Abstract

This paper empirically investigates the relationship between ESG practices, responsible banking, and systemic risk for the global banking sector. Utilizing the Heckman two-stage model and the Difference-in-Difference (DiD) model, the study analyzes the impact of ESG practices and responsible banking frameworks on various systemic risk measures. The findings reveal that responsible banking and ESG practices have a positive association, significantly mitigating systemic risk. Results are consistent across different measures, including SRISK, volatility, distance to default, and default probabilities. Robustness tests and control variables further validate the reliability of the results. These findings highlight the role of ESG practices and responsible banking in ensuring a stable banking sector.

Keywords: Systemic Risk, Environmental, Social, and Governance (ESG), Responsible Banking, PRB, TCFD, GFANZ, Heckman Two-Stage, Difference-in-Difference (DiD)

1. Introduction

Climate change is a significant threat not only to the environment but also as an emerging threat to financial stability (Aevoae et al., 2023; Battiston et al., 2021). The risks arising from climate-related events are systemic, which means they can have far-reaching implications for investors and financial markets. In order to effectively identify and address potential risks that may negatively impact financial stability, authorities must develop a comprehensive understanding of Environmental, Social, and Governance (ESG) practices. The transmission channels of climate change risk to the financial sector include physical climate risks, transition risks, and liability risks. This is why ESG scores are critical, as they serve as proxies for Corporate Social Responsibility (CSR) performance. Gillan et al. (2021) note that ESG is a broader term than CSR, as it explicitly incorporates governance aspects, whereas CSR does so indirectly. Investing in ESG can help reduce systemic risk, with the social pillar being the main driver (Scholtens & van't Klooster, 2019). In addition, investors in socially responsible funds are less sensitive to past negative returns compared to those who invest in conventional funds (Cerqueti et al., 2021; Renneboog et al., 2011).

The banking industry is facing a new era where sustainable development is a top priority. In response, the United Nations introduced on September 22, 2019, to encourage banks to take responsibility for their impact on the environment and society. The PRB consists of six sections, including alignment, impact and target setting, clients and customers, shareholders, governance and culture, and transparency and accountability. Each section outlines expectations and objectives for banks to align their business strategy with the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change. Participating in the PRB is voluntary for each bank, but the impact of joining this initiative is enormous. Currently, the total assets of all signatories account for approximately 54% of the total assets of global banks (UNEPFI, 2021). At the same time, the Glasgow Financial Alliance for Net Zero (GFANZ) has made significant strides in its mission to achieve net-zero emissions by 2050. Their latest progress report (in December 2021) shows that 98 banks from 39 countries, representing a staggering US$66 trillion in assets, have joined GFANZ and committed to climate-related stress testing. In addition, 38 central banks worldwide have pledged to take part in these tests to examine the resilience of the financial sector when faced with climate-related risks. The report highlights the importance of achieving long-term scientific carbon reduction goals and the need for a 50% reduction in emissions by the end of 2029.

As the world continues to become more cognizant of the dangers posed by climate change, the banking sector is also taking notice and striving for a clear objective. The PRB is leading the way by providing the industry with a framework for sustainable development, while GFANZ is actively advocating for sustainable development transformation. This shift in focus implies that the banking sector is now more interested in safeguarding the environment and society and adhering to sustainable development, as opposed to simply concentrating on profits. The banking industry is putting a greater focus on the knowledge and skills required for ESG-sustainable finance, including staying up-to-date with international sustainable finance trends, green financial disclosure standards, corporate social responsibility standards, and sustainable development planning. Additionally, the Task Force on Climate-Related Financial Disclosures (TCFD) and the Carbon Disclosure Project (CDP) are both initiatives that aim to promote transparency and accountability in corporate reporting related to climate change. While the TCFD primarily focuses on disclosing climate-related financial risks and opportunities, the CDP encourages companies to report on their environmental impact, including their greenhouse gas emissions and water usage (TCFD, 2022).

Our study presents several innovations that incorporate responsible banking practices in the relationship between ESG practices and bank risk. These initiatives promote financial stability while also contributing to the fight against climate change. The financial industry recognizes the impact of climate change and environmental degradation (Brunetti et al., 2021). Financial institutions can create their own ESG financial development blueprint and ESG strategy, which involves designing financial operations and risk management. The responsible banking practices include the Principles for Responsible Banking, the Net Zero Banking Alliance (NZBA), TCFD supporters, and CDP disclosure. These initiatives promote sustainability, accelerate the transition towards a low-carbon economy, and encourage transparency in disclosing environmental impact data.

We focus on globally listed commercial banks and use market information-based risks such as SRISK, volatility of SRISK, distance to default (DTD), and default probability (PD) as dependent variables. Because there may be no ESG score information in the sample of listed commercial banks, this study employs the Heckman two-step model to address the estimation problem of sample selection bias. We estimate the probability of listed commercial banks without ESG score information and then conduct empirical studies to explore the individual impacts of ESG on bank risks. Additionally, the study will analyze individual overall environmental, social, and governance aspects using combined ESG and ESG pillars of ASSET4 in the Thomson Reuters Refinitiv database. Finally, the study employs the Differences-in-Differences (DiD) estimation method to robustness test the impact of banks' voluntarily joining responsible institutions to disclose sustainability reports on systemic risk.

Our research represents a significant breakthrough in understanding the factors that affect systemic risk in the banking sector. By focusing specifically on how ESG-related information impacts banks' risk, we have expanded the existing body of knowledge on the subject. Our investigation includes an analysis of whether transparency and accountability, as demonstrated by adherence to responsible institutions (like the PRB, the GFANZ, the TCFD, and CDP disclosure), influence the relationship between ESG and systemic risk. Additionally, we examine whether (e.g., size, capitalization, loan, liquidity, debt, ROA), banking system (e.g., bank concentration), macroeconomic variables (e.g., economic growth, inflation rate), and economic crisis shocks (e.g., financial crises, COVID-19 pandemic) play a role in the ESG-bank systemic risk relationship.

Our study analyzed ESG combined scores and ESG pillars (including Environmental, Social, and Governance) to understand their aggregate effect on systemic risk. Moreover, we took a deeper dive into the ESG and bank systemic risk nexus by simultaneously examining the effects of climate-change responsibility in the banking sector (considering both those who join and those who do not join responsible institutions). Our results demonstrate that the ESG combined score and its three pillars have a significant impact on reducing banks' systemic risk and maintaining financial stability. We find that this impact is even more pronounced for banks that join responsible institutions. These results highlight the crucial role of implementing ESG practices and joining responsible institutions as key tools in mitigating systemic risk for banks.

2. Hypothesis Development

2.1 Does banks' strengthening of ESG performance reduce systemic risks?

Corporate Social Responsibility (CSR) is a strategic tool that can help companies reduce risks and improve their bottom line. Recent studies have shown that market participants who recognize the association between CSR and lower risks can benefit from reduced capital costs and agency/information asymmetry issues (El Ghoul et al., 2011). This, in turn, can lead to better financing opportunities with fewer capital restrictions (Cheng et al., 2014). Banks that invest in CSR have been found to significantly improve the quality of their profits (García-Sánchez & García-Meca, 2017). In the non-financial industry, companies that engage in CSR activities can lower their risk of engaging in high-leverage activities, which could lead to a loss of market share (Bae et al., 2019). CSR has also been linked to reduced stock price crash risk (Kim et al., 2014) and improved credit rating (Attig et al., 2013), with similar outcomes expected in the banking industry. By using sustainability as a tool to mitigate the adverse impact of negative corporate events, managers can strategically manage risks (Attig et al., 2013; Godfrey et al., 2009). Recent empirical analysis suggests that sustainability practices function like insurance during special event risks, especially during the global financial crisis (Godfrey et al., 2009; Lins et al., 2017).

ESG practices can be a game-changer for banks, promoting sustainable and cautious banking practices that can help reduce overall risk levels. This effect is even more significant during times of crisis when negative events can occur. Recent research on non-financial companies suggests that companies that participate in CSR activities may still benefit from them even when trust is unexpectedly lost (Lins et al., 2017). By enhancing market trust in banks and reducing their risks during turbulent periods, ESG scores can be instrumental in building a better banking system. Additionally, corporate social responsibility can help maximize shareholder value and serve as a powerful insurance strategy that can effectively mitigate stakeholder conflicts during financial crises (Bouslah et al., 2018).

Previous research has primarily focused on using proxy variables to examine a single aspect of ESG (Anginer et al., 2018; Berger et al., 2016; Gangi et al., 2019). In contrast, our study sets itself apart by examining the effect of combined ESG and ESG pillars on bank risk. Despite the significant intercorrelation among ESG components (Galbreath, 2013), existing literature suggests that each ESG pillar should play a vital role in promoting bank stability. Some evidence suggests that investors in environmentally proactive companies experience reduced perceived risk (Feldman et al., 1997) and better stakeholder engagement (Cheng et al., 2014), which is likely in banking. Furthermore, Gangi et al. (2019) found a significant negative relationship between the environmental friendliness of banks and their risks. They discovered that different channels have direct and indirect effects on capital costs or risks, such as loan channels and operations efficiency. Additionally, an organization's environmental performance can strengthen its ethical standing and reputation, thereby enhancing stakeholder confidence (Godfrey, 2005). In light of this, based on the moral capital theory, our study aims to explore the positive role of environmental banks in reducing systemic risk.

The social pillar focuses on improving human rights and employee relations, which could potentially lead to a better culture and more effective loan screening and monitoring, ultimately reducing the overall risk of the bank. However, the risk mitigation effect of the social pillar may not be as obvious as financial derivatives instruments that can protect banks from market shocks. Some scholars have proposed a positive impact between labor-related social aspects and stability. For example, commitment, loyalty, and litigation costs have been found to contribute to stability (Bauer et al., 2007; Chiaramonte et al., 2022), while cooperation and trust in the company have also been found to be important (Kane et al., 2005). Additionally, higher social performance can lead to higher moral capital, which can translate into a more significant impact on the performance of stakeholders

(Bouslah et al., 2018). During economic crisis shocks, high social capital can alleviate concerns and reduce bank risk (Lins et al., 2017).

The relationship between governance and systemic risk aligns with banking supervision and financial supervision. Previous bank crises have been partly attributed to poor governance or mismanagement (Dowling, 2006). The relationship between corporate governance and bank risk-taking is complex and important, as highlighted by Berger et al. (2016). The presence of deposit insurance safety nets has resulted in a significant increase in the independent and systemic risks of banks with shareholder-friendly governance mechanisms, as discovered by (Anginer et al., 2018). However, it has been found that banks with stronger CEOs perform better and reduce bank risk, even during times of higher bankruptcy risk, such as the sovereign debt crisis (Mollah & Liljeblom, 2016). According to Kirkpatrick (2009), the governance pillar should be positively related to bank stability due to lower incentives to pass risks. These findings underscore the need for strong governance in the banking industry to decrease systemic risk and promote financial stability.

Hypothesis 1: *The higher ESG scores reduce the bank's systemic risk.*

Hypothesis 1a: *The higher Environmental pillar scores reduce the bank's systemic risk.*

Hypothesis 1b: *The higher Social pillar scores reduce the bank's systemic risk.*

Hypothesis 1c: *The higher Governance pillar scores reduce the bank's systemic risk.*

2.2 How Does The Bank's Responsibility Affect Systemic Risk?

2.2.1 The Principles for Responsible Banking (PRB) and Systemic Risk

The fact that the largest banks have yet to sign up for the agreement could indicate that the agreement carries substantial weight and that banks are hesitant to be held accountable for their lending practices (Griffiths & Baudier, 2022). However, the signatory banks have invested a significant effort in this activity because banks are still struggling to regain trust after the 2008 financial crisis, in which governments rescued corporate giants with taxpayers' money, leaving a long-lasting impact on their reputations (Haddad & Hornuf, 2019). Thus, the PRB offers an opportunity for banks to demonstrate their responsibility to mitigate environmental and social risks and redirect investments away from greenhouse gas-emitting sectors and towards a greener economy. Furthermore, in response to the 2008 crisis, governments and regulators have introduced stringent new regulations regarding capital and liquidity to prevent past excesses. These regulations are expected to evolve to include climate risk, and as a result, banks are eager to demonstrate that they can self-regulate. The goal of the PRB is to encourage banks to adopt responsible and sustainable banking practices, which can help mitigate environmental and social risks, promote financial stability, and drive a positive impact on society. Banks that join the PRB commit to aligning their business strategies with the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change. By adopting responsible and sustainable practices, banks can better manage risks related to environmental, social, and governance issues, which can have a significant impact on the financial system as a whole. For example, climate change risks such as extreme weather events and transition risks related to the shift towards a low-carbon economy can disrupt financial markets and cause significant economic losses.

Hypothesis 2*: The banks that voluntarily join the PRB reduce systemic risk.*

2.2.2 The Glasgow Financial Alliance For Net Zero (GFANZ) and Systemic Risk

The GFANZ is a fascinating illustration of the benefits and challenges of voluntary climate change measures. Despite the failure of wealthy nations to mobilize $100 billion of public funds in the Global Finance Delivery Plan, GFANZ pledged to deploy $130 trillion of private capital towards limiting global warming (Walker, 2021). In June 2022, GFANZ announced that it would adopt stricter membership rules drawn from the race to zero campaign, which included limitations on supporting new fossil fuel projects and backing for "no new coal." However, GFANZ later backed down after receiving exit threats from major banks and emphasized its members' legal right to follow voluntary commitments (Bryan, 2022). Nevertheless, GFANZ has reaffirmed its commitment to tackling climate change by partnering with the New Zealand Bankers' Association (NZBA) to embed net-zero targets across the financial system by 2027. The World Economic

Forum's philanthropic ethos may have spurred GFANZ's involvement in climate mitigation activities. GFANZ's journey highlights the importance of both voluntary and mandatory measures in addressing the pressing threat of climate change.

The GFANZ aims to mobilize the financial sector in support of climate action and to reduce systemic risk associated with climate change. One of their key objectives is to encourage financial institutions to commit to achieving net-zero emissions by 2050. The GFANZ recognizes that climate change poses a significant threat to financial stability and that the transition to a net-zero economy requires collaboration across the financial sector and beyond. By aligning their portfolios with the goals of the Paris Agreement, members of GFANZ are working to reduce their exposure to climate-related risks and to support the transition to a sustainable, low-carbon economy. By doing so, GFANZ is addressing systemic risk and promoting long-term financial stability.

Hypothesis 3*: The banks that voluntarily join the GFANZ reduce systemic risk.*

2.2.3 The Task Force on Climate-Related Financial Disclosures (TCFD) ans Systemic Risk

According to Bingler et al. (2022), if financial actors downplay the risks associated with climate change, it could trigger the next financial crisis. Recognizing this, the Financial Stability Board (FSB) established the TCFD to encourage transparency and informed decision-making in the financial sector. In June 2017, the TCFD reported four categories of climate-related disclosures: governance, strategy, risk management, and metrics and targets (TCFD, 2017). By disclosing material information on risks and opportunities, financial institutions can better assess risk exposure and improve internal climate risk management. This, in turn, enables investors to conduct better risk assessment and management, ultimately safeguarding the stability of the financial system.

The widespread implementation of TCFD guidelines by financial institutions reflects an increasing voluntary demand for climate change disclosure, or transparency and accountability (TCFD, 2022). Recent research has emphasized the value of disclosing climate information in annual reports. For example, Guay et al.

(2016) discovered that voluntary disclosure in annual reports can assist managers in effectively communicating with investors. Hahn et al. (2015) noted that Carbon Disclosure Project (CDP) was the most commonly used data source for climate change disclosure.

Hypothesis 4*: The banks that voluntarily join the TCFD reduce systemic risk.*

Hypothesis 5*: Banks that voluntarily disclose their environmental performance (CDP disclosure) decrease systemic risk.*

3. Sample and Methodology

3.1 Sample Selection

We based our sample on publicly traded financial institutions in Bankscope that had data on equity returns and total assets between 2001 and 2022. We excluded non-publicly traded financial institutions as our measures of systemic risk rely on equity returns. Our sample consisted of 1,026 financial institutions. We further limited our analysis to deposit-taking institutions, specifically commercial banks and bank holding companies, and excluded non-bank financial institutions. As a result, we ended up with a sample size of 877 financial institutions from 51 different countries. We focused our analysis on financial institutions more likely to disclose systemic risk and ESG scores.

Table 2 provides a list of the countries that have at least one large bank and also have country-level data on macroeconomics, bank characteristics, systemic risk, and ESG score variables, which will be defined later. There are a total of 51 countries that match these criteria. The presence of large banks varies significantly across these countries. Some countries have only one large bank, while seven large economies, including the United States of America, Japan, China, the United Kingdom, Canada, and Italy, have more than five large banks. The United States of America tops the list with a total of 55 large banks.

3.2 Systemic Risk Measures

This study use market information basis to calculate the systemic risk of two major individual banks: A Conditional Capital Shortfall Measure of Systemic Risk (SRISK) and Distance to Default (DTD); at the same time, it also refers to Laeven et al. (2016) and Sedunov (2016) research designs to set up relevant empirical models and estimate them.

3.2.1 A Conditional Capital Shortfall Measure of Systemic Risk (SRISK)

The first measure of systemic risk is SRISK, to measure the systemic risk value of individual banks, the SRISK index is calculated based on Acharya et al. (2012), Acharya et al. (2017), and Brownlees and Engle (2017), that is, bank i triggers a crisis in the financial system when the market continues to decline significantly. The expected capital shortage faced during the period is

$$SRISK_{i,t} = kD_{i,t} - (1-k)W_{i,t}\left[1 - LRMES_{i,t+h|t}\left(C_{t+h|t}\right)\right] \tag{1}$$

where k represents the minimum fraction of bank i that needs to maintain capital to total assets ratio, which is set to 8% capital ratio, $D_{i,t}$ and $W_{i,t}$ represent the total liabilities of bank i respectively. Book value to total equity and total debt book value to total equity ratios. This study intends to set h in $C_{t+h|t}$ to be equal to 180 days and set $C_{t+180|t}$ to -40% based on the settings of Acharya et al. (2012). At the same time, based on the 1-day MSE, the following approximation formula is used to calculate the long-term MSE:

$$LRMES_{i,t+180|t}\left(C_{t+180|t}\right) = 1 - \exp\left[-18 \times MES_{i,t+1|t}\left(C_{t+1|t}\right)\right] \tag{2}$$

where the 1-day MSE is defined as the tail expected value of the bank's equity return when the market declines:

$$MES_{i,t+1|t}\left(C_{t+1|t}\right) = -E_t\left(R_{i,t+1|t} \mid R_{m,t+1|t} < C\right) \tag{3}$$

where $R_{i,t+1|t}$ and $R_{m,t+1|t}$ represent the bank i and the market respectively. One-day stock price return, C represents the threshold value for the decline of the market stock price index (this study intends to set it to -2%). This study follows Laeven et al. (2016) in allowing SRISK to be negative, meaning that highly capital-adequate banks have higher capital buffers that can easily absorb systemic adverse shocks from the financial system; finally, all the stock price returns of listed banks in individual countries are calculated based on the currency exchange rates of the individual countries.

The second measure of systemic risk is volatility. Volatility is a measure of systemic risk in finance that reflects the degree of variation in a stock's price over time. Volatility is calculated by determining the annualized standard deviation of returns based on daily stock returns, expressed in percentages.

3.2.2 Credit risk measures: DTD and DP

The third measure of systemic risk is the default distance or DTD. The DTD measures based on market information is better than traditional bank risk measures like Z-score. This is because DTD can be updated more frequently and reflects forward-looking stock market information. We base it on the framework proposed by Merton (1974) to measure the banks' default risk. Many scholars (e.g., Hillegeist et al. (2004); Campbell et al. (2008); Bharath and Shumway (2008)) have confirmed that the default distance measure, proposed by Merton (1974), is a more reliable bankruptcy predictor compared to the accounting-based model. Merton (1977a) and (Merton, 1977b) has also emphasized the suitability of the contingent request method for evaluating deposit insurance in the banking industry. In addition, renowned scholars such as (Bongini et al., 2002) and (Bartram et al., 2007) have utilized the Merton (1974) model to measure the default risk of commercial banks.

The Merton (1974) model presupposes that financial firms are funded by equity, with S_t representing its value at time t and D_t representing a single pure discount bond that matures on date T and principal X. The asset value (V_t) follows a geometric Brownian motion and W_t is a standard Brownian motion:

$$dV_t = \mu V_t dt + \sigma V_t dW_t \quad (4)$$

Because of restricted liability, the equity value at maturity is $S_T = \max\left(V_t - X, 0\right)$. Thus, the equity value at time $t \le T$ by the Black-Scholes option pricing is measured as

$$S\left(V_t, \sigma\right) = V_t N(d_t) - e^{-r(T-t)} X N\left(d_t - \sigma\sqrt{T-t}\right)$$

(5)

where r is the risk-free interest rate, $N\left(.\right)$ is the standard normal cumulative distribution function, and

$$d_t = \frac{\log\left(\frac{V_t}{X}\right) + \left(r + \frac{\sigma^2}{2}\right)\left(T-t\right)}{\sigma\sqrt{T-t}}$$

(6)

Following the Merton (1974) model, the probability of the financial firm defaulting at time T evaluated at time t is $N(-DTD_t)$, where the DTD at time t can be calculated using the following equation

$$DTD_t = \frac{\log\left(\frac{V_t}{X}\right) + \left(\mu - \frac{\sigma^2}{2}\right)\left(T-t\right)}{\sigma\sqrt{T-t}}$$

(7)

However, Duan and Wang (2012) argues that the limitations of the KMV estimation method are financial firms because they typically have a large proportion of liabilities that cannot be accounted for by the KMV estimation method. Thus, the maximum likelihood method proposed first by Duan (1994) and modified later by Duan (2000) and Duan and Wang (2012) to deal with financial firms is the most appropriate and flexible method for estimating DTD. According to Duan and Wang (2012), the setting $\mu = \frac{\sigma^2}{2}$ in Equation 4 can be calculated without requiring the value μ to improve the stability of DTD estimation.

$$DTD_t = \frac{\log\left(\frac{V_t}{X}\right)}{\sigma\sqrt{T-t}} \qquad (8)$$

Finally, the DTD data is estimated by using the Merton (1974) model, which has been tailored to overcome drawbacks in the financial sector identified by Duan (1994), Duan (2000) and Duan and Wang (2012). According to Anginer et al. (2013) and Jessen and Lando (2015), the default probability (PD) can be estimated through the normal transform of the DTD measure. It is defined as $PD = F\left(-DTD\right)$, in which F is the cumulative distribution function of a standard normal distribution. The higher are DTD values, the lower is the bank default risk. We collect DTD and PDs data from Thomson Reuters Datastream.

3.4 Empirical models

3.4.1 Heckman two stages

Some studies have noted that there can be issues with endogeneity when examining the impact of ESG on dependent factors. This occurs because using OLS can lead to a missing third variable problem due to non-random engagement in ESG influences (Wu & Shen, 2013). The two-stage procedure, developed by Heckman (1979), is often used to estimate consistent regression for models with selectivity. In the first step, a probit model is utilized to estimate the decision equation and generate IMR, where the dependent variable is a binary number. In the second step, the resulting IMR is used as an additional explanatory variable in the performance equation to guarantee an unbiased ESG effect estimation (Li & Prabhala, 2007; Hamilton & Nickerson, 2003).

As previous scholars, we employ the Heckman two-stage model to ensure a more accurate assessment of the impacts of ESG on banks' risk by controlling for potential selection bias. In the first step, the dependent variable is a binary dummy, which is assigned a value of 1 from the year a bank initiates ESG practices and 0 for previous years, using the probit model to estimate the decision equation and generate IMR. In the second step, we included IMR as an additional explanatory variable to correct for selection bias by employing the GLS regression. Heckman (1978) suggested that the generalized least squares (GLS) can improve the precision of the ordinary least squares (OLS) by addressing issues such as heteroscedasticity or autocorrelation. The GLS method produces lower sampling variances than the OLS, hence, it is preferable. Moreover, the approximate GLS estimates can converge to true GLS estimates, as stated in the Cramer convergence theorem (Cramer, 1946). The empirical specifications for our regression models are:

The first step of the Heckman two-stage model is followed as:

$$\begin{aligned}\text{Dum\_ESG}_{i,j,t} &= \beta_0 + \beta_1 \times \text{PRB\_Joining}_{i,j,t} + \beta_2 \times \text{TCFD\_Supporters}_{i,j,t} \\ &+ \gamma \times \text{Control Variables}_{i,j,t} + \text{FE}_{i,j,t} + \zeta_{i,j,t}\end{aligned}$$

(9)

The second step of the Heckman two-stage model is followed as:

$$\begin{aligned}\text{SystemicRisk}_{i,j,t} &= \beta_0 + \beta_1 \times \text{ESG(E,S,G)}_{i,j,t} + \beta_2 \times \text{Responsible Banking}_{i,j,t} \\ &+ \beta_4 \times \text{ESG(E,S,G)}_{i,j,t} \times \text{Responsible Banking}_{i,j,t} \\ &+ \gamma \times \text{ControlVariables}_{i,j,t} + \lambda * \text{IMR}_{i,j,t} + \text{FE}_{i,j,t} + \varepsilon_{i,j,t}\end{aligned}$$

(10)

where the subscripts *i, j,* and *t* signify the *i*th bank in the *j*th country at time t. In the decision equation (9), *Dum_ESG* represents ESG practices, which are assigned a value of 1 from the year a bank initiates ESG practices and 0 for previous years, following the approach proposed by Jo and Harjoto (2011). In the performance equation (10), the dependent variables are *SRISKm, Volatility, DTD, and PDs* as systemic risk measurement, *ESG(E,S,G)* represents ESG scores and ESG pillars, responsible banking represents four dummy variables (including *PRB_Joining, Net zero_GFANZ, TCFD_Supporters, and CDP_Disclosure*). The control variables include *Bank Size, Concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, and Dum_Covid-19*. The Inverse Mills Ratio (*IMR*) is the resulting parameter estimated by the first step of the Heckman two-stage model. *FE* is fixed effects, including *bank-, country-, and year-fixed effects.* The definition of all variables is shown in Appendix A.

3.4.2 The Difference-in-Difference (DiD) model

Several prominent scholars have shed light on the effectiveness and usefulness of the DiD approach in various research areas, such as Blundell and Dias (2009), Imbens and Wooldridge (2009), Lechner (2011), Abadie and Cattaneo (2018), Chen et al. (2018), Liu et al. (2021), Chiaramonte et al. (2022), Do and Vo (2023). We use the DiD model to test whether banks that voluntarily joined responsible institutions have a significant impact on the relationship between ESG and systemic risk. This responsible banking is the intervention for the DiD model and has proposed a list of banks, which is the selection criteria of the treated group. The dependent variables are LogSRISKm, Volatility, DTD, PD_6ms, and PD_1Yr. The control variables included *Bank Size, Concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, and Dum_Covid-19*. The DiD model allows us to estimate the average treatment effect on the treated (ATET). This involves comparing the change in outcomes for banks that received the treatment (the treated group) to the change in outcomes for individuals who did not receive the treatment (the control group). The fit regression model is followed as

$$SystemicRisk_{i,j,t} = \gamma_i + \gamma_t + Z_{i,j,t}\beta + D_{j,t}\delta + \varepsilon_{i,j,t} \quad (11)$$

where the subscripts *i, j*, and *t* signify the *i*th bank in the *j*th country at time t, γ_i denotes the group effects, γ_t denotes the time effects, $D_{j,t}$ denotes the treatment with $D_{j,t}$ =1 for all observations that are subject to the treatment in country *j* at time *t*, $Z_{i,j,t}$ represents bank-level control, country-level control, and economic crisis shocks. The coefficient δ is a regression estimate of the ATET, representing the difference in expected outcomes between bank that received treatment and those that did not.

4. Empirical Results

4.1. Sample description

Table 1 provides important statistics, including the mean, standard deviation, minimum, and maximum values of the variables in both the first-stage and second-stage Heckman models. According to Table 1 (Panel A), the mean value of Dum_ESG is 0.454, which indicates that approximately 45.4% of the listed banks in our sample are involved in ESG practice. Table 1 (Panel B) presents the summary statistics of our four measures of systemic risk, along with the key independent variables and control variables used in the Heckman two-stage analysis. The LogSRISKm value ranges from a low of 1.05 (US$ -398.940 billion) to a high of 12.897 (US$ 215.305 billion), and the volatility of SRISK varies from a low of 0% to a high of 105.6%. The average distance to default for the sample banks is 3.413%, with a standard deviation of 2.767. The distance to default ranges from a low of -2.059% to a high of 13.816%. Moreover, the average default probability of the sample banks is 0.182% (6 months), 0.412% (1 year), 0.908% (2 years), 1.396% (3 years), and 2.302% (5 years). The ESG discrepancies among countries are quite significant, ranging from 14.967 to 95.343 points out of a total of 100 points. The average ESG score for the sample banks is 23.897 points, with a standard deviation of 26.667 points. Furthermore, ESG practices have been measured at the sub-pillar levels, including environmental (E_Pillar), social (S_Pillar), and governance (G_Pillar). The overall ESG score suggested by Refinitiv is a weighted average of each sub-pillar score, adjusted to the controversy scores. According to the discription results, 13% of the banks are joining the PRB, out of which 9% are joining the GFANZ for Net zero. Additionally, 33.6% of the banks are TCFD supporters, and 20.7% disclose CDP. These figures indicate that there is a growing awareness among banks about the significance of sustainability and transparency in their operations. Furthermore, Table 1 (Panel C) displays the different mean tests (T-test) for all regression variables among banks that have non-joining and joining the responsible institutions (i.e., non-PRB_Joining versus PRB_Joining, non-Net zero_GFANZ versus Net zero_GFANZ, non-TCFD_Supporters versus TCFD_Supporters, and non-CDP_Disclosure versus CDP_Disclosure). The Chi-square test is used for the dummy variables. The columns of difference tests report the p-values for the T-test and the Chi-square test of difference in mean, respectively. The results indicate a significant difference in the mean of all the variables, with the p-values being less than 5%.

Table 3 demonstrates the pairwise correlation between variables, with Pearson's correlation coefficients shown in the lower triangle and Spearman's rank correlations shown above the diagonal. All regressors have a pairwise correlation of less than 0.5, together with many significantly correlated variables. However, the magnitude of the correlations assures us that the concern of multicollinearity is mitigated. For exception, the ESG score is calculated as the average of the three individual pillar scores, which include environmental (E_PillarScore), social (S_PillarScore), and governance (G_PillarScore). Therefore, their high correlation is expected, and we do not consider them to be in the same model to avoid multicollinearity.

4.2 The Heckman first-stage model

Tables 4 presents the findings of the Heckman first-stage model discussed in Eq.(1). The decision equation (i.e., Eq. (1)) shows that the dummy ESG is the dependent variable using the probit method. The main results are highlighted, as the estimates of the decision equations generate IMR, which is then inserted into the performance equation to avoid bias. The coefficients of PRB_Joining and TCFD_Supporters are significantly positive with ESG, indicating that banks that are more responsible engage in more ESG practices. The coefficients of bank-level variables (i.e., size, concentration, liquidity, ROA, loans/assets, and capitalization) are also significantly positive. These figures suggest that banks with stronger financial sources engage in more ESG practices, while banks with higher debt ratios engage in fewer ESG practices. Moreover, banks engage in more ESG practices in countries with high GDP growth and suitable inflation rates. During financial crisis shocks, banks have less disclosure responsibility, while during the Covid-19 pandemic, they have more.

4.3 The Heckman second-stage model

Table 5 presents the findings of the Heckman second-stage model discussed Eq.(2). In Table 5, the dependent variables are LogSRISKm, Volatility, DTD, and PDs (i.e., PD_6Ms, PD_1Yr, PD_2Yrs, PD_3Yrs, and PD_5Yrs), which are all measurements of systemic risk. The composite ESG score and ESG pillars are evaluated separately or interacted with the dummy PRB_Joining.

4.3.1 Systemic risk as measured by SRISK

The findings in Panel A suggest that the ESG combined scores (ESG_Score) and ESG pillars (E_pillar, S_pillar, and G_pillar) are effective in mitigating systemic risk (LogSRISKm), regardless of whether banks join the PRB (PRB_Joining). Our study also reveals that joining the PRB reduces LogSRISKm, regardless of their ESG score level. However, the regression coefficient that represents the effect of combined ESG and ESG pillars is smaller than joining the PRB's effect. This could be due to the joint effect of the previous finding on the time-invariant dummy for joining the PRB, whereas ESG scores vary widely across our sample, offering more information on banks. The interaction term reveals that banks with high ESG scores (or sub-pillars) experience a stronger risk-mitigating effect after joining the PRB than conventional banks, leading to lower levels of

LogSRISKm. In conclusion, our study confirms that both ESG practices and joining the PRB can reduce risks for banks. This confirms the risk-mitigating effect of ESG practices, particularly for banks that join the PRB. Based on the coefficient of our baseline results, a one standard deviation change in ESG_Score is associated with a change of -0.2% in LogSRISKm, and PRB_Joining is associated with a change of -0.3% in LogSRISKm (see model 1). Remarkably, a one standard deviation change in ESG_Score results in a change of -0.6% in LogSRISKm for banks that join the PRB (see model 5). Regarding control variables, we observe a positive association between bank size and systemic risk, consistent with previous literature (Chordia et al., 2000; Kamara et al., 2008; Sila et al., 2016; Cheung, 2016; Ben-Nasr and Ghouma, 2018; Kabir Hassan et al., 2021). This finding is reasonable since larger banks are more susceptible to volatility.

The coefficients of IMR have a significant negative impact on SRISKm. The inclusion of IMR in the Heckman two-stage model is crucial to remove self-selection bias. The significance of the IMR coefficient justifies that the bias is removed, and this econometric background was developed by Heckman (1978). Clatworthy et al. (2009) argue that IMR is a proxy for unobservable characteristics that affect both selection and performance equations. However, the unobservable characteristic is rather an abstract concept and very difficult to materialize. These unobservable characteristics could be the banks' knowledge of management, regulations, and so on. The significance of these characteristics indicates that the performance equation is systematically related to the unobservable characteristics of banks. Not adding this factor into the equations results in a biased estimation, which can lead to incorrect conclusions. Therefore, including IMR becomes meaningful to ensure that the empirical models are valid and reliable.

We calculate the variance inflation factors (VIFs). There are no VIFs greater than 10, and the mean VIF is greater than 1, substantially lower than the rule-of-thumb cutoff of 10 (Ryan, 1997). Thus, multicollinearity was not a serious concern in these models.

4.3.2 Systemic risk as measured by the volatility of SRISK

In Table 5 (Panel B), we repeat the same regressions for the volatility of SRISK (Volatility) as measure of systemic risk. Again, both ESG (or sub-pillars) and joining the PRB can significantly reduce the volatility of risk for banks at the 1% level. However, the interaction term is negative and significantly different from zero at the 10% level. The baseline results show that a one standard deviation change in ESG_Score is associated with a change of -0.14% in Volatility, and PRB_Joining is associated with a change of -0.23% in Volatility. Besides, a one standard deviation change in ESG_Score results in a change of -0.02% in Volatility for banks that join the PRB. The study also finds a positive association between bank size and systemic risk, which is consistent with the too-big-to-fail hypothesis (e.g., Farhi and Tirole, 2012). Additionally, the results show that Volatility is negatively associated with TCFD_supporters, concentration, loanprov/NII, liquidity, ROA, GDP growth, and inflation rate but positively associated with the debt/assets ratio. Finally, the study concludes that banks tend to meet more risk during financial crisis shocks and the Covid-19 pandemic than in other periods. The coefficients of IMR have a significant negative impact on *Volatility,* indicating that the Heckman two-stage models are valid and reliable. There are no VIFs greater than 10 and the mean VIF is greater than 1, suggesting that multicollinearity was not a serious concern in these models.

4.3.3 Systemic risk as measured by the distance to default

In Panel C (Table 5), the findings of the Heckman second-stage model show a significant and positive correlation between ESG_Score and sub_pillars (E_pillar, S_pillar, and G_pillar) and DTD. These figures suggest that implementing ESG practices can increase the bank's default distance. Additionally, joining responsible disclosure regulations (as measured by PRB_Joining and TCFD_Supporters) can stretch the bank's default distance by improving transparency and encouraging firms to engage in social and environmental activities. The study controls for bank, country, and year-fixed effects for all models. The coefficients of our baseline results indicate that a one standard deviation change in ESG_Score is linked to a 0.588% (p<1%) change in DTD, while PRB_Joining is associated with a 1.806% change in DTD (as per model 1). Interestingly, for banks that join the PRB, a one standard deviation change in ESG_Score leads to a 0.711% (p<5%) change in DTD (as per model 5). The results also show a negative association between bank size and systemic risk, consistent with previous literature (Trung K. Do, 2023). The study concludes that banks tend to shorten the distance to default during financial crises and the Covid-19 pandemic. Additionally, the study found that DTD is positively associated with concentration, loanprov/NII, liquidity, ROA, capitalization, GDP growth, and inflation rate but negatively associated with the debt/assets ratio. The results suggest that the Heckman two-stage models are valid and reliable, as indicated by the significantly negative impact of IMR on DTD. There are no VIFs greater than 10, and the mean VIF is greater than 1, suggesting that multicollinearity was not a serious concern in these models.

4.3.4 Systemic risk as measured by the probability of default

Panels D and E in Table 5 show the results of the Heckman two-stage analysis. The same regressions have been repeated for the probability of default as the third measure of systemic risk. The dependent variables examined include default probabilities at various time horizons, such as 6 months (PD_6Ms) and the first year (PD_1Yr). Additionally, Table 6 presents the results of robustness tests for default probabilities in the second year (PD_2Yrs), the third year (PD_3Yrs), and the fifth year (PD_5Yrs). According to the findings, ESG and sub-pillars can significantly decrease the possibility of default in the short term for banks at a 1% level. Furthermore, the groups of bank responsibility, measured as PRB_Joining and TCFD_Supporters, can also significantly decrease the default probability. While PRB_Joining can effectively reduce default probabilities in the short term at the 1% level, TCFD_Supporters showed significant results at the 10% level or insignificant level. This suggests that joining the PRB can be more effective in reducing risk than becoming a supporter of the TCFD. Additionally, the interaction term (ESG_Score × PRB_Joining) is negative and significantly different from zero at the 1% level. These results also hold for the probability of default in the long term (i.e., 2 years, 3 years, and 5 years) (see Panel A of table 6 for Robustness Test). The baseline results suggest that there is a correlation between ESG_Score and PDs with a one standard deviation change in ESG_Score resulting in a change of -0.222%, -0.505%, -0.148%, -0.237%, and -0.347%, respectively, in PDs. Similarly, PRB_Joining is correlated with a change in PDs, with a change of -0.987%, -2.257%, -2.871%, -3.028%, and -2.181%, respectively, in PDs. Additionally, the control variables were found to have similar effects on PDs as previous measures of systemic risk.

5. Robustness Test

5.1 Systemic risk and ESG (t-1)

In order to ensure that our results are reliable and accurate, we have implemented a robustness test that includes using independent variables that are lagged by one period (year). This approach helps control the speed of adjustment of systemic risk measures and addresses any potential endogeneity concerns related to reverse causality or simultaneity bias. This method has been recommended by several reputable studies, such as Anginer et al. (2014), Neitzert and Petras (2021), and Aevoae et al. (2023).

The results are presented in Panel B of Table 6. There is a significant and negative relationship between the ESG combined score and systemic risk measurements (SRISKm, Volatility, and PD), as well as a positive relationship for DTD. Moreover, the study highlights the importance of responsibility for sustainable development (Accountability) in reducing banks' systemic risk and extending the default distance. It is noteworthy that voluntary banks that join the PRB and the TCDF have made commendable contributions to this cause. Further, we compute the principal systemic factors based on SRISKm, Volatility, DTD, and PD in a similar approach to previous studies (Berger et al., 2020; Aevoae et al., 2023; Acharya et al., 2017; Atif & Ali, 2021; Brownlees & Engle, 2017; Palmieri et al., 2023). This approach enables the generation of new systemic risk indicators by synthesizing the most important information contained in the original factors. The results suggest that the ESG combined score and Accountability have contributed to a decrease in systemic risk, which is consistent with the main outcome presented in Table 5. These findings suggest that responsible practices and disclosures can help in mitigating systemic risks in the banking sector, which is a critical aspect of sustainable development and financial stability.

5.2 Systemic risk, ESG and joining the GFANZ, CDP disclosure

Table 7 presents the robustness tests obtained from the second step of the Heckman two-stage model over the period 2001–2022. The dependent variables are systemic risk (including SRISKm, Volatility, DTD, PD_6Ms, and PD_1Yr). In

Panel A, the interest variables are ESG_Score, Net zero_GFANZ, and their interaction. In Panel B, the interest variables are ESG_Score, CDP_Disclosure, and their interaction.

5.3 Difference-in-Difference (DiD) model

Considering the potential risk of banks' non-responsibility and responsibility that could bias the estimation results, we conducted a difference-in-difference (DiD) approach to test whether banks that voluntarily joined responsible institutions (such as PRB, GFANZ, TCFD, CDP disclosure) had a significant impact on systemic risk. We set two cutoff points for banks' responsibility, which were before and after the year in which a bank joined the responsible institutions. We found that joining responsible institutions had a significant negative impact on banks' systemic risk, with p-values of less than 10% (Table 8). Furthermore, based on the literature (authors), we incorporated dummy variables (i.e., PRB_Joining, Net Zero_GFANZ, TCFD_Supporters, and CDP_Disclosure), which take the value of one in the starting joining year for the responsible institutions. Additionally, we also included interaction terms between ESG and the responsibilities. We found that our primary results remained robust even after adding these variables to our analysis. These results highlight the importance of responsible banking practices and underscore the potential benefits of voluntary participation in initiatives that promote sustainability, transparency, and accountability.

Figure 2 shows the event-study plots, which compel evidence of the positive impact that joining the PRB has on systemic risks. The estimated coefficient values for SRISKm, Volatility, and PD_1Yr were all positive before joining the PRB, indicating high levels of risk. However, after joining the PRB, the values became negative, signaling a significant decrease in systemic risks. The effects of the initiative were not immediate, but after a certain time lag, starting in the third year of participation, the benefits of joining the PRB became increasingly apparent. These trends make a clear case for the effectiveness of the PRB in reducing systemic risks and promoting a more stable financial system.

5.4 Discussion

The findings in this study significantly contribute to the existing research that explores the connection between ESG and banking systemic risk. The study reveals that ESG factors have a risk-mitigating impact across all four systemic risk measurements, including SRISKm, Volatility, DTD, and PDs. This discovery further supports the initial hypothesis (H1) that incorporating ESG factors into financial decision-making processes can effectively reduce the risk of systemic failures in the banking sector. Moreover, the study shows that the three pillars of ESG, which are Environmental, Social, and Governance factors, significantly and negatively impact all four systemic risk measurements, providing robust support for the initial hypotheses (H1a, H1b, and H1c). The results suggest that the incorporation of ESG factors in the decision-making process could be a crucial step towards achieving a more sustainable and stable financial system. Overall, the study's findings demonstrate the importance of considering ESG factors in the decision-making process within the banking sector.

Our research findings suggest that banks that take responsibility for their impact on the environment and society can experience fewer systemic risks than conventional banks. Specifically, we found that joining the Principles for Responsible Banking can help reduce systemic risk, which aligns with our second hypothesis (H2). This is because, through the PRB, banks commit to following responsible banking practices that are aligned with the UN Sustainable Development Goals and the Paris Climate Agreement. By adopting these practices, banks can reduce their exposure to risks associated with environmental, social, and governance factors. We also found that voluntarily joining the Glasgow Financial Alliance for Net Zero can reduce systemic risks for banks, which aligns with our second hypothesis (H3). This is because, the GFANZ is a group of financial institutions committed to achieving net-zero emissions by 2050, and it provides a framework for banks to align their business strategies with the goals of the Paris Agreement. By joining GFANZ, banks can reduce their exposure to climate-related risks, such as physical risks from climate change and transition risks associated with the shift to a low-carbon economy. Furthermore, we found that voluntarily joining the Task Force on Climate-related Financial Disclosures can also reduce systemic risks for banks, which aligns with our second hypothesis (H4). This is because, the TCFD provides a framework for banks to disclose their climate-related risks and opportunities, which helps investors make more informed decisions. By disclosing this information, banks can improve their transparency and reduce their exposure to reputational risks. Finally, we found that voluntarily disclosing environmental performance through the Carbon Disclosure Project (CDP) can reduce systemic risks for banks, which aligns with our second hypothesis (H5). This is because, the CDP is a platform that allows companies to report on their environmental performance, including their carbon emissions, water use, and supply chain impacts. By disclosing this information, banks can improve their transparency and reduce their exposure to risks associated with climate change and other ESG factors.

Our results present compelling evidence that should prompt governments and financial institutions to prioritize ESG factors in their decision-making processes. We note that when banks volunteer to join responsible institutions, they can bolster accountability regarding climate change and improve their ESG scores. Ultimately, this can mitigate systemic risks and ensure banks' long-term sustainability.

6. Conclusion

Our study provides a compelling analysis of the relationship between environmental, social, and governance (ESG) practices, responsible banking, and systemic risk in the banking sector. Through the use of the Heckman two-stage approach and the Difference-in-Difference approach, we discover the relationships between these variables and highlight some critical findings. Firstly, we find that banks demonstrating a higher level of responsibility, as evidenced by their participation in initiatives such as the PRB and the TCFD, are more likely to engage in ESG practices. This suggests that responsible banking can be a driving force behind ESG practices. Secondly, we show that both ESG practices and responsible banking significantly contribute to mitigating systemic risk. This effect is consistently found for several measures of systemic risk, such as SRISKm, Volatility, DTD, and PDs. Thirdly, we observed variations in the impact of ESG practices and responsible banking during different periods, such as financial crises and the Covid-19 pandemic. The results show that banks face more risk during these shocks. However, banks have fewer ESG practices and responsibilities in financial crises than during the COVID-19 pandemic period. Finally, we conducted robustness tests, including lagged variables and treatment groups of the DiD method, to ensure the reliability and validity of our results. The inclusion of control variables, such as bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, and macroeconomic factors, strengthened the robustness and validity of our findings.

Overall, our findings highlight the potential of sustainable and responsible practices to enhance financial stability, aligning with the broader goals of sustainable development and responsible finance. As the banking industry evolves, it is important to incorporate environmental and social considerations into risk management practices for a resilient, sustainable financial system.

Table 1. Descriptive statistics of the variables

Panel A of Table 1 displays the Heckman first-stage variables, while Panel B of Table 1 shows the Heckman second-stage variables. Furthermore, Panel C of Table 1 presents the T-test of means for [a]Non-PRB_Joining versus PRB_Joining, Non-Net zero_GFANZ versus Net zero_GFANZ, [c]Non-TCFD_Supporters versus TCFD_Supporters, and [d]Non-CDP_Disclosure versus CDP_Disclosure. The Chi-square test is used for the dummy variables. "Difference Tests" columns report the p-value for the T-test and for the Chi-square test of difference in mean, respectively. All the variables are defined in Appendix A. The coefficients marked with asterisks (***, **,*) represent the statistical significance levels of 1%, 5%, and 10%, respectively.

Variable	Unit	Panel A: Heckman first-stage variables					Panel B: Heckman second-stage variables				
		Obs.	Mean	S.D.	Min	Max	Obs.	Mean	S.D.	Min	Max
A. Sytematic risk measures											
LogSRISKm (Log of SRISKm)	US$ bn						11,450	6.359	2.255	1.05	12.897
Volitility	%						11,450	36.38	21.81	0.00	105.60
DTD	%						11,450	3.413	2.767	-2.059	13.816
PD_6Ms	%						11,450	0.182	0.440	0.000	2.250
PD_1yr	%						11,450	0.412	0.894	0.000	4.569
PD_2Yrs	%						11,450	0.908	1.707	0.000	8.810
PD_3Yrs	%						11,450	1.396	2.393	0.000	12.588
PD_5Yrs	%						11,450	2.302	3.637	0.000	19.417
B. ESG (Environmental, Social, and Governance)											
ESG_Score	Points						11,450	23.897	26.667	14.967	95.343
E_pillar	Points						11,450	19.250	28.248	7.651	98.846
S_pillar	Points						11,450	24.256	27.751	9.621	97.110
G_pillar	Points						11,450	28.189	30.719	13.791	97.373
Dum_ESG	Dummy	14,239	0.454	0.498	0	1					
C. Responsibility of banks (Accountability)											
PRB_Joining	Dummy	14,239	0.104	0.305	0	1	11,450	0.138	0.345	0	1
Net zero_GFANZ	Dummy	14,239	0.079	0.270	0	1	11,450	0.090	0.286	0	1
TCFD_Supporters	Dummy	14,239	0.234	0.380	0	1	11,450	0.336	0.387	0	1
CDP_Disclosure	Dummy	14,239	0.205	0.404	0	1	11,450	0.207	0.405	0	1
D. Bank level variables											
Concentration	%	14,239	60.615	19.650	25.370	83.943	11,450	59.165	19.641	27.470	85.543
Bank size (Log of Total Assets)	US$ bn	14,239	23.065	2.163	6.908	29.379	11,450	23.195	2.189	6.908	29.379
Loanprov/NII	%	14,239	73.246	13.746	0.005	95.278	11,450	74.711	14.021	0.005	97.183
Liquidity	%	14,239	15.649	20.062	0.000	88.256	11,450	15.962	20.463	0.000	90.022
ROA	%	14,239	1.418	84.067	-5.659	25.804	11,450	1.447	85.748	-5.772	26.320
Loans/Assets	%	14,239	27.392	30.657	0.000	83.981	11,450	27.939	31.270	0.000	85.661
Capitalization	%	14,239	16.803	85.452	2.054	92.116	11,450	17.139	87.161	2.095	93.958
Debt/Assets	%	14,239	15.649	20.062	0.056	88.256	11,450	15.962	20.463	0.057	90.022
E. Country level control and Economic Crisis											
GDP Growth	%	14,239	3.964	2.206	0.078	8.381	11,450	4.043	2.250	0.079	8.548
Inflation Rate	%	14,239	2.786	2.858	-4.863	11.989	11,450	2.842	2.915	-4.961	12.229
Dum_Crisis	Dummy	14,239	0.224	0.417	0	1	11,450	0.228	0.425	0	1
Dum_COVID-19	Dummy	14,239	0.120	0.325	0	1	11,450	0.123	0.332	0	1

Panel C. T-Test of Means

Variable	Obs.	PRB_Joining[a] Non-join	Join	Different test	Net zero_GFANZ[b] Non-join	Join	Different test	TCFD_Supporters[c] Non-join	Join	Different test	CDP_Disclosure[d] Non-join	Join	Different test
A. Sytematic risk measures													
LogSRISKm	11,450	9.042	6.155	2.887***	9.089	6.100	2.989***	9.060	6.282	2.778***	6.837	6.229	0.608***
Volitility	11,450	33.975	35.872	1.897**	36.097	35.860	0.237**	36.047	31.458	4.590***	36.513	35.706	0.807*
DTD	11,450	1.941	3.602	-1.661***	1.758	3.630	-1.873***	2.749	3.496	-0.746***	3.325	3.509	-0.184***
PD_6Ms	11,450	0.254	0.176	0.079***	0.281	0.141	0.14***	0.185	0.152	0.033*	0.170	0.149	0.022**
PD_1Yr	11,450	0.583	0.397	0.185***	0.653	0.327	0.326***	0.475	0.410	0.066**	0.392	0.345	0.047***
PD_2Yrs	11,450	1.273	0.877	0.396***	1.420	0.747	0.673***	1.066	0.903	0.163**	0.872	0.786	0.086**
PD_3Yrs	11,450	1.920	1.352	0.567***	2.091	1.175	0.915***	1.648	1.388	0.260***	1.341	1.230	0.11**
PD_4Yrs	11,450	3.073	2.237	0.835***	3.161	1.979	1.182***	2.740	2.288	0.453***	2.201	2.048	0.153**
B. ESG (Environmental, Social, and Governance)													
ESG_Score	11,450	20.613	62.069	-41.456***	21.348	57.786	-36.438***	22.237	68.890	-46.653***	22.012	33.437	-11.425***
E_pillar	11,450	15.254	65.706	-50.452***	15.737	61.778	-46.041***	17.372	70.130	-52.757***	16.727	30.463	-13.736***
S_pillar	11,450	21.092	61.023	-39.930***	22.012	55.171	-33.159***	22.606	68.951	-46.345***	22.516	33.377	-10.861***
G_pillar	11,450	25.497	59.478	-33.981***	26.299	56.409	-30.111***	26.735	67.588	-40.853***	26.797	36.471	-9.674***
C. Bank Responsibility/Accountability													
PRB_Joining	11,450						4,900***			1,400***			293.5***
Net zero_GFANZ	11,450			4,900***						769.32***			294.23***
TCFD_Supporters	11,450			1,400***			769.32***						78.52***
CDP_Disclosure	11,450			391.99***			294.23***			72.62***			
D. Bank-level variables													
Concentration	11,450	59.106	79.003	-19.896***	57.045	80.682	-23.637***	60.365	67.813	-7.448***	58.282	62.366	-4.084***
Bank size (Log)	11,450	22.802	26.260	-3.458***	22.861	26.584	-3.723***	22.957	26.161	-3.204***	23.057	23.694	-0.638***
Loanprov/NII	11,450	6.854	10.978	-4.123**	2.438	21.368	-18.929***	3.555	7.304	-3.750**	2.911	8.575	-5.663*
Liquidity	11,450	15.542	16.945	-1.403***	15.084	21.106	-6.022***	15.512	19.564	-4.051***	15.181	17.228	-2.046***
ROA	11,450	0.569	1.837	-1.268***	0.469	1.628	-1.159***	0.657	0.882	-0.225***	0.530	0.727	-0.196***
Loans/Assets	11,450	53.450	61.541	-8.091	89.885	96.556	-6.670*	53.002	61.017	-8.016**	96.443	94.197	2.246
Capitalization	11,450	6.695	17.633	-10.938***	6.092	17.057	-10.966***	9.015	17.074	-8.059***	12.179	17.149	-4.97**
Debt/Assets	11,450	43.760	16.071	27.689**	45.364	15.176	30.187***	19.564	15.512	4.051**	18.612	17.683	0.928
E. Country-level control and Economic Crisis shocks													
GDP Growth	11,450	2.647	1.955	0.692***	2.552	1.772	0.78***	2.615	2.020	0.594***	2.514	2.366	0.149**
Inflation Rate	11,450	2.554	2.590	-0.036	2.210	2.592	-0.382***	2.784	2.843	-0.159***	2.572	2.506	0.066
Dum_Crisis	11,450			4.327**			0.116			129.23***			2.875*
Dum_COVID-19	11,450			31.54***			1.462			416***			13.596***

Table 2. Country characteristic

Country	No. of Bank	No. of Obs.	No. of large Bank	Log GDP per capita	SRISKm	Volitility	DTD	PD (6 monthS)	PD (12 month)	ESG_ Score	PRB_ Joining	TCFD_ Supporters
	(Bank)	*(Bank-year)*	*(Bank)*		*(US$bn)*	*(%)*	*(%)*	*(%)*	*(%)*	*(Points)*	*(Dummy)*	*(Dummy)*
Argentina	3	42	1	9.416	-0.101	54.560	0.227	0.605	1.240	15.745	0.476	0.000
Australia	12	234	6	10.906	1.024	29.431	4.759	0.204	0.494	68.803	0.244	0.094
Austria	7	102	3	10.694	1.931	29.209	3.399	0.095	0.223	50.104	0.368	0.032
Bahrain	3	39	1	10.040	-0.374	31.077	3.217	0.070	0.164	6.325	0.000	0.000
Bangladesh	2	19	1	7.212	-0.185	34.843	2.338	0.128	0.297	36.133	0.000	0.000
Belgium	6	88	1	10.611	0.319	29.688	10.552	0.039	0.088	26.213	0.065	0.078
Brazil	4	80	3	9.018	2.399	44.741	1.779	0.408	0.889	49.962	0.350	0.063
Canada	19	364	5	10.656	2.202	30.693	4.443	0.068	0.263	33.800	0.192	0.066
Chile	4	82	3	9.407	-1.522	33.804	3.618	0.053	0.126	25.173	0.012	0.037
China	49	484	30	9.019	4.061	37.056	2.430	0.493	1.032	20.513	0.089	0.034
Colombia	6	104	2	8.650	-1.530	33.302	3.540	0.084	0.202	26.100	0.135	0.096
Denmark	6	95	2	10.894	3.750	30.338	2.668	0.098	0.236	25.630	0.326	0.021
Finland	5	70	1	10.691	1.648	35.759	3.518	0.058	0.148	34.114	0.300	0.100
France	7	110	2	10.501	28.077	33.699	3.383	0.124	0.295	44.761	0.327	0.056
Germany	12	160	5	10.584	17.043	36.752	2.434	0.143	0.350	41.158	0.177	0.054
Greece	7	127	4	9.901	0.733	55.650	1.907	0.229	0.509	47.965	0.473	0.011
Hong Kong	9	176	4	10.558	-2.071	32.430	4.258	0.094	0.224	29.218	0.000	0.028
India	46	723	14	7.254	-0.203	45.015	1.542	0.999	2.105	27.856	0.027	0.011
Indonesia	20	339	4	8.016	-1.928	52.815	2.743	0.436	0.927	30.950	0.053	0.009
Ireland	3	66	2	10.936	0.762	57.938	1.525	0.091	0.221	39.668	0.121	0.136
Israel	5	107	4	10.440	2.100	34.152	2.732	0.097	0.237	28.936	0.000	0.000
Italy	15	254	6	10.368	5.135	36.232	1.937	0.109	0.264	34.634	0.222	0.053
Japan	49	825	31	10.443	13.436	33.362	2.077	0.391	0.858	33.746	0.132	0.169
Jordan	4	56	1	8.352	-0.793	31.403	2.790	0.087	0.208	45.195	0.000	0.000
South Korea	19	273	10	10.212	4.072	40.927	3.042	0.378	0.790	35.915	0.201	0.103
Kuwait	5	72	1	10.319	-2.862	28.646	3.404	0.075	0.179	22.183	0.000	0.000
Malaysia	11	220	6	9.085	-1.240	26.729	4.155	0.115	0.242	32.513	0.023	0.018
Malta	2	39	1	10.027	-0.190	86.923	3.533	0.057	0.134	30.171	0.000	0.000
Mexico	6	94	1	9.150	-2.646	42.306	3.502	0.077	0.184	47.516	0.032	0.011
Morocco	4	63	1	8.009	-1.607	24.175	3.362	0.099	0.228	23.625	0.254	0.079
Netherlands	7	92	2	10.718	15.086	34.398	1.899	0.128	0.304	56.221	0.277	0.133
Nigeria	4	70	1	7.770	-0.621	47.525	0.623	0.615	1.295	37.995	0.288	0.000
Norway	12	99	1	11.225	0.042	38.412	2.425	0.109	0.268	13.742	0.264	0.034
Oman	5	60	1	9.846	-0.225	25.011	2.799	0.090	0.213	9.589	0.000	0.000
Pakistan	6	102	1	7.148	-0.262	42.641	1.358	0.499	1.064	8.324	0.000	0.000
Peru	3	58	2	8.585	-2.959	29.104	3.622	0.046	0.121	57.751	0.000	0.000
Philippines	10	173	2	7.919	-0.650	33.256	3.913	0.101	0.218	25.265	0.000	0.012
Poland	8	130	1	9.341	-0.884	41.240	1.896	0.156	0.363	28.675	0.009	0.000
Puerto Rico	3	21	1	10.279	0.124	43.835	1.660	0.261	0.650	29.833	0.000	0.000
Qatar	4	71	2	11.066	-6.137	27.228	5.401	0.019	0.051	15.693	0.000	0.000
Saudi Arabia	11	170	6	9.862	-8.682	28.160	4.505	0.050	0.115	13.157	0.000	0.000

Country	No. of Bank	No. of Obs.	No. of large Bank	Log GDP per capita	SRISKm	Volitility	DTD	PD (6 monthS)	PD (12 month)	ESG_ Score	PRB_ Joining	TCFD_ Supporters
	(Bank)	*(Bank-year)*	*(Bank)*		*(US$bn)*	*(%)*	*(%)*	*(%)*	*(%)*	*(Points)*	*(Dummy)*	*(Dummy)*
Singapore	6	125	3	10.833	-0.630	22.309	5.240	0.106	0.252	26.964	0.000	0.080
South Africa	7	143	5	8.677	0.281	38.815	2.769	0.323	0.692	34.704	0.336	0.049
Spain	8	124	6	10.166	10.136	34.342	3.166	0.081	0.202	60.116	0.496	0.160
Sri Lanka	5	65	1	8.275	-0.085	41.586	1.368	0.416	0.875	17.424	0.000	0.000
Sweden	11	219	4	10.802	-0.633	33.947	5.688	0.053	0.135	32.410	0.301	0.046
Switzerland	22	353	4	11.325	1.464	25.302	4.911	0.032	0.080	26.966	0.136	0.026
Thailand	12	223	5	8.577	-0.142	46.271	2.689	0.132	0.287	22.730	0.018	0.013
United Kingdom	28	368	8	10.691	7.484	37.921	3.862	0.082	0.203	49.453	0.207	0.063
United States of America	342	5944	55	10.929	-0.660	36.079	3.765	0.070	0.183	15.950	0.004	0.011
Vietnam	13	122	2	7.957	-0.550	38.207	2.050	0.252	0.558	8.475	0.000	0.000
Total	**877**	**14,239**	**269**	**10.204**	**1.299**	**36.377**	**3.413**	**0.182**	**0.412**	**23.897**	**0.076**	**0.034**

Note: The sample includes publicly listed banks with large banks denote banks in the same sample with assets greater than US$ 50 billion at end-2022. Country characteristics are computed as of the end of 2022. Log GDP per capita is the log of real gross domestic product per capita in US dollars.

Table 3. Correlation Matrix (Pearson/ Spearman)

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1) LogSRISKm		0.18*	-0.48*	0.45*	0.45*	-0.32*	-0.36*	-0.31*	-0.25*	-0.38*	-0.27*	0.23*	0.43*	-0.14*	-0.01	-0.44*	-0.13*	-0.47*	0.15*	-0.15*	-0.16*	0.08*	0.13*
(2) Volitility	0.10*		-0.44*	0.42*	0.41*	-0.07*	-0.06*	-0.06*	-0.07*	-0.02*	-0.03*	0.07*	-0.1*	-0.27*	-0.03*	-0.08*	-0.06*	-0.03*	0.08*	-0.21*	0.08*	0.31*	0.14*
(3) DTD	-0.38*	-0.31*		-0.48*	-0.42*	0.02*	0.01	0.03*	0.05*	0.21*	0.06*	-0.12*	-0.24*	0.24*	0.01	0.44*	0.07*	0.45*	-0.14*	0.29*	-0.04*	-0.23*	-0.09*
(4) PD_6Ms	0.33*	0.26*	-0.38*		0.85*	-0.06*	-0.12*	-0.04*	-0.03*	-0.2*	-0.07*	0.31*	0.38*	-0.35*	-0.03*	-0.34*	-0.04*	-0.42*	0.23*	-0.42*	0.07*	0.24*	0.08*
(5) PD_1Yr	0.35*	0.26*	-0.41*	0.90*		-0.06*	-0.11*	-0.03*	-0.02*	-0.2*	-0.07*	0.27*	0.37*	-0.33*	-0.02*	-0.35*	-0.04*	-0.43*	0.23*	-0.48*	0.09*	0.23*	0.06*
(6) ESG_Score	-0.43*	-0.06*	0.00	-0.04*	-0.04*		0.92*	0.97*	0.95*	0.35*	0.28*	0.2*	0.49*	0.08*	0.06*	0.05*	0.00	0.1*	0.2*	0.01	0.00	-0.15*	0.3*
(7) E_Pillar	-0.49*	-0.06*	0.05*	-0.08*	-0.09*	0.9*		0.87*	0.8*	0.37*	0.28*	0.31*	0.43*	0.11*	0.06*	0.09*	0.01	0.15*	0.24*	0.15*	-0.04*	-0.08*	0.19*
(8) S_Pillar	-0.39*	-0.05*	0.01	-0.03*	-0.03*	0.95*	0.83*		0.9*	0.33*	0.27*	0.16*	0.47*	0.08*	0.05*	0.04*	0.00	0.07*	0.19*	0.02*	-0.02*	-0.17*	0.34*
(9) G_Pillar	-0.31*	-0.05*	0.03*	0.00	0.00	0.91*	0.69*	0.82*		0.28*	0.23*	0.13*	0.41*	0.04*	0.04*	0.02*	0.00	0.04*	0.15*	0.07*	0.00	-0.16*	0.33*
(10) PRB_Joining	-0.38*	-0.02	0.14*	-0.05*	-0.06*	0.42*	0.48*	0.39*	0.3*		0.34*	0.28*	0.4*	0.12*	-0.1*	-0.2*	0.02	-0.31*	0.13*	-0.16*	-0.02*	-0.02	0.05*
(11) TCFD_Supporters	-0.29*	-0.04*	0.05*	-0.01	-0.01	0.32*	0.35*	0.31*	0.25*	0.31*		0.09*	0.25*	0.03*	-0.03*	-0.13*	-0.01	-0.14*	0.11*	-0.02	0.01	-0.1*	0.19*
(12) Concentration	0.17*	0.00	0.00	-0.01	-0.01	0.24*	0.33*	0.19*	0.15*	0.27*	0.07*		0.37*	0.23*	-0.14*	-0.08*	0.02	-0.13*	0.17*	-0.55*	-0.14*	0.19*	-0.06*
(13) Bank Size	0.43*	-0.12*	-0.25*	0.19*	0.21*	0.43*	0.45*	0.49*	0.41*	0.42*	0.27*	0.3*		0.16*	-0.05*	-0.27*	0.02*	-0.47*	0.31*	-0.29*	-0.05*	-0.04*	0.11*
(14) Loanprov/NII	0.01	-0.01	0.00	0.01	0.01	-0.03*	-0.02	-0.02*	-0.03*	0.01	0.00	-0.02	0.02*		-0.08*	-0.01	-0.05*	-0.01	0.09*	-0.39*	0.14*	0.12*	0.08*
(15) Liquidity	-0.03*	-0.02*	0.02*	-0.03*	-0.03*	-0.02*	-0.05*	-0.02	0.00	-0.03*	-0.02*	-0.09*	0.01	0.00		-0.01	0.00	-0.01	-0.03*	0.15*	-0.06*	0.01	0.00
(16) ROA	-0.01	0.00	-0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.05*	0.01	0.00		0.22*	0.36*	0.02	0.01	0.21*	-0.09*	-0.02
(17) Loans/Assets	0.01	-0.02*	-0.01	-0.03*	-0.03*	0.01	0.02	0.01	0.01	0.03*	0.00	0.02*	0.01	0.00	0.00	0.00		-0.04*	0.02*	-0.08*	0.12*	-0.06*	-0.02*
(18) Capitalization	-0.07*	0.01	0.1*	-0.04*	-0.04*	-0.01	-0.02	-0.01	0.00	-0.03*	-0.02*	0.02	-0.04*	-0.01	-0.01	0.38*	0.00		-0.08*	0.15*	0.03*	-0.02*	0.04*
(19) Debt/Assets	0.05*	0.05*	-0.08*	0.1*	0.11*	0.12*	0.12*	0.12*	0.1*	0.02*	0.04*	0.04*	0.11*	0.01	-0.04*	0.01	-0.01	0.00		-0.16*	-0.05*	0.02	0.00
(20) GDP Growth	-0.11*	-0.12*	0.23*	-0.34*	-0.34*	-0.09*	-0.16*	-0.07*	-0.01	-0.05*	0.01	-0.34*	-0.18*	-0.04*	0.08*	0.00	-0.01	0.01	-0.02		-0.08*	-0.14*	0.13*
(21) Inflation Rate	-0.08*	0.08*	-0.12*	0.20*	0.20*	0.04*	-0.01	0.08*	0.05*	0.02	0.00	-0.01	-0.04*	0.01	-0.01	0.00	0.00	-0.01	-0.03*	-0.30*		0.06*	-0.03*
(22) Dum_Crisis	0.04*	0.21*	-0.16*	0.12*	0.13*	-0.13*	-0.05*	-0.16*	-0.15*	-0.01	-0.1*	0.09*	-0.04*	0.01	0.00	0.00	0.01	0.01	-0.02*	-0.05*	0.05*		-0.20*
(23) Dum_COVID 19	0.12*	0.12*	-0.08*	0.00	-0.01	0.28*	0.14*	0.32*	0.32*	0.05*	0.18*	-0.05*	0.1*	-0.02	0.00	0.00	0.00	0.00	0.03*	0.03*	-0.03*	-0.20*	

Note: The table displays the correlation matrix for the primary variables. All the variables are defined in Appendix A. The lower triangle of the table displays the Pearson's correlation coefficients, while the Spearman's rank correlations are shown above the diagonal. An asterisk (*) is denoted as the correlation is significant at the 1% and 5% levels.

Table 4. The estimation results of first stage of the Heckman two-stage model

	Dum_ESG_Score	
	Coeff.	Std.Err.
Constant	-12.76***	0.246
PRB_Joining	0.158***	0.056
TCFD_Supporters	0.734**	0.090
Bank Size	0.503***	0.009
Concentration	0.610***	0.073
Loanprov/NII	-0.089	0.060
Liquidity	0.183***	0.062
ROA	1.842***	0.226
Loans/Assets	0.156***	0.040
Capitalization	1.789***	0.079
Debt/Assets	-0.198***	0.036
GDP Growth	0.172***	0.007
Inflation Rate	0.419***	0.045
Dum_Crisis	-0.255***	0.031
Dum_COVID-19	1.046***	0.042
Log likelihood	-6,763	
Number of Observations	14,239	

Note: This table shows the outcomes of the first stage of the Heckman two-stage model for the years 2001–2022. The first stage utilizes a multinomial probit model to estimate the decision equation, and the resulting parameters are used to compute the Inverse Mills Ratio (IMR). In this context, the dependent variables are represented by a dummy variable (specifically, ESG), which is equal to 1 starting from the year in which a bank in our sample initiated ESG practices and 0 for previous years, following the approach proposed by Jo and Harjoto (2011). The standard errors are presented in parentheses. The coefficients marked with asterisks (***, **,*) represent the statistical significance levels of 1%, 5%, and 10%, respectively, in two-tailed tests, indicating they are statistically different from zero.

Table 5. The estimation results of the Heckman two-stage model

Panel A: Systemic risk as measured by SRISK and ESG

Variable	**LogSRISKm**							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-2.711***	-2.520***	-2.662***	-2.921***	-2.690***	-2.529***	-2.638***	-2.892***
	(0.153)	(0.146)	(0.149)	(0.151)	(0.153)	(0.146)	(0.149)	(0.152)
LogSRISKm(t-1)	0.884***	0.888***	0.882***	0.860***	0.885***	0.888***	0.883***	0.863***
	(0.005)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)
ESG_Score	-0.168***				-0.135***			
	(0.040)				(0.041)			
E_Pillar		-0.105***				-0.066		
		(0.039)				(0.040)		
S_Pillar			-0.136***				-0.112***	
			(0.037)				(0.038)	
G_Pillar				-0.0816***				-0.0696**
				(0.030)				(0.031)
ESG, E, S, G × PRB_Joining					-0.631***	-0.526***	-0.538***	-0.498***
					(0.167)	(0.140)	(0.162)	(0.160)
PRB_Joining	-0.339***	-0.323***	-0.329***	-0.235**	-0.063**	-0.007**	-0.014**	-0.066**
	(0.096)	(0.096)	(0.096)	(0.098)	(0.145)	(0.134)	(0.141)	(0.142)
TCFD Supporters	-0.254***	-0.240***	-0.253***	-0.324***	-0.297***	-0.278***	-0.297***	-0.345***
	(0.059)	(0.059)	(0.059)	(0.059)	(0.061)	(0.062)	(0.061)	(0.061)
Bank Size	0.206***	0.195***	0.203***	0.210***	0.205***	0.196***	0.201***	0.209***
	(0.011)	(0.010)	(0.010)	(0.011)	(0.011)	(0.010)	(0.010)	(0.011)
Concentration	-0.799***	-0.780***	-0.797***	-0.732***	-0.802***	-0.796***	-0.796***	-0.743***
	(0.080)	(0.079)	(0.079)	(0.081)	(0.080)	(0.080)	(0.079)	(0.081)
Loanprov/NII	-0.028	-0.020	-0.020	0.012	-0.023	-0.015	-0.016	-0.0113
	(0.071)	(0.067)	(0.069)	(0.070)	(0.070)	(0.067)	(0.069)	(0.070)
Liquidity	-0.840***	-0.863***	-0.783***	-0.640**	-0.854***	-0.866***	-0.816***	-0.666**
	(0.031)	(0.030)	(0.030)	(0.032)	(0.031)	(0.031)	(0.030)	(0.032)
ROA	-0.333***	-0.331***	-0.325***	-0.266***	-0.344***	-0.340***	-0.338***	-0.279***
	(0.081)	(0.082)	(0.081)	(0.081)	(0.081)	(0.082)	(0.081)	(0.081)
Loans/Assets	-0.244***	-0.235***	-0.246***	-0.290***	-0.244***	-0.239***	-0.244***	-0.285***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Capitalization	-0.225***	-0.216***	-0.221***	-0.239***	-0.224***	-0.217***	-0.221***	-0.237***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Debt/Assets	0.567***	0.550***	0.566***	0.592***	0.563***	0.559***	0.559***	0.585***
	(0.050)	(0.049)	(0.049)	(0.051)	(0.050)	(0.049)	(0.049)	(0.051)
GDP Growth	-0.156***	-0.197***	-0.148***	0.010	-0.151***	-0.185***	-0.147***	0.001
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Inflation Rate	-0.816***	-0.805***	-0.806***	-0.903***	-0.821***	-0.816***	-0.809***	-0.901***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Dum_Crisis	0.882***	0.932***	0.879***	1.150***	0.917***	0.957***	0.902***	1.152***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Dum_COVID-19	0.333*	0.201	0.332*	0.271	0.291	0.121	0.316*	0.251
	(0.018)	(0.017)	(0.018)	(0.021)	(0.019)	(0.018)	(0.018)	(0.021)
IMR	-0.214***	-0.205***	-0.213***	-0.213***	-0.215***	-0.210***	-0.212***	-0.214***
	(0.018)	(0.018)	(0.018)	(0.019)	(0.018)	(0.018)	(0.018)	(0.019)
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450
Wald chi^2	120,710***	119,609***	122,116***	144,975***	117,073***	114,096***	118,190***	124,599***
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean of VIF*	1.380	1.370	1.370	1.340	2.090	1.980	1.980	1.910

Note: This table showcases the impressive results of the second step of the Heckman two-stage model over the period 2001–2022. The second step estimates the generalized least squares (GLS) regression with the IMR generated by the first step. The dependent variable is the logarithm of the amount of SRISK, which measures banks' systemic risk. The main independent variables used in the second step include the ESG score and its pillars, the dummy PRB_JOINING, the dummy TCFD supporters, and their interaction. The control variables include Bank Size, Concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Appendix A offers definitions of variables. Bank, year, and country fixed effects (FE) are included in all specifications. The coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively. Additionally, there are no VIFs greater than 10, and the mean VIF is greater than 1, suggesting that the data is reliable.

Table 5. (Cont.)

Panel B: Systemic risk as measured by the volatility of SRISK and ESG

Variable	**Volatility**							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.140***	0.148***	0.146***	0.141***	0.141***	0.149***	0.147***	0.142***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Volatility (t-1)	0.465***	0.465***	0.465***	0.465***	0.465***	0.465***	0.465***	0.466***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
ESG_Score	-0.140***				-0.138***			
	(0.004)				(0.004)			
E_Pillar		-0.0860**				-0.0897**		
		(0.004)				(0.004)		
S_Pillar			-0.106***				-0.107***	
			(0.004)				(0.004)	
G_Pillar				-0.122***				-0.114***
				(0.003)				(0.003)
ESG, E, S, G × PRB_Joining					-0.019*	-0.033*	-0.025*	-0.117*
					(0.014)	(0.012)	(0.013)	(0.013)
PRB_Joining	-0.232***	-0.231***	-0.232***	-0.233***	-0.230***	-0.233***	-0.233***	-0.226***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.012)	(0.011)	(0.012)	(0.011)
TCFD_Supporters	-0.994**	-1.004**	-1.074**	-1.056**	-0.982**	-1.022**	-1.077**	-0.976**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Bank Size	0.232***	0.227***	0.229***	0.231***	0.232***	0.227***	0.229***	0.231***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Concentration	-0.251***	-0.249***	-0.251***	-0.251***	-0.251***	-0.249***	-0.251***	-0.251***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Loanprov/NII	-0.604***	-0.595***	-0.598***	-0.604***	-0.604***	-0.595***	-0.599***	-0.603***
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Liquidity	-0.0445*	-0.0441*	-0.0436*	-0.0433*	-0.0446*	-0.0441*	-0.0437*	-0.0434*
	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)	(0.025)
ROA	-0.262***	-0.265***	-0.260***	-0.259***	-0.266***	-0.266***	-0.263***	-0.263***
	(0.066)	(0.066)	(0.066)	(0.065)	(0.066)	(0.066)	(0.066)	(0.066)
Loans/Assets	0.0537	0.0535	0.0534	0.0539	0.0536	0.0534	0.0535	0.0539
	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)	(0.056)
Capitalization	-0.0362	-0.0408	-0.0348	-0.0353	-0.0358	-0.0404	-0.0341	-0.0358
	(0.119)	(0.118)	(0.119)	(0.119)	(0.118)	(0.118)	(0.118)	(0.119)
Debt/Assets	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.142***	0.143***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
GDP Growth	-0.097***	-0.099***	-0.098***	-0.096***	-0.098***	-0.099***	-0.098***	-0.097***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Inflation Rate	-0.122***	-0.123***	-0.122***	-0.121***	-0.122***	-0.123***	-0.122***	-0.122***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Dum_Crisis	0.347***	0.352***	0.346***	0.346***	0.347***	0.352***	0.346***	0.347***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Dum_COVID	0.375***	0.361***	0.375***	0.377***	0.375***	0.362***	0.375***	0.377***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
IMR	-0.600***	-0.599***	-0.600***	-0.600***	-0.601***	-0.598***	-0.600***	-0.602***
	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450
Wald chi^2	9,244***	9,498***	9,515***	8,962***	9,375***	9,621***	9,444***	8,950***
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean of VIF*	1.200	1.200	1.200	1.200	1.880	1.790	1.780	1.750

Note: This table showcases the results obtained from the second step of the Heckman two-stage model over the period 2001–2022. The GLS regression with the IMR generated by the first step is estimated in the second step. The dependent variable used in the second step is Volatility, which measures banks' systemic risk. The variables of interest used in the second step are the ESG score, the dummy PRB_JOINING, the dummy TCFD supporters, and their interaction. The control variables include Bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Variable definitions are provided in Appendix A. Bank, Year, and Country fixed effects (FE) are included in all specifications. The standard errors are presented in parentheses. The coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively. The table also indicates that there are no VIFs greater than 10, and the mean VIF is greater than 1.

Table 5. (Cont.)

Panel C: Systemic risk as measured by the probability of default and ESG

Variable	**DTD**							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	3.744***	3.379***	3.479***	3.431***	1.233***	1.200***	1.133***	1.129***
	(0.170)	(0.138)	(0.168)	(0.164)	(0.143)	(0.133)	(0.140)	(0.133)
DTD (t-1)	0.720***	0.740***	0.720***	0.718***	0.631***	0.626***	0.632***	0.633***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)	(0.005)	(0.005)
ESG_Score	0.588***				0.349***			
	(0.049)				(0.040)			
E_Pillar		0.533***				0.379***		
		(0.026)				(0.030)		
S_Pillar			0.433***				0.288***	
			(0.045)				(0.034)	
G_Pillar				0.382***				0.249***
				(0.039)				(0.027)
ESG, E, S, G × PRB_Joining					0.711***	0.195***	1.053***	0.261***
					(0.126)	(0.107)	(0.116)	(0.128)
PRB_Joining	1.806***	1.601***	1.839***	1.862***	1.330***	1.322***	1.308***	1.365***
	(0.088)	(0.085)	(0.090)	(0.090)	(0.095)	(0.087)	(0.097)	(0.097)
TCFD Supporters	0.087*	0.054	0.073	0.034	0.155**	0.187***	0.141**	0.111*
	(0.052)	(0.035)	(0.053)	(0.053)	(0.062)	(0.061)	(0.062)	(0.061)
Bank Size	-0.317***	-0.285***	-0.305***	-0.301***	-0.168***	-0.164***	-0.164***	-0.163***
	(0.011)	(0.009)	(0.011)	(0.011)	(0.009)	(0.009)	(0.009)	(0.009)
Concentration	0.228***	0.208***	0.230***	0.228***	0.145***	0.138***	0.145***	0.145***
	(0.010)	(0.009)	(0.010)	(0.010)	(0.008)	(0.007)	(0.008)	(0.008)
Loanprov/NII	0.521	0.475	0.494	0.488	0.412***	0.417***	0.402***	0.405***
	(0.331)	(0.331)	(0.331)	(0.332)	(0.111)	(0.110)	(0.110)	(0.111)
Liquidity	0.250	0.201	0.244	0.233	0.284	0.343	0.271	0.244
	(0.342)	(0.342)	(0.344)	(0.344)	(0.322)	(0.321)	(0.323)	(0.323)
ROA	0.324***	0.174***	0.317***	0.345***	0.406***	0.422***	0.390***	0.380***
	(0.068)	(0.065)	(0.068)	(0.068)	(0.055)	(0.055)	(0.055)	(0.054)
Loans/Assets	-0.0802	-0.0627	-0.0658	-0.0824	-0.0703	-0.0697	-0.0579	-0.0683
	(0.130)	(0.133)	(0.132)	(0.129)	(0.141)	(0.144)	(0.139)	(0.140)
Capitalization	0.114***	0.0992***	0.118***	0.123***	2.408***	2.478***	2.417***	2.415***
	(0.027)	(0.027)	(0.027)	(0.027)	(0.073)	(0.070)	(0.073)	(0.073)
Debt/Assets	-1.266***	-1.245***	-1.273***	-1.263***	-0.995***	-0.987***	-0.991***	-0.991***
	(0.050)	(0.049)	(0.051)	(0.051)	(0.046)	(0.045)	(0.046)	(0.046)
GDP Growth	0.106***	0.0907***	0.106***	0.100***	0.109***	0.112***	0.108***	0.105***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Inflation Rate	0.133***	0.129***	0.130***	0.127***	0.091***	0.090***	0.092***	0.092***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)
Dum_Crisis	-0.285***	-0.343***	-0.282***	-0.278***	-0.348***	-0.366***	-0.350***	-0.352***
	(0.023)	(0.022)	(0.023)	(0.023)	(0.021)	(0.020)	(0.021)	(0.021)
Dum_COVID-19	-0.412***	-0.371***	-0.398***	-0.402***	-0.442***	-0.402***	-0.450***	-0.444***
	(0.027)	(0.018)	(0.028)	(0.029)	(0.023)	(0.021)	(0.023)	(0.022)
IMR	0.483***	0.456***	0.485***	0.485***	0.409***	0.404***	0.409***	0.409***
	(0.019)	(0.018)	(0.019)	(0.019)	(0.016)	(0.016)	(0.016)	(0.016)
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450
Wald chi^2	41,744***	406,730***	27,689***	26,274***	117,472***	341,521***	73,358***	50,108***
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean of VIF*	1.330	1.320	1.320	1.280	1.880	1.770	1.820	1.740

Note: This table showcases the results obtained from the second step of the Heckman two-stage model over the period 2001–2022. The GLS regression with the IMR generated by the first step is estimated in the second step. The dependent variable used in the second step is the distance of default, which measures banks' systemic risk. The variables of interest used in the second step are the ESG score, the dummy PRB_JOINING, the dummy TCFD supporters, and their interaction. The control variables include Bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Variable definitions are provided in Appendix A. Bank, Year, and Country fixed effects (FE) are included in all specifications. The standard errors are presented in parentheses. The coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively. The table also indicates that there are no VIFs greater than 10, and the mean VIF is greater than 1.

Table 5. (Cont.)

Panel D: Probability of Defaul (6 months) and ESG

Variable	PD (6 months)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-1.202***	-1.150***	-1.206***	-0.987***	-1.207***	-1.138***	-1.237***	-0.996***
	(0.122)	(0.116)	(0.119)	(0.118)	(0.122)	(0.117)	(0.119)	(0.119)
PD (6 months) (t-1)	0.627***	0.622***	0.626***	0.635***	0.626***	0.622***	0.624***	0.635***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
ESG_Score	-0.222***				-0.201***			
	(0.036)				(0.037)			
E_Pillar		-0.222***				-0.195***		
		(0.037)				(0.038)		
S_Pillar			-0.208***				-0.157***	
			(0.032)				(0.034)	
G_Pillar				-0.116***				-0.114***
				(0.027)				(0.027)
ESG, E, S, G × PRB_Joining					-0.542***	-0.450***	-0.685***	-0.203***
					(0.186)	(0.161)	(0.178)	(0.162)
PRB_Joining	-0.987***	-1.025***	-1.005***	-0.985***	-0.659***	-0.736***	-0.655***	-0.875***
	(0.01%84)	(0.077)	(0.080)	(0.084)	(0.144)	(0.132)	(0.139)	(0.127)
TCFD Supporters	-0.065	-0.098*	-0.068	-0.061	-0.099*	-0.129**	-0.092	-0.071
	(0.058)	(0.059)	(0.054)	(0.057)	(0.060)	(0.060)	(0.058)	(0.057)
Bank Size	0.186***	0.188***	0.186***	0.178***	0.187***	0.187***	0.190***	0.180***
	(0.009)	(0.008)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
Concentration	-1.460***	-1.482***	-1.474***	-1.485***	-1.457***	-1.483***	-1.448***	-1.495***
	(0.077)	(0.070)	(0.073)	(0.079)	(0.078)	(0.070)	(0.073)	(0.080)
Loanprov/NII	-0.337*	-0.327*	-0.328*	-0.340*	-0.332*	-0.322*	-0.318*	-0.340*
	(0.181)	(0.176)	(0.175)	(0.175)	(0.180)	(0.174)	(0.173)	(0.176)
Liquidity	-0.236*	-0.297**	-0.259**	-0.234*	-0.238*	-0.296**	-0.262**	-0.235*
	(0.126)	(0.124)	(0.129)	(0.132)	(0.126)	(0.124)	(0.128)	(0.133)
ROA	-0.199***	-0.168**	-0.180**	-0.226***	-0.209***	-0.172**	-0.254***	-0.230***
	(0.071)	(0.073)	(0.072)	(0.074)	(0.072)	(0.074)	(0.074)	(0.075)
Loans/Assets	0.321***	0.320***	0.321***	0.322***	0.321***	0.320***	0.319***	0.322***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
Capitalization	-0.171***	-0.169***	-0.166***	-0.168***	-0.172***	-0.168***	-0.166***	-0.169***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Debt/Assets	0.641***	0.704***	0.658***	0.622***	0.645***	0.704***	0.693***	0.627***
	(0.043)	(0.036)	(0.040)	(0.043)	(0.043)	(0.036)	(0.038)	(0.043)
GDP Growth	-0.128***	-0.129***	-0.125***	-0.140***	-0.127***	-0.128***	-0.126***	-0.141***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Inflation Rate	-0.062***	-0.071***	-0.061***	-0.063***	-0.063***	-0.072***	-0.058***	-0.064***
	(0.005)	(0.004)	(0.005)	(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
Dum_Crisis	0.074***	0.082***	0.073***	0.073***	0.075***	0.084***	0.064***	0.073***
	(0.016)	(0.016)	(0.016)	(0.017)	(0.016)	(0.016)	(0.016)	(0.017)
Dum_COVID	0.095***	0.090***	0.109***	0.094***	0.092***	0.091***	0.097***	0.093***
	(0.017)	(0.015)	(0.016)	(0.018)	(0.018)	(0.015)	(0.016)	(0.018)
IMR	-0.265***	-0.279***	-0.267***	-0.259***	-0.267***	-0.279***	-0.280***	-0.261***
	(0.017)	(0.014)	(0.016)	(0.017)	(0.017)	(0.014)	(0.015)	(0.017)
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450
Wald chi^2	11,662***	10,902***	12,107***	13,155***	11,479***	10,933***	10,853***	13,227***
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean of VIF*	1.310	1.310	1.300	1.270	2.020	1.920	1.920	1.840

Note: This table showcases the results obtained from the second step of the Heckman two-stage model over the period 2001–2022. The GLS regression with the IMR generated by the first step is estimated in the second step. The dependent variable used in the second step is the probability of default (6 months), which measures banks' systemic risk. The variables of interest used in the second step are the ESG score, the dummy PRB_JOINING, the dummy TCFD supporters, and their interaction. The control variables include Bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Variable definitions are provided in Appendix A. Bank, Year, and Country fixed effects (FE) are included in all specifications. The standard errors are presented in parentheses. The coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively. The table also indicates that there are no VIFs greater than 10, and the mean VIF is greater than 1.

Table 5. (Cont.)

Panel E: Probability of Defaul (1 year) and ESG

Variable	PD (1 year)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-3.362***	-3.046***	-3.260***	-2.855***	-3.324***	-3.003***	-3.164***	-2.886***
	(0.253)	(0.244)	(0.249)	(0.241)	(0.253)	(0.244)	(0.249)	(0.243)
PD (1 year) (t-1)	0.702***	0.730***	0.673***	0.705***	0.700***	0.718***	0.672***	0.706***
	(0.007)	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.006)
ESG_Score	-0.505***				-0.489***			
	(0.077)				(0.078)			
E_Pillar		-0.519***				-0.476***		
		(0.078)				(0.080)		
S_Pillar			-0.513***				-0.466***	
			(0.071)				(0.072)	
G_Pillar				-0.363***				-0.362***
				(0.053)				(0.054)
ESG, E, S, G × PRB_Joining					-0.936***	-0.721***	-1.280***	-0.321***
					(0.381)	(0.327)	(0.369)	(0.332)
PRB_Joining	-2.257***	-2.126***	-2.101***	-2.132***	-1.663***	-1.678***	-1.305***	-1.975***
	(0.177)	(0.173)	(0.175)	(0.172)	(0.293)	(0.270)	(0.290)	(0.258)
TCFD Supporters	-0.114	-0.323***	-0.143	-0.233**	-0.196	-0.363***	-0.266**	-0.218*
	(0.124)	(0.122)	(0.121)	(0.118)	(0.127)	(0.124)	(0.124)	(0.122)
Bank Size	0.422***	0.409***	0.412***	0.400***	0.422***	0.409***	0.409***	0.403***
	(0.020)	(0.019)	(0.019)	(0.019)	(0.020)	(0.018)	(0.019)	(0.019)
Concentration	-2.964***	-3.104***	-2.955***	-3.084***	-3.003***	-3.109***	-2.987***	-3.107***
	(0.162)	(0.160)	(0.163)	(0.161)	(0.163)	(0.158)	(0.164)	(0.162)
Loanprov/NII	-0.666*	-0.659**	-0.658**	-0.670**	-0.665*	-0.649**	-0.655**	-0.671**
	(0.344)	(0.334)	(0.334)	(0.332)	(0.342)	(0.329)	(0.330)	(0.335)
Liquidity	-0.547**	-0.689***	-0.595**	-0.486*	-0.544**	-0.687***	-0.572**	-0.491*
	(0.251)	(0.249)	(0.260)	(0.263)	(0.251)	(0.249)	(0.257)	(0.265)
ROA	-0.711***	-0.553***	-0.550***	-0.600***	-0.679***	-0.532***	-0.540***	-0.599***
	(0.146)	(0.146)	(0.148)	(0.144)	(0.146)	(0.147)	(0.149)	(0.146)
Loans/Assets	0.528***	0.525***	0.527***	0.528***	0.527***	0.525***	0.522***	0.528***
	(0.086)	(0.086)	(0.086)	(0.086)	(0.086)	(0.085)	(0.087)	(0.086)
Capitalization	-0.384***	-0.367***	-0.383***	-0.376***	-0.388***	-0.369***	-0.383***	-0.379***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.009)	(0.009)
Debt/Assets	1.393***	1.376***	1.365***	1.331***	1.395***	1.414***	1.364***	1.341***
	(0.091)	(0.087)	(0.090)	(0.091)	(0.090)	(0.085)	(0.089)	(0.091)
GDP Growth	-0.235***	-0.240***	-0.226***	-0.243***	-0.236***	-0.238***	-0.230***	-0.244***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Inflation Rate	-0.089***	-0.122***	-0.094***	-0.108***	-0.096***	-0.123***	-0.101***	-0.110***
	(0.010)	(0.010)	(0.010)	(0.011)	(0.010)	(0.010)	(0.010)	(0.011)
Dum_Crisis	0.0548	0.0720**	0.105***	0.0788**	0.0655*	0.0872**	0.113***	0.0773**
	(0.035)	(0.034)	(0.035)	(0.035)	(0.035)	(0.034)	(0.035)	(0.035)
Dum_COVID	0.132***	0.109***	0.194***	0.169***	0.140***	0.127***	0.198***	0.168***
	(0.039)	(0.036)	(0.039)	(0.038)	(0.039)	(0.035)	(0.038)	(0.039)
IMR	-0.574***	-0.559***	-0.556***	-0.551***	-0.575***	-0.567***	-0.556***	-0.556***
	(0.035)	(0.034)	(0.035)	(0.035)	(0.035)	(0.034)	(0.035)	(0.036)
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450
Wald Chi^2	22,265	36,657	15,386	25,040	21,843	28,344	15,584	24,920
Prob > Chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Mean of VIF*	1.320	1.310	1.310	1.270	2.030	1.920	1.930	1.840

Note: This table showcases the results obtained from the second step of the Heckman two-stage model over the period 2001–2022. The GLS regression with the IMR generated by the first step is estimated in the second step. The dependent variable used in the second step is the probability of default (1 year), which measures banks' systemic risk. The variables of interest used in the second step are the ESG score, the dummy PRB_JOINING, the dummy TCFD supporters, and their interaction. The control variables include Bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Variable definitions are provided in Appendix A. Bank, Year, and Country fixed effects (FE) are included in all specifications. The standard errors are presented in parentheses. The coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively. The table also indicates that there are no VIFs greater than 10, and the mean VIF is greater than 1.

Table 6.

Robustness test.: ESG_Score × PRB_Joining

This table presents the additional results obtained from the second step of the Heckman two-stage model over the period 2001–2022. In Panel A, the dependent variable is a systemic risk, which is measured by long-run default probabilities, namely 2 years (PD_2Yrs), 3 years (PD_3Yrs), and 5 years (PD_5Yrs). The interest variables are ESG_Score, PRB_Joining, and their interaction. In Panel B, the dependent variables are systemic risk (including SRISKm, Volatility, DTD, PD_6Ms, and PD_1Yr). The interest variables are ESG_Score (t-1), PRB_Joining, and their interaction. Bank-level and country-level control are lagged by one period (year). The control variables used in both panels A and B are Bank size, Concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, and Inflation Rate. Economic crisis shocks include Dum_Crisis and Dum_COVID-19. Variable definitions are provided in Appendix A. IMR generated by the Heckman first-stage model (see Table 4). Bank, Year, and Country fixed effects are included in all specifications. The standard errors are presented in parentheses, and the coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively.

Panel A: Probability of Default (PD) and ESG

Variable	PD_2Ys		PD_3Ys		PD_5Ys	
Constant	-6.014***	-6.019***	-8.575***	-8.599***	-8.886***	-8.881***
	[0.458]	[0.457]	[0.635]	[0.635]	[0.946]	[0.946]
ESG_Score	-0.015***	-0.014***	-0.024***	-0.023***	-0.035***	-0.034***
	[0.001]	[0.001]	[0.002]	[0.002]	[0.003]	[0.003]
PRB_Joining	-2.871***	-2.038***	-3.028***	-2.178***	-2.181***	-1.813*
	[0.276]	[0.503]	[0.451]	[0.711]	[0.653]	[0.996]
ESG_Score × PRB_Joining		-0.013***		-0.014***		-0.006**
		[0.007]		[0.009]		[0.012]
IMR[(a)]	-8.362***	-8.349***	-9.233***	-9.305***	-7.794***	-7.832***
Wald chi^2	19,944	19,875	23,723	23,699	29,882	29,903
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000

Panel B: Systemic risk and ESG (t-1)

	SRISKm		Volatylity		DTD		PD_6Ms		PD_1Yr	
Constant	-2.638***	-2.619***	0.151***	0.152***	3.954***	1.475***	-1.280***	-1.257***	-2.834***	-2.606***
	[0.152]	[0.152]	[0.016]	[0.016]	[0.163]	[0.137]	[0.124]	[0.124]	[0.251]	[0.249]
ESG_Score (t-1)	-0.121***	-0.091**	-0.270*	-0.294*	0.664***	0.524***	-0.253***	-0.222***	-0.333***	-0.029*
	[0.043]	[0.044]	[0.436]	[0.457]	[0.047]	[0.039]	[0.040]	[0.040]	[0.077]	[0.074]
PRB_Joining	-0.517***	-0.267**	-0.233***	-0.234***	1.782***	1.316***	-1.011***	-0.682***	-2.297***	-1.599***
	[0.093]	[0.124]	[0.009]	[0.011]	[0.090]	[0.092]	[0.087]	[0.131]	[0.178]	[0.264]
ESG_Score (t-1) × PRB_Joining		-0.421***		-0.294*		0.075***		-0.572***		-1.610***
		[0.147]		[1.286]		[0.123]		[0.167]		[0.339]
IMR[(b)]	-2.368***	-2.362***	-0.602***	-0.601***	4.834***	4.197***	-2.733***	-2.732***	-6.154***	-6.587***
Wald chi^2	109,062	110,062	8,965	8,949	30,975	103,541	10,564	10,635	14,903	16,841
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Control variables (t-1)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450

Table 7.
Robustness test: ESG_Score × Net zero_GFANZ

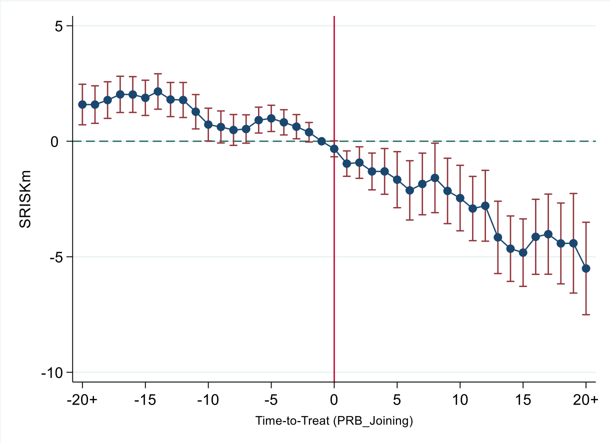
This table presents the robustness tests obtained from the second step of the Heckman two-stage model over the period 2001–2022. The dependent variables are systemic risk (including SRISKm, Volatility, DTD, PD_6Ms, and PD_1Yr). In Panel A, the interest variables are ESG_Score, Net zero_GFANZ, and their interaction. In Panel B, the interest variables are ESG_Score, CDP_Disclosure, and their interaction. The control variables used in both panels A and B are Bank size, Concentration, TCFD_Supporters, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, and Inflation Rate. Economic crisis shocks include Dum_Crisis and Dum_COVID-19. Variable definitions are provided in Appendix A. IMR generated by the Heckman first-stage model (see Table 4). Bank, Year, and Country fixed effects are included in all specifications. The standard errors are presented in parentheses, and the coefficients marked with asterisks (***, **, *) represent the statistical significance levels of 1%, 5%, and 10%, respectively.

Panel A: Systemic risk, ESG and joining the GFANZ										
Variable	SRISKm		Volitylity		DTD		PD_6Ms		PD_1Yr	
Constant	-1.292***	-0.939***	0.311***	0.306***	2.267***	2.198***	-0.637***	-0.632***	-1.885***	-1.927***
	[0.175]	[0.189]	[0.013]	[0.013]	[0.186]	[0.195]	[0.123]	[0.122]	[0.223]	[0.222]
ESG_Score	-0.147***	-0.101***	-0.017***	-0.015***	0.612***	0.588***	-0.177***	-0.156***	-0.432***	-0.392***
	[0.037]	[0.038]	[0.004]	[0.003]	[0.051]	[0.054]	[0.036]	[0.036]	[0.073]	[0.074]
Net zero_GFANZ	-0.431***	-0.747***	-0.009**	-0.004**	0.063*	0.133*	-0.216***	-0.066***	-0.388***	-0.068***
	[0.061]	[0.089]	[0.004]	[0.007]	[0.044]	[0.070]	[0.052]	[0.091]	[0.101]	[0.189]
ESG_Score × Net zero_GFANZ		-0.006***		-0.0001*		0.002*		-0.006***		-0.009***
		[0.001]		[0.000]		[0.001]		[0.001]		[0.003]
IMR	-0.105***	-0.118***	-0.173***	-0.176***	0.138***	0.141***	-0.122***	-0.134***	-0.253***	-0.259***
	[0.011]	[0.011]	[0.010]	[0.010]	[0.009]	[0.010]	[0.011]	[0.011]	[0.013]	[0.010]
Wald chi^2	94,012	31,065	29,426	29,426	29,426	28,538	11,125	11,177	18,406	18,586
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Panel B: Systemic risk, ESG and CDP disclosure										
Variable	SRISKm		Volitylity		DTD		PD_6Ms		PD_1Yr	
Constant	-2.185***	-2.144***	0.317***	0.327***	2.430***	2.401***	-0.456***	-0.530***	-1.559***	-1.843***
	[0.135]	[0.134]	[0.013]	[0.013]	[0.160]	[0.162]	[0.104]	[0.104]	[0.217]	[0.220]
ESG_Score	-0.137***	-0.090**	-0.023***	-0.016***	0.612***	0.568***	-0.143***	-0.158***	-0.428***	-0.445***
	[0.036]	[0.040]	[0.004]	[0.004]	[0.051]	[0.055]	[0.036]	[0.039]	[0.073]	[0.081]
CDP_Disclosure	-0.023	-0.065***	-0.004**	-0.017***	-0.025	0.024	0.007	-0.059***	-0.038	-0.115***
	[0.016]	[0.020]	[0.002]	[0.002]	[0.023]	[0.033]	[0.014]	[0.019]	[0.030]	[0.044]
ESG_Score × CDP_Disclosure		-0.225***		-0.037***		0.194**		-0.237***		-0.416***
		[0.070]		[0.008]		[0.094]		[0.069]		[0.150]
IMR	-0.160***	-0.165***	-0.154***	-0.159***	0.143***	0.146***	-0.098***	-0.108***	-0.217***	-0.240***
	[0.009]	[0.009]	[0.009]	[0.009]	[0.008]	[0.008]	[0.009]	[0.009]	[0.015]	[0.011]
Wald chi^2	151,499	159,503	23,590	112,352	28,622	27,147	11,689	10,782	23,273	18,719
Prob > chi^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Selected Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450

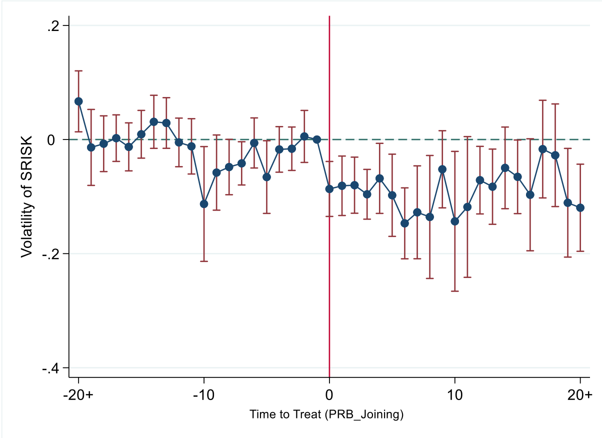
Table 8.

Robustness Test. The table presents the coefficients obtained from difference-in-difference (DiD) regressions that examine whether banks that voluntarily joined responsible institutions have a significant impact on the relationship between ESG and systemic risk. The dependent variables are LogSRISKm, Volatility, DTD, PD_6ms, and PD_1Yr. The table also incorporates dummy variables (i.e., PRB_Joining, Net Zero_GFANZ, TCFD_Supporters, and CDP_Disclosure) and interaction terms between ESG and the responsibilities. The control variables include Bank size, concentration, Loanprov/NII, Liquidity, ROA, Loans/Assets, Capitalization, Debt/Assets, GDP Growth, Inflation Rate, Dum_Crisis, Dum_COVID-19. Variable definitions are provided in Appendix A. Bank, Year, and Country fixed effects (FE) are included in all specifications. The standard errors are presented in parentheses, and the coefficients marked with asterisks (***, **, *) correspond to statistical significance levels of 1%, 5%, and 10%, respectively.

Variable	PRB_Joining (Treatment=1)					Net zero_GFANZ (Treatment=1)				
	SRISKm	Volitylity	DTD	PD_6Ms	PD_1Yr	SRISKm	Volitylity	DTD	PD_6Ms	PD_1Yr
Constant	0.288**	0.479***	19.315***	-1.261**	-2.344**	-0.328**	0.408**	19.083***	-16.050***	-28.307***
	[0.620]	[0.182]	[3.198]	[0.589]	[1.088]	[0.523]	[0.168]	[3.185]	[4.826]	[8.107]
PRB_Joining	-0.577*	-0.073***	0.771***	-0.196***	-0.394***					
	[0.314]	[0.021]	[0.253]	[0.047]	[0.097]					
Net zero_GFANZ						-0.432**	-0.037**	0.477**	-2.754**	-5.232**
						[0.271]	[0.029]	[0.227]	[2.560]	[4.341]
ESG_Score	-0.407***	-0.039***	0.179**	-0.113**	-0.123**	-0.349***	-0.040***	0.148**	-1.234**	-0.770*
	[0.112]	[0.010]	[0.149]	[0.020]	[0.042]	[0.117]	[0.009]	[0.147]	[1.161]	[1.535]
ESG × PRB_Joining	-0.292**	-0.0395**	-0.284**	0.408**	0.607**					
	[0.408]	[0.246]	[0.268]	[0.332]	[0.671]					
ESG × Net zero_GFANZ						-0.593*	-0.020**	0.237**	-0.028***	-0.060***
						[0.593]	[0.204]	[0.188]	[0.008]	[0.016]
Variable	TCFD Supporters (Treatment=1)					CDP_Disclosure (Treatment=1)				
	SRISKm	Volitylity	DTD	PD_6Ms	PD _1Yr	SRISKm	Volitylity	DTD	PD_6Ms	PD_1Yrs
Constant	0.137***	0.482***	19.461***	-16.612***	-29.486***	-3.916***	0.487***	19.889***	-18.247***	-23.022**
	[0.558]	[0.168]	[3.273]	[4.860]	[8.149]	[1.368]	[0.173]	[3.254]	[4.829]	[10.860]
TCFD_Supporters	-0.526***	-0.009*	0.005**	-1.825***	-3.884***					
	[0.124]	[0.007]	[0.106]	[0.532]	[1.077]					
CDP_Disclosure						-0.111***	-0.003**	0.010**	-0.256**	-0.311**
						[0.042]	[0.003]	[0.029]	[0.186]	[0.142]
ESG_Score	-0.419***	-0.042***	0.134**	-1.237**	-0.777**	-0.588*	-0.035*	0.123**	-0.360**	-0.043**
	[0.123]	[0.008]	[0.140]	[1.161]	[1.536]	[0.304]	[0.019]	[0.144]	[0.342]	[0.401]
ESG × TCFD_Supporters	-0.062**	0.154*	0.020**	-0.027***	-0.057***					
	[1.241]	[0.080]	[0.010]	[0.008]	[0.016]					
ESG × CDP_Disclosure						-0.255**	-0.004**	0.097**	0.309**	-0.192**
						[0.357]	[0.022]	[0.082]	[0.341]	[0.316]
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank, Country, Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450	11,450



(a)



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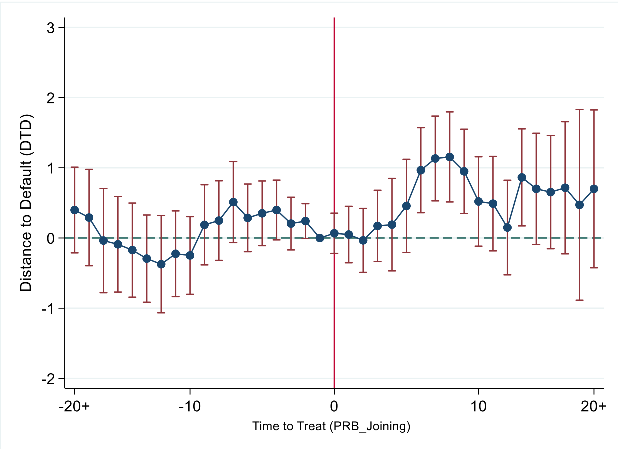

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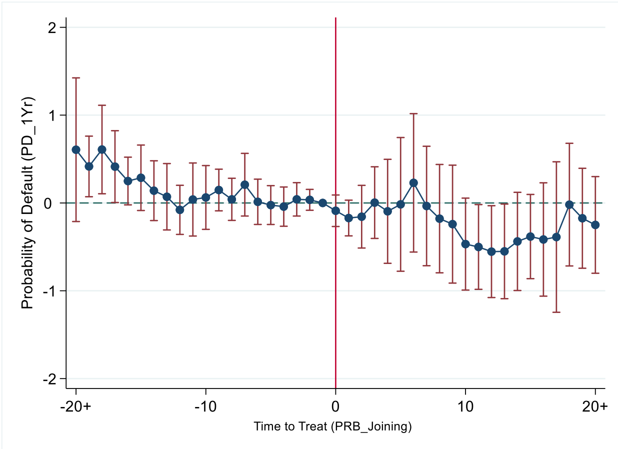

(d)

Figure 2. The event-study plots.

Each plot shows regression coefficients relative to the base period, with a solid point representing the point estimation of the coefficient for the given time. The vertical line on each plot represents the 95% confidence interval, which is calculated using the standard error of clustering to the bank level.

Apendix A: Variables definition and data source

Variables	Definition	Source
A1. Sytematic risk measures (Dependent variables)		
SRISKm	A Conditional Capital Shortfall Measure of Systemic Risk (SRISK) is SRISK computed over the period January 2001 to December 2022, expressed in millions of US dollars. SRISK per unit of market capitalization. SRISK is defined as the loss of the bank i conditional by the financial system being in distress (5% worst outcomes) given by $Stt\ ii = kk \times Ltt\ ii - (1 - kk) \times Ett\ ii \times (1 - Ltt\ ii)$, where kk is set at 8% and denotes regulatory capital ratio, $Ltt\ ii$ is the book value of total liabilities, $Ett\ ii$ is the market capitalization of the bank, and $Ltt\ ii$ is the long-run marginal expected shortfall computed as $1 - \exp(\log(1 - dd) \times b)$, where dd is the sixmonth crisis threshold for the market decline set at 40% and beta is the bank's beta coefficient. SRISK is determined using the GJR-GARCH method with two steps Quasi Maximum Likelihood (QML) estimation as in Acharya et al. (2012) and Brownlees and Engle (2017). SRISK is expressed in USD. System is defined by the MSCI World Financials index. Higher values are associated with greater systemic importance	World Financials Global Dynamic MES Systemic Risk Analysis (https://vlab.stern.nyu.edu/srisk/RISK.WORLDFIN-MR.GMES)
Volitylity	The annualized standard deviation of returns based on daily stock returns, expressed in percentages	
DTD	The distance to default for each bank is estimated using the Merton (1974) model, which has been tailored to overcome drawbacks in the financial sector identified by Duan (1994, 2000, 2010) and Duan et al. (2012).	Thomson Reuters Datastream
PDs (PD_6Ms, PD_1Yr, PD_2Yrs, PD_3Yrs, PD_5Yrs)	The default probability is defined as PD = F(–DTD), in which F is the cumulative distribution function of a standard normal distribution. PD is calculated for 6 months, 1 year, 2 years, 3 years, and 5 years.	Thomson Reuters Datastream
A2. ESG (Environmental, Social, and Governance) and sub-pillars		
ESG_Score + E_Pillar + S_Pillar + G_Pillar	Environmental, Social, and Governance (ESG) refers to an overall sustainability score. This score is calculated as the average of the three individual pillar scores, which include Environmental (E_Pillar), Social (S_Pillar), and Governance (G_Pillar).	
A3. Bank responsible group		
PRB_Joining	The time dummy variable is coded as 1 for the year in which a bank joined the PRB and 0 for the previous periods.	United Nations Environment Finance Initiative (UNEPFI) (https://www.unepfi.org/member)
Net zero_GFANZ	The time dummy variable is coded as 1 for the year in which a bank joined the Glasgow Financial Alliance for Net Zero (GFANZ) and 0 for the previous periods.	
TCFD Supporters	The time dummy variable is coded as 1 for the year in which a bank joined the TCFD supporter and 0 for the previous periods.	Task Force on Climate Related Financial Disclosures (TCFD) (https://www.fsb-tcfd.org/supporters/)
CDP_Disclosure	The time dummy variable is coded as 1 for the year in which a bank disclosed its climate impacts through CDP and 0 for the previous periods.	
A4. Bank level control		
Concentration	The share of the top five banks as a proportion of total banking assets in a certain nation	Author's computation based on Bankscope data
Bank Size	The logarithm of total assets, in billions of US dollars	Author's computation based on Bankscope data
Loanprov/NII	The ratio of loan-loss provisions to net interest income	Author's computation based on Bankscope data
Liquidity	The ratio of total deposits to total assets	Author's computation based on Bankscope data
ROA	The ratio of net income to total assets	Author's computation based on Bankscope data
Loans/Assets	The ratio of total loans to total assets	Author's computation based on Bankscope data
Capitalization	The ratio of total equity to total assets	Author's computation based on Bankscope data
Debt/Assets	The ratio of total debt to total assets	Author's computation based on Bankscope data
A5. Country level control		
GDP Growth	The real gross domestic product (GDP) growth rate	World Bank Financial Development database
Inflation Rate	Consumer price index (CPI)	World Bank Financial Development database
A6. Economic shocks		
Dum_Crisis	The time dummy variable is coded as 1 for years 2008–2012 and 0 for the other periods.	Author's computation
Dum_COVID-19	The time dummy variable is coded as 1 for the COVID-19 year and 0 for the other periods.	World Health Organisation

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