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Green Bonds Issuance And Bank Stability: Safe Haven Or Risk Under Central Bank Policy Rates?

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Abstract

This study examines the effect of green bond issuance on bank stability and the moderating role of central bank policy rates. Using panel data of 1,462 banks from 29 countries during 2010-2024, the analysis applies fixed effects and dynamic System GMM to address potential endogeneity. Bank stability is measured using alternative Z-score specifications and non-performing loans. The results show that green bond issuance reduces bank stability, suggesting that the expansion of green finance may introduce short-term risks to banks. However, central bank policy rates moderate this relationship, where higher rates mitigate the adverse impact. Further analysis indicates that the negative effect is stronger during monetary tightening periods, while a U-shaped relationship suggests that more developed green bond markets may eventually support stability. These findings highlight the importance of monetary policy conditions in evaluating the financial stability implications of sustainable finance. By distinguishing between early-stage adjustment costs and longer-term market-maturity effects, this study helps reconcile mixed findings on sustainable finance and financial stability.

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1. Introduction

In recent decades, the green bond market has grown substantially. This reflects increasing investor demand for climate-aligned investments and stronger environmental policies around the world. Recent estimates show that the global stock of green bonds will exceed USD 3 trillion by 2025, highlighting the rapid expansion of climate-related financial instruments in international capital markets (Meng & Clements, 2025). In emerging markets alone, green bond issuance reached USD 135 billion in 2023, representing a 34% increase from the previous year, while the broader category of green, social, sustainable, and sustainability-linked bonds exceeded USD 1 trillion globally (IFC, 2024). Similarly, in the European Union, green bonds accounted for nearly 7% of all corporate and government bond issuance in 2024, demonstrating the growing role of sustainable finance in mainstream financial markets (EEA, 2025).

While the rapid development of the green bond market supports climate mitigation and sustainable investment, it also raises important questions regarding its implications for financial stability and banking systems. International institutions such as the BIS and IMF emphasize that climate-related financial instruments may influence risk allocation, asset valuation, and capital flows across financial institutions, thereby shaping systemic stability in financial markets (Government, 2026; IFC, 2024). On one hand, green bonds can enhance financial stability by promoting long-term investment and facilitating the transition toward sustainable economic activities (Nguyen, 2025). On the other hand, the rapid expansion of climate-related assets may introduce new sources of financial risk, including market concentration, policy uncertainty, and valuation challenges associated with environmental projects (Tian et al., 2025). In addition, evidence indicates that green bond issuance may alter banks' lending behavior and capital allocation, sometimes leading to credit expansion toward firms whose environmental performance remains uncertain, thereby raising concerns regarding potential risk mispricing in sustainable finance markets (Han et al., 2025).

This study differs from previous literature by showing that the effect of sustainable finance on financial stability is conditional, rather than uniform. While some studies argue that green finance strengthens financial stability by enhancing climate risk mitigation and sustainable capital allocation (Nguyen, 2025), others find that green finance policies can increase bank risk-taking or systemic vulnerabilities under weak institutional and market conditions (Huang et al., 2025; Tian et al., 2025). This study reconciles these mixed findings by focusing specifically on green bond issuance and showing that its effect on bank stability depends on market maturity and monetary policy conditions.

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Beyond financial considerations, the debate is also closely linked to legal and regulatory frameworks governing sustainable finance. The growing adoption of green bond regulations, such as the European Green Bond Standard, aims to enhance transparency, prevent greenwashing, and improve market credibility through stricter disclosure and verification requirements. Nevertheless, differences in regulatory quality and institutional capacity across countries may affect how green finance interacts with banking risk and financial stability. In this context, the effectiveness of green bonds as either a stabilizing financial instrument or a potential source of risk depends not only on market dynamics but also on the strength of legal frameworks and supervisory oversight in sustainable finance markets (Dung & Hanh, 2025). Monetary policy plays a central role in shaping bank behavior and financial stability through the risk-taking channel of interest rates. When policy rates remain low for a prolonged period, banks may increase risk exposure by expanding lending or reallocating portfolios toward higher-yield assets in order to maintain profitability. Conversely, tighter monetary conditions tend to constrain risk-taking and strengthen bank balance sheets (Borio & Zhu, 2012)

In the context of sustainable finance, the monetary policy environment may also shape how financial institutions respond to the expansion of green capital markets. Changes in policy rates affect bond yields, investment incentives, and the relative attractiveness of long-term climate-related assets, including green bonds (IMF, 2025). As a result, the effectiveness of green financial instruments in promoting financial stability may depend on the prevailing interest rate environment and monetary policy stance (Dikau & Volz, 2021)

Moreover, central banks and financial regulators increasingly recognize that climate finance and monetary policy are becoming interconnected policy domains (Dikau & Volz, 2021; Mertzanis, 2024). Several jurisdictions have begun integrating climate considerations into financial supervision, disclosure requirements, and macroprudential frameworks to safeguard financial stability (FSB, 2022; NGFS, 2020; BCBS, 2022). Legal and regulatory initiatives, such as climate-related financial disclosure standards and sustainable finance taxonomies, seek to ensure that the growing integration of climate-related assets into financial markets does not introduce systemic vulnerabilities (Coelho & Restoy, 2023; Dung & Hanh, 2025).

2. Literature Review

The literature on green bond issuance and banking stability can generally be classified into two streams. The first focuses on the green bond market itself, specifically on issuance motives, pricing, investor response, and firm-level outcomes. Green bonds can enhance corporate reputational capital and expand access to market-based financing (Flammer, 2021; Tang & Zhang, 2020; Zerbib, 2019). The second examines the relationship between green

finance, climate risk, and banking stability. Some studies argue that green finance supports financial stability by encouraging more sustainable capital allocation and mitigating climate-related risks, while others suggest that green finance policies may also increase risk-taking or systemic vulnerabilities when institutional quality, policy design, and market maturity remain limited (Huang et al., 2025; Nguyen, 2025).

Theoretically, this study draws on market-based financing theory and the monetary policy risk-taking channel. Market-based financing theory holds that bond market development can reduce firms' dependence on banks, thereby weakening traditional intermediation channels and potentially affecting the risk profiles of banking institutions (Allen & Gale, 2000). The risk-taking channel holds that monetary policy influences banks' risk appetite through changes in funding costs, portfolio allocation, and credit supply behavior (Borio & Zhu, 2012; Dell'Ariccia et al., 2014; Jiménez et al., 2014). By combining these perspectives, this study develops a framework in which the development of the green bond market can directly affect bank stability. In contrast, central bank policy rates shape the intensity and direction of this relationship.

From Sustainable Funding to Fragile Intermediation? Green Bond Issuance and Bank Stability

Green bond issuance can affect bank stability through both positive and negative mechanisms. On the one hand, the growth of the green bond market can improve financing efficiency and long-term commitment to climate-related projects (Flammer, 2021). On the other hand, as more companies access funding through green bonds, banks may face disintermediation, with high-quality borrowers shifting from traditional bank loans to capital-market instruments. This shift could diminish banks' franchise value and prompt them to rebalance their portfolios toward riskier borrowers or alternative assets to maintain profitability (Mertzanis, 2024; Tang & Zhang, 2020). Furthermore, when the green bond market is still in its infancy, information asymmetry, certification costs, policy uncertainty, and the potential for greenwashing can increase risk mispricing and weaken bank balance sheet resilience. Adjustment costs and transition risks can explain these negative effects in the early stages. These adjustments can increase operational costs and uncertainty in credit risk assessments. At the same time, transition risks can arise when borrowers face regulatory changes, technological shifts, or exposure to stranded assets during the transition to a low-carbon economy (NGFS, 2020; BCBS, 2022). The broader green finance literature also suggests that the financial stability consequences of sustainable finance are not always positive and may depend on market readiness and regulatory capacity (Nguyen, 2025).

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Therefore, in the short to medium term, the expansion of green bond issuance is expected to be associated with lower banking stability.

H1: Green bond issuance is negatively associated with bank stability.

When Interest Rates Discipline Green Risk: The Moderating Role of Central Bank Policy Rates

Central bank policy interest rates can play an important moderating role in the relationship between green bond issuance and bank stability. According to the risk-taking channel of monetary policy, prolonged low-interest-rate environments tend to squeeze bank margins and encourage greater risk-taking through aggressive lending, portfolio reallocation, and yield-seeking behavior. Conversely, tighter monetary conditions tend to enhance financial discipline, raise screening standards, and curb excessive risk exposure (Borio & Zhu, 2012; Dell'Ariccia et al., 2014; Jiménez et al., 2014). In the context of sustainable finance, monetary policy is also relevant because it shapes bond yields, financing conditions, and broader incentives for green investment. Recent studies have shown that central bank policy is related to the development of green bond issuance, while monetary conditions also influence the relationship between green credit and bank risk-taking (Mertzanis, 2024). Therefore, when policy interest rates are higher, banks tend to respond more cautiously to the expansion of the green bond market, thereby mitigating the potential destabilizing effects of disintermediation and portfolio adjustments. Therefore, higher central bank policy rates are expected to mitigate the negative effect of green bond issuance on bank stability.

H2: Central bank policy rates positively moderate the relationship between green bond issuance and bank stability, such that the negative effect of green bond issuance on bank stability becomes weaker when policy rates are higher.

3. Research Methods

Data and Sample Selection

This study uses a panel dataset of banks from multiple countries covering the period 2010–2024. Bank-level financial data are obtained from the BankFocus database, which provides comprehensive information on banks' financial statements and balance sheet indicators. Data on green bond issuance are collected from the IMF Climate Finance Database, while macroeconomic and institutional variables, including GDP growth, inflation, and regulatory quality, are sourced from the World Bank. In addition, information on central bank policy rates is obtained from the Bank for International Settlements (BIS).

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The initial sample consisted of bank-level financial data, green bond issuance data, policy interest rate data, and macroeconomic control variables available for the study period. Following standard procedures in banking research, observations with missing values on key variables were excluded to ensure data consistency. The final dataset includes 1,462 banks from 29 countries. Details of sample selection and the number of observations at each stage are reported in Table 3.

Variable Definitions

Bank Stability

Bank stability is the dependent variable in this study and is primarily measured using the Z-score, which captures the distance of a bank from insolvency by combining profitability, capitalization, and earnings volatility (Fu et al., 2014; Lepetit & Strobel, 2013). A higher Z-score indicates a more stable bank and lower insolvency risk. To ensure robustness, this study employs several alternative formulations of the Z-score, including LZS, LZS1, LZS2, and LZS_L, which differ in how profitability and capitalization components are incorporated into the stability measure. In addition, non-performing loans (NPL) are used as an alternative indicator of bank risk, where a higher NPL ratio reflects greater credit risk and lower bank stability.

Table 1. Variables of Research

Variable	Formula/Description	Reference(s)
Bank stability measures		
LZS	ROA + equity to total assets/ standard deviation of ROA. A higher value indicates a more stable bank (Fu et al., 2014).	BankFocus
LZS1	ROA / standard deviation of ROA. A higher value indicates a more stable bank (Fu et al., 2014).	BankFocus
LZS2	Equity to total assets/ standard deviation of ROA. A higher value indicates a more stable bank (Fu et al., 2014).	BankFocus
LZS_L	Mean of ROA + equity to total assets/ standard deviation of ROA. A higher value indicates a more stable bank (Lepetit & Strobel, 2013).	BankFocus
NPL	Non-performing Loan	BankFocus
Green Bond Issuance		
GRBN	Natural logarithm of the aggregate value (USD billions) of green bonds offered to investors in each country (Mertzanis, 2024)	IMF Climate Finance
Central Bank Policy Rates		
CBPR	The central bank's main policy interest rate. If the policy rate is presented as a target range, the midpoint of the range is used; if a single rate is set, that rate is used directly	Bank for International Settlements

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Bank-level variables		
NIM	Net interest margin	BankFocus
EQTA	Equity to total asset	BankFocus
LLP	Loan loss provision	BankFocus
LTA	Loan to total asset	BankFocus
CAR	Capital adequacy ratio	BankFocus
Country-level variables		
GDP	Growth of GDP	World Bank
INF	Inflation rate	World Bank
REG	Regulatory quality. Scale from -2.5, the worst, to 2.5, the best	World Bank

Note: This table defines the main variables used in this study. All variables are annual.
Source: Developed by the author (2026)

Green Bond Issuance

The key independent variable is green bond issuance (GRBN), which reflects the development of green bond markets within a country. It is measured as the natural logarithm of the aggregate value of green bonds issued in each country, expressed in USD billions (Mertzanis, 2024). This measure captures the scale of green financing activities available to financial institutions and investors. Data on green bond issuance are obtained from the IMF Climate Finance Database.

Bank Policy Rates

The moderating variable in this study is the central bank policy rate (CBPR), which represents the primary policy interest rate set by the central bank in each country. This variable reflects the stance of monetary policy and the broader macro-financial environment in which banks operate (Borio & Zhu, 2012; Jiménez et al., 2014). When the policy rate is presented as a target range, the midpoint of the range is used; otherwise, the single policy rate is applied directly. Data on central bank policy rates are obtained from the Bank for International Settlements (BIS).

Control Variables

To account for bank-specific characteristics that may influence stability, several bank-level control variables are included, namely net interest margin (NIM), equity to total assets (EQTA), loan loss provisions (LLP), loan to total assets (LTA), and the capital adequacy ratio (CAR). These variables capture banks' profitability, capitalization, credit risk, and lending structure (Fu et al., 2014; Lepetit & Strobel, 2013). In addition, country-level control variables are incorporated to control for macroeconomic and institutional conditions,

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including GDP growth (GDP), inflation (INF), and regulatory quality (REG). The definitions and data sources for all variables are summarized in Table 1.

Empirical Model

To examine the relationship between green bond issuance and bank stability, this study estimates the following baseline panel regression model:

$$LZS|1|2_{i,j,t} = \alpha + \beta_1 GRBN_{c,t} + \beta_2 Controls_{i,c,t} + \mu_i + \lambda_t + \varepsilon_{i,c,t} \quad (1)$$

where $LZS|1|2_{i,j,t}$represents the stability of bank i in country j at time t, measured using alternative Z-score indicators and non-performing loans. $GRBN_{j,t}$denotes green bond issuance at the country level, while $Controls_{i,j,t}$includes bank-level and macroeconomic control variables. $\mu_i$captures unobserved bank-specific effects, $\lambda_t$represents year fixed effects, and $\varepsilon_{i,j,t}$is the error term.

To examine the moderating role of monetary policy, the model incorporates an interaction term between green bond issuance and central bank policy rates:

$$LZS|1|2_{i,j,t} = \alpha + \beta_1 GRBN_{j,t} + \beta_2 CBPR_{j,t} + \beta_3 (GRBN_{j,t} \times CBPR_{j,t}) + \beta_4 Controls_{i,j,t} + \mu_i + \lambda_t + \varepsilon_{i,j,t} \quad (2)$$

where $CBPR_{j,t}$represents the central bank policy rate, capturing the stance of monetary policy. The interaction term allows us to assess whether monetary policy conditions influence the effect of green bond issuance on bank stability.

4. Results

Descriptive Statistics

Table 2 presents the descriptive statistics of the variables used in this study. Overall, the results show considerable variation in both bank-specific and macroeconomic variables across countries and over time. The average value of the bank stability measure (LZS) is 3.122, with a standard deviation of 1.170, indicating moderate differences in stability among banks in the sample. Alternative stability measures (LZS1, LZS2, and LZS_L) exhibit similar patterns, supporting the robustness of the stability indicators.

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Table 2. Description Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
LZS	20,698	3.122	1.170	-1.124	5.841
LZS1	18,561	0.489	1.265	-9.628	5.273
LZS2	20,762	3.066	1.170	-3.300	7.842
LZS_L	20,698	3.122	1.170	-1.124	5.841
NPL	16,794	4.700	6.216	0.000	24.613
GRBN	16,937	11.093	21.330	0.004	97.630
CBPR	27,426	5.540	7.758	-0.750	101.000
NIM	20,874	4.783	6.040	-0.996	40.288
EQTA	20,984	0.156	0.160	0.015	0.911
LLP	17,951	0.023	0.036	0.000	0.231
LTA	20,448	0.562	0.223	0.001	0.974
CAR	17,594	24.466	25.888	7.990	192.3
GDP	27,690	3.101	3.373	-10.933	13.363
INF	27,690	5.310	12.653	-1.611	219.884
REG	27,690	0.289	1.009	-1.197	2.101

Source: Author's calculation (2026)

Regarding the main explanatory variables, the mean value of green bond issuance (GRBN) is 11.093, with a relatively large standard deviation of 21.330, indicating substantial differences in the development of green bond markets across countries. The central bank policy rate (CBPR) has an average of 5.540%, but ranges widely from −0.750% to 101%, reflecting diverse monetary policy conditions across economies. In terms of bank-level characteristics, the average net interest margin (NIM) is 4.783%, while the mean equity-to-total-assets ratio (EQTA) is 0.156, suggesting that banks maintain moderate capitalization levels. Regarding the description of the average main variables per country, see Table 3.

Table 3. The country-level mean of the main variable of interest

Country	N. Bank	N. Obs	LZS	LZS1	LZS2	GBND	CBPR
Argentina	47	705	2.059	0.270	1.927	0.504	36.719
Australia	27	405	3.711	1.075	3.639	3.669	2.394
Brazil	139	2,085	2.501	0.200	2.453	1.427	9.624
Canada	56	840	3.190	0.626	3.101	7.624	1.444
Chile	16	240	3.189	1.005	3.064	3.373	4.101
China	259	3,885	3.617	0.926	3.535	42.827	4.700
Colombia	24	360	2.653	0.238	2.593	0.801	5.501
Denmark	22	330	2.942	0.402	2.880	7.400	0.216
Hong Kong	30	450	3.539	0.786	3.458	7.573	1.640
India	43	645	2.787	0.376	2.737	2.953	6.320

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Country	N. Bank	N. Obs	LZS	LZS1	LZS2	GBND	CBPR
Indonesia	91	1,365	3.246	0.605	3.179	3.419	5.690
Japan	132	1,980	4.082	0.824	4.049	10.950	-0.035
Korea Rep.	18	270	3.515	0.775	3.463	8.463	2.065
Malaysia	28	420	3.750	1.091	3.667	0.361	2.811
Mexico	59	885	2.836	0.411	2.766	2.174	5.997
Morocco	14	210	3.307	0.912	3.266	0.059	2.513
New Zealand	17	255	3.486	1.079	3.660	0.998	2.482
Norway	15	225	3.442	0.820	3.394	5.585	1.490
Peru	32	480	2.598	0.179	2.535	0.389	3.692
Philippines	44	660	3.389	0.913	3.300	1.173	3.893
Poland	73	1,095	2.573	-0.070	2.486	1.271	2.905
Romania	16	240	2.137	-0.064	2.117	2.514	3.853
Russia	290	4,350	2.376	-0.318	2.319	0.696	9.113
South Africa	14	210	2.559	0.656	2.505	0.289	5.989
Sweden	33	495	3.372	0.808	3.297	10.088	0.740
Switzerland	116	1,740	4.422	1.276	4.439	2.734	-0.106
Thailand	24	360	3.778	0.847	3.722	0.623	1.740
Turkiye	46	690	2.296	0.038	2.230	1.039	13.436
United Kingdom	121	1,815	2.707	-0.151	2.676	10.827	1.116
Total	1,846	27,690					
Average			3.12233	0.48856	3.06587	11.093	5.54014

Note: please see table 1 for the definition of variables.
Source: Author's calculation (2026)

In addition, this study conducts a variance inflation factor (VIF) test to examine potential multicollinearity among the explanatory variables. The VIF results indicate that all variables have values well below the commonly accepted threshold of 10, suggesting that multicollinearity is not a concern in the regression models.(O'brien, 2007) Therefore, the explanatory variables included in the analysis provide reliable and independent information for estimating the impact of green bond issuance on bank stability.

Baseline Results: Green Bond Issuance and Bank Stability

Table 4 reports the basic estimation results regarding the relationship between green bond issuance and bank stability. The results show that green bond issuance (GRBN) has a negative and statistically significant effect on bank stability in all model specifications using different Z-score measures (LZS, LZS1, and LZS2).

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Table 4. Green Bond and Bank Stability

	(1) LZS	(2) LZS1	(3) LZS2
GRBN	-0.000486***	-0.00327***	-0.000366***
	(-3.10)	(-5.38)	(-2.84)
NIM	0.0101***	0.0454***	0.00290*
	(4.87)	(7.79)	(1.87)
EQTA	4.358***	2.515***	4.257***
	(18.90)	(5.33)	(20.69)
LLP	-2.366***	-3.963***	-0.108
	(-3.64)	(-2.96)	(-0.38)
LTA	0.377***	-0.0210	0.232***
	(5.79)	(-0.11)	(5.07)
CAR	-0.00253***	-0.00399*	-0.00230***
	(-2.75)	(-1.96)	(-2.98)
GDP	0.00105*	0.0296***	-0.00163***
	(1.84)	(11.44)	(-3.88)
INF	0.000568	0.00501***	0.000355
	(1.54)	(2.99)	(1.32)
REG	-0.0324	-0.167*	0.0164
	(-1.20)	(-1.90)	(0.82)
Constanta	2.713***	0.385***	2.712***
	(60.40)	(3.08)	(74.87)
N. Obs	10460	9654	10472
N. Bank	1462	1417	1462
R^2_within	0.521	0.0852	0.673

Note: All models include bank-level and country-level control variables. t-statistics are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

These findings suggest that the expansion of the green bond market is associated with a decline in bank stability. One possible explanation relates to the disintermediation effect in financial markets. As the green bond market develops, companies increasingly choose to raise funds directly from the capital market rather than relying on bank loans. This phenomenon is consistent with market-based financing theory, which suggests that the development of capital markets can shift financing activities from banks to securities markets (Allen & Gale, 2000). As companies become increasingly dependent on bond issuance, banks may experience a decline in high-quality lending opportunities and may instead shift their portfolios toward riskier borrowers or alternative assets to maintain profitability (Mertzanis, 2024). Previous studies highlight that green bonds enable companies to diversify their

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funding sources and reduce their dependence on bank loans (Flammer, 2021; Tang & Zhang, 2020). As a result, the expansion of the green bond market may temporarily weaken bank stability by changing traditional financing channels and increasing competition between banks and capital markets in financing sustainable projects.

Moderating Role of Central Bank Policy Rates

Table 5. The Role of Central Bank Policy Rates

	(1) LZS	(2) LZS1	(3) LZS2
GRBN	-0.00119***	-0.00389***	-0.00107***
	(-6.09)	(-5.11)	(-7.76)
CBPR	0.00141**	0.0109***	0.00125***
	(2.35)	(4.85)	(2.96)
GRBN x CBPR	0.000345***	0.000445*	0.000333***
	(5.32)	(1.80)	(7.31)
Control Variable	YES	YES	YES
Constanta	2.701***	0.353***	2.702***
	(149.49)	(4.92)	(213.21)
N. Obs	10460	9654	10472
N. Banks	1462	1417	1462
R^2_within	0.521	0.0852	0.673
Marginal test			
Percentile 30 (Low)	0.009***	0.009	0.007***
	(5.12)	(1.39)	(7.05)
Percentile 50 (Medium)	0.016***	0.018	0.016***
	(5.20)	(1.56)	(7.20)
Percentile 70 (High)	0.022***	-0.029	0.023***
	(5.24)	(1.64)	(7.24)

Notes: The interaction term GRBN × CBPR captures the moderating effect of monetary policy. All regressions include bank-level and country-level control variables. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

Table 5 presents the estimation results examining the moderating role of central bank policy rates (CBPR) in the relationship between green bond issuance and bank stability. Consistent with the baseline results, the coefficient of green bond issuance (GRBN) remains negative and statistically significant across all specifications, indicating that the expansion of green bond markets is associated with lower bank stability. However, the interaction term GRBN × CBPR is positive and statistically significant, suggesting that central bank policy rates mitigate the negative effect of green bond issuance on bank stability.

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This finding implies that the macro-financial environment plays an important role in shaping how sustainable finance affects banking stability. When policy rates are higher, banks tend to face stricter funding conditions and tighter credit environments, which may reduce excessive risk-taking and improve balance sheet resilience. In this context, higher policy rates can offset some of the risks associated with the expansion of green bond markets. This result is consistent with the risk-taking channel of monetary policy, which suggests that monetary policy conditions influence banks' risk appetite and portfolio allocation decisions (Borio & Zhu, 2012; Dell'Ariccia et al., 2014; Jiménez et al., 2014).

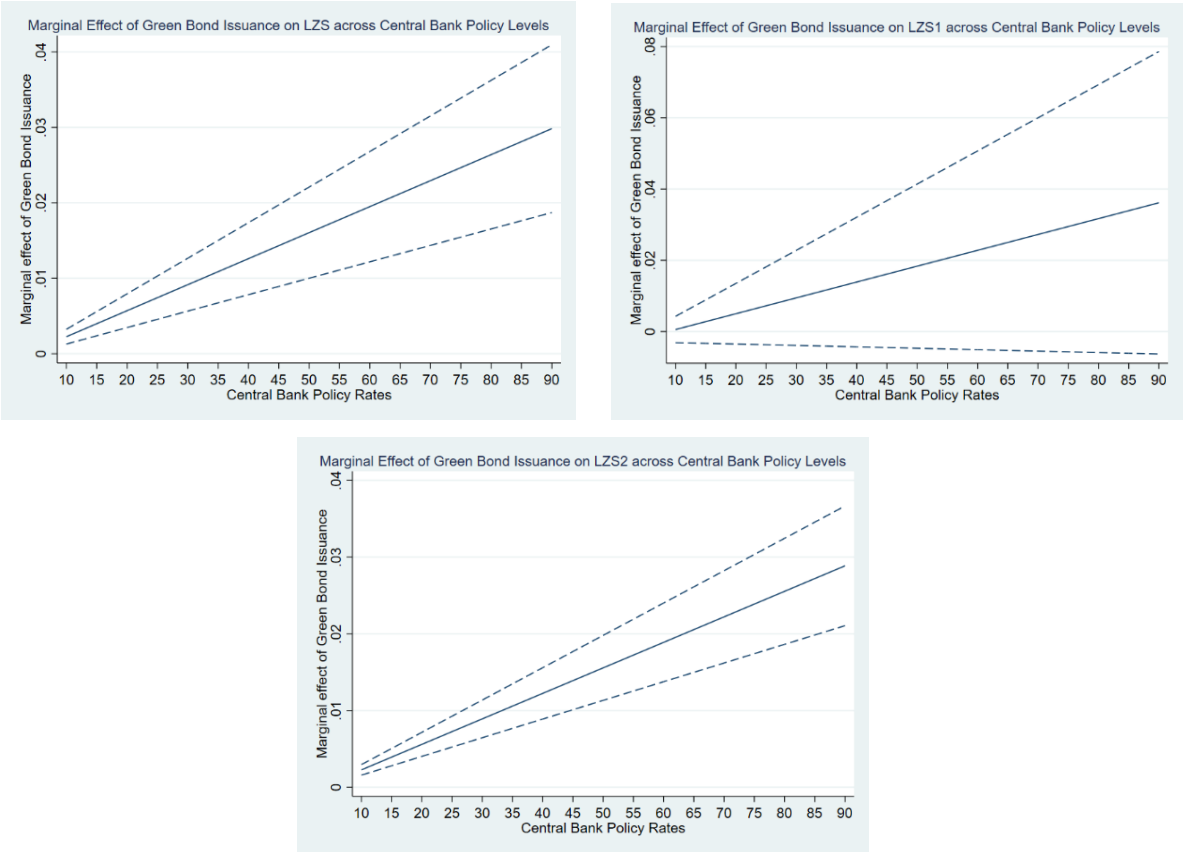

Fig 1. Marginal Effect of Green Bond Issuance across Central Bank Policy Rate Levels

Note: The solid line shows the estimated marginal effect, while the dashed line represents the confidence interval. The upward trend indicates that the effect of green bond issuance on banking stability increases as the central bank's policy interest rate increases.
Source: Author's calculation (2026)

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The marginal effect analysis further supports this interpretation (see Figure 1). The results show that the moderating effect of policy rates becomes stronger as the level of policy rates increases. At low policy rate levels (30th percentile), the marginal effect of green bond issuance on bank stability remains relatively small, whereas the effect becomes larger and more positive at medium and high policy rate levels (50th and 70th percentiles). This pattern indicates that the stabilizing role of monetary policy becomes more pronounced when interest rates are higher, as tighter monetary conditions may discourage excessive risk-taking and strengthen financial discipline in banking institutions.

Addressing Endogeneity: System GMM Results

Table 6. Endogeneity with GMM

	(1) LZS	(2) LZS1	(3) LZS2
LZS_{t-1}	0.936***		
	(34.15)		
$LZS1_{t-1}$		0.559***	
		(4.14)	
$LZS2_{t-1}$			0.903***
			(24.39)
GRBN	-0.00171***	-0.00310***	-0.000997***
	(-2.76)	(-2.58)	(-2.66)
Control Variable	YES	YES	YES
Constanta	0.185*	1.244	0.268**
	(1.70)	(1.16)	(2.22)
N.Obs	10155	9035	10174
N.Banks	1454	1365	1454
AR(1)	0.000	0.000	0.000
AR(2)	0.080	0.094	0.928
Sargan	0.518	0.232	0.360
Hansen	0.563	0.237	0.600

Notes: The t-1 shows the value of the dependent variable in the previous period (lag). AR(1) and AR(2) represent the Arellano-Bond tests for first- and second-order serial correlation, while Sargan and Hansen tests examine the validity of the instruments. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

Table 6 presents the results from the dynamic System GMM estimation, which addresses potential endogeneity and dynamic persistence in bank stability. The coefficients of the

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lagged dependent variables (LZS_{t-1}, $LZS1_{t-1}$, and $LZS2_{t-1}$) are positive and highly significant, indicating that bank stability exhibits strong persistence over time. This finding suggests that the current level of bank stability is strongly influenced by its past performance, which is consistent with previous studies emphasizing the dynamic nature of bank risk and financial stability (Arellano & Bover, 1995; Blundell & Bond, 1998; Fu et al., 2014).

Consistent with the baseline results, the coefficient of green bond issuance (GRBN) remains negative and statistically significant across all model specifications. This indicates that even after controlling for potential endogeneity and dynamic effects, the expansion of green bond markets is associated with lower bank stability. The persistence of this result strengthens the reliability of the baseline findings and suggests that the observed relationship is not driven by reverse causality or omitted variable bias.

The diagnostic tests further support the validity of the GMM estimation. The Arellano–Bond test for serial correlation shows significant first-order correlation AR(1), which is expected in dynamic panel models, while the second-order correlation AR(2) is insignificant, indicating that the model does not suffer from second-order serial correlation. In addition, the Sargan and Hansen tests of overidentifying restrictions fail to reject the null hypothesis, suggesting that the instruments used in the System GMM estimation are valid.

Monetary Policy Regimes: Tightening vs Easing

Table 7. Tightening vs Easing Regime

	(1) LZS	(2) LZS1	(3) LZS2
Panel A. Tightening			
GRBN	-0.00405***	-0.00354***	-0.00388***
	(-5.12)	(-2.72)	(-7.53)
Control Variable	YES	YES	YES
Constanta	2.694***	-0.00873	2.764***
	(31.38)	(-0.04)	(44.50)
N. Obs	3702	3433	3704
N. Banks	952	918	953
R^2_within	0.542	0.0918	0.688
Panel B. Easing Regime			
GRBN	-0.000186	-0.000147	-0.000148
	(-1.24)	(-1.14)	(-1.23)
Control Variable	YES	YES	YES
Constanta	2.733***	2.775***	2.699***

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	(58.87)	(72.00)	(72.12)
N. Obs	6758	6768	6768
N. Banks	1437	1437	1437
R^2_within	0.513	0.641	0.685

Notes: All regressions include bank-level and country-level control variables. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

Table 7 presents additional analysis by distinguishing between monetary tightening and easing regimes. The results show that green bond issuance has a negative and significant effect on bank stability during tightening periods, while the effect becomes statistically insignificant during easing regimes. This finding suggests that the adverse impact of green bond market expansion is more pronounced when monetary policy becomes restrictive. Under tightening conditions, higher interest rates increase funding costs and reduce liquidity in the banking system, which may amplify the risks associated with portfolio adjustments and competition with capital markets. This result is consistent with the risk-taking channel of monetary policy, which indicates that changes in interest rates influence banks' risk exposure and balance sheet adjustments (Borio & Zhu, 2012; Jiménez et al., 2014)

Non-Linear Relationship Between Green Bonds and Bank Stability

Table 8. Non-Linear Relationship Between Green Bonds and Bank Stability

	(1) LZS	(2) LZS1	(3) LZS2
GRBN	-0.00208***	-0.00775***	-0.00180***
	(-4.43)	(-6.18)	(-4.55)
$GRBN^2$	0.00002***	0.00005***	0.00002***
	(4.10)	(3.80)	(4.47)
Control Variable	YES	YES	YES
Constanta	2.726***	0.427***	2.724***
	(60.31)	(3.41)	(74.94)
N. Obs	10460	9654	10472
N. Banks	1462	1417	1462
R^2_within	0.523	0.0871	0.675
Lind & Mehlum U-Shape Test			
L-B Slope	-0.002***	-0.0077***	-.0018***
	(-4.43)	(-6.17)	(-4.55)
U-B Slope	0.0013***	0.0017	0.0012***
	(3.20)	(1.16)	(1.16)
U-Test	3.21	1.17	3.85

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P-val	0.000	0.122	0.000
Turning Poin	59.98	79.35	57.66

Notes: GRBN² captures the quadratic effect. The Lind and Mehlum (2010) U-test is used to verify the existence of a U-shaped relationship, where L-B slope and U-B slope indicate the lower- and upper-bound slopes, respectively. All regressions include control variables. t-statistics are reported in parentheses, and *, **, *** denote significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

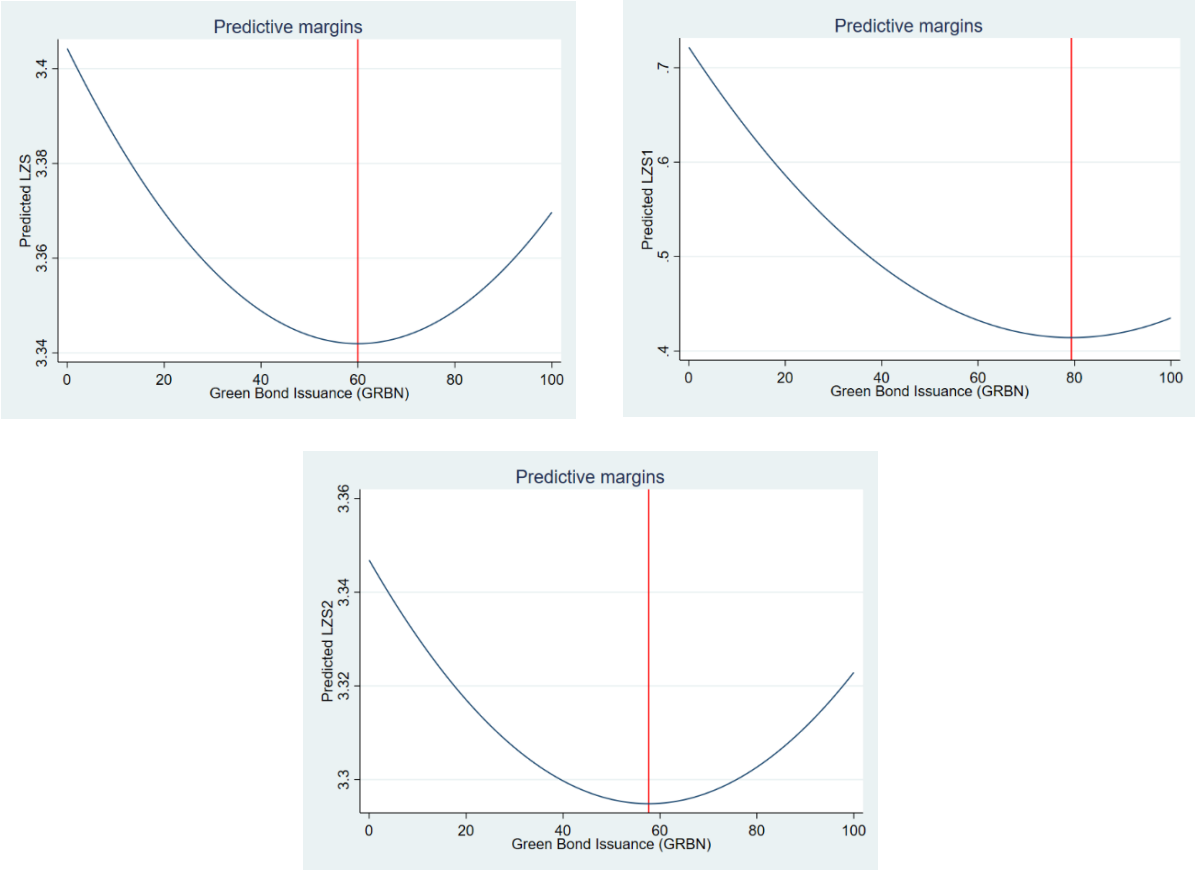

Fig 2. U-Shaped Relationship between Green Bond Issuance and Bank Stability

Note: The solid curve represents the predicted values of bank stability at different levels of green bond issuance. The vertical red line indicates the turning point, where the relationship changes from negative to positive, supporting a U-shaped relationship between green bond issuance and bank stability.
Source: Author's calculation (2026)

Table 8 and figure 2 examines the potential nonlinear relationship between green bond issuance and bank stability. The results show that the coefficient of GRBN is negative, while

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the squared term ($GRBN^2$) is positive and significant, indicating a U-shaped relationship. This U-shaped pattern supports the argument that green bond market development involves short-term adjustment costs but long-term stability benefits. At low levels of development, green bond markets can increase uncertainty due to limited liquidity, weak verification mechanisms, fragmented taxonomies, and the potential for greenwashing. However, beyond a certain threshold, further green bond market development can enhance financial stability as the market matures and information asymmetries decrease (Chantana et al., 2025; NGFS, 2020). U-tests confirm the existence of this U-shaped relationship, with the turning point indicating the level at which green bond market development begins to positively impact banking stability (Lind & Mehlum, 2010).

Robustness Check

Table 9 presents several robustness checks to verify the stability of the baseline findings. First, the analysis employs an alternative measure of bank stability (LZS_L) in column (1), and the results remain negative and statistically significant, confirming that the adverse relationship between green bond issuance and bank stability is not sensitive to the choice of stability indicator. Second, column (2) uses non-performing loans (NPL) as an alternative proxy for bank risk. The positive and significant coefficient on GRBN indicates that higher green bond issuance is associated with increased credit risk, consistent with earlier findings that green bond market expansion may weaken bank stability.

Table 9. Robustness Test

	(1) LZS_L	(2) NPL	(3) LZS	(4) LZS
GRBN	-0.000354***	0.00407**		-0.000699***
	(-2.75)	(2.27)		(-6.09)
$GRBN_{t-1}$			-0.000386***	
			(-3.05)	
Control Variable	YES	YES	YES	YES
Constanta	2.790***	5.570***	2.723***	2.442***
	(76.34)	(9.06)	(62.44)	(79.50)
N. Obs	10472	9863	9435	10460
N. Banks	1462	1404	1457	1462
R^2_within	0.651	0.258	0.528	
R^2_overall				0.515

Notes: Column (1) uses an alternative stability measure (LZS_L), while column (2) employs non-performing loans (NPL) as an alternative proxy for bank risk. Column (3) introduces the lagged value of green bond issuance ($GRBN_{t-1}$) to address potential reverse causality, and column (4) reports an alternative model specification. GRBN denotes the natural logarithm of the aggregate value of green bonds issued in each country.

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All regressions include bank-level and country-level control variables. t-statistics are reported in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.
Source: Author's calculation (2026)

Third, column (3) introduces the lagged value of green bond issuance ($GRBN_{t-1}$) to address potential reverse causality. The coefficient remains negative and statistically significant, suggesting that the impact of green bond market development on bank stability persists over time. Finally, column (4) reports the results using an alternative model specification, and the negative effect of green bond issuance remains significant. Overall, these robustness tests confirm that the main findings are consistent across alternative variable definitions and model specifications, strengthening the reliability of the empirical results.

5. Conclusion and Suggestion

This study examines the relationship between green bond issuance and bank stability and investigates the moderating role of central bank policy rates. The empirical results show that the expansion of green bond markets is associated with lower bank stability, suggesting that the rapid growth of green finance may introduce short-term risks to banking institutions. However, the findings also indicate that central bank policy rates mitigate this negative effect, implying that the macro-financial environment plays an important role in shaping the relationship between sustainable finance and financial stability. Additional analyses reveal that the adverse impact of green bond issuance is more pronounced during periods of monetary tightening, while a nonlinear relationship suggests that more mature green bond markets may eventually contribute positively to banking stability.

These findings provide technical implications for central banks and financial regulators. Regulators should integrate climate-related financial risks into macroprudential supervision by requiring banks to identify, measure, and report exposures to green bond issuers, transition-sensitive sectors, and borrowers vulnerable to climate policy changes. These risks should also be incorporated into climate scenario analysis, systemic stress testing, capital adequacy assessments, and financial stability monitoring frameworks (FSB, 2022; BCBS, 2022; Bartsch et al., 2025; Coelho & Restoy, 2023). In addition, stronger green bond disclosure, taxonomy alignment, external verification, and post-issuance monitoring are needed to reduce greenwashing risks and improve the reliability of green assets.

This study contributes to the literature in several ways. First, it contributes to the growing research on sustainable finance by providing new empirical evidence on the relationship between green bond market development and bank stability, an area that has received limited

attention in prior studies. Second, this study contributes to the banking and monetary policy literature by demonstrating that the financial stability implications of green finance depend on the broader monetary policy environment. Third, the findings provide new insights for policymakers on how the interaction between green finance and monetary policy conditions may influence banking-sector resilience.

Despite these contributions, this study has several limitations. First, the analysis measures green finance using country-level green bond issuance, which may not fully capture banks' direct exposure to green financial instruments. Future research may benefit from using bank-level green investment data to provide more detailed insights into banks' involvement in sustainable finance. Second, although this study includes a broad international sample, institutional differences across countries may influence the effectiveness of green finance policies and financial regulations. Further studies could explore regional or regulatory heterogeneity to better understand how legal and supervisory frameworks shape the relationship between green finance and banking stability.

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