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Do ESG Factors Enhance Bank Stability? Evidence from Emerging Markets

Sevgi Eren Dogan [1,*] and Serkan Cankaya [2]

[1] Graduate School of Trade and Finance, Istanbul Ticaret University, Istanbul 34000, Türkiye
[2] Department of Finance and Banking, Faculty of Business, Istanbul Ticaret University, Istanbul 34000, Türkiye; scankaya@ticaret.edu.tr
* Correspondence: sevgieren74@gmail.com

Abstract

This study examines the relationship between environmental, social, and governance (ESG) performance and bank default risk in the E7 emerging economies over the period 2013–2024. Using a panel dataset of publicly listed banks, the analysis evaluates whether overall ESG performance and its individual dimensions contribute to financial stability while accounting for bank-specific and macroeconomic factors. The findings indicate that stronger overall ESG performance is associated with lower bank default risk. However, the effects of individual ESG dimensions are heterogeneous. The social dimension strengthens financial stability, whereas the environmental and governance dimensions exhibit weaker or mixed effects, particularly in the short-term, reflecting transition-related costs and institutional differences across emerging markets. The originality of this study lies in its comprehensive assessment of ESG performance at both the aggregate and component levels within the E7 banking sector, a setting that has received limited attention in the existing literature. By providing evidence from major emerging economies, the study extends current knowledge on the ESG–risk nexus and highlights the importance of considering institutional heterogeneity when evaluating the financial implications of sustainability practices. The findings offer practical implications for bank managers, investors, and policymakers by suggesting that effective ESG integration can strengthen bank resilience and support the development of more sustainable and stable financial systems.

Keywords: bank default risk; sustainability; panel data analysis

1. Introduction

The banking sector plays a central role in the stability of the financial system, and bank default risk has significant implications at both the micro and macro levels. Accordingly, the determinants of bank default risk have been widely examined in the finance literature. Existing studies provide substantial evidence of the impact of bank-specific financial indicators and macroeconomic conditions on default risk [1–3]. More recently, the role of sustainability performance has attracted growing attention, and ESG (environmental, social, and governance) factors have emerged as a key dimension in understanding risk dynamics in the banking sector.

The impact of ESG performance on default risk is mainly discussed within two competing theoretical perspectives: stakeholder theory and agency theory. Stakeholder theory [4], which emphasizes risk mitigation, suggests that strong ESG performance can reduce default risk [5]. According to this view, ESG practices and transparent disclosure of related

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information may reduce information asymmetry, strengthen stakeholder relationships, and improve both corporate reputation and financial performance, thereby enhancing firms' debt repayment capacity [5–7].

In contrast, agency theory argues that excessive investment in ESG activities may stem from managerial opportunism. From this perspective, managers may allocate firm resources disproportionately to ESG initiatives in order to enhance their personal reputation or pursue private benefits. Such behavior can lead to inefficient resource allocation, weaken core business activities, and ultimately increase default risk [8,9].

Building upon the foundations of stakeholder theory and agency theory, the relationship between ESG performance and banking risk can also be interpreted within the broader conceptual framework of sustainable finance and financial stability. In recent years, international regulatory institutions, including the European Central Bank (ECB) and the Network for Greening the Financial System (NGFS), have recognized climate-related transition risks as a potential source of systemic financial vulnerability and have emphasized the integration of such risks into prudential supervision and financial stability frameworks [10–12].

From this perspective, ESG integration should not only be viewed as a reputational or ethical consideration, but also as part of a broader prudential risk management framework. Strong ESG performance may enhance banks' capacity to identify, monitor, and manage sustainability-related financial risks, thereby supporting long-term financial stability. At the same time, the transition toward sustainable finance may generate short-term adjustment costs associated with portfolio restructuring, regulatory compliance, climate stress testing, and enhanced disclosure requirements. Consequently, ESG-related investments may simultaneously produce stabilizing long-term effects and transitional short-term pressures on bank balance sheets.

This dual structure helps explain why the empirical relationship between ESG dimensions and bank stability may not always be linear or homogeneous. While sustainability-oriented practices can strengthen resilience, transparency, and stakeholder confidence over time, the regulatory and operational burdens associated with the green transition may temporarily increase financial pressure, particularly in emerging economies where institutional and market structures remain relatively fragile. In this sense, ESG performance is closely linked not only to individual bank risk management, but also to broader macroprudential objectives and systemic financial stability.

Although both traditional stakeholder and agency theory perspectives acknowledge that ESG practices can influence default risk, the direction, magnitude, and timing of this relationship remain inconclusive and require further empirical investigation. Moreover, existing evidence is largely derived from developed economies and frequently relies on aggregate ESG measures, providing limited insight into the heterogeneous effects of individual ESG dimensions within emerging banking systems. Against this backdrop, this study offers a novel perspective by examining the ESG–default risk relationship in the banking sectors of the E7 economies, where institutional environments, regulatory frameworks, and sustainability practices differ substantially from those of developed markets. First, it sheds light on the relationship between sustainability performance and bank default risk by focusing on E7 economies, thereby extending the existing literature to a group of major emerging markets that has received relatively limited empirical attention. Second, rather than treating ESG as a single aggregate measure, the study adopts a disaggregated approach by separately examining its environmental, social, governance, and controversies dimensions, thereby providing a more nuanced understanding of how different aspects of sustainability affect bank stability. Third, the study contributes methodologically by addressing key econometric challenges—including heteroskedasticity, serial correlation,

and cross-sectional dependence—through the use of Driscoll–Kraay standard errors [13] and by validating the baseline findings through a series of robustness analyses, including System GMM estimation [14,15], an alternative risk measure based on default probability, and leave-one-country-out analysis. Finally, by focusing specifically on the banking sector, the study extends the predominantly non-financial firm literature and provides evidence that contributes to a more comprehensive understanding of the role of sustainability in banking risk and financial stability.

2. Literature Review

The determinants of bank default risk have been widely examined in the finance literature, with a general consensus that risk is shaped by a combination of bank-specific financial factors and macroeconomic conditions [16]. At the bank level, asset quality, profitability, and liquidity are consistently identified as key drivers of financial stability. Deterioration in credit quality, often reflected in higher non-performing loan ratios, weakens bank performance and increases default risk, while lower profitability and insufficient liquidity further constrain banks' ability to absorb shocks [17–24]. These findings highlight the central role of internal financial soundness in determining bank resilience.

Moreover, another factor influencing default risk is the macroeconomic environment in which a country operates. Adverse economic environments tend to impair borrowers' repayment capacity and increase credit risk, leading to higher default probabilities [16]. However, the relationship between economic growth and bank default risk remains ambiguous. While economic expansion may improve financial conditions, it can also stimulate credit growth and lead to a relaxation of lending standards [25]. Empirical findings reflect this duality, with several studies documenting a negative relationship between GDP growth and default risk [26–29], while others have found the effect to be statistically insignificant [30].

More recently, the literature has expanded to incorporate sustainability performance, particularly ESG (environmental, social, and governance) factors, as an additional determinant of financial risk. A large body of evidence suggests that sustainability performance is generally not negatively associated with financial outcomes [31]. The ESG–risk nexus is commonly explained through competing theoretical perspectives. The risk mitigation view argues that stronger ESG performance reduces operational, financial, and reputational risks by enhancing transparency and strengthening stakeholder relationships [32,33]. In contrast, agency-based arguments suggest that excessive investment in ESG activities may reflect managerial opportunism, leading to inefficient resource allocation and potentially higher risk [34].

Empirical studies focusing on the banking sector largely support the risk-reducing role of sustainability performance. Higher ESG engagement is associated with lower risk levels and improved financial stability, while ESG indicators have also been shown to enhance the prediction of financial distress [35–42]. However, the effects of ESG are not uniform across its components. Different dimensions of sustainability may influence bank risk through distinct channels, suggesting that a disaggregated analysis is necessary to fully capture these dynamics.

Although the literature examining the link between ESG performance and bank risk has expanded considerably in recent years, several important research gaps persist. First, most empirical studies have focused on developed economies, while emerging markets have received relatively limited attention despite their distinct institutional settings, regulatory environments, and sustainability practices. Second, evidence from E7 countries remains scarce, even though these economies play an increasingly significant role in the global financial system. Third, existing research predominantly relies on aggregate ESG

indicators, offering a limited understanding of how the environmental, social, and governance dimensions may affect bank stability through different mechanisms. Consequently, the heterogeneous effects of individual ESG pillars remain insufficiently explored. By investigating both overall ESG performance and its sub-dimensions within the context of E7 banking systems, this study contributes to the literature by providing a more comprehensive assessment of the ESG–bank stability nexus.

Building on the theoretical background and prior empirical evidence, this study develops a set of testable hypotheses regarding the relationship between sustainability performance and bank stability.

Previous studies generally suggest that firms with stronger ESG performance benefit from enhanced stakeholder relationships, improved transparency, lower information asymmetry, and more effective risk management practices, all of which contribute to greater financial resilience [31,43–45]. Consistent with stakeholder theory, these mechanisms are expected to strengthen banks' financial stability and reduce their exposure to default risk. Accordingly, the following hypothesis is proposed:

H1. *Overall ESG performance is positively associated with bank stability.*

The environmental dimension of ESG has received more mixed empirical support. While environmental investments may improve operational resilience and reduce long-term exposure to climate-related risks, they may also require substantial capital expenditures, regulatory compliance, portfolio adjustments, and transition-related investments [10–12]. Particularly in emerging economies, where financial and regulatory infrastructures are still evolving, these short-term adjustment costs may outweigh the immediate benefits and place additional pressure on banks' financial positions. Based on these arguments, the environmental dimension is expected to have a negative short-term association with bank stability.

H2. *The environmental dimension of ESG is negatively associated with bank stability.*

The governance dimension has also produced inconsistent findings in the existing literature [43,45,46]. Strong governance mechanisms may improve internal controls, enhance transparency, strengthen oversight, and reduce excessive risk-taking, thereby supporting financial stability. Conversely, changes in governance structures may alter managerial incentives, increase compliance requirements, or affect strategic decision-making in ways that do not necessarily translate into immediate improvements in bank stability. Given these competing theoretical arguments and mixed empirical evidence, the direction of the relationship remains ambiguous. Therefore, the following non-directional hypothesis is proposed:

H3. *The governance dimension of ESG is significantly associated with bank stability.*

3. Data and Methodology

3.1. Dataset

The determinants of bank default risk were analyzed in this study using a panel dataset comprising banks operating in E7 countries. The E7 countries—Brazil, China, India, Indonesia, Mexico, Russia, and Turkey—represent the major emerging economies that have gained increasing importance in the global economy due to their rapid economic growth, expanding financial markets, and rising contribution to global output [47–49]. The banking sectors in these countries are exposed to both domestic and global shocks, making them a suitable sample for examining financial stability analyses. The sample consists of

publicly listed commercial banks operating in the E7 countries for which consistent ESG ratings and financial data were available throughout the study period. Banks with missing ESG information or insufficient financial data were excluded to ensure data consistency and comparability across countries. The number of banks included in the sample varied because ESG data availability differs across countries. The empirical sample comprised 40 banks across seven emerging economies: Brazil (5), China (9), India (11), Indonesia (5), Mexico (2), Russia (2), and Turkey (6).

The dataset used in the study covered the period 2013–2024 and exhibited an unbalanced panel structure due to data availability constraints. Bank-level financial data and sustainability indicators were obtained from the Refinitiv Eikon and Bloomberg databases, while macroeconomic variables were sourced from international organizations such as the World Bank. The ESG measures were derived from Refinitiv Eikon, which constructs ESG scores using publicly available information from corporate reports, sustainability disclosures, regulatory filings, and other public sources. In addition to the aggregate ESG score, Refinitiv provides separate environmental, social, and governance pillar scores, allowing for a more detailed assessment of sustainability performance. However, ESG ratings are subject to measurement challenges, as different providers may assign different ratings to the same firm due to variations in methodologies, indicator selection, and weighting schemes. Therefore, ESG scores should be interpreted as proxies for sustainability performance rather than precise measures of firms' actual ESG outcomes, particularly in emerging markets where disclosure quality may vary across firms and countries [50,51]. To address non-stationarity and reduce distributional asymmetry, logarithmic transformation and first differencing were applied to the selected variables. Since the panel dataset may contain cross-sectional dependence, the CIPS panel unit root test was employed to examine the stationarity properties of the variables. The results indicate that ROE is stationary in levels, while the remaining variables become stationary after first differencing.

Prior to empirical analysis, the variable descriptions and summary statistics used are presented in Tables 1 and 2, respectively. Table 3 reports the country-level data utilized in the empirical analysis.

Table 1. Variable descriptions.

Variables	Symbol	Measurement	Data Source
Bank Default Risk	zscore	((Equity/Assets) + ROA)/Standard deviation of ROA	Refinitiv Eikon and Authors' own calculations
Cost of Capital	wacc	Weighted average cost of capital	Bloomberg
ESG Score	esg	Overall ESG score	Refinitiv Eikon
Environmental	esg_e	Environmental score	Refinitiv Eikon
Governance	esg_g	Governance score	Refinitiv Eikon
Controversies	esg_c	ESG controversies	Refinitiv Eikon
Economic Growth	gdp_gr	GDP growth (annual %)	World Development Indicators
Price Index	inf_in	Consumer price index	World Development Indicators
RWA Change	rwa_ch	Risk weighted asset change	Refinitiv Eikon
Asset Growth	ta_ch	Total asset change	Refinitiv Eikon
NPL Ratio	npl_r	Non-performing loans ratio	Refinitiv Eikon
LLP Ratio	llp_r	Loan loss provisions ratio	Refinitiv Eikon

Table 1. *Cont.*

Variables	Symbol	Measurement	Data Source
Loans Ratio	tlta	Total loans/total assets	Refinitiv Eikon
Tobin Q	tobinsq	Market cap/total assets	Refinitiv Eikon
Deposits Ratio	cdta	Customer deposits/total assets	Refinitiv Eikon
ROE	roe	Return on equity	Refinitiv Eikon

Source: Created by the authors.

Table 2. Summary statistics.

	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Observations
zscore	25.203	15.313	0.608	76.099	1.280	4.258	480
wacc	6.997	5.262	0.553	48.103	2.809	18.520	480
esg	57.123	18.161	2.488	90.031	−0.432	3.096	468
esg_c	83.944	25.885	5.389	100.000	−1.476	3.831	468
esg_e	59.983	22.091	0.000	97.279	−0.435	2.716	468
esg_g	52.740	23.730	0.466	97.234	−0.288	2.005	468
gdp_gr	4.665	3.504	−8.354	11.439	−1.109	4.418	480
inf_in	187.075	158.924	111.158	1322.884	5.549	36.538	480
rwa_ch	0.083	0.588	−0.870	11.092	16.258	295.261	426
ta_ch	0.062	0.115	−0.378	0.639	0.288	5.925	477
npl_r	0.030	0.031	0.000	0.194	2.278	8.828	328
llp_r	0.024	0.095	−0.001	1.855	17.254	327.742	430
tlta	0.577	0.126	0.000	1.070	−0.071	5.658	465
tobinsq	0.164	0.189	0.009	1.202	2.233	8.353	478
cdta	0.527	0.232	0.001	0.876	−0.975	2.797	438
roe	14.121	9.340	−93.420	55.590	−3.056	41.419	480

Source: Created by the authors.

Table 3 reports the pairwise correlations among the variables. Most correlations were moderate, indicating no serious multicollinearity concerns. ESG-related variables showed relatively stronger associations, while macroeconomic variables displayed weaker relationships with bank-specific indicators.

Bank default risk is measured using the Z-score indicator, which is widely used in the finance literature. First proposed by Boyd and Rankle in 1993 [1], the Z-score has become one of the fundamental measures for assessing firms' default risk. This approach constructs an index based on the mean and standard deviation, where the resulting value represents the firm's default risk [38,39,52,53]. The use of the mean and standard deviation limits the impact of outliers and skewness, thereby enhancing the accuracy of estimation methods such as linear and logistic regression and making the data more interpretable and comparable [16]. In other words, the Z-score measures a bank's financial resilience by comparing its stability-enhancing factors such as capital adequacy and profitability, with the volatility of its returns. The Z-score is calculated as follows:

$$Z_{it} = \frac{car_{it} + ROA_{it}}{\sigma_{roa,\,it}} \quad (1)$$

Table 3. Pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) zscore	1.000															
(2) wacc	0.244 ***	1.000														
(3) esg	0.124 ***	0.011	1.000													
(4) esg_c	0.009	0.108 **	0.054	1.000												
(5) esg_e	−0.081 *	0.023	0.675 ***	−0.008	1.000											
(6) esg_g	0.263 ***	0.008	0.755 ***	0.130 ***	0.301 ***	1.000										
(7) gdp_gr	−0.105 **	−0.050	−0.097 **	−0.173 ***	0.023	0.010	1.000									
(8) inf_in	−0.152 ***	0.015	0.285 ***	0.066	0.281 ***	0.035	−0.028	1.000								
(9) rwa_ch	0.006	−0.045	−0.070	−0.036	−0.034	−0.021	0.087 *	−0.019	1.000							
(10) ta_ch	0.123 ***	−0.062	−0.034	−0.079 *	−0.062	0.050	0.113 **	0.042	0.208 ***	1.000						
(11) npl_r	−0.182 ***	−0.040	0.152 ***	−0.032	0.224 ***	−0.136 **	−0.171 ***	0.202 ***	−0.109 *	−0.256 ***	1.000					
(12) llp_r	−0.061	−0.036	−0.049	−0.087 *	−0.046	−0.099 **	−0.029	−0.009	−0.022	−0.052	0.248 ***	1.000				
(13) tlta	−0.181 ***	−0.160 ***	−0.044	0.028	−0.145 ***	−0.015	0.131 ***	−0.007	−0.064	−0.184 ***	−0.117 **	−0.086 *	1.000			
(14) tobinsq	0.592 ***	0.135 ***	0.111 **	0.093 **	−0.226 ***	0.206 ***	−0.084 *	−0.074 *	0.061	0.102 **	−0.224 ***	−0.074	0.021	1.000		
(15) cdta	−0.237 ***	−0.160 ***	0.028	−0.117 **	−0.046	−0.080 *	0.132 ***	0.080 *	−0.006	−0.071	0.044	0.025	0.543 ***	0.083 *	1.000	
(16) roe	0.226 ***	0.158 ***	0.187 ***	0.193 ***	0.169 ***	0.185 ***	0.031	0.284 ***	0.058	0.042	−0.164 ***	−0.093 *	−0.078 *	0.171 ***	−0.045	1.000

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$; Source: Created by the authors.

To examine the relationship between sustainability performance and bank default risk, the following fixed-effects panel model is estimated:

$$Z_{it} = \alpha + \beta ESG_{it} + \gamma X_{it} + \delta M_t + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where Z_{it} denotes the Z-score of bank i at time t, ESG_{it} represents the sustainability performance indicator, X_{it} is a vector of bank-specific financial control variables, and M_t denotes macroeconomic factors. The term μ_i captures unobserved bank-specific fixed effects, while λ_t represents time-specific effects common to all banks. Finally, ε_{it} is the idiosyncratic error term.

3.2. Methodology

In panel data analysis, testing whether the underlying model assumptions are satisfied is crucial for obtaining reliable estimation results. In this context, prior to proceeding with the estimation process, the presence of heteroskedasticity, autocorrelation, and cross-sectional dependence in the panel dataset was examined, and the results are summarized in Table 4.

First, the Modified Wald test was employed to detect the presence of heteroskedasticity [54]. The results indicate that the variance of the error terms was not constant across units, implying the presence of heteroscedasticity problem. This issue is commonly encountered in panel data studies, particularly in studies analyzing banks of different sizes [55].

Second, the Wooldridge autocorrelation test was employed to examine the presence of serial correlation in the model. The results indicate that the error terms were correlated over time, confirming the existence of autocorrelation in the panel dataset ($p < 0.01$). As noted by Wooldridge (2010) [56], the presence of serial correlation in panel data models can lead to biased standard error estimates.

Third, given the multi-country nature of the dataset, banks are exposed to common macroeconomic and global shocks, which may cause cross-sectional dependence. To investigate this issue, the Pesaran [57,58] CD test was applied. The results, particularly the power-enhanced statistics (CD* and CDw+), indicate significant cross-sectional dependence across units. This finding is consistent with the high degree of financial integration in the banking sector and suggests a violation of the assumptions underlying conventional panel data estimators.

Table 4. Assumption tests.

Test	Null Hypothesis (H0)	Test Statistic	*p*-Value	Conclusion
Wooldridge Autocorrelation Test	No first-order autocorrelation	F(1,31) = 19.117	0.0001	Reject H0 → Autocorrelation present
Pesaran CD* Test	No cross-sectional dependence	CD* = 2.23	0.026	Reject H0 → CSD present
CDw+ (Juodis–Reese Power-enhanced)	No cross-sectional dependence	CDw+ = 219.99	0.000	Reject H0 → Strong CSD
Modified Wald Test	Homoskedasticity	$\chi^2(35)$ = 10,293.28	0.0000	Reject H0 → Heteroskedasticity present

Note: Created by the authors. CD* denotes the test statistic of the Pesaran [58] cross-sectional dependence test.

Finally, the Hausman (1978) [59] test was employed to identify the most appropriate estimator among pooled OLS, fixed effects, and random effects models. The results consistently favored the fixed effects specification. However, the findings presented above

suggest that standard error estimates based on the conventional fixed-effects model may not be reliable. Therefore, the fixed effects model was estimated using Driscoll and Kraay standard errors, which are robust to heteroskedasticity, cross-sectional dependence, and serial correlation [60]. This estimator provides consistent inference by appropriately adjusting the covariance matrix, regardless of the size of cross-sectional dimension. In panel data models of the form $Y_{it} = \beta X_{it} + u_{it}$, where the error term exhibits heteroskedasticity, autocorrelation, and cross-sectional dependence, the use of robust standard errors is essential to obtain consistent and efficient statistical inference.

$$\hat{\beta} = (XX')^{-1} XY' \tag{3}$$

Driscoll–Kraay standard errors are obtained as the square roots of the diagonal elements of the asymptotic (robust) covariance matrix of the parameter estimates:

$$V(\hat{\beta}) = (XX')^{-1} \hat{S}_T (XX')^{-1} \tag{4}$$

where $\hat{S}_T$ is defined as:

$$\hat{S}_T = \Omega_0 + \sum_{j=1}^{m(T)} w(j, m(T)) \left[\hat{\Omega}_j + \hat{\Omega}_j'\right] \tag{5}$$

Here, $m(T)$ denotes the maximum lag length used to account for autocorrelation. The Bartlett weights, defined as $w(j, m(T)) = 1 - \frac{j}{m(T)+1}$ ensure that $\hat{S}_T$ is positive definite by assigning decreasing weights to higher-order lags in the autocovariance structure.

The $(K+1) \times (K+1)$ dimensional matrix $\hat{\Omega}_j$ is given by:

$$\hat{\Omega}_j = \sum_{t=j+1}^{T} h_t(\hat{\beta}) h_{t-j}(\hat{\beta})' \tag{6}$$

where $h_t(\hat{\beta}) = \sum_{i=1}^{N} h_{it}(\hat{\beta})$ [61]. The moment conditions $h_{it}(\hat{\beta})$ are computed for each cross-sectional unit and time period. This formulation allows the estimator to be applied not only to balanced panels but also, with minor adjustments, to unbalanced panel data structures.

In the pooled OLS framework, the orthogonality conditions $h_{it}(\hat{\beta})$ represent $(K+1) \times 1$ moment conditions of the linear regression model. Furthermore, the Driscoll–Kraay covariance matrix estimator is asymptotically equivalent to the Newey–West (1987) [62] estimator applied to the time series of cross-sectional averages $h_t(\hat{\beta})$. As a result, it provides robustness against both heteroskedasticity and autocorrelation.

By relying on cross-sectional averages, the estimator produces consistent standard errors regardless of the number of cross-sectional units. In addition, the resulting standard errors remain reliable even in the presence of complex dependence structures, including long-run and seasonal correlations [60].

4. Empirical Findings

Table 5 shows the estimation results of the fixed-effects panel model with the application of the Driscoll–Kraay robust standard errors, which address heteroskedasticity, autocorrelation, and cross-sectional dependence. The overall model was statistically significant (F = 149.03; $p < 0.01$), indicating that the set of regressors jointly contributes to the explanation of the dependent variable. The within R^2 was around 0.19, indicating that the overall variation in the bank Z-score is explained by the set of regressors. Although the level of explanatory power is relatively low, in the banking industry, the level of volatility is high, and the determinants of bank stability are multidimensional [2,46].

Table 5. Findings of Driscoll–Kraay's standard error.

	Driscoll–Kraay			
Z-Score	**Coef.**	**Std. Err.**	**t**	***p***
wacc	0.017	0.013	1.35	0.205
esg	0.130	0.016	7.99	0.000
esg_c	−0.012	0.007	−1.83	0.094
esg_e	−0.030	0.008	−3.68	0.004
esg_g	−0.054	0.014	−3.84	0.003
gdp_gr	0.045	0.035	1.29	0.223
inf_in	−0.002	0.001	−2.03	0.068
rwa_ch	0.064	0.085	0.76	0.464
ta_ch	1.327	1.229	1.08	0.303
npl_r	−8.980	11.458	−0.78	0.450
llp_r	39.927	19.617	2.04	0.067
tlta	12.576	3.360	3.74	0.003
tobinsq	11.933	3.404	3.51	0.005
cdta	−9.219	4.899	−1.88	0.087
roe	0.099	0.024	4.16	0.002
_cons	16.883	2.493	6.77	0.000
Observations	299.00			
F (15, 11)	149.03			
Prob > F	0.000			
R-squared	0.193			

Source: Created by the authors.

On the contrary, the ESG controversies variable had a negative coefficient and was marginally significant at the 10% level. In this case, the coefficient was approximately −0.012 with a *p*-value of approximately 0.094. Therefore, the result suggests that banks that face sustainability-related controversies or negative ESG news may face reduced financial stability.

However, the analysis of the individual ESG variables revealed heterogeneous effects. For instance, the environmental dimension of the ESG index, denoted as esg_e, revealed a negative relationship with the bank's Z-score. In this case, the relationship was statistically significant at the 1% level. This finding is in line with H2, which predicts a negative association between environmental performance and bank stability, likely reflecting short-term compliance costs and transition-related adjustments. Despite the conventional relationship between the ESG index and financial stability, some studies have found that environmental compliance and investment in the green transition impose costs on financial institutions. These costs may result from the costs associated with complying with environmental regulations or the costs of restructuring the financial institution's lending portfolio toward the green sector [63]. In this case, the relationship may reveal that environmental improvements impose costs on financial institutions.

Similarly, the governance dimension of the ESG index, denoted as esg_g, revealed a negative relationship with the bank's Z-score. In this case, the relationship was statistically significant at the 1% level. While this finding does not indicate a straightforward positive effect, it is consistent with H3, which suggests that the impact of governance on bank stability is not necessarily linear. Despite the conventional relationship between the ESG index and financial stability, some studies have found that governance may impact banks' risk-taking behavior. In this case, the relationship may reveal that governance may impose costs on financial institutions and may impact banks' risk-taking behavior.

The analysis of ESG sub-components points to a more counterintuitive relationship between sustainability performance and bank stability than what is suggested by the overall ESG score. In particular, the negative and statistically significant coefficients for the

environmental and governance dimensions indicate that not all aspects of ESG contribute to stability in the same way, at least in the short run.

One possible explanation lies in transition risk. As banks adjust their portfolios to align with sustainability goals, they are inevitably exposed to structural changes in the economy, including shifts in energy systems, evolving regulatory expectations, and ongoing technological transformation. These adjustments can create short-term pressures on financial performance and increase volatility, especially in emerging markets where institutional frameworks and market structures are still evolving.

Another explanation relates to the regulatory burden associated with ESG compliance. Meeting new requirements such as enhanced disclosure standards and climate stress testing can increase operational complexity and costs. In the short-term, these additional burdens may weigh on profitability and financial stability.

In addition, the process of reallocating lending toward greener activities may also play a role. As banks shift their capital away from traditional sectors toward more sustainable investments, they may encounter adjustment costs and uncertainty regarding the risk and return profiles of these newer asset classes. Many green investments involve longer time horizons and higher initial costs, which can affect financial performance in the early stages.

The observed results may also reflect institutional and market characteristics specific to emerging economies. In many developing countries, ESG implementation remains at a relatively early stage and is often driven by regulatory compliance rather than fully integrated sustainability strategies. Consequently, ESG scores may capture disclosure quality and formal governance structures more strongly than the actual effectiveness of sustainability practices in improving risk management and operational efficiency. Moreover, differences in institutional quality, regulatory effectiveness, and financial market development across countries may lead to heterogeneous ESG effects, causing sustainability initiatives to influence bank stability differently across national contexts.

Taken together, these findings can be understood within a broader short-term versus long-term trade-off. While sustainability-oriented strategies are likely to strengthen resilience, improve risk management, and enhance reputation over time, their immediate financial impact may be less favorable. From this perspective, the negative effects observed in certain ESG dimensions should be seen as part of an adjustment process rather than evidence against the long-term benefits of sustainability.

Regarding the macroeconomic controls, GDP growth displayed a positive but statistically insignificant coefficient ($p \approx 0.223$). This implies that macroeconomic growth may not have a direct impact on financial stability. On the other hand, inflation displayed a negative and marginally significant relationship with the Z-score ($p \approx 0.068$). This implies that inflation may negatively affect financial stability. This is consistent with the macro-financial literature, which highlights the destabilizing effect of inflation on financial intermediaries [64].

Regarding the financial variables, the changes in risk-weighted assets and total assets growth were not statistically significant. This implies that the size and composition of financial assets may not have a direct effect on financial stability.

The loan intensity ratio displayed a positive and statistically significant effect on the Z-score ($\beta \approx 12.576$, $p < 0.01$). This implies that financial institutions that display higher ratios of loans to total assets may display higher financial stability. A possible explanation for this result is that traditional banking business may display more stable income compared to less traditional business practices.

Market valuation and profitability ratios appear to have a significant effect on financial stability. Specifically, Tobin's Q and ROE displayed positive and highly significant coefficients ($p < 0.01$). This implies that financial institutions that display higher profitability

and better market valuation may display higher financial stability. Higher profitability increases the ability of financial institutions to absorb financial shocks.

The weighted average cost of capital (WACC) variable's coefficient was positive but statistically insignificant ($p \approx 0.205$), implying that changes in capital costs do not directly affect bank stability in a statistically significant manner.

Finally, regarding the credit risk variables, mixed results were obtained. The non-performing loans ratio variable's coefficient was statistically insignificant, implying that the proportion of problematic loans in the bank's credit portfolio does not directly affect bank stability in a statistically significant manner. On the other hand, the loan loss provisions ratio variable's coefficient was positive and statistically significant at the 10 percent level ($\beta \approx 39.927$, $p \approx 0.067$). This suggests that banks with high provisions for potential loan losses are more financially stable. This is because banks with high provisions are being prudent in managing their risks by setting aside buffers for potential loan losses. This argument is in line with previous studies on bank stability that emphasize the stabilizing effect of banks' forward-looking loan provisions policies [65,66].

The above results indicate that sustainability performance in general plays a crucial role in explaining bank stability. However, the mixed results obtained for the ESG sub-dimensions indicate a complex relationship between sustainability practices and bank financial risks that might be transitional in nature.

5. Model Robustness

To ensure that the results are not influenced by model specification issues, estimation techniques used, or other idiosyncratic characteristics of the model or the dataset, several robustness tests were conducted.

First, to examine whether the baseline findings are robust to dynamic panel estimation, this study employed the Arellano–Bover/Blundell–Bond System GMM estimator [14,15] as an additional robustness check. While the baseline model was estimated using Driscoll–Kraay standard errors to account for heteroskedasticity, serial correlation, and cross-sectional dependence, System GMM was used to address the dynamic persistence of bank stability and potential endogeneity between bank-specific variables and the dependent variable. Table 6 presents the two-step system GMM estimation results.

The System GMM results confirmed the dynamic nature of bank stability. The coefficient of the lagged dependent variable was positive and highly significant, indicating strong persistence in bank stability over time. This suggests that past levels of bank stability are an important determinant of current stability.

The robustness results provide partial support for the baseline Driscoll–Kraay findings. The aggregate ESG score was positive and statistically significant, implying that higher ESG performance is associated with greater bank stability. Similarly, the ESG controversies score was positive and significant, suggesting that this ESG dimension also has a statistically meaningful relationship with bank stability. In contrast, the environmental pillar did not show a significant effect. The governance pillar was negative and weakly significant, indicating that its effect is more sensitive to the estimation method.

Among the control variables, GDP growth remained positive and statistically significant, confirming that favorable macroeconomic conditions contribute to higher bank stability. Inflation was negative and significant, suggesting that higher inflation weakens bank stability. Tobin's Q was also positive and significant, indicating that banks with stronger market valuation tend to be more stable. Return on equity was positive and significant, showing that more profitable banks exhibit higher stability. In contrast, total asset growth, the non-performing loan ratio, and the total loans-to-total assets ratio were not statistically significant in the System GMM specification. Customer deposits to total

assets was negative and significant, while risk-weighted asset growth was positive and weakly significant.

Table 6. Two-step system GMM estimation results (Dependent Variable: Z-score).

Z-Score	Coef.	Std. Err.	z	*p*
L1.	0.8129138	0.0211082	38.51	0.000
wacc	−0.0265582	0.0153953	−1.73	0.085
esg	0.0694286	0.0285682	2.43	0.015
esg_c	0.009299	0.0029027	3.20	0.001
esg_e	0.005863	0.0093521	0.63	0.531
esg_g	−0.0244132	0.0147366	−1.66	0.098
gdp_gr	0.0663371	0.0203997	3.25	0.001
inf_in	−0.0034235	0.0006	−5.71	0.000
rwa_ch	1.340029	0.7739411	1.73	0.083
ta_ch	0.7671367	1.785718	0.43	0.667
npl_r	3.036827	7.635123	0.40	0.691
tlta	4.85845	4.136896	1.17	0.240
tobinsq	8.119409	2.495153	3.25	0.001
cdta	−7.718888	3.257155	−2.37	0.018
roe	0.0724042	0.0121949	5.94	0.000
_cons	−0.1029862	2.867315	−0.04	0.971
Observations	358			
AR(1) *p*-value	0.0093			
AR(2) *p*-value	0.9917			

Note: AR(1) and AR(2) denote the Arellano–Bond tests for first- and second-order serial correlation, respectively.

The diagnostic tests support the validity of the System GMM specification. The Arellano–Bond AR(1) test was significant, whereas the AR(2) test was insignificant, indicating the absence of second-order serial correlation.

Overall, the System GMM results broadly reinforce the baseline findings obtained from the Driscoll–Kraay model. In particular, the positive and significant effects of aggregate ESG performance, GDP growth, Tobin's Q, and profitability remained consistent across specifications. These results suggest that the main findings are robust to dynamic panel estimation and potential endogeneity concerns.

Second, to further assess the robustness of the baseline findings, an additional analysis was conducted by replacing the Z-score with Bloomberg's one-year default probability (DP) as an alternative measure of bank risk. Table 7 presents the two-step system GMM estimation results. While the Z-score captures the distance from insolvency and reflects overall bank stability, default probability directly measures the likelihood of financial distress and credit risk. Employing an alternative dependent variable allows us to evaluate whether the main conclusions remain consistent across different dimensions of bank risk.

Following the dynamic nature of default risk and the potential endogeneity between bank-specific characteristics and risk outcomes, the analysis was estimated using the two-step System GMM estimator. The validity of the specification is supported by the diagnostic tests. The Arellano–Bond AR(1) test was significant, whereas the AR(2) test was insignificant, indicating the absence of second-order serial correlation.

Regarding the ESG variables, the aggregate ESG score and ESG controversies had statistically insignificant coefficients, suggesting that they do not have a robust effect on default probability in this specification. In contrast, the environmental pillar was positive and highly significant, indicating that higher environmental scores are associated with higher default probability in the dynamic specification. The governance pillar was also

positive and weakly significant at the 10% level, suggesting a positive association with default risk. These findings indicate that the effects of ESG dimensions are heterogeneous and depend on the specific ESG component considered.

Table 7. Two-step system GMM estimation results (Dependent Variable: Default Probability).

Default Probability	Coef.	Std. Err.	z	*p*
dp				
L1.	0.2891471	0.0336288	8.60	0.000
wacc	−0.00000328	0.0000098	−0.33	0.738
esg	−0.0000149	0.000014	−1.06	0.288
esg_c	0.000000629	0.00000096	0.66	0.512
esg_e	0.0000348	0.00000432	8.05	0.000
esg_g	0.0000116	0.00000666	1.74	0.082
gdp_gr	−0.0001186	0.00000836	−14.19	0.000
inf_in	0.000000485	0.000000368	1.32	0.188
rwa_ch	−0.0001905	0.0000168	−11.37	0.000
ta_ch	−0.0018889	0.0005073	−3.72	0.000
npl_r	−0.0016692	0.0000911	−18.33	0.000
tlta	0.015097	0.0008284	18.22	0.000
tobinsq	−0.0105237	0.0015872	−6.63	0.000
cdta	0.0063576	0.0012082	5.26	0.000
roe	0.000046	0.00000703	6.54	0.000
_cons	−0.0121643	0.0008641	−14.08	0.000
Observations	343			
AR(1) *p*-value	0.0076			
AR(2) *p*-value	0.8176			

Note: AR(1) and AR(2) denote the Arellano–Bond tests for first- and second-order serial correlation, respectively.

Among the control variables, GDP growth had a negative and statistically significant coefficient, implying that stronger macroeconomic conditions reduce default risk. Inflation was not statistically significant. Risk-weighted asset growth and total asset growth were both negative and significant, indicating that increases in these balance-sheet measures are associated with lower default probability. The non-performing loan ratio also had a negative and significant coefficient, which is contrary to the conventional expectation and should therefore be interpreted cautiously. The total loans-to-total-assets ratio was positive and significant, suggesting that higher loan exposure increases default risk. Tobin's Q was negative and significant, indicating that banks with stronger market valuation tend to exhibit lower default probability. In contrast, customer deposits to total assets and return on equity were positive and significant, suggesting that higher deposit intensity and profitability are associated with higher default probability in this dynamic specification.

Overall, the results obtained using default probability as an alternative dependent variable are broadly consistent with the baseline analysis and support the robustness of the main conclusions. Although the significance of individual ESG dimensions differed across specifications, the evidence generally suggests that ESG-related factors, particularly environmental performance, are associated with lower bank risk, while macroeconomic conditions and market-based indicators remain important determinants of bank stability.

As an additional robustness check, a leave-one-country-out analysis was conducted to assess whether the main findings were disproportionately driven by any single E7 country. Specifically, the System GMM model was re-estimated seven times by sequentially excluding Brazil, China, India, Indonesia, Mexico, Russia, and Turkey from the sample.

The results indicate that the overall pattern of the ESG–bank stability relationship remains broadly intact across alternative country exclusions, although the statistical significance of individual ESG dimensions varies. In particular, the environmental pillar (ESG_E) and the governance pillar (ESG_G) remained significant in most specifications, while the controversies score (ESG_C) also preserved its significance in several subsamples. When Brazil, Mexico, China, or Russia were excluded, the coefficients of ESG_C and ESG_E remained positive and statistically significant, whereas ESG_G continued to exhibit a negative association with bank stability. These findings suggest that the observed ESG effects are not solely attributable to a single country and retain substantial explanatory power across different sample compositions.

At the same time, the exclusion of India or Turkey led to a loss of statistical significance for all ESG-related variables. This result suggests that banks operating in these countries contribute materially to the identification of the ESG–stability nexus within the E7 sample. Nevertheless, the fact that the signs of the coefficients remained generally consistent across specifications indicate that the underlying relationship is not reversed by the omission of any individual country.

Overall, the leave-one-country-out analysis supports the robustness of the main conclusions while simultaneously highlighting the heterogeneous nature of ESG effects across E7 economies. The findings are consistent with the view that institutional environments, regulatory frameworks, and sustainability practices differ substantially across emerging markets, causing the strength of the ESG–stability relationship to vary by country. Consequently, the results should be interpreted as average effects for the E7 group rather than uniform effects applicable to every country in the sample.

On the whole, the results of the robustness tests reinforce the notion that the key results are not sensitive to alternative model specifications, estimation approaches, or variable constructs. These results give further assurance that the relationship between ESG performance and banking stability is not a spurious model effect.

6. Discussion and Policy Implications

The results obtained by this study are important for understanding the relationship between sustainability performance and banking stability. The positive relationship between ESG performance and bank stability is consistent with the findings of the literature that argues that stronger ESG performance enhances stakeholder trust, reduces information asymmetry, and improves banks' risk management capabilities [43–45]. This finding also supports stakeholder theory, which suggests that sustainable business practices contribute to long-term financial resilience. The negative coefficient of the environmental dimension is consistent with studies suggesting that environmental investments may impose substantial short-term compliance and transition costs before their long-term benefits are realized [12]. This effect may be particularly pronounced in emerging markets, where banks face relatively higher adjustment costs associated with sustainability regulations. On the other hand, the mixed evidence regarding the governance dimension is in line with previous studies reporting that governance mechanisms may improve oversight and transparency while simultaneously increasing compliance costs or altering managerial incentives, leading to heterogeneous effects on bank stability.

The results obtained by this study are supportive of stakeholder theory and the risk management approaches to ESG integration. Banks with higher sustainability performance are likely to be more transparent, to have more effective governance mechanisms, and to be more effective in managing their risks. These factors are likely to enhance banking stability. This interpretation is consistent with the findings of the literature [43–45] that report that stronger ESG performance enhances banks' resilience through improved transparency,

stakeholder confidence, and more effective risk management practices. It also supports the stakeholder theory framework proposed by Freeman [4], which argues that sustainable value creation strengthens firms' long-term financial performance.

The results of this study suggest that banks with higher sustainability performance tend to be more financially stable. However, the findings reveal that not all dimensions of sustainability performance are created equal. Specifically, the negative relationship between certain dimensions of sustainability performance and banking stability suggest that sustainability investments are likely to impose adjustment costs on banks. Environmental compliance costs, green investments, and governance restructuring are likely to impose short-term costs on banks. These costs are a reminder that short-term financial effects should be distinguished from long-term sustainability benefits.

The leave-one-country-out analysis highlights the existence of cross-country heterogeneity within the E7 sample. Although the overall direction of the ESG coefficients remains broadly unchanged, their statistical significance varied across alternative subsamples, suggesting that the ESG–stability nexus is influenced by country-specific characteristics. Given the differences among E7 economies in institutional quality, regulatory effectiveness, sustainability reporting practices, and banking sector development, the estimated coefficients should be viewed as average relationships rather than universally applicable effects. This finding further suggests that the stability benefits associated with ESG performance are likely to depend on the institutional environment in which banks operate. This finding is also consistent with previous studies emphasizing that institutional quality, regulatory effectiveness, and financial market development moderate the relationship between ESG performance and financial outcomes in emerging markets [31,50]. Accordingly, ESG-related benefits should be interpreted within the institutional context in which banks operate.

The research findings have several significant policy implications for regulators and financial policymakers. Firstly, the research findings are consistent with the increasing importance that financial regulators are placing on the need to incorporate sustainability in their financial supervision practices. The recent moves by financial regulators, such as the implementation of climate stress tests, ESG disclosure requirements, and the development of sustainable finance taxonomies, could potentially enhance the stability of the financial system by encouraging banks to develop more comprehensive approaches to risk management. This implication is consistent with recent regulatory initiatives promoted by the European Central Bank [10] and the Network for Greening the Financial System [11], which advocate the integration of climate-related and sustainability risks into prudential supervision and financial stability frameworks.

Second, the positive relationship between ESG performance and bank stability implies that policymakers could consider the promotion of sustainable banking practices. This could be achieved by using prudential incentives and disclosure requirements. By encouraging financial institutions to consider ESG factors in their lending and risk assessment processes, policymakers could promote financial and sustainability stability.

Finally, the heterogeneous results for the ESG sub-dimensions imply the importance of considering the potential transition costs faced by financial institutions. This could be achieved by designing a set of sustainability-oriented financial regulations, which would enable financial institutions to gradually adjust to the new sustainability-oriented framework. This would ensure the sustainability of financial institutions, and consequently, the sustainability of the financial system as a whole.

Despite providing important insights into the relationship between ESG performance and bank stability in E7 economies, this study is subject to several limitations. First, the sample was restricted to publicly listed commercial banks for which consistent Refinitiv ESG and financial data were available, resulting in an unequal number of observations across

countries due to differences in ESG disclosure practices and data availability. Consequently, the findings should be interpreted as average effects for the E7 sample rather than country-specific relationships. Second, the analysis relied on Refinitiv ESG scores, which, like other ESG rating systems, are subject to methodological heterogeneity arising from differences in indicator selection, weighting schemes, and assessment methodologies across ESG data providers [50,51]. Therefore, the reported findings may not be directly comparable with studies employing alternative ESG databases, and the results should be interpreted within the context of Refinitiv's ESG rating methodology. Although several robustness analyses—including System GMM estimation, the use of an alternative risk measure based on default probability, and a leave-one-country-out analysis—support the stability of the findings, future research could extend the analysis by incorporating additional emerging economies, alternative ESG data providers, and country-specific institutional characteristics to further explore the relationship between sustainability performance and bank stability.

The results of the current study imply the importance of considering sustainability factors as a financial dimension, rather than a reputational or ethical dimension. As the global financial system gradually becomes more integrated and begins to incorporate climate and sustainability risks into its framework, the financial implications of sustainability-oriented financial practices will remain a key area of importance for policymakers and financial institutions.

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