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Funding Costs and Liquidity Creation: Does ESG Play Any Role?

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ABSTRACT

This study examines how banks' funding costs affect liquidity creation and whether environmental, social, and governance (ESG) performance shapes this relationship. Using panel data for 136 U.S. commercial banks from 2005 to 2022, we show that higher funding costs are associated with lower liquidity creation, indicating that more expensive funding constrains banks' capacity to supply liquidity in the economy. We also find that stronger ESG performance is linked to greater liquidity creation. Moreover, ESG performance significantly moderates the funding cost–liquidity creation nexus, consistent with the view that banks with stronger ESG profiles can attract more stable or cheaper deposits, as depositors may accept relatively lower interest rates. These findings remain robust across alternative liquidity-creation measures and a range of empirical approaches, including random-effects models, two-step system GMM, and regression discontinuity designs.

JEL Classification: G2, G21, G28, G29, G32

1 | Introduction

Modern theories of financial intermediation emphasize that the central function of banks is liquidity creation (Bryant 1980; Diamond and Dybvig 1983). These theories typically suggest two main channels. First, banks generate liquidity on the balance sheet by funding relatively illiquid assets (e.g., loans with liquid liabilities and most notably deposits). Second, banks create liquidity off the balance sheet through instruments that provide access to funds on demand, including loan commitments and related contingent credit lines. In addition, these theories portray banks as risk transformers. By issuing low-risk liabilities (e.g., savings deposits and certificates of deposit) to finance riskier assets (e.g., mortgages and consumer credit), banks can help smooth the flow of funds from savers to borrowers while reducing the economy-wide costs of risk and maturity transformation (Diamond 1984; Boyd and Prescott 1986). Building on this perspective, Berger and Bouwman (2015) show that off-balance-sheet activities account for a substantial share of liquidity creation in the United States. Accordingly, they propose "Catfat" as a measure that captures a bank's liquidity creation from off-balance-sheet activities and argue that it provides a particularly informative indicator for this dimension of intermediation.

A key determinant of bank liquidity creation, especially given liquidity risk and interest-rate conditions in short-term funding markets, is the cost of funding. It can be defined as the costs that banks incur to obtain funds. Such costs are primarily focused on the interest expenses associated with different types of deposits (Gerlach et al. 2018). Figures 1 and 2 (Panel A) are consistent with the argument of Thakor and Yu (2022) that lower funding costs enable banks to provide more credit and stimulate economic activity, while higher funding costs can constrain liquidity creation and impact economic growth.

A substantial body of research has examined the relationship between liquidity creation and funding costs (e.g., Abbas et al. 2021; Umar and Sun 2016; Khan et al. 2017; Viverita

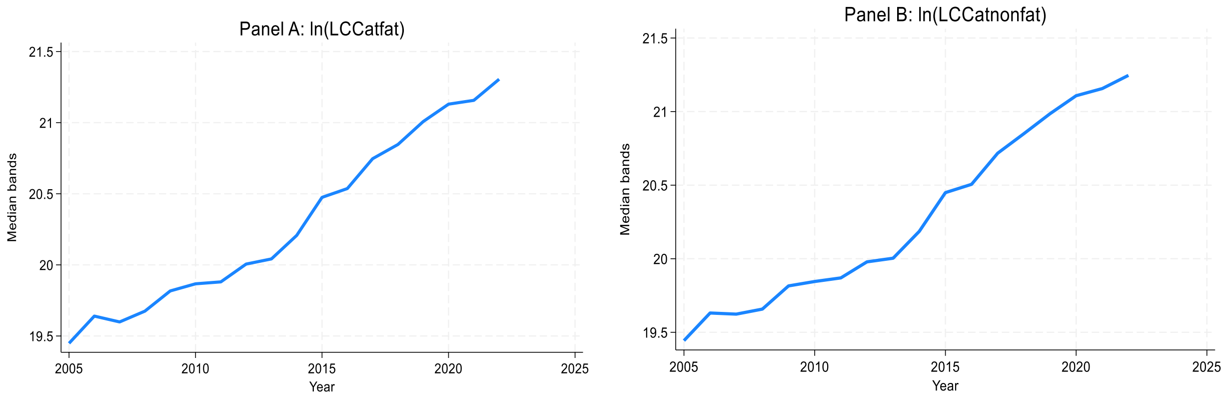

FIGURE 1 | The median LC Catfat (Panel A) and LC Catnonfat (Panel B) of the sampling U.S. commercial banks from 2005 to 2022.

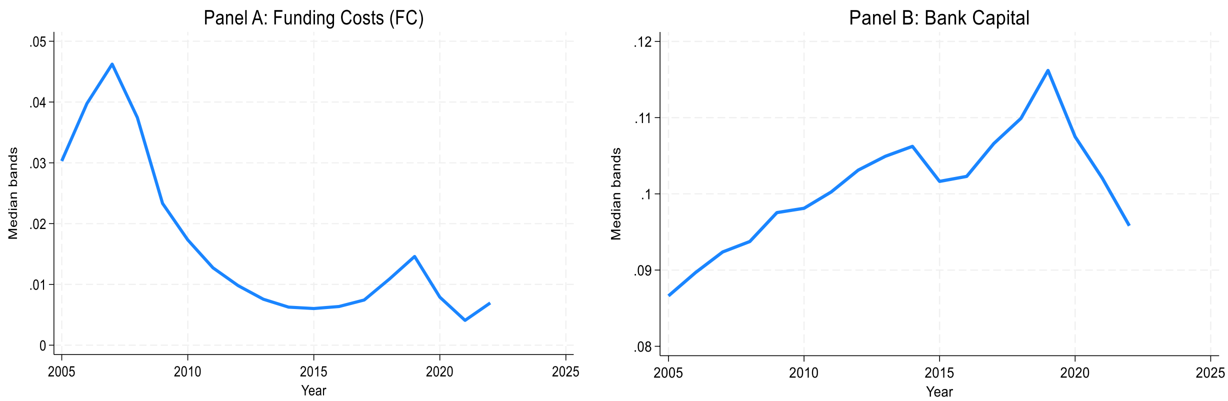

FIGURE 2 | The median funding cost (Panel A) and bank capital (Panel B) of the sampling U.S. commercial banks from 2005 to 2022.

et al. 2024). The empirical literature on funding costs and liquidity creation documented that banks may be less willing or able to create liquidity due to the higher funding costs, as well as deposit withdrawals as bank customers request higher returns (e.g., Bechtel et al. 2023; Gerlach et al. 2018; Khan et al. 2017).

Following the 2007–08 global financial crisis, the United States enacted major regulatory reforms. In July 2010, the Dodd–Frank Act was adopted to strengthen the stability of the U.S. financial system, enhance consumer protection, improve market transparency, and curb excessive risk-taking in lending and financial markets. Later that year, in December 2010, the Basel Committee on Banking Supervision (BCBS) issued the Basel III framework. Basel III introduced a broad set of prudential reforms aimed at strengthening bank resilience, including higher and better-quality capital requirements, the Liquidity Coverage Ratio (LCR), the Net Stable Funding Ratio (NSFR), a leverage ratio, more stringent counterparty credit risk rules, and enhanced disclosure and transparency. Consistent with this view, Khan et al. (2015) suggest that Basel III–style liquidity requirements can enhance bank performance and may also lower deposit funding costs.

In addition to funding costs, this study also considers ESG performance as another factor that affects bank liquidity creation. Previous literature documents that banks with excellent ESG performance and that seek sustainable development pay lower interest rates to depositors, which implies enhancing banks' ability to create liquidity (Baek and Kang 2025; Galletta et al. 2021). The impact of ESG adoption is well documented in previous banking literature. Nonetheless, the majority of the current literature is primarily concentrated on its impact on bank performance (e.g., Bătae et al. 2020; La Torre et al. 2021), risk-taking and stability (e.g., Di Tommaso and Thornton 2020; Galletta and Mazzù 2023; Li et al. 2023), bank efficiency (e.g., Alam et al. 2022), bank profitability (e.g., Azmi et al. 2021; Ersoy et al. 2022), bank reputation (e.g., Murè et al. 2021), liquidity creation (e.g., Lee et al. 2024), funding costs and asset quality (Agnese and Giacomini 2023; Andrieș and Sprincean 2023; Baek and Kang 2025), and depositor behavior (Galletta et al. 2021).

Given the growing literature in ESG engagement in the banking industry, to the best of our knowledge, no study has yet explored the moderating role of ESG in the link between funding costs and liquidity creation. Hence, the motivation of this study stems from filling this gap in existing literature. Particularly, the present study aims to examine whether ESG performance significantly moderates the relationship between funding costs and liquidity creation, in the context of U.S. commercial banks. In other words, if banks are offering low returns on the deposits but they are performing well on ESG, are the depositors accepting low interest payments? Therefore, the main hypothesis of the present study is that ESG performance significantly reduces the funding costs for the sampling banks, which results in increasing the sampling banks' ability to create liquidity. This hypothesis highlights the main contribution of this study.[1]

In the empirical section of this study, we collect data on 136 U.S. commercial banks for the period from 2005 to 2022. We employ the ordinary least squares (OLS) regression with bank, state, and year fixed effects as baseline regression. For robustness checks, we employ three methods that include: random effects (RE), two-step system Generalized Method of Moments (GMM), and regression discontinuity (RD) models.[2] The results indicate that funding costs significantly lower the ability of the sampling banks to create liquidity at the 1% significance level. Also, the results show that ESG performance positively affects the sampling banks' ability to create liquidity. Moreover, we find that funding costs significantly decrease, at the 1% significance level, as the sampling banks engage in ESG practices. Furthermore, the results show that banks' governance practices, to some extent, contribute significantly to reducing the funding costs. Finally, we find that the interaction term (FC × ESG) is negative and statistically significant at the 1% level, suggesting that the ESG performance of the sampling banks is instrumental in moderating the link between funding costs and liquidity creation. This finding highlights the main contribution of this study.

This study proceeds as follows: Section 2 reviews the related literature to highlight gaps in existing literature, presents a theoretical framework, and states the research hypotheses. Section 3 presents the data collection process, the selected variables, and the research methodology. Section 4 reports the baseline results. Section 5 discusses the results for the robustness checks. Section 6 concludes the study.

2 | Theoretical Framework, Literature Review, and Hypotheses Development

2.1 | Literature Review on Funding Costs and Liquidity Creation

As previously discussed, financial intermediation theories suggest that banks hold something illiquid (the loan commitment) and give the public something liquid (deposits), thereby creating liquidity. Drehmann and Nikolaou (2013) defined funding liquidity as the ability to pay debts with immediacy. The implication of this definition is that a bank is referred to as illiquid if it cannot meet its obligations at maturity. Therefore, the authors defined funding liquidity risk as the possibility that over a particular period of time, the bank will be unable to fulfill obligations with immediacy. This definition is aligned with the implications of "bank run" explained by (Diamond and Dybvig 1983) since a bank run leads to sudden deposits withdrawals as the depositors anticipate that the bank will be insolvent. This action by the depositors will indeed drive the bank to sell off many of its assets at a loss, which leads to bank failure. Insuring deposits, by which banks are required to issue equity and maintain cash reserves, is a way to prevent or mitigate bank runs (Cornett et al. 2011).

Empirical research ascertains that a decrease in banks' funding liquidity risk leads to higher bank risk-taking, as shown by an increase in risk-weighted assets, greater liquidity creation, and lower Z-scores (Abbas et al. 2021; Khan et al. 2017; Umar and Sun 2016; Viverita et al. 2024). Also, prior research documents that borrowers facing high liquidity risk are willing to accept a higher cost when they experience liquidity constraints (Bechtel et al. 2023; Gerlach et al. 2018). This implies that banks may be less willing or able to create liquidity due to two reasons: first, higher funding costs; second, deposit withdrawals since bank customers pursue greater returns.

Thus, based on the above discussion of theories and related literature on funding costs and liquidity creation, this study hypothesizes the following:

Hypothesis 1. *Funding costs significantly reduce banks liquidity creation.*

2.2 | Literature Review on ESG Practices in Banking

ESG risk is a fundamental aspect of sustainable finance and represents a major research focus within the field. It refers to the risks arising from the intersection of business, social, and natural environments, as well as corporate governance issues. Given the increasing importance of ESG risk in banking and financial institutions, particularly in relation to environmental risk, a key strategy to mitigate this risk is an efficient management system. ESG risk directly impacts the financial stability and liquidity of banks, since they tolerate the financial consequences of liquidity loss from their borrowers and the penalties resulting from noncompliance with regulations or harmful environmental practices (Ziolo et al. 2021).

Previous literature shows that banks' ESG performance positively affects bank liquidity creation, which is more manifest in countries with high geopolitical and corruption risks, and low levels of democratization (Lee et al. 2024). Other strand of literature examine the impact of ESG on banks' funding cost suggesting that sustainable banking governance practices play a key role in lowering the cost of debt financing (Agnese and Giacomini 2023; Andrieș and Sprincean 2023; Baek and Kang 2025).

2.3 | Literature Review on ESG and Depositor Behavior

This study also argues that depositors' behavior might be driven by the bank's ESG performance, which might help them to create more liquidity at a lower cost. Therefore, ESG performance of the sampling banks is also considered as another key explanatory variable. Previous studies provide evidence to justify the importance of strong ESG practices in banks' activities since such practices are associated with lower funding costs, reduced risk, and sustainable bank stability (Ahmed et al. 2018; Andrieș and Sprincean 2023; Galletta et al. 2021; Homanen 2018).

Other ESG literature on banking mainly focuses on its impact on bank performance (e.g., Bătae et al. 2020; La Torre et al. 2021), risk-taking and stability (e.g., Di Tommaso and Thornton 2020; Galletta and Mazzù 2023; Li et al. 2023), bank efficiency (e.g., Alam et al. 2022), bank profitability (e.g., Azmi et al. 2021; Ersoy et al. 2022), and bank reputation (e.g., Murè et al. 2021).

Therefore, given the above discussion of previous literature on ESG practices in banking and the related theories, we hypothesize the following:

Hypothesis 2. *ESG performance positively affects liquidity creation.*

Hypothesis 3. *ESG performance significantly reduces funding costs.*

Hypothesis 4. *Banks' governance practices significantly reduce funding costs.*

Hypothesis 5. *ESG performance significantly moderate the relationship between funding costs and liquidity creation.*

3 | Data and Methodology

3.1 | Sample Selection

Data on U.S. commercial banks are collected as follows.[3] The first set of data contains data on ESG overall score, environmental score, social score, and governance score. These data are generated from Refinitiv Eikon and are considered as independent variables in our regression models. Banks with ESG data of two observations or less are dropped from the sample to avoid any issues caused by missing data. Table A1 in the appendix provides a list of all variables used, their definitions, and the source of data. The second set of data include financial performance data that consist of balance sheet data and off-balance sheet data.[4] We use the Wharton Research Data Services (WRDS) in addition to Refinitiv Eikon to collect the financial data that are used to calculate the dependent variable represented by liquidity creation measures as described in (Berger and Bouwman 2009). Additionally, these dataset are used to calculate the funding costs, which is our second main independent variable. Moreover, we add bank-level control variables that include bank size, capital, earnings, growth, nonperforming loans (NPL), Z-score, noninterest incomes (NII), and the interaction between the funding costs and overall ESG score ($FC \times ESG$). All the dataset are winsorized at the 1% level in order to remove extreme values. The final sample contains 136 US commercial banks, located in 36 states, for the period 2005–2022 and total number of obervations of 2448. The sample distribution shows that more than 50% of our sampling banks are located in New York, Pennsylvania, California, Ohio, New Jersey, Illinois, Indiana, Texas, and Washington. Table 1 shows the number of sampling banks and observations by state.

TABLE 1 | Number of sampling banks and observations by state.

State	Freq.	Number of banks	Percent	Valid	Cum.
NY	234	13	9.56	9.56	9.56
PA	234	13	9.56	9.56	19.12
CA	180	10	7.35	7.35	26.47
OH	162	9	6.62	6.62	33.09
NJ	126	7	5.15	5.15	38.24
IL	90	5	3.68	3.68	41.91
IN	90	5	3.68	3.68	45.59
TX	90	5	3.68	3.68	49.26
WA	90	5	3.68	3.68	52.94
FL	72	4	2.94	2.94	55.88
IA	72	4	2.94	2.94	58.82
LA	72	4	2.94	2.94	61.76
MA	72	4	2.94	2.94	64.71
VA	72	4	2.94	2.94	67.65
AR	54	3	2.21	2.21	69.85
GA	54	3	2.21	2.21	72.06
MD	54	3	2.21	2.21	74.26
ME	54	3	2.21	2.21	76.47
MI	54	3	2.21	2.21	78.68
MO	54	3	2.21	2.21	80.88
NC	54	3	2.21	2.21	83.09
AL	36	2	1.47	1.47	84.56
CO	36	2	1.47	1.47	86.03
CT	36	2	1.47	1.47	87.5
KS	36	2	1.47	1.47	88.97
MN	36	2	1.47	1.47	90.44
MS	36	2	1.47	1.47	91.91
TN	36	2	1.47	1.47	93.38
WV	36	2	1.47	1.47	94.85
DE	18	1	0.74	0.74	95.59
KY	18	1	0.74	0.74	96.32
ND	18	1	0.74	0.74	97.06
OK	18	1	0.74	0.74	97.79
RI	18	1	0.74	0.74	98.53
SD	18	1	0.74	0.74	99.26
VT	18	1	0.74	0.74	100
Total	2448	136	100	100	

3.2 | Selection of Variables

Following (Berger and Bouwman 2009), we select two measures of liquidity creation that include *Catfat* and *Catnonfat* as our dependent variables. "Cat" classifies loans by category "cat" rather than maturity. Moreover, "fat" includes off-balance sheet activities. Hence, this measure includes both stable and volatile sources of funding (broad liquidity creation). On the contrary, the "nonfat" excludes off-balance sheet activities. Thus, this measure focuses on stable, more reliable funding sources (narrower liquidity creation). For our independent variables, we also select two main variables that include funding costs along with the overall ESG score and its individual pillar scores (environmental, social, and governance). In addition, we include several control variables as described in Section 3.3.4 and Table A1 in the appendix.

3.3 | Measurement of Variables

3.3.1 | Measurement of Liquidity Creation

We measure bank liquidity creation by applying the three-step framework proposed by Berger and Bouwman (2009). In Step 1, we classify each bank activity into one of three liquidity categories: liquid, semi-liquid, or illiquid. This classification covers balance-sheet items (assets, liabilities, and equity) as well as off-balance-sheet activities. In Step 2, we assign category-specific weights consistent with liquidity creation theory using a dollar-for-dollar logic: liquidity creation is highest when banks fund illiquid assets with liquid liabilities, whereas liquidity creation declines when banks hold liquid assets or rely more on illiquid liabilities or equity. In Step 3, we aggregate the weighted components to compute two liquidity creation indicators, *Catfat* and *Catnonfat*, based on the classifications from Step 1 and the weights from Step 2. Table 2 reports the liquidity classifications of bank activities, while Equations (1) and (2) present the computations for *Catfat* and *Catnonfat*, respectively.

$$\begin{aligned} \boldsymbol{LC(Catfat)} = & \ 0.5\times(\textit{Illiquid assets (cat)} + \textit{liquid liabilities} + \textit{illiquid guarantees}) \\ & + 0\times(\textit{semiliquid assets (cat)} + \textit{Semiliquid Liabilities} + \textit{semiliquid guarantees}) \\ & - 0.5\times(\textit{liquid Asset} + \textit{Illiquid Liabilities} + \textit{equity} + \textit{liquid guarantees} + \textit{liquid derivatives}) \end{aligned} \quad (1)$$

$$\begin{aligned} \boldsymbol{LC(Catnonfat)} = & \ 0.5\times(\textit{illiquid assets} + \textit{liquid liabilities}) + 0\times(\textit{semiliquid assets} + \textit{semiliquid liabilities}) \\ & - 0.5\times(\textit{liquid asset} + \textit{illiquid liabilities} + \textit{equity}) \end{aligned} \quad (2)$$

3.3.2 | Measurement of Funding Costs

Following (Andrieș and Sprincean 2023), the bank funding cost is calculated as the interest expenses on domestic deposits divided by the amount of interest-bearing domestic deposits at the beginning of a period, as follows:

$$FC_{i,t} = \left(\frac{\textit{interest expenses on domestic deposits}}{\textit{interest} - \textit{bearing domestic deposits}}\right) \quad (3)$$

where $FC_{i,t}$ is the funding costs for bank i at year t.

3.3.3 | Measurement of ESG

While ESG scores are widely used by investors and stakeholders to assess corporate sustainability performance, ESG rating agencies use different methodologies. The variation in methodologies used leads to subjectivity and inconsistencies in ESG scores for the same company. This issue arises among providers such as Refinitiv (LSEG), MSCI, and Sustainalytics due to varying scope, measurement (i.e., "rater effect" or "halo effect"), weights, and dimensions (see Table A2 in the appendix). Chatterji et al. (2016) reported fairly low correlation among six major social raters including KLD, Asset4, FTSE4Good, Calvert, DJSI, and Innovest, suggesting that ESG ratings from different providers greatly disagree. Similarly, (Berg et al. 2022) documented that the correlations between ESG ratings range from 0.38 to 0.71. Moreover, their findings indicate that measurement divergence is the main contributor to the inconsistencies in ESG ratings, accounting for 56% of the divergence. Furthermore, the authors suggested greater transparency and standardization in measurement practices in order to enhance the reliability and comparability of ESG ratings.

Following previous literature (e.g., Lee et al. 2024; Agnese and Giacomini 2023; Galletta and Mazzù 2023; Andrieș and Sprincean 2023; Ersoy et al. 2022; La Torre et al. 2021), we collect the ESG combined scores, environmental pillar scores, social pillar scores, and governance pillar scores from the Refinitiv Eikon database (i.e., LSEG).

Based on the Refinitiv Eikon methodology, the ESG score is calculated as a relative sum of weights of the category scores. The pillar score weights are normalized to percentages ranging from 0 to 1. Score ranging from 0 to 0.25 indicate poor ESG performance (ESG laggards), while scores ranging from 0.75 to 1 indicate excellent relative ESG performance (ESG leaders). Any scores in between indicate satisfactory to good relative ESG performance.

3.3.4 | Control Variables

In addition, several control variables affecting liquidity creation are included. These variables include bank size, capital, earnings, growth, NPL, Z-score, and noninterest incomes (NII). Moreover, we include the interaction between the funding costs and overall ESG score (FC × ESG) to capture the moderating role of ESG in the effect of funding costs on liquidity creation. Figure 3 illustrates the moderating role of ESG in the relationship between funding costs and liquidity creation. Previous literature (e.g., Baron and Kenny 1986; Namazi and Namazi 2016) defined a moderator variable (e.g., ESG) as the one that affects the strength and/or the direction of the relationship between the dependent variable (e.g., LC) and the independent variable (e.g., FC). Hence, if the path for the interaction effect is significant, then the fifth hypothesis is supported that ESG performance of the sampling banks significantly moderates the relationship between funding costs and liquidity creation.

TABLE 2 | The liquidity classification of bank activities.

Assets		
Illiquid assets ($w^*=½$)	**Semiliquid assets ($w^*=0$)**	**Liquid assets ($w^*=-½$)**
(*Cat*)	**(*Cat*)**	
Commercial real estate loans (CRE)	Residential real estate loans (RRE)	Cash and due from banks
Loans to finance agricultural production	Consumer loans	Total investment securities
Commercial and industrial loans (C&I)	Loans to depository institutions	Trading account assets
Other loans and lease financing receivables	Loans to state and local governments	Feds funds sold
Other real estate owned	Loans to foreign governments	
Customers' liability on bankers acceptances		
Investment in unconsolidated subsidiaries		
Intangible assets		
Premises		
Other assets, total		
Liabilities plus equity[a]		
Liquid liabilities ($w^*=½$)	Semiliquid liabilities ($w^*=0$)	Illiquid liabilities plus equity ($w^*=-½$)
Total deposits	Time deposits	Total debt
Interest-earning deposits	Total short term borrowings	Other liabilities
Fed funds purchased/security sold under repurchase agreement		Total equity
Other bearing liabilities, total		
Off-balance sheet guarantees		
Illiquid guarantees	Semiliquid guarantees	Liquid guarantees
($w^*=½$)	($w^*=0$)	($w^*=-½$)
Revolving line of credit—unused amount	Net credit derivatives	Net participations acquired
Net standby letters of credit	Net securities lent	
Commercial and similar letters of credit		
Other liabilities, total		
Off-balance sheet derivatives		
		Liquid derivatives ($w^*=-½$)
		Interest rate derivatives
		Foreign exchange derivatives
		Equity and commodity derivatives

[a]Due to data limitation for transactions deposits, savings deposits, trading liabilities, other borrowed money, bank's liability on bankers acceptances, subordinated debt, unused commitments, we used the ones included in the table. Note that w* represents the weight assigned to the activities.

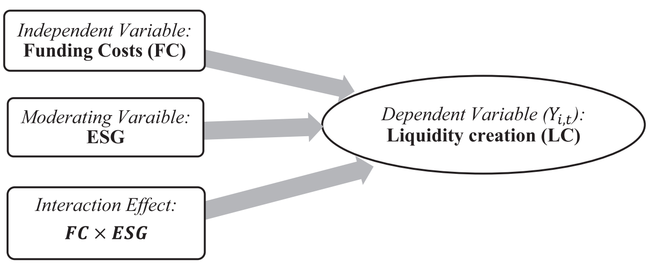

FIGURE 3 | Moderation Model.

3.4 | Methodology

The baseline model developed to assess the effect of funding costs and ESG performance on liquidity creation is expressed as follows:

$$Y_{i,t}=\alpha+\beta*FC_{i,t}+\delta*ESG_{i,t}\left(or\ ENV_{i,t}, SOC_{i,t}, GOV_{i,t}\right) + \lambda*X_{i,t}+\theta_{i,t}+\gamma_{i,t}+\tau_t+\varepsilon_{i,t} \quad (4)$$

$Y_{i,t}$ denotes bank liquidity creation measured by LC (Catfat) divided by total assets ($LCCatfat / TA$) and LC (Catnonfat) divided by total assets ($LCCatnonfat / TA$), following (Berger and Bouwman 2009), $FC_{i,t}$ is the bank funding costs for bank i at year t, $ESG_{i,t}, ENV_{i,t}, SOC_{i,t}, and\ GOV_{i,t}$ are the ESG combined score, environmental pillar score, social pillar score, and governance pillar score for bank i at year t, respectively. $X_{i,t}$ is a vector including bank-level variables affecting bank liquidity creation (i.e., size, capital, growth, Z-score, noninterest income, earnings, nonperforming loans, and the interaction term $ESG \times FC$, which capture the moderating role of ESG in the effect of funding cost on bank liquidity creation). $\theta_{i,t}$, $\gamma_{i,t}$, and τ_t are state, bank, and year fixed effects, respectively.

4 | Results

4.1 | Descriptive Statistics

Table 3 exhibits the summary statistics of our selected variables. It shows that liquidity creation equals about 38% of total assets (see Panel A of Table 3). Furthermore, liquidity creation represents $2.713 of liquidity creation per $1 of equity capital and is almost 40% as large as gross loans and about 34% as large as total deposits, which are two main items of asset and liability that measure bank size (see Table A4 in the appendix). Moreover, our findings indicate that, on average, banks create liquidity of $4.280 billion based on the "Catfat" liquidity measure, as shown in Table A3 in the appendix. Table 3 also shows that the ESG score has a mean of 36.09, whereas the ENV score, SOC score, and GOV score have means of 14.655, 35.26, and 47.943, respectively. In addition, we can notice that the average funding costs is 1.60%, ranging from 0.1% to 6.20%, with a standard deviation of 1.40%.

4.2 | Correlation Analyses

Table 4 reports the correlation matrix. Most pairwise correlations are statistically significant at the 10% level. Funding costs, the overall ESG score, and the environmental, social, and governance pillar scores are all negatively correlated with liquidity creation. By contrast, bank capital is positively correlated with liquidity creation and is statistically significant at the 10% level. This pattern is broadly consistent with Berger and Bouwman (2009), who document a positive association between capital and liquidity creation primarily for large banks. This suggests that the capital–liquidity creation link may differ by bank size, which has potentially important policy implications. In contrast, Casu et al. (2019), using data on European commercial, savings, and cooperative banks, reports a negative bidirectional relationship between capital and liquidity creation

TABLE 3 | Summary statistics.

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
Panel A: Dependent variables					
LC1	2227	0.376	5.252	−0.998	248.083
LC2	2227	0.371	5.253	−2.595	248.083
Panel B: Independent variables					
FC	2162	0.016	0.014	0.001	0.062
ESG	1059	36.097	15.815	9.44	81.48
ENV	1059	14.655	22.436	0	86.93
SOC	1059	35.26	16.778	7.76	85.66
GOV	1059	47.943	21.133	4.68	89.46
Panel C: Control variables					
Size	2227	3.098	0.074	2.983	3.347
Capital	2227	0.105	0.024	0.058	0.19
Earnings	2227	0.012	0.008	−0.027	0.028
Growth	2090	0.095	0.129	−0.131	0.689
lnNPL	1845	17.45	2.041	10.8	25.071
lnZscore	2173	10.695	8.121	−32.346	28.564
NII	2448	0.159	0.629	−0.83	4.464
Panel D: Interaction variable					
$ESG \times FC$	1058	0.436	0.507	0.021	3.172

Note: LC1 and LC2 represent the liquidity creation measure calculated as: $LC1 = (LCCatfat / TA)$, and $LC2 = (LCCatnonfat / TA)$. All of the selected variables are winsorized at the 1% level to remove extreme values. For Z-score, we first calculate the log and then winsorize it at the 1% level. For nonperforming loans, we just calculate the log.

TABLE 4 | Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) LC1	1														
(2) LC2	1.000*	1													
(3) FC	−0.133*	−0.103*	1												
(4) ESG	−0.398*	−0.300*	0.069*	1											
(5) ENV	−0.509*	−0.382*	0.196*	0.741*	1										
(6) SOC	−0.411*	−0.301*	0.122*	0.891*	0.747*	1									
(7) GOV	−0.205*	−0.162*	−0.014	0.798*	0.370*	0.459*	1								
(8) Size	−0.039	−0.039	−0.066*	0.710*	0.789*	0.753*	0.378*	1							
(9) Capital	0.072*	0.072*	−0.173*	−0.118*	−0.091*	−0.136*	−0.055	0.136*	1						
(10) Earnings	−0.107*	−0.107*	−0.098*	0.022	−0.026	−0.004	0.054	0.143*	0.151*	1					
(11) Growth	−0.037	−0.037	−0.116*	−0.066*	−0.112*	−0.046	−0.049	0.004	0.027	0.071*	1				
(12) NPL	−0.399*	−0.343*	0.03	0.561*	0.692*	0.568*	0.269*	0.596*	−0.02	−0.012	−0.071*	1			
(13) lnZscore	−0.141*	−0.136*	−0.067*	0.070*	−0.033	0.046	0.086*	0.099*	−0.103*	0.870*	0.116*	−0.007	1		
(14) NII	−0.001	−0.001	0.028	−0.084*	−0.031	−0.052	−0.101*	−0.044*	0.021	0.011	0.214*	−0.019	0.023	1	
(15) $ESG \times FC$	−0.375*	−0.287*	0.875*	0.425*	0.438*	0.427*	0.283*	0.509*	−0.106*	−0.108*	−0.077*	0.352*	−0.078*	0.021	1

Note: ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

in the post-Basel III period. Most importantly, the interaction term ESG×FC is negatively correlated with liquidity creation and is statistically significant at the 10% level.

4.3 | Liquidity Creation, Funding Costs, and ESG Performance

Table 5 (Panel A) reports the baseline estimates from Equation (4) with state fixed effects only. The first row presents the coefficient related to funding costs and liquidity creation. Across specifications, the coefficients are negative, although they are statistically insignificant in most columns; the estimate in Column (5) is the exception and is significant at the 10% level. Overall, the signs are consistent with the view that higher funding costs constrain banks' capacity to create liquidity. These results provide support for our first hypothesis that funding costs weaken liquidity creation among the sampled banks, in line with the results of prior research (e.g., Umar and Sun 2016; Gerlach et al. 2018; Abbas et al. 2021; Bechtel et al. 2023; Viverita et al. 2024). However, when accounting for year fixed effect in addition to state fixed effect, as shown in Table 5 (Panel B), the results suggest that funding costs positively and significantly affect liquidity creation at the 1% level, which is inconsistent with the theory and empirical evidence that implies higher funding costs reduces banks' ability to create liquidity. Moreover, including the year fixed effect in addition to state fixed effect makes the results for funding costs also inconsistent and the opposite of those reported in the random effect and the two step system GMM models shown in Tables 7 and 8, respectively. Alternatively, when including bank fixed effect in addition to the state fixed effect, as illustrated in Table 5 (Panel C), the results become more significant and consistent with the theory and empirical evidence. Also, the results become consistent with those reported in the random effect and the two step system GMM models.

Also, Table 5 (Panel A) shows the results of the association between liquidity creation and ESG performance of the sampling banks. The results indicate that there is a positive relationship between ESG performance and liquidity creation although insignificant. These results confirm our second hypothesis that ESG performance positively affects banks' ability to create liquidity, and is consistent with (Lee et al. 2024). Hence, these results suggest that engaging in ESG practices increases the ability of the sampling banks to create more liquidity. The social pillar score (SOC) shows consistent results, whereas the government pillar score (GOV) shows consistent results only when considering the "Catfat" measure of liquidity creation. In contrast, the environmental pillar score (ENV) shows a negative and significant effect on liquidity creation at the 1% level. One possible channel that can explain this result is that high environmental investment can crowd out liquidity creation "crowding out effect". Prior research documented that environmental damage costs reduce bank profitability (Bressan 2025). Consequently, banks will have fewer funds allocated for liquidity creation as they also need funds to maintain capital requirements and cover their operational costs. We also believe that ESG disclosure might affect the coefficient of the ENV since some banks do not have available data for this pillar score. Fatemi et al. (2018) argue that ESG disclosure plays a key moderating role by mitigating the negative effect of weaknesses and attenuating the positive effect of strengths.

However, the results in Table 5 (Panel B) indicate that when including year fixed effects in addition to state fixed effects, the impact of ESG becomes negative. This result is inconsistent with previous results in Table 5 (Panel A), the results reported in the RE and the two-step system GMM models, and the results documented in previous empirical research (e.g., Lee et al. 2024). Therefore, we include the bank fixed effects instead of year fixed effects in Table 5 (Panel C). The results for the impact of ESG on bank liquidity creation become consistent with those reported in Tables 5 (Panel A), 7, and 8, and previous empirical research (e.g., Lee et al. 2024).

4.4 | The Effects of ESG Performance and Bank Governance Practices on Funding Costs

As an additional investigation and to test Hypotheses 3 and 4, Table 6 shows the impact of ESG performance and its pillar scores on funding costs. The results in Columns (1–4) show that the ESG overall score, environmental pillar score, social pillar score, and governance pillar score have a negative and significant impact on bank funding costs. These effects are significant at the 1% level except for the governance pillar score, which is significant at the 10% level. These results confirm our third hypothesis, which is consistent with (Agnese and Giacomini 2023) and (Andrieș and Sprincean 2023). Additionally, the result for the governance pillar score validates Hypothesis 4. Therefore, we can conclude that the sampling banks significantly reduce funding costs when engaging in ESG practices.

4.5 | The Moderating Role of ESG in the Relationship Between Funding Costs and Liquidity Creation

To test the Hypothesis 5, we consider a control variable that captures the interaction between the ESG performance and funding costs (FC×ESG). In Table 5 (Panel A), the results for this coefficient are negative (−0.020 and −0.022) and statistically significant at the 1% level. However, in Table 5 (Panel B), the results are still negative (−0.001 and −0.004) but insignificant. Therefore, we instead use state and bank fixed effects as shown in Table 5 (Panel C). The results for the interaction variable (*ESG×FC*) in Table 5 (Panel C) become consistent with the theory, empirical research, and our empirical results reported in the robustness checks section. The coefficients for this interaction variable are (−0.018 and −0.019), which are significant at the 1% level. These results confirm the fifth hypothesis that ESG performance plays a significant role in moderating the relationship between bank funding costs and liquidity creation. In other words, it indicates that the ESG performance reduces the cost of funding for the sampling banks, which results in increasing the ability of the banks to create liquidity.

5 | Robustness Checks

We applied several econometric methods to test the robustness of the baseline results as follows:[5]

TABLE 5 | The relationship between liquidity creation, funding cost, and ESG performance.

Panel A

	$(LCCatfat / TA)$			$(LCCatnonfat / TA)$		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FC	−0.328	−0.365		−0.399	−0.443*	
	(0.266)	(0.258)		(0.279)	(0.269)	
ESG	0.000			0.000		
	(0.000)			(0.000)		
ENV		−0.001***			−0.001***	
		(0.000)			(0.000)	
SOC		0.001**			0.001**	
		(0.000)			(0.000)	
GOV		0.000			−0.000	
		(0.000)			(0.000)	
Size	−0.683***	−0.624***	−0.620***	−0.706***	−0.661***	−0.640***
	(0.093)	(0.096)	(0.084)	(0.095)	(0.103)	(0.087)
Capital	−0.228	−0.355**	−0.256	−0.253	−0.374**	−0.283
	(0.178)	(0.167)	(0.178)	(0.181)	(0.167)	(0.180)
Earnings	−0.961	−0.412	−1.100	−0.578	0.016	−0.726
	(1.184)	(1.085)	(1.171)	(1.151)	(1.061)	(1.138)
Growth	0.064***	0.062***	0.062***	0.069***	0.065***	0.066***
	(0.019)	(0.018)	(0.018)	(0.021)	(0.020)	(0.021)
lnNPL	0.004	0.007***	0.004	0.005	0.008**	0.004
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
lnZscore	0.001	−0.000	0.001	−0.000	−0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NII	0.001	0.001	0.001	0.001	0.001	0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$ESG \times FC$			−0.020***			−0.022***
			(0.006)			(0.007)
Constant	2.415***	2.193***	2.232***	2.479***	2.298***	2.287***
	(0.250)	(0.262)	(0.225)	(0.256)	(0.280)	(0.234)
Observations	996	996	996	996	996	996
R-squared	0.431	0.448	0.437	0.242	0.254	0.246
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Panel B

	$(LCCatfat / TA)$			$(LCCatnonfat / TA)$		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FC	1.620***	1.684***		1.527***	1.559***	
	(0.370)	(0.359)		(0.375)	(0.367)	

(Continues)

Panel B

	(*LCCatfat / TA*)			(*LCCatnonfat / TA*)		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ESG	−0.000			−0.000		
	(0.000)			(0.000)		
ENV		−0.001***			−0.001***	
		(0.000)			(0.000)	
SOC		0.000			0.001	
		(0.000)			(0.000)	
GOV		0.000			−0.000	
		(0.000)			(0.000)	
Size	−0.616***	−0.589***	−0.652***	−0.612***	−0.602***	−0.650***
	(0.095)	(0.098)	(0.088)	(0.100)	(0.100)	(0.091)
Capital	−0.452**	−0.485***	−0.415**	−0.517**	−0.530***	−0.479**
	(0.189)	(0.180)	(0.191)	(0.211)	(0.190)	(0.208)
Earnings	0.759	0.721	0.623	0.757	0.681	0.598
	(1.219)	(1.156)	(1.217)	(1.233)	(1.174)	(1.231)
Growth	0.081***	0.080***	0.072***	0.078***	0.074***	0.068***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
lnNPL	0.005*	0.007**	0.005*	0.005*	0.007**	0.005*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
lnZscore	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NII	0.001	0.001	0.002	0.001	0.001	0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
ESG × FC			−0.001			−0.004
			(0.010)			(0.011)
Constant	2.088***	1.970***	2.272***	2.079***	2.009***	2.270***
	(0.261)	(0.270)	(0.237)	(0.276)	(0.276)	(0.246)
Observations	996	996	996	996	996	996
R-squared	0.469	0.479	0.457	0.262	0.270	0.256
State fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes	Yes

Panel C

	(*LCCatfat / TA*)			(*LCCatnonfat / TA*)		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FC	−0.874***	−1.008***		−0.975***	−1.145***	
	(0.260)	(0.270)		(0.264)	(0.275)	

(Continues)

Panel C						
	(LCCatfat / TA)			***(LCCatnonfat / TA)***		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
ESG	0.0003			0.0066*		
	(0.000)			(0.000)		
ENV		−0.0003*			−0.0003*	
		(0.000)			(0.000)	
SOC		0.0002			0.0003	
		(0.000)			(0.000)	
GOV		0.0001			0.0003	
		(0.000)			(0.000)	
Size	0.084	0.038	0.267**	−0.262	−0.294	0.045
	(0.170)	(0.170)	(0.133)	(0.349)	(0.321)	(0.251)
Capital	−0.375*	−0.424*	−0.366*	0.137	0.080	0.158
	(0.221)	(0.217)	(0.222)	(0.588)	(0.588)	(0.598)
Earnings	−0.612	−0.447	−0.600	−0.770	−0.577	−0.744
	(1.054)	(1.008)	(1.049)	(1.243)	(1.205)	(1.226)
Growth	0.019	0.020	0.017	0.028	0.028	0.024
	(0.015)	(0.015)	(0.015)	(0.024)	(0.023)	(0.023)
lnNPL	0.001	0.002	−0.000	0.002	0.003	0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)
lnZscore	−0.000	−0.000	−0.000	0.000	−0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NII	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
ESG × FC			−0.018***			−0.019***
			(0.006)			(0.006)
Constant	0.016	0.149	−0.517	0.978	1.065	0.085
	(0.489)	(0.489)	(0.385)	(0.969)	(0.887)	(0.689)
Observations	996	996	996	996	996	996
R-squared	0.803	0.804	0.801	0.522	0.522	0.519
State fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows the results for the OLS panel regression when including state and bank fixed effects. All variables are winsorized at the 1% level. The dependent variables are liquidity creation measured by LCCatfat to total assets and LCCatnonfat to total assets. The main independent variables are represented by the funding costs (FC), the overall ESG score (ESG), and the ESG pillars scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), the natural logarithm of nonperforming loans (NPL), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). Robust standard errors are presented in parentheses. ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

5.1 | Random Effects Model (RE)

We employ the Hausman test to select the best model. The results indicate that the RE model provides better results (see Table A5 in the appendix). Other studies in the literature also used the RE GLS approach as a robustness check (e.g., Hassan et al. 2019). Moreover, as alternative measures of liquidity creation, we consider the natural logarithm of liquidity measures "Catfat" and "Catnonfat" as the dependent variables. As expected, the results overall validate our main findings that funding costs negatively

TABLE 6 | The effect of ESG performance and its pillar scores on bank funding costs

	Funding costs (FC)			
Variables	**(1)**	**(2)**	**(3)**	**(4)**
ESG	−0.00025***			
	(0.00006)			
ENV		−0.00029***		
		(0.00004)		
SOC			−0.00017***	
			(0.00005)	
GOV				−0.00006*
				(0.00003)
Size	−0.14064***	−0.21583***	−0.16565***	−0.19252***
	(0.03071)	(0.02658)	(0.03025)	(0.03155)
Capital	−0.05134*	−0.08671***	−0.05783*	−0.06275**
	(0.02953)	(0.02775)	(0.02995)	(0.03067)
Earnings	0.25891	0.30206*	0.29343*	0.30894*
	(0.17133)	(0.15502)	(0.17641)	(0.17639)
Growth	0.00231	0.00313	0.00291	0.00341
	(0.00232)	(0.00213)	(0.00242)	(0.00243)
NPL	−0.02448	−0.00746	−0.02576	−0.01870
	(0.02185)	(0.01318)	(0.02103)	(0.02012)
lnZscore	−0.00220	−0.00326**	−0.00265*	−0.00294*
	(0.00149)	(0.00138)	(0.00152)	(0.00153)
NII	0.00034*	0.00034*	0.00037**	0.00034*
	(0.00019)	(0.00018)	(0.00017)	(0.00019)
Constant	0.44848***	0.67235***	0.52160***	0.60226***
	(0.09347)	(0.08156)	(0.09252)	(0.09621)
Observations	952	952	952	952
R-squared	0.528	0.568	0.518	0.508
State fixed effect	Yes	Yes	Yes	Yes
Bank fixed effect	Yes	Yes	Yes	Yes

Note: This table reports the OLS panel regression results for the effect of ESG performance on funding costs. All variables are winsorized at the 1% level. The dependent variable is the funding costs (FC) measured by the interest expense over interest-bearing liabilities represented by deposits (total cost of funds). The main independent variables are represented by the overall ESG score (ESG) and the ESG pillar scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), nonperforming loans (NPLs), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). Robust standard errors are presented in parentheses. ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

affect liquidity creation, while ESG performance positively affects liquidity creation. Moreover, the results for the interaction between funding cost and liquidity creation suggest that ESG performance plays a significant role in moderating the relationship between funding costs and liquidity creation. As presented in Table 7, all of the coefficients for the effect of funding costs on liquidity creation as well as the interaction between ESG and funding cost are negative and statistically significant at the 0.1% level.

5.2 | Two-Step System GMM

In addition to the static models, we also employ a dynamic panel data model represented by a two-step system GMM to mitigate problems related to endogeneity and autocorrelation. According to (Roodman 2009), the two-step system GMM is useful in case we have a small number of periods (T) and a larger number of groups (N), which is the case in our study. Table 8 reports the results of the two-step system GMM. The

TABLE 7 | Robustness checks using the random effects model.

Variables	lnLCCatfat			lnLCCatnonfat		
	(1)	(2)	(3)	(4)	(5)	(6)
FC	−12.53***	−13.44***		−10.59***	−11.03***	
	(−10.94)	(−11.61)		(−11.67)	(−11.95)	
ESG	0.002			0.002*		
	(1.23)			(1.97)		
ENV		−0.003***			−0.001	
		(−3.30)			(−1.22)	
SOC		0.002			0.002*	
		(1.64)			(2.21)	
GOV		0.000			−0.000	
		(0.38)			(−0.31)	
Size	20.50***	20.45***	21.68***	21.45***	21.45***	22.53***
	(32.36)	(32.46)	(37.71)	(45.77)	(45.57)	(52.02)
Capital	−1.290	−1.742*	−1.297	−0.708	−0.789	−0.685
	(−1.56)	(−2.08)	(−1.57)	(−1.12)	(−1.23)	(−1.07)
Earnings	−3.562	−1.205	−5.153	−6.428	−5.944	−7.936*
	(−0.82)	(−0.27)	(−1.19)	(−1.93)	(−1.75)	(−2.36)
Growth	0.0895	0.0938	0.0666	−0.00262	−0.00389	−0.0216
	(1.18)	(1.24)	(0.88)	(−0.05)	(−0.07)	(−0.37)
lnNPL	0.021	0.029*	0.006	0.020	0.022*	0.008
	(1.48)	(1.98)	(0.42)	(1.86)	(2.01)	(0.71)
lnZscore	0.002	−0.000	0.004	−0.000	−0.000	0.002
	(0.36)	(−0.18)	(0.90)	(−0.01)	(−0.13)	(0.69)
NII	0.008	0.010	0.001	0.017	0.016	0.010
	(0.45)	(0.59)	(0.07)	(1.27)	(1.21)	(0.79)
ESG × FC			−0.314***			−0.258***
			(−11.91)			(−12.01)
Constant	−42.75***	−42.68***	−46.14***	−45.71***	−45.73***	−48.82***
	(−23.27)	(−23.40)	(−27.74)	(−33.76)	(−33.66)	(−39.09)
Observations	972	972	972	961	961	961
R-squared	0.665	0.666	0.664	0.774	0.7737	0.769
Number of banks	135	135	135	134	134	134

Note: This table reports the results for panel regression random effects model. All variables are winsorized at the 1% level, except the dependent variables. The dependent variables are liquidity creation measured by the natural logarithm of LCCatfat and LCCatnonfat (lnLCCatfat and lnLCCatnonfat) as alternative measures of bank liquidity creation. The main independent variables are represented by the funding costs (FC), the overall ESG score (ESG), and the ESG pillars scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), the natural logarithm of nonperforming loans (NPL), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). The t-statistics are presented in parentheses.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

TABLE 8 | Robustness checks using the two-step system generalized method of moments (GMM).

	lnLCCatfat			lnLCCatnonfat		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
$lnLCCatfat_{t-1}$	0.454***	0.436***	0.431***			
	(0.035)	(0.034)	(0.034)			
$lnLCCatnonfat_{t-1}$				0.795***	0.796***	0.817***
				(0.034)	(0.033)	(0.033)
FC	−4.643***	−5.106***		−1.949***	−1.984***	
	(0.699)	(0.798)		(0.537)	(0.506)	
ESG	0.001			0.001		
	(0.001)			(0.001)		
ENV		−0.001			0.000	
		(0.001)			(0.000)	
SOC		0.001			0.001	
		(0.001)			(0.001)	
GOV		0.001			−0.000	
		(0.001)			(0.000)	
Size	11.036***	11.712***	12.030***	3.872***	3.801***	3.773***
	(1.039)	(1.051)	(0.869)	(0.785)	(0.768)	(0.793)
Capital	1.993**	1.298	2.665***	1.240	1.518*	1.449*
	(0.879)	(1.001)	(0.885)	(0.767)	(0.839)	(0.782)
Earnings	−17.108***	−12.912**	−23.309***	−12.044***	−13.722***	−14.861***
	(5.233)	(5.454)	(4.706)	(3.626)	(3.960)	(3.716)
Growth	0.172	0.130	0.237*	0.600***	0.598***	0.662***
	(0.134)	(0.130)	(0.124)	(0.080)	(0.081)	(0.090)
lnNPL	0.021	0.016	0.022	0.019**	0.018**	0.014*
	(0.016)	(0.017)	(0.016)	(0.008)	(0.008)	(0.008)
lnZscore	0.016***	0.012**	0.023***	0.010***	0.012***	0.014***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.004)	(0.003)
NII	0.051***	0.059***	0.037**	0.025***	0.024***	0.021**
	(0.018)	(0.019)	(0.015)	(0.008)	(0.008)	(0.008)
$ESG \times FC$			−0.146***			−0.050***
			(0.023)			(0.014)
Constant	−23.281***	−24.841***	−25.944***	−8.118***	−7.932***	−8.193***
	(2.447)	(2.518)	(1.947)	(1.769)	(1.753)	(1.799)
Observations	966	966	966	957	957	957
Number of groups	135	135	135	133	133	133
Number of instruments	39	41	38	39	41	38
AR [1] (*p*-value)	0.089	0.091	0.096	0.001	0.001	0.001
AR [2] (*p*-value)	0.215	0.215	0.183	0.266	0.286	0.252

(Continues)

TABLE 8 | (Continued)

Variables	lnLCCatfat (1)	lnLCCatfat (2)	lnLCCatfat (3)	lnLCCatnonfat (4)	lnLCCatnonfat (5)	lnLCCatnonfat (6)
Hansen test (*p*-value)	0.276	0.160	0.230	0.533	0.545	0.549
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table reports the results for the panel regression two-step system (GMM) model. All variables are winsorized at the 1% level, except the dependent variables. The dependent variables are liquidity creation measured by the natural logarithm of LCCatfat and LCCatnonfat (lnLCCatfat and lnLCCatnonfat) as alternative measures of bank liquidity creation. The main independent variables are represented by the funding costs (FC), the overall ESG score (ESG), and the ESG pillars scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), the natural logarithm of nonperforming loans (NPL), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). The standard errors are presented in parentheses. ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

TABLE 9 | Robustness checks using sharp RD estimates using local polynomial regression.

Panel A

Cutoff (c) = 0.75	Left of (c)	Right of (c)
Number of observations	913	145
Eff. Number of observations	913	144
Order est. (p)	1	1
Order bias (q)	2	2
BW est. (h)	5.000	5.000
BW bias (b)	5.000	5.000
rho (h/b)	1.000	1.000

Outcome: **LC1** Running variable: ***ESG × FC*** Cutoff (c) = **0.75** Cutoff (c) = **0.75** Obs.: **1058**

Method	Coef.	Standard error	z	$P > \|z\|$	[95% Conf. interval]	
Conventional	−0.04255	0.01603	−2.6542	0.008	−0.073978	−0.011131
Robust	—	—	0.3079	0.758	−0.037836	0.051937

Panel B

Cutoff (c) = 0.75	Left of (c)	Right of (c)
Number of observations	913	145
Eff. number of observations	913	144
Order est. (p)	1	1
Order bias (q)	2	2
BW est. (h)	5.000	5.000
BW bias (b)	5.000	5.000
rho (h/b)	1.000	1.000

Outcome: **LC2** Running variable: ***ESG × FC*** Cutoff (c) = **0.75** Obs.: **1058**

Method	Coef.	Standard error	z	$P > \|z\|$	[95% Conf. interval]	
Conventional	−0.04449	0.01673	−2.6588	0.008	−0.077288	−0.011694
Robust	—	—	0.0347	0.972	−0.046979	0.048675

Note: This table reports the estimates for the Sharp RD utilizing a local polynomial regression. The bandwidth type is manual, kernel is triangular, and VCE method is NN.

model allows us to use the first lags of our dependent variables (i.e., "Catfat" and "Catnonfat") as independent variables. As shown in the table, funding costs negatively and statistically significantly affect bank liquidity creation at the 1% level, which aligns with the baseline findings. Moreover, the results for the ESG performance indicate a positive but insignificant relationship between the two variables, which also aligns with the baseline results.

In addition, the results for the interaction between funding costs and ESG performance are also consistent with our baseline results. The coefficients for this variable are −0.146 and −0.05 and all statistically significant at the 1% significance level. Therefore, it indicates that the ESG performance reduces the cost of funding for the sampling banks, which results in increasing the ability of the sampling banks to create liquidity.

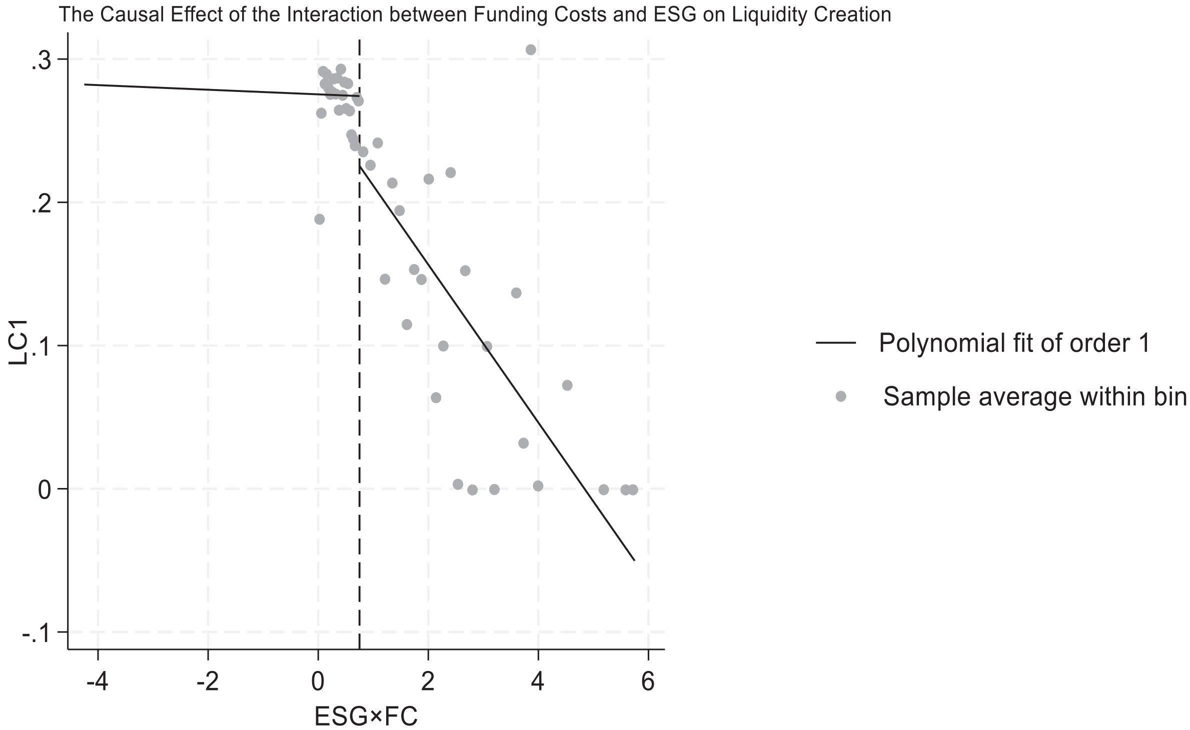

FIGURE 4 | Sharp RD plot using local polynomial regression for LC1 and $ESG \times FC$.

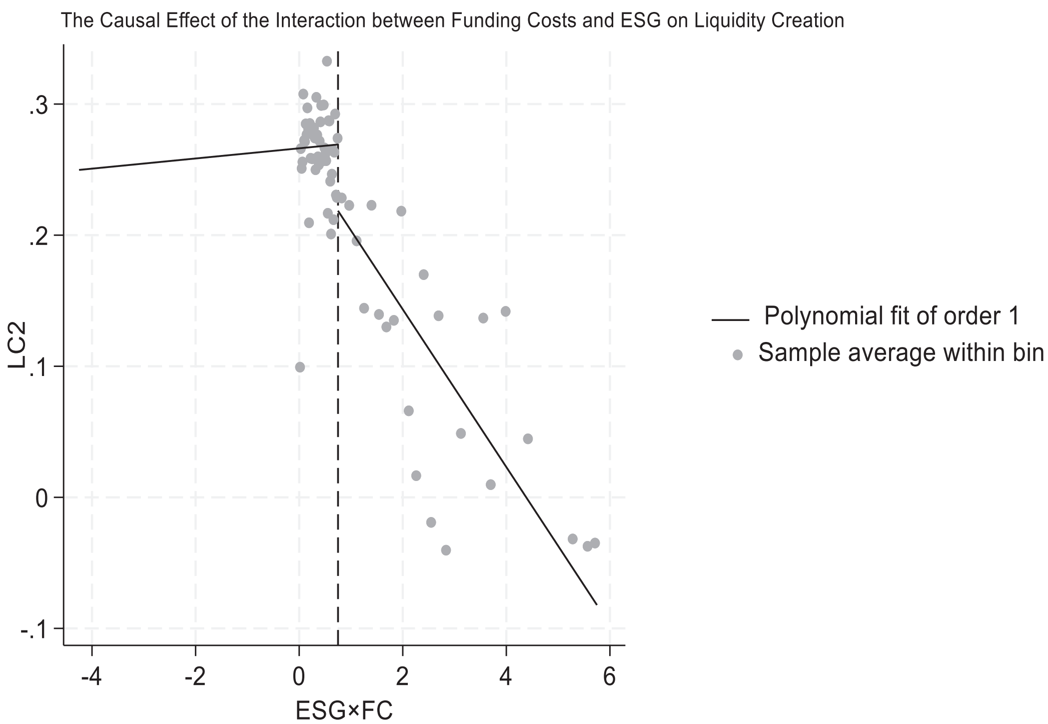

FIGURE 5 | Sharp RD plot using local polynomial regression for LC2 and $ESG \times FC$.

TABLE 10 | Robustness checks using the lagged ESG

	LCCatfat/TA			*LCCatnonfat/TA*		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FC	−1.11863***	−0.92116***		−1.14831***	−1.08277***	
	(0.36638)	(0.25937)		(0.37245)	(0.27465)	
ESG $_{t\text{-}1}$	−0.00009			−0.00010		
	(0.00032)			(0.00047)		
ESG $_{t\text{-}2}$	0.00005			0.00048		
	(0.00036)			(0.00061)		
ENV		0.00003			−0.00005	
		(0.00015)			(0.00017)	
SOC		0.00006			0.00010	
		(0.00019)			(0.00023)	
GOV		0.00007			0.00028	
		(0.00014)			(0.00027)	
Size	0.02974	0.15619	0.27721**	−0.22685	−0.15287	0.06799
	(0.26387)	(0.15590)	(0.12557)	(0.37971)	(0.30443)	(0.23194)
Capital	−0.09412	−0.28618	−0.29883	0.70721	0.30910	0.29870
	(0.45489)	(0.34180)	(0.33929)	(0.95867)	(0.71777)	(0.71953)
Earnings	−0.66707	−0.66086	−0.71606	−0.82870	−0.78074	−0.95896
	(1.31078)	(0.96256)	(0.92778)	(1.67675)	(1.23218)	(1.21043)
ROA	−1.34613	0.05933	0.35024	−2.77966	−0.07279	0.51331
	(3.55822)	(2.75504)	(2.63926)	(4.33639)	(3.13979)	(2.99945)
Growth	0.02878	0.01525	0.01408	0.04913	0.02272	0.01974
	(0.02123)	(0.01561)	(0.01552)	(0.04207)	(0.02439)	(0.02362)
NPL	−0.32431*	−0.13001	−0.17426	−0.40671**	−0.12803	−0.19657
	(0.18711)	(0.16428)	(0.16097)	(0.20218)	(0.17771)	(0.17113)
lnZscore	0.00045	−0.00017	−0.00026	0.00149	0.00000	−0.00014
	(0.00255)	(0.00211)	(0.00205)	(0.00307)	(0.00233)	(0.00224)
NII	0.00083	0.00068	0.00051	0.00023	0.00058	0.00035
	(0.00086)	(0.00074)	(0.00076)	(0.00088)	(0.00067)	(0.00070)
ESG × FC			−0.01827***			−0.02006***
			(0.00637)			(0.00641)
Constant	0.17805	−0.19488	−0.55507	0.86349	0.66988	0.01848
	(0.79120)	(0.46016)	(0.37640)	(1.08984)	(0.85837)	(0.65249)
Observations	736	972	972	736	972	972
R-squared	0.819	0.804	0.802	0.537	0.521	0.518
State-FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows the results for the OLS panel regression when including state and bank fixed effects as well as the first and second lags of ESG overall score. All variables are winsorized at the 1% level. The dependent variables are liquidity creation measured by LCCatfat to total assets and LCCatnonfat to total assets. The main independent variables are represented by the funding costs (FC), the first and second lags of the overall ESG score (ESG), and the ESG pillars scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), nonperforming loans (NPL), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). Robust standard errors are presented in parentheses. ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

5.3 | RD

Moreover, for robustness check, the RD is also applied. In this regression, liquidity creation measures (LC1 and LC2) are used as the outcome variables, whereas the interaction between funding costs and ESG performance ($ESG \times FC$) is used as the running variable. Furthermore, a cutoff of 0.75 is selected for the running variable ($ESG \times FC$) to estimate the treatment

TABLE 11 | Robustness checks using the natural logarithm of ESG and its pillar scores.

	LCCatfat/TA			*LCCatnonfat/TA*		
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
FC	−0.94323***	−0.95184***		−1.08262***	−1.13867***	
	(0.25928)	(0.26024)		(0.26730)	(0.28111)	
lnESG	0.00216			0.01240		
	(0.00717)			(0.01137)		
lnENV		0.00024			−0.00145	
		(0.00191)			(0.00279)	
lnSOC		−0.00300			−0.00773	
		(0.00521)			(0.01077)	
lnGOV		0.00150			0.00785	
		(0.00489)			(0.00823)	
Size	0.17066	0.20170	0.22493*	−0.14267	−0.07987	−0.00176
	(0.15610)	(0.15456)	(0.13124)	(0.31371)	(0.28506)	(0.24321)
Capital	−0.27701	−0.27240	−0.27600	0.31718	0.32875	0.33242
	(0.23372)	(0.23493)	(0.23596)	(0.66184)	(0.66890)	(0.67308)
Earnings	−0.65107	−0.63899	−0.62919	−0.87069	−0.77236	−0.86108
	(1.01803)	(1.02233)	(1.01271)	(1.22073)	(1.20275)	(1.21042)
Growth	0.01501	0.01467	0.01495	0.02153	0.02182	0.02065
	(0.01554)	(0.01581)	(0.01556)	(0.02366)	(0.02444)	(0.02333)
NPL	−0.13951	−0.14605	−0.15679	−0.14035	−0.16295	−0.18309
	(0.16412)	(0.16568)	(0.16268)	(0.17742)	(0.17778)	(0.17215)
lnZscore	−0.00012	−0.00012	−0.00010	0.00004	−0.00002	0.00012
	(0.00100)	(0.00100)	(0.00099)	(0.00124)	(0.00121)	(0.00123)
NII	0.00066	0.00069	0.00062	0.00054	0.00061	0.00049
	(0.00072)	(0.00073)	(0.00073)	(0.00065)	(0.00064)	(0.00066)
lnESGFC			−0.23621***			−0.27648***
			(0.07245)			(0.07531)
Constant	−0.24029	−0.32366	−0.39782	0.61265	0.46505	0.22830
	(0.44941)	(0.45202)	(0.38835)	(0.86135)	(0.80810)	(0.68174)
Observations	972	972	972	972	972	972
R-squared	0.804	0.804	0.803	0.521	0.521	0.519
State-FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank-FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table shows the results for the OLS panel regression when including state and bank fixed effects. All variables are winsorized at the 1% level. The dependent variables are liquidity creation measured by LCCatfat to total assets and LCCatnonfat to total assets. The main independent variables are represented by the funding costs (FC), the log of overall ESG score (ESG), and the log ESG pillars scores (ENV), (SOC), and (GOV). The control variables include bank size (Size), bank capital (Capital), bank earnings (Earnings), bank growth (Growth), nonperforming loans (NPL), the natural logarithm of Z-score (lnZscore), and the percentage of noninterest income (NII). Robust standard errors are presented in parentheses. ***, **, * denote 1%, 5%, and 10% significance levels, respectively.

effect. This cutoff is chosen based on the LSEG[6] criteria that banks with ESG scores of 75 to 100 have excellent ESG performance and are considered ESG leaders. Thus, these types of banks, theoretically, pay less interest payments (i.e., less funding cost), which is reflected by the coefficient of the moderating variable (i.e., $ESG \times FC$), which is negative and significant at the 5% level. The results are reported in Table 9 Panels A and B and Figures 4 and 5. The findings align with the baseline results indicating that depositors accept low interest payments when the sampling banks adopt ESG principles. Table 9 (Panel A) and Figure 4 show that LC1 decreases by about 0.043 units for a one-unit increase in $ESG \times FC$ at the cutoff. In other words, if $ESG \times FC$ crosses from below 0.75 to above 0.75, the LC1 decreases by almost 0.043. The negative sign implies that there is a negative relationship between the $ESG \times FC$ and the LC1 at the cutoff. Furthermore, the p-value of 0.008 suggests that the treatment effect is statistically significant at the 5% level. Similar interpretation applies to the results in Table 9 (Panel B) and Figure 5, which show a negative and significant effect of $ESG \times FC$ on LC2, with a coefficient of −0.044, which is also significant at the 5% level.

5.4 | Additional Tests

In addition to RE, GMM, and RD models, we also perform lagged ESG robustness by taking the first and second lags of the ESG score. The results are reported in Table 10. The coefficients for the interaction variable ($ESG \times FC$) are −0.01827 and −0.02006, which are significant at the 1% level. The results are consistent with our baseline results that suggest that depositors accept low interest payments when the sampling banks adopt ESG activities, which in turn enhances liquidity creation.

Moreover, we transform the overall ESG score and its pillar scores by taking their natural logarithm following prior studies (Asimakopoulos et al. 2023; Bock et al. 2025). The results are reported in Table 11. The coefficients for the interaction variable ($ESG \times FC$) are −0.23621 and −0.27648, which are significant at the 1% level. These results also support the baseline results that depositors accept low interest payments when the sampling banks adopt ESG activities, which in turn enhances liquidity creation.

6 | Conclusion

This paper examines the effect of funding costs on bank liquidity creation and whether ESG performance plays a moderating role. Our final sample contains 136 U.S. commercial banks distributed across 36 states and covering the period from 2005 to 2022. We employ OLS with fixed effects as the baseline panel regression. In addition, several robustness checks are performed by employing the RE model based on the Hausman (1978) specification test. Moreover, we applied the two-step system (GMM) and RD models. Also, two additional tests are performed by taking the first and second lags of ESG as well as transforming ESG and its pillar scores by taking their natural logarithm.

The baseline results, as shown in Table 5 (Panel C), reveal that the cost of funding significantly reduces the ability of the sampling banks to create liquidity. Moreover, the results show that ESG performance is positively linked to liquidity creation, and it is statistically significant at the 10% level, only when considering the *Catnonfat* to total assets measure of liquidity creation. This result implies that engaging in ESG activities increases the ability of the sampling banks to create more liquidity. The ESG pillar scores, namely SOC and GOV, show consistent results of no significant impact on liquidity creation. However, the results for the ENV pillar score indicate that it negatively affects banks' liquidity creation at the 10% significance level, a result that can be explained by the crowding out effect. Furthermore, the findings reveal that ESG performance significantly reduces the sampling banks' cost of funding at the 1% level. In addition, the results indicate that banks' governance practices negatively and significantly affect bank funding costs at the 10% level. Also, the results reveal that the environmental and social practices of banks negatively and significantly affect funding costs at the 1% level. These findings indicate that the sampling banks significantly reduce funding costs when adopting ESG principles. Finally, the findings show that ESG performance plays a significant role in moderating the relationship between bank funding costs and liquidity creation. This result is negative and significant at the 1% level. Furthermore, it indicates that ESG performance reduces the funding costs for the sampling banks, which results in increasing the sampling banks' ability to create liquidity. This finding highlights the main contribution of this study.

Additionally, this study complements the previous literature by emphasizing that the higher the cost of funding, the less likely the bank is to take higher risk and create more liquidity. Finally, the present study also contributes to the literature on the role of bank size in determining the funding cost and risk behavior.

On the one hand, the baseline results indicate an insignificant effect of bank size on liquidity creation, whereas the robustness checks, namely RE and two-step system GMM, reveal that size has a positive and statistically significant effect on liquidity creation. On the other hand, bank size significantly reduces funding costs, which is significant at the 1% level. This result suggests that when the bank's size increases, funding costs decrease. Hence, we can infer that large banks pay less funding costs compared to medium and small-sized banks.

Finally, the results for the robustness checks confirm the baseline results. The findings of these robustness checks suggest that depositors accept low interest payments when the sampling banks adopt ESG activities, as shown in coefficients of the interaction $ESG \times FC$.

In conclusion, the findings suggest that ESG performance can reduce reliance on high-cost deposits, which in turn enhances bank liquidity creation. This finding aligns with Basel III liquidity rules that aim to strengthen banks' short-term resilience to liquidity stress, measured by LCR, and promote a more stable funding structure, measured by NSFR. Therefore, the findings provide policy implication for policymakers, bank managers, and researchers that adopting ESG principles reduces funding costs requested from depositors (i.e., interest payments) and enhances liquidity creation. While the study fills a notable gap in literature by investigating the moderating role of ESG in the relationship between funding costs and bank liquidity creation, future research could examine whether the results may generalize to smaller or emerging economies, Islamic or sustainable banking systems, and Post-2022 ESG shifts such as greenwashing concerns.

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Endnotes

[1] The remaining hypotheses are discussed in (Sections 2.1 and 2.2).

[2] We also perform two additional tests for robustness by taking the lagged ESG and natural logarithm of ESG and its pillar scores. Please see the additional tests in Section 5.4.

[3] Only commercial banks are considered for the analysis. Hence, bank holding companies and savings institutions and other depository credit intermediation are excluded from the analysis.

[4] The maximum period for which the off-balance sheet data are available is JUN 2021. Hence, we only consider data up to DEC 2020.

[5] Since we select the RE model for our analysis, the results for the fixed effects model are not reported.

[6] Previously known as Refinitiv Eikon.

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Appendix A

TABLE A1 | Description of variables.

Variables	Definitions	Source/database
Dependent variables		
LC (Catfat)	The dollar value of liquidity creation is standardized by total asset. The "Catfat" measure labels loans based on category and also includes off-balance sheet activities.	Berger and Bouwman (2009), WRDS, Refinitiv Eikon database (LSEG); Authors' calculation
LC (Catnonfat)	The dollar value of liquidity creation standardized by the gross total asset. The "Catnonfat" measure labels loans based on category but without off-balance sheet activities.	Berger and Bouwman (2009), WRDS, Refinitiv Eikon database (LSEG); Authors' calculation
Independent variables		
Funding Cost (FC)	The interest expense over interest-bearing liabilities represented by deposits (total cost of funds).	Authors' calculation Andrieș and Sprincean (2023)
ESG	The ESG score is an overall company rating obtained from self-reported data across the Environmental (ENV), Social (SOC), and Governance (GOV) pillars.	Refinitiv Eikon (LSEG)
ENV	The environmental score is a company-wide rating computed as the weighted average of self-reported data from the Resource Use, Emissions, and Environmental Innovation scores.	Refinitiv Eikon (LSEG)
SOC	The social score is a company-wide rating obtained from the weighted average of self-reported data in the Workforce, Human Rights, Community, and Product Responsibility scores	Refinitiv Eikon (LSEG)
GOV	The governance score is a company-wide rating estimated as the weighted average of self-reported data in the Management, Shareholders, and Corporate Social Responsibility (CSR) Strategy scores	Refinitiv Eikon (LSEG)
Control variables		
SIZE	$Size = \log(Gross\ total\ assets)$	Authors' calculation
CAPITAL	$Capital = \text{Equity} / Gross\ total\ assets$	Refinitiv Eikon (LSEG); Authors' calculation
EARNINGS	Income before taxes, provisions recognized in income over total gross assets.	Refinitiv Eikon (LSEG); Authors' calculation
GROWTH	Rate of change of total gross assets.	Refinitiv Eikon (LSEG); Authors' calculation
NPL	Nonperforming assets over the quarter, scaled by total loans at the beginning of the quarter.	Refinitiv Eikon (LSEG); Authors' calculation
ZSCORE	$Z - score = \frac{ROA_{it} + \left(\frac{Equity}{Assets}\right)_{i,t}}{\sigma ROA}$	Authors' calculation
$ESG \times FC$	The interaction between natural logarithm of the cost of (domestic) deposits and the overall ESG score (funding cost multiplied by ESG overall score). It captures the moderating role of ESG in the effect of funding costs on liquidity creation.	Authors' calculation
NII	$NII = Non - interest\ incomes / the\ net\ operating\ incomes$	Refinitiv Eikon (LSEG)

TABLE A2 | ESG scoring methodologies.

Criteria	Refinitiv (LSEG)	MSCI	Sustainalytics
Focus	To provide transparent and data-driven assessment of companies' ESG performance.	To provide an opinion of companies' management of financially relevant ESG risks and opportunities that can affect the long-term performance of companies.	To measure the extent to which enterprise value is at risk due to environmental, social, and governance (ESG) issues.
ESG dimensions	3 pillars (environmental, social, and governance) containing 10 categories.	3 pillars (environmental, social, and governance) containing 10 categories and 33 key issues.	2 dimensions (exposure and management) and 22 material ESG issues.
Methodology type	Quantitative.	Quantitative and qualitative.	Quantitative and qualitative.
Source of data	Public disclosures collected manually by over 600 content research analysts.	Company disclosures and other sources such as government and academic dataset and media searches.	Company disclosure, in-house data and research, and third-party data sources such as World Bank database.
Update frequency	Annually.	Annually. Some data are updated throughout the year such as voting results and governance controversies.	Rating inputs are updated regularly or at some points during the year.
Scoring scale	0–1, with higher scores indicating higher performance and transparency.	Letter ratings ranging from AAA (leaders) To CCC (laggards).	Open-ended scale starting from 0 (no risk). Based on their quantitative scores, companies are grouped into one of five risk categories (negligible, low, medium, high, severe).

Source: Annual reports published by Refinitiv (LSEG 2024), MSCI (MSCI 2024), and Sustainalytics (Sustainalytics 2024).

TABLE A3 | Summary dtatistics of the liquidity creation measures.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
LCCatfat	2448	4.583[a]	2.671[b]	−2.488[c]	3.617[c]
lnLCCatfat	2381	20.046	2.928	7.03	26.614
wLCCatfat	2448	4.279[a]	1.341[b]	−1.098[a]	9.703[b]
LC1	2227	0.376	5.252	−0.998	248.083
LC2	2227	0.371	5.253	−2.595	248.083

Note: wLCCatfat is the winsorized value of liquidity creation measure (LCCatfat). [a], [b], and [c] indicate that numbers are in one billion, ten billion, and hundred billion dollars, respectively. For example, $(4.583 \times 1{,}000{,}000{,}000 = \$\,4{,}583{,}000{,}000)$.

TABLE A4 | Summary statistics of liquidity creation to equity, total gross loans, and deposits.

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
LCEQT	2228	2.713	1.358	−4.404	18.49
LCGLNS	2120	0.399	0.241	−0.631	8.526
LCDEP	2227	0.338	0.114	−0.55	0.911

Note: LCEQT = (wLCCatfat/total equity), LCGLNS = (wLCCatfat/total gross loans), and LCDEP = (wLCCatfat/total deposits).

TABLE A5 | (Hausman 1978) specification test.

	Coef.
Chi-square test value	3.303
p	0.914