0.011*** (0.003)	- 0.014*** (0.004)
Num.Obs.	4400	4400	4400	4400	4400	4400	4400	4400	4400
R2	0.667	0.675	0.696	0.667	0.675	0.697	0.667	0.675	0.697
RMSE	0.15	0.14	0.19	0.15	0.14	0.19	0.15	0.14	0.19
FE:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
bank_id									
FE:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
country									
FE: year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports coefficients from regressions of log Z-score measures on the individual ESG pillar scores. The specification, fixed effects, clustering, and control variables are identical to those in Table 4. The independent variables are the natural logarithms of the Environmental (Ln(E)), Social (Ln(S)), and Governance (Ln(G)) pillar scores from MSCI. The dependent variables are log Z-score measures: Ln (Z-score 1), Ln (Z-score 2), and Ln (Z-score 3). RMSE is the root mean squared error. ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. N = 4,400 bank-year observations

Table 6. ESG slope by lagged Z-score quartile (within year)

Outcome	ESG var	Q1 (lag-Q1)	Q2 (lag-Q2)	Q3 (lag-Q3)	Q4 (lag-Q4)	N
Ln (Z-score 1)	Ln (ESG raw)	-0.072***	-0.003	0.027*	0.071***	3725
Ln (Z-score 1)	Ln (ESG ind)	-0.064***	-0.002	0.027***	0.070***	3725
Ln (Z-score 1)	Ln (E)	-0.086***	-0.016*	0.020**	0.070***	3725
Ln (Z-score 1)	Ln (S)	-0.086***	-0.016*	0.015	0.061***	3725
Ln (Z-score 1)	Ln (G)	-0.046***	0.017	0.044***	0.083***	3725
Ln (Z-score 2)	Ln (ESG raw)	-0.074***	-0.009	0.024	0.066***	3725
Ln (Z-score 2)	Ln (ESG ind)	-0.062***	-0.002	0.030***	0.071***	3725
Ln (Z-score 2)	Ln (E)	-0.088***	-0.020***	0.016*	0.066***	3725
Ln (Z-score 2)	Ln (S)	-0.085***	-0.019**	0.014	0.059***	3725
Ln (Z-score 2)	Ln (G)	-0.042***	0.019	0.048***	0.086***	3725
Ln (Z-score 3)	Ln (ESG raw)	-0.097***	-0.006	0.040*	0.083***	3725
Ln (Z-score 3)	Ln (ESG ind)	-0.081***	0.001	0.046***	0.087***	3725
Ln (Z-score 3)	Ln (E)	-0.116***	-0.019*	0.028**	0.080***	3725
Ln (Z-score 3)	Ln (S)	-0.116***	-0.025*	0.022*	0.067***	3725
Ln (Z-score 3)	Ln (G)	-0.064***	0.022	0.064***	0.101***	3725

Notes: Quartiles are formed each year using the lagged outcome (Q1 is the lowest lagged Z-score). Entries are ESG coefficients from a single interaction regression with bank and year fixed effects; standard errors are clustered by bank, country×year, and country. Stars: * p<0.10, ** p<0.05, *** p<0.01.

Table 7. ESG quartile differences in bank financial stability within year

Outcome	ESG var	Q2 – Q1	Q3 – Q1	Q4 – Q1	N
Ln (Z-score 1)	Ln (ESG raw)	-0.002	0.001	0.002	4400
Ln (Z-score 1)	Ln (ESG ind)	0.003	-0.006	0.005	4400
Ln (Z-score 1)	Ln (E)	-0.000	-0.012	0.008	4400
Ln (Z-score 1)	Ln (S)	-0.012***	-0.001	-0.008	4400
Ln (Z-score 1)	Ln (G)	0.008	0.013	0.018	4400
Ln (Z-score 2)	Ln (ESG raw)	-0.000	0.004	0.005	4400
Ln (Z-score 2)	Ln (ESG ind)	0.005	-0.000	0.010	4400
Ln (Z-score 2)	Ln (E)	0.000	-0.012	0.005	4400
Ln (Z-score 2)	Ln (S)	-0.009**	-0.001	-0.009	4400
Ln (Z-score 2)	Ln (G)	0.009	0.015	0.021*	4400
Ln (Z-score 3)	Ln (ESG raw)	0.000	0.003	0.004	4400
Ln (Z-score 3)	Ln (ESG ind)	0.005	0.001	0.010	4400
Ln (Z-score 3)	Ln (E)	0.001	-0.015	0.009	4400
Ln (Z-score 3)	Ln (S)	-0.015***	-0.004	-0.018	4400
Ln (Z-score 3)	Ln (G)	0.014	0.022	0.027*	4400

Note: Entries report coefficient differences in the outcome relative to ESG Quartile 1 within the same year (Q2 – Q1, Q3 – Q1, Q4 – Q1), estimated from regressions with bank and year fixed effects and the full control set. Standard errors are clustered by bank, by country×year, and by country; p-values are shown in parentheses. * p<0.10, ** p<0.05, *** p<0.01.

Table 8. Country influence diagnostics and equal country weighted estimates

Outcome	ESG spec	Baseline β (SE)	Worst country	$\Delta\beta$ country	Δ SE country	USA $\Delta\%$	JPN $\Delta\%$	Equal-weight β (SE)
Ln (Z-score 1)	Ln (ESG raw)	0.013 (0.012)	TUR	+0.008	+0.62	+3.3%	+27.4%	0.030 (0.023)
Ln (Z-score 1)	Ln (ESG ind)	0.003 (0.010)	USA	-0.010	-0.99	-305.6%	-64.4%	-0.006 (0.012)
Ln (Z-score 1)	Ln (E)	-0.001 (0.013)	USA	-0.020	-1.52	-2024.4%	-11.9%	-0.020 (0.011)
Ln (Z-score 1)	Ln (S)	-0.016 (0.007)	USA	+0.003	+0.50	+21.1%	+9.4%	0.012 (0.016)
Ln (Z-score 1)	Ln (G)	0.023 (0.014)	JPN	-0.006	-0.44	+12.3%	-27.3%	-0.022 (0.028)
Ln (Z-score 2)	Ln (ESG raw)	0.016 (0.011)	TUR	+0.007	+0.57	+14.6%	+15.6%	0.027 (0.022)
Ln (Z-score 2)	Ln (ESG ind)	0.006 (0.010)	USA	-0.011	-1.07	-167.6%	-37.0%	-0.007 (0.012)
Ln (Z-score 2)	Ln (E)	-0.003 (0.012)	USA	-0.017	-1.37	-485.9%	-25.6%	-0.020 (0.011)
Ln (Z-score 2)	Ln (S)	-0.016 (0.007)	USA	+0.005	+0.70	+30.3%	+7.2%	0.013 (0.015)
Ln (Z-score 2)	Ln (G)	0.029 (0.014)	FRA	-0.005	-0.40	+7.5%	-18.3%	-0.012 (0.027)
Ln (Z-score 3)	Ln (ESG raw)	0.018 (0.016)	USA	+0.009	+0.59	+53.0%	+8.2%	0.028 (0.030)
Ln (Z-score 3)	Ln (ESG ind)	0.009 (0.014)	USA	-0.014	-1.05	-154.1%	-45.0%	-0.012 (0.017)
Ln (Z-score 3)	Ln (E)	-0.004 (0.016)	USA	-0.020	-1.22	-545.3%	-43.2%	-0.028 (0.016)
Ln (Z-score 3)	Ln (S)	-0.024 (0.009)	USA	+0.007	+0.71	+27.1%	+0.2%	0.009 (0.020)
Ln (Z-score 3)	Ln (G)	0.036 (0.019)	JPN	-0.008	-0.41	+17.7%	-22.0%	-0.025 (0.036)

Notes: $\Delta\beta$ is the change in the ESG coefficient when excluding all observations from the listed country; Δ SE is that change divided by the baseline standard error. USA $\Delta\%$ and JPN $\Delta\%$ are percentage changes relative to the baseline coefficient. The equal country weighted estimate reweights observations so each country receives the same total weight. Model specification, fixed effects, and clustering match the baseline results.

Table 9. Year influence diagnostics

Outcome	ESG spec	Baseline β (SE)	Worst year	$\Delta\beta$ year	Δ/SE year
Ln (Z-score 1)	Ln (ESG raw)	0.013 (0.012)	2019	+0.013	+1.08
Ln (Z-score 1)	Ln (ESG ind)	0.003 (0.010)	2024	-0.004	-0.40
Ln (Z-score 1)	Ln (E)	-0.001 (0.013)	2024	+0.005	+0.40
Ln (Z-score 1)	Ln (S)	-0.016 (0.007)	2024	+0.008	+1.19
Ln (Z-score 1)	Ln (G)	0.023 (0.014)	2015	-0.010	-0.69
Ln (Z-score 2)	Ln (ESG raw)	0.016 (0.011)	2019	+0.014	+1.23
Ln (Z-score 2)	Ln (ESG ind)	0.006 (0.010)	2024	-0.005	-0.53
Ln (Z-score 2)	Ln (E)	-0.003 (0.012)	2024	+0.005	+0.42
Ln (Z-score 2)	Ln (S)	-0.016 (0.007)	2024	+0.005	+0.76
Ln (Z-score 2)	Ln (G)	0.029 (0.014)	2015	-0.011	-0.78
Ln (Z-score 3)	Ln (ESG raw)	0.018 (0.016)	2019	+0.020	+1.24
Ln (Z-score 3)	Ln (ESG ind)	0.009 (0.014)	2024	-0.008	-0.59
Ln (Z-score 3)	Ln (E)	-0.004 (0.016)	2024	+0.006	+0.36
Ln (Z-score 3)	Ln (S)	-0.024 (0.009)	2019	+0.008	+0.84
Ln (Z-score 3)	Ln (G)	0.036 (0.019)	2015	-0.014	-0.74

Notes: Each entry shows the change in the ESG coefficient when dropping a single calendar year. $\Delta\beta$ is the leave one year out change in the coefficient; Δ/SE scales this change by the baseline standard error to ease comparison. Model specification, fixed effects, and clustering match the baseline results.

Table 10. COVID 19 shock and change in ESG slope relative to pre 2020

Outcome	ESG spec	Slope change vs. pre-2020			Placebo cutoffs	
		Post-2020 Δ slope	Acute (20–21)	Recovery (22–24)	Placebo 2018	Placebo 2017
Ln (Z-score 1)	Ln (ESG raw)	-0.014	0.016	-0.035	-0.059	-0.064
Ln (Z-score 1)	Ln (ESG ind)	-0.023	-0.020	-0.027	-0.021	-0.029
Ln (Z-score 1)	Ln (E)	0.013	0.034	-0.001	0.014	0.014
Ln (Z-score 1)	Ln (S)	0.031	0.048**	0.019	0.004	-0.014
Ln (Z-score 1)	Ln (G)	-0.085**	-0.131***	-0.053	-0.034	-0.024
Ln (Z-score 2)	Ln (ESG raw)	-0.021	0.012	-0.044	-0.064	-0.064
Ln (Z-score 2)	Ln (ESG ind)	-0.029	-0.024	-0.034*	-0.022	-0.028
Ln (Z-score 2)	Ln (E)	0.009	0.032*	-0.006	0.013	0.013

Table 10. Continued

Outcome	ESG spec	Slope change vs. pre-2020			Placebo cutoffs	
		Post-2020 Δ slope	Acute (20–21)	Recovery (22–24)	Placebo 2018	Placebo 2017
Ln (Z-score 2)	Ln (S)	0.027	0.048**	0.012	-0.003	-0.020
Ln (Z-score 2)	Ln (G)	-0.080**	-0.125***	-0.049	-0.032	-0.021
Ln (Z-score 3)	Ln (ESG raw)	-0.022	0.031	-0.061	-0.076	-0.075
Ln (Z-score 3)	Ln (ESG ind)	-0.039	-0.028	-0.048*	-0.026	-0.032
Ln (Z-score 3)	Ln (E)	0.011	0.045*	-0.011	0.020	0.019
Ln (Z-score 3)	Ln (S)	0.037	0.071***	0.012	-0.007	-0.029
Ln (Z-score 3)	Ln (G)	-0.098**	-0.164***	-0.053	-0.032	-0.017

Notes: Entries report the change in the ESG slope relative to the pre 2020 period from regressions with bank fixed effects and year dummies, with standard errors clustered by bank, by country×year, and by country. Acute is 2020–2021 and Recovery is 2022–2024. Wald tests show the p values for the joint test that both changes are zero and for the equality of the two changes. Placebo cutoffs at 2018 and 2017 provide falsification checks. Bold indicates $p < 0.05$; italics indicate $0.05 \leq p < 0.10$.

Table 11. Arellano–Bond GMM diagnostics and ESG coefficients

Outcome	ESG_spec	ESG coeff (SE)	AR1_p	AR2_p	Hansen_p	N_groups	N_obs
Ln (Z-score 1)	Ln (ESG raw)	0.383 (0.154)**	0	0.383	0.156	688	3104
Ln (Z-score 1)	Ln (ESG ind)	0.097 (0.051)*	0	0.295	0.038	688	3104
Ln (Z-score 1)	Ln (E)	0.128 (0.057)**	0	0.495	0.771	688	3104
Ln (Z-score 1)	Ln (S)	0.136 (0.062)**	0	0.607	0.617	688	3104
Ln (Z-score 1)	Ln (G)	0.264 (0.114)**	0	0.458	0.438	688	3104
Ln (Z-score 2)	Ln (ESG raw)	0.388 (0.136)***	0	0.388	0.048	688	3104
Ln (Z-score 2)	Ln (ESG ind)	0.100 (0.045)**	0	0.314	0.005	688	3104
Ln (Z-score 2)	Ln (E)	0.131 (0.051)**	0	0.585	0.475	688	3104
Ln (Z-score 2)	Ln (S)	0.138 (0.054)**	0	0.675	0.185	688	3104
Ln (Z-score 2)	Ln (G)	0.267 (0.099)***	0	0.526	0.350	688	3104
Ln (Z-score 3)	Ln (ESG raw)	0.381 (0.195)*	0	0.441	0.561	688	3104

Table 11. Continued

Outcome	ESG_spec	ESG coeff (SE)	AR1_p	AR2_p	Hansen_p	N_groups	N_obs
Ln (Z-score 3)	Ln (ESG ind)	0.098 (0.066)	0	0.623	0.123	688	3104
Ln (Z-score 3)	Ln (E)	0.131 (0.072)*	0	0.312	0.732	688	3104
Ln (Z-score 3)	Ln (S)	0.143 (0.076)*	0	0.257	0.879	688	3104
Ln (Z-score 3)	Ln (G)	0.282 (0.149)*	0	0.400	0.308	688	3104

Notes: Estimated by two-step first-difference GMM with a collapsed instrument matrix. Lagged levels of the dependent variable and ESG (t-2:t-3) serve as GMM instruments; other regressors are treated as standard instruments. The number of instruments is 13. AR1_p and AR2_p are Arellano-Bond serial-correlation tests (desired pattern: reject AR(1), do not reject AR(2)); Hansen_p tests overidentifying restrictions. N_groups and N_obs are banks and bank-years.

Table 12. Tests of Non-Linearity in the ESG-Bank Financial Stability Relationship (Quadratic Specification)

Outcome	ESG spec	$\beta(\text{ESG}_c)$	$\beta(\text{ESG}_c^2)$	N	RMSE	Within R ²
Ln (Z-score 1)	ESG (raw)	0.0378	0.0494	4400	0.148	0.054
Ln (Z-score 1)	ESG (ind)	0.0037	0.0005	4400	0.148	0.053
Ln (Z-score 1)	Ln (E)	-0.0003	0.0021	4400	0.148	0.053
Ln (Z-score 1)	Ln (S)	-0.0148	0.0016	4400	0.148	0.054
Ln (Z-score 1)	Ln (G)	0.0189	-0.0067	4400	0.148	0.054
Ln (Z-score 2)	ESG (raw)	0.0411	0.0496	4400	0.142	0.059
Ln (Z-score 2)	ESG (ind)	0.0105	0.0043	4400	0.142	0.059
Ln (Z-score 2)	Ln (E)	-0.0027	0.0024	4400	0.142	0.059
Ln (Z-score 2)	Ln (S)	-0.0139	0.0017	4400	0.142	0.059
Ln (Z-score 2)	Ln (G)	0.0209	-0.0151	4400	0.142	0.061
Ln (Z-score 3)	ESG (raw)	0.0390	0.0425	4400	0.189	0.0667
Ln (Z-score 3)	ESG (ind)	0.0112	0.0020	4400	0.189	0.0666
Ln (Z-score 3)	Ln (E)	-0.0032	0.0013	4400	0.189	0.0664
Ln (Z-score 3)	Ln (S)	-0.0229	0.0012	4400	0.189	0.0672
Ln (Z-score 3)	Ln (G)	0.0276	-0.0148	4400	0.189	0.0678

Note: This table presents tests for non-linearity in the ESG-bank financial stability relationship by augmenting the baseline fixed-effects specification with a squared ESG term. All models include bank, country, and year fixed effects, with standard errors two-way clustered by bank and country. The control set is identical to Table 4. The dependent variables are the log Z-scores defined in Table 1. Statistical significance: * p<0.10, ** p<0.05, *** p<0.01.

Table 13. Placebo lead test for ESG with current and next year ESG

Outcome	ESG spec	$\beta(\text{ESG}_t)$ (SE)	$\beta(\text{Lead ESG}_{t+1})$ (SE)	N	RMSE	R ²	Within R ²
Ln (Z-score 1)	ESG (raw)	-0.017 (0.013)	0.000 (0.013)	3725	0.142	0.679	0.054
Ln (Z-score 1)	ESG (ind)	0.001 (0.008)	0.009* (0.005)	3725	0.142	0.679	0.054
Ln (Z-score 1)	Ln (E)	0.012 (0.010)	-0.004 (0.007)	3725	0.142	0.679	0.054
Ln (Z-score 1)	Ln (S)	-0.013 (0.009)	-0.015* (0.008)	3725	0.142	0.680	0.055
Ln (Z-score 1)	Ln (G)	0.033** (0.015)	0.009 (0.013)	3725	0.142	0.680	0.056
Ln (Z-score 2)	ESG (raw)	-0.010 (0.012)	0.004 (0.013)	3725	0.137	0.684	0.059
Ln (Z-score 2)	ESG (ind)	0.003 (0.008)	0.008 (0.005)	3725	0.137	0.684	0.059
Ln (Z-score 2)	Ln (E)	0.009 (0.01)	-0.003 (0.007)	3725	0.137	0.684	0.059
Ln (Z-score 2)	Ln (S)	-0.015* (0.008)	-0.013 (0.008)	3725	0.137	0.684	0.06
Ln (Z-score 2)	Ln (G)	0.034** (0.014)	0.013 (0.012)	3725	0.137	0.685	0.062
Ln (Z-score 3)	ESG (raw)	-0.021 (0.015)	-0.005 (0.017)	3725	0.182	0.705	0.066
Ln (Z-score 3)	ESG (ind)	0.003 (0.010)	0.010 (0.006)	3725	0.182	0.705	0.066
Ln (Z-score 3)	Ln (E)	0.011 (0.012)	-0.004 (0.010)	3725	0.182	0.705	0.066
Ln (Z-score 3)	Ln (S)	-0.023* (0.012)	-0.016 (0.011)	3725	0.182	0.706	0.067
Ln (Z-score 3)	Ln (G)	0.048** (0.020)	0.012 (0.017)	3725	0.182	0.706	0.068

Note: This table examines potential reverse causality by including both contemporaneous and one-year lead values of ESG measures in the fixed-effects specification. The model specification, fixed effects, clustering, and control variables are identical to Table 4. A statistically insignificant coefficient on the lead ESG term suggests that future bank financial stability does not predict current ESG performance, supporting a causal interpretation of our main results. *** p<0.01, ** p<0.05, * p<0.10.

Appendix

We construct three variants of the Z-score to ensure robustness across alternative measures of bank financial stability.

Z-score 1

$$Z - score_1 = \frac{ROA + (Equity/Total Assets)}{\sigma(ROA)}$$

Z-score 2

Five-year rolling averages of ROA and ETA divided by the standard deviation of ROA.

Z-score 3

Five-year rolling averages scaled by the range of ROA over the previous five years. All measures are expressed in logarithmic form in the empirical analysis.