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**Climate threats to bank default risk and financial stability:
Any market concern about the ECB 2022 climate risk stress test?**

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Abstract

This paper examines the market reaction to the 2022 publication of the first-ever ECB climate risk stress test results, revealing whether there is any concern about climate change threats to European financial stability. Bank default risk is measured through the CDS spreads from banks that the ECB tested on their climate risk resilience. Our findings reveal a significant increase in the risk premium required by market participants, specifically for short and medium CDS maturities. Interestingly, we also did not find evidence that ESG considerations can serve as a protective shield against risk premium, on the contrary.

JEL classification: G01, G21, G28

Keywords: Climate stress test, ESG, Bank default risk, Financial stability

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1. Introduction

The impact of climate change on financial stability is now a major concern for market participants and policymakers. This paper aims to address this issue by examining the impact of the 2022 ECB climate risk stress test on the assessment of the default risk of the banks concerned. The possibility that climate-related risks could undermine financial stability was addressed back in 2010, Article 23 (Identification and measurement of systemic risk) of the EU Regulation² included a specific reference to the potential environmental-related systemic risk to be reflected in the stress test regime. In 2015, the speech of Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, marked a turning point (Carney, 2015). Climate change is a source of two new main types of risk to the financial system: physical risks and transition risks³. Climate change threatens the safety of the banking system (Battiston *et al.*, 2021; Reghezza *et al.*, 2022). According to Krueger *et al.* (2020), a vast majority of financial institutions recognizes that climate risks affect their regular activity versus only 10 % that believe that climate risks will materialize only in 10 years (Krueger *et al.*, 2020). In this context, the implications of climate-related risks are many but the most relevant in the banking industry are how they affect credit risk, through the probability of default, the loss given default and thus the expected loss, and market risk, through the sensitivity of the price of securities to changes in market-risk factors due to climate risks.

Our paper belongs to the research stream that studies the relationship between climate risk in general and its effect on financial stability (in line with Bolton *et al.*, 2020; Battiston *et al.*, 2020; Reinders *et al.*, 2023; Acharya *et al.*, 2023; Cartellier, 2022; etc.). One possible approach, taken by supervisors and central banks to quantify the exposure to climate change, is the use of climate stress tests. These are quantitative assessments of the resilience of individual banks and the financial system to extreme outcomes, in our case here climate-related risks. Central banks and supervisors adapt the methodology of prudential stress tests to climate-related risks. Acharya *et al.* (2023) discuss the design of the scenarios used and how this affects the impact on financial stability, as well as how different Central Banks around the world do or do not take climate change into account in their regulatory decisions. Cartellier (2022) presents these different stress test exercises in the case of Europe as well as the climate scenarios used and how they impact on the financial system. In addition to previous work, our study focuses on the 2022 climate risk stress test, which should be understood in the context of a broader set of activities undertaken by ECB Banking Supervision in 2022 to assess the level of preparedness of supervised institutions to properly manage climate risks⁴.

The aim of this paper is to study whether market investors are indeed concerned about climate-related risks and their potential impact on financial stability of the European system. Thus, this study tries to shed light on whether the publication of the results of the first climate risk stress test really was taken

² Regulation (EU) No.1093/2010 of the European Parliament and of the council establishing a European Supervisory Authority (European Banking Authority), amending Decision No. 716/2009/EC and repealing Commission Decision 2009/78/EC.

³ Physical risks relate to the impact on the economy of the physical consequences of climate change, such as temperature anomalies, floods, heatwaves, wildfires, etc. Transition risks refer to the economic and social losses resulting from policy changes, such as the development of green technologies, the redirection of financial flows, preferences during the transition to a less carbon-intensive economy, etc. The definition of these two types of risk can be found for example in BCBS (2021).

⁴ A total of 104 banks participated in the test consisting of three modules, in which banks provided information on their: (i) own climate stress-testing capabilities, (ii) reliance on carbon-emitting sectors, and (iii) performance under different scenarios over several time horizons. The bottom-up stress test within the third module was limited to 41 directly supervised banks to ensure proportionality towards smaller banks

into account by the market, whether the market has readjusted its assessment of bank default risk depending on climate threats?

Previous studies revealed the importance of being included in sustainability indices, especially when public attention to environmental issues is increasing (El Ouadghiri *et al.*, 2021; Hawn *et al.*, 2018). The EBA, in collaboration with the European Commission under the Action Plan on Financing Sustainable Growth, incorporates sustainable issues into financial services and regulatory and supervisory frameworks of European credit institutions⁵.

Companies and thus banks' sustainable awareness are measured by Environmental, Social and Governance (ESG) scores. These evaluations have been developed by various ESG rating providers presented on the market (Bloomberg, LSEG, Sustainalytics, Vigeo to name a few) and provide investors relevant information about firms' complex ESG activities and the single criteria evaluation (E, S or G), within which the E Pillar offers a more precise assessment of firms' actions in the environmental field. We complete our research question: if the market adjusts the bank default risk premium they require, does it value banks' climate change commitments?

To answer this question, we conduct an event study. We focus on climate-related risks and financial stability in Europe, in particular because the ECB complemented its 2022 stress test by an ongoing supervisory thematic review of climate-related and environmental risk management practices, which will seek to comprehensively assess how banks have incorporated these risks into their strategy, governance and risk management frameworks and processes (ECB, 2022a). As a result, this test is even more risk-focused than the other climate stress tests conducted by the ECB or other Central Banks. To analyze the market reaction of this specific stress test on bank default risk, we choose to use banks' Credit Default Swap (CDS). Indeed, the CDS spread is a measure of the market's valuation of bank default risk and thus allows us to assess whether there is a change in the risk premium required by market investors. Since CDS have different maturities, we can explore the impact of climate risk, if any, depending on the maturity. The literature review shows that our study is one of the first to consider the ECB 2022 climate risk stress test which takes greater account of climate risks, and we examine the valuation of bank default risk by market investors following the publication of the results.

Our paper provides a substantial contribution to the existing literature on the relationship between climate change and financial stability: i) this paper is among the first studies to analyze the market reaction to the ECB climate risk stress test by applying the event study methodology and under the condition of the absence of individual bank data in the published ECB climate stress test results, ii) we show a positive increase in the valuation of bank default risk by market investors after the official publication of results, i.e. July, 8th 2022, and, to our best knowledge, there is no previous research around this date; iii) we provide the evidence that banks' overall ESG and E Pillar ratings are not yet considered as relevant determinants to measure the banks' resilience to default risk under climate change threats as stress-tested by the ECB. On the contrary, the market's expectation of better performance from banks with good ESG scores actually penalized them more.

⁵ See EBA: <https://www.eba.europa.eu/activities/single-rulebook/regulatory-activities/sustainable-finance>

2. Data and methodology

2.1 Data and sample

For its 2022 climate risk stress test, the ECB has not displayed the name of the banks that were part of it. The information given, in its technical report and in a press release (ECB, 2022a; ECB, 2022b), is that 41 banks were included. Moreover, unlike the “traditional” stress tests undertaken by the ECB, the European Banking Authority (EBA) did not provide any individual results about the banks part of this stress test. It just provided a general analysis stating that all banks are vulnerable to both transition and physical risks whatever the scenario considered.

To conduct our work, we proceeded as follows: we have taken the banks included in the 2018 stress test (48 banks), and those included in the 2023 stress test (70 banks). Then we identified those for which we were able to have CDS in 2022. Because of the Brexit, we have excluded UK banks. We finish with 24 banks.

ESG and E Pillar scores are taken from Bloomberg and LSEG Eikon databases in 2022. Of these 24 banks, 2 banks are missing ESG and E-Pillar Bloomberg scores and 2 banks are missing ESG and E-Pillar LSEG scores. We end up with 1 bank with no score at all, 1 bank with Bloomberg scores but no LSEG scores, and vice versa.

Table 1 provides the names of the bank, CDS availability and information about their ESG and E Pillar scores (in particular below or above the median).

[Insert Table 1 here]

Each bank has one CDS per maturity.

Accounting data were collected from BankFocus.

2.2. Methodology

To investigate whether market investors actually are concerned by climate-related risks and their potential impact on financial stability, we first employ an event study methodology (Brown and Warner, 1985; Campbell, Lo, and MacKinlay, 1997) to capture the market reaction to the publication of the 2022 ECB climate risk stress test results. Then, we conduct a multivariate regression analysis with the market reaction (CARs) as the dependent variable.

2.2.1. Event study methodology

To capture the market reaction, we calculate the Cumulative Average Abnormal CDS spreads Returns (CAAR) over a relevant window around the disclosure date (“event window”).

We measure first the abnormal return $AR_{i,t}$ of bank i , over each date t of the event window. It is the difference between the observed CDS spread return of bank i on day t $R_{i,t}$, and the return that would be expected if the disclosure did not take place $\hat{R}_{i,t}$ ($AR_{i,t} = R_{i,t} - \hat{R}_{i,t}$). To estimate $\hat{R}_{i,t}$, we use a single-factor market model ($R_{i,t} = \alpha_i + \beta_i \cdot R_{m,t} + \varepsilon_{i,t}$) over a 84-trading days estimation window, $R_{m,t}$ being the daily CDX spread return on day t . The estimation window ends 10 trading days before the event as it goes from $t-94$ to $t-11$, t being the date of the publication of the 2022 ECB climate risk stress test results.

$$AR_{i,t} = R_{i,t} - (\hat{\alpha}_i + \hat{\beta}_i \cdot R_{m,t}) \quad (1)$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are respectively the Ordinary Least Squares estimates of α_i and β_i . As we can see, α and β are estimated separately for each bank i . Following the work of Flannery *et al.* [2017] and Ahnert *et al.* [2018], we compute the returns $R_{i,t}$ ($R_{m,t}$) by transforming CDS (CDX) spreads into logarithmic returns with:

$$R_{i,t} = \log\left(\frac{S_{i,t}}{S_{i,t-1}}\right) \quad \text{and} \quad R_{m,t} = \log\left(\frac{S_{m,t}}{S_{m,t-1}}\right) \quad (2)$$

where $S_{i,t}$ is the daily CDS MID spread of bank i , on day t when $S_{m,t}$ is the daily CDX MID spread on day t ⁶. For each bank, we collect daily data on senior CDS spread from the Bloomberg terminal, considering all maturities of CDS (from 6-month to 10-year maturity). As Indices (CDX), following Flannery *et al.* (2017), Ahnert *et al.* (2018) and Sahin *et al.* (2020), we employ the *Markit iTraxx Europe Investment Grade index* of which we also collect daily data from the Bloomberg terminal, but not for all maturities. Indeed, only four maturities are available (3, 5, 7 and 10 years). Therefore, we first compute the 4Y daily CDX spreads by taking the average between the 3Y and the 5Y CDX spreads, at the level of each date. Secondly, for the remaining unavailable maturities (6-month, 1-year and 2-year), we assigned them the spreads of the nearest available maturity to perform our investigations (so the spreads of the 3-year maturity).

To obtain the Cumulative Abnormal Returns of bank i CAR_i , we sum the Abnormal Returns AR_{it} over the event window ($t-2$; $t+4$):

$$CAR_i(-2; +4) = \sum_{t=-2}^{+4} AR_{it} \quad (3)$$

Finally, we calculate the Cumulative Average Abnormal CDS spreads Returns (CAAR) which is the average of the different CAR_i .

2.2.2. Regressions models

We then conduct a multivariate regression analysis with the market reaction (CARs) as the dependent variable. We regress the latter on ESG or Pillar E scores and several control variables. Following the literature, we control for bank liquidity, profitability and solvability.

To control for bank liquidity, we use the ratio of net loans to deposits and short-term funding following Kosmidou (2008) and Naceur and Kandil (2009). The higher the value of the ratio, the lower the bank liquidity. Hence, this ratio is positively related to bank CDS spreads. We control for bank profitability by considering the return on equity which is negatively related to bank CDS spreads. Finally, we use a measure of solvability, measured as the Core Tier 1. An increase in the Core Tier 1 ratio should lead to a lower CDS spreads (and vice versa).

$$CAR_i^M = \alpha_0 + \alpha_1 * ESG/E_Score_{i,2022} + \alpha_3 * Bank\ controls_{i,2021} + \epsilon_i \quad (4)$$

In equation 4, CAR_i^M is the market response to the divulgation of the 2022 climate risk stress test outcomes about bank i , and estimated using the M -year maturity CDS spreads. ESG/E_Score_i

⁶ The MID spread of CDS (CDX) corresponds to the average between the BID and the ASK CDS (CDX) quotes.

corresponds to the ESG or E Pillar scores of bank i . *Bank controls_i* are observable specific-characteristics of bank i , at the most recent year prior to the disclosure of the results.

Descriptives statistics are presented in Table 2.

[Insert Table 2 here]

3. Results

Table 3 displays the Cumulative Average Abnormal Returns of CDS spread at the announcement of ECB 2022 climate risk stress test results for different CDS maturities, while Table 4 presents the determinants of the Cumulative Abnormal Returns. For each table, we have several panels. Panel A presents the results for banks for which we have Bloomberg ESG / E Pillar scores, Panel B presents the results for banks for which we have LSEG ESG/E Pillar scores and Panel C considers all 24 banks (including those without scores).

[Insert Table 3 here]

Looking at the CAARs tells us whether and how the market reacted to 2022 climate risk stress test results in terms of the required risk premium.

Whether we consider panels A, B or C, all results show with high significance that a higher risk premium was required for all banks, and that the increase was more important for short and medium maturities than for long maturities. The upward adjustment in the assessment of banks' default risk is greater in the short term than in the long term. A parallel can be drawn with the fact that the stress test considers the impact of transition risk based on credit risk and market risk. The assessment of short-term vulnerabilities assumes a static balance sheet, while the long-term strategy assumes a dynamic balance sheet (ECB, 2021). The market may therefore assume that banks will have taken measures to adapt to climate change in the long term.

We then split the sample of banks in two: those below the median of the sample's ESG/E pillar scores and those above. Looking at the sample split according to ESG scores, we observe that the value of the CAARs for banks below the median is quite low, with slightly higher values for long maturities than for short and medium maturities (for both providers), but they are mostly insignificant. As for the CAARs of banks above the median, they are positive and significant, and the value is higher for short and medium maturities than for long maturities. The analysis of the maturity results is similar to that for the full sample. Regarding the required risk premium, given that the ECB announced that all banks are exposed to climate-related risks, our results show that the market penalized banks with a good ESG score even more, as it certainly expected them to perform better. We explore this issue further and split the sample according to Pillar E scores. First, we observe that, globally, the increase in the risk premium (CAARs) is higher for the short and medium term than for the long term, a result that is consistent with what we found earlier. Second, the increase in CAARs is still higher for banks with a good Pillar E assessment than for banks with a lower assessment. However, the difference in the increase in the risk premium is now much smaller. Using the E Pillar score to assess banks' commitment to climate change may be a better measure.

[Insert Table 4 here]

By analyzing Table 4, we look at the factors that led investors to increase the required risk premium. First, our results show that market investors do not value banks' environmental commitment, as measured by the Bloomberg and LSEG E-Pillar indicators, when determining their increase in the default risk premium. The market may not yet have confidence in the information content of this indicator. Regarding ESG scores, we find no significance for Panel B, but for Panel A we find positive and significant coefficients for short and medium CDS maturities. This result can be interpreted as the market demanding a higher increase in the risk premium for banks with higher ESG scores. This is consistent with our previous finding that the market penalizes banks with a good ESG score even more, as it certainly expects them to perform better. Overall, in the majority of our regressions, we do not manage to capture a significant response of sustainability scores that could provide a clear conclusion to our findings. This finding is in line with previous scholars who have argued much about the convergence of ESG measurement concepts and the need for investors to critically evaluate the respective methodology of ESG rating providers when making their investment decisions (Berg et al., 2020a, Berg et al., 2020b, Escrig-Olmedo et al., 2019).

The usual determinants produce the expected results, irrespective of the sample (panels A, B or C): (i) the coefficient associated with the amount of capital held by banks (Core Tier 1) is negative and highly significant. Market investors demanded a smaller increase in the risk premium for banks with higher levels of capital, whatever the maturity; (ii) the coefficient on the ratio Net Loans to Total Assets is positive and highly significant. This coefficient is on average higher for medium and long maturities than for short maturities. We can argue that market investors take into account that climate physical risks increase the credit risk of banks; therefore, investors may expect the counterparty risk to be more likely to materialize and to be greater in the medium and long term.

4. Robustness

First, we perform robustness check for the event study analysis by substituting the 84-trading days estimation window with a longer period, 120-trading days. The main results still hold.

Second, we consider the alternative event windows for the robustness check of both the event study analysis and the regression analysis (dependent variable event window) due to possible subjectivity in the selection of event windows for generating the cumulative abnormal return. We consider the following event windows: [-4 ;4], [0 ;4], [-2 ;3]. Our main findings are confirmed.

Third, to avoid that the results of parametric tests might not be sufficient to determine the significance of CAARs, we check whether the preceding results are robust by conducting nonparametric tests, which are an important widely-used tool to control nonnormal distribution and cross-sectional dependence. Our nonparametric test results are robust both in the main models, when the data period is extended to 120 trading days before the event window and when changing the event window.

5. Conclusion

In 2022, the ECB conducted its first climate risk stress test, providing only global results and not individual ones. This stress test differs from the previous climate stress tests in that it focuses more on

how banks have integrated climate-related and environmental risk management practices into their strategy, governance and risk management frameworks and processes. It aimed to explore from different angles the level of banks' preparedness for tackling and managing climate risk. Using banks' CDS spread as a measure of bank default risk, we show a strong market reaction around the disclosure date of the climate-risk stress test results. More precisely, we show a significant increase of the risk premium required by market participants. This increase in the risk premium is lower for longer maturities of CDS. Investors may anticipate that banks in the long run will have undertaken measures to adapt to climate change. Also, our results show that, back at the date when the stress test was realized, a better ESG or Pillar E scores do not allow for a better resilience of banks in terms of default risk. On the contrary, as the market expected banks with good ESG scores to perform better, it penalized them even more. This increase in the risk premium is also driven by the amount of capital owned by banks, the more they owned the lesser the increase, and by the ratio of net loans to total assets, the higher the ratio the higher the increase. Indeed, that climate physical risks increase the credit risk of banks.

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Table 1, Panel A: List of tested banks rated by Bloomberg (ESG score, Pillar E score)

Bank Name	Bank Country	2018 ST Sample	2023 ST Sample	CDS	Above ESG median	Below ESG median	Above E Pillar median	Below E Pillar median
Erste Group Bank AG	Austria	x	x					
Raiffeisen Bank International AG	Austria	x	x					
Belfius Banque SA	Belgium	x	x					
KBC Bank	Belgium	x	x	x		x		x
Danske Bank A/S	Denmark	x	x	x		x		x
Jyske Bank	Denmark	x	x					
Nykredit Realkredit	Denmark	x	x					
OP Financial Group	Finland	x	x					
BNP Paribas SA	France	x	x	x	x		x	
Credit Agricole SA	France	x	x	x		x		x
Group Crédit Mutuel	France	x	x					
Groupe BPCE	France	x	x					
La Banque Postale	France	x	x					
Societe Generale	France	x	x	x	x		x	
Bayerische Landesbank	Germany	x	x	x		x	x	
Commerzbank AG	Germany	x	x	x		x		x
Deutsche Bank AG	Germany	x	x	x		x	x	
Dz Bank AG	Germany	x	x					
Landesbank Badenwuerttemberg	Germany	x	x	x		x		x
Landesbank Hessen-Thueringen Girozentrale	Germany	x	x	x				
Norddeutsche Landesbank - Girozentrale -	Germany	x	x					
NRW.BANK	Germany	x						
OTP Bank Nyrt.	Hungary	x	x					
Allied Irish Banks plc	Ireland	x	x					
Bank of Ireland	Ireland	x	x	x				
Banca Monte Paschi	Italy		x	x		x		x
Banco BPM SpA	Italy	x	x					
Intesa Sanpaolo Spa	Italy	x	x	x	x		x	
Mediobanca Spa	Italy		x	x	x			x
UniCredit SpA	Italy	x	x	x	x		x	
Unione Di Banche Italiane SPA	Italy	x						
ABN AMRO Bank NV	Netherlands	x	x					
Cooperatieve Rabobank U.A.	Netherlands	x	x					
ING Bank N V	Netherlands	x	x	x		x		x
N.V. Bank Nederlandse Gemeenten	Netherlands	x						
DnB ASA	Norway	x	x					
Bank Polska Kasa Opieki SA	Poland	x	x					
Powszechna Kasa Oszczednosci Bank Polski SA	Poland	x	x					
Banco Company Portugues	Portugal		x	x	x			x
Caixa Geral de Diposits	Portugal		x	x	x			x
Banco de Sabadell	Spain	x	x	x	x			x
Banco Santander SA	Spain	x	x	x	x		x	
BBV Argentaria SA	Spain	x	x	x	x		x	
Caixabank S.A.	Spain	x	x					
Nordea Bank AB (publ)	Sweden	x						
Skandinaviska Ensk BNKN	Sweden	x	x	x	x		x	
Svenska HB	Sweden	x	x	x		x	x	
Swedbank AB	Sweden	x	x	x		x		x
BofA Securities Europe SA	France		x					
Sydbank A/S	Denmark		x					
Nordea Bank Abp	Finland		x					
Citigroup Global Markets Europe AG	Germany		x					
Deutsche Apotheker- und Ärztebank eG	Germany		x					

Goldman Sachs Bank Europe SE	Germany		x					
HASPA Finanzholding	Germany		x					
J.P. Morgan SE	Germany		x					
Morgan Stanley Europe Holding SE	Germany		x					
Volkswagen Bank GmbH	Germany		x					
Barclays Bank Ireland PLC	Ireland		x					
Citibank Holdings Ireland Limited	Ireland		x					
BPER Banca S.p.A.	Italy		x					
Cassa Centrale Banca - Credito Cooperativo Italiano S.p.A.	Italy		x					
Iccrea Banca S.p.A. – Istituto Centrale del Credito Cooperativo	Italy		x					
de Volksbank N.V.	Netherlands		x					
ABANCA Corporación Bancaria S.A.	Spain		x					
Bankinter, S.A.	Spain		x					
Kutxabank, S.A.	Spain		x					
Unicaja Banco, S.A.	Spain		x					
Länsförsäkringar Bank AB (publ)	Sweden		x					
SBAB Bank AB – group	Sweden		x					
Alpha Services & Holdings S.A.	Greece		x					
Eurobank Ergasias Services and Holdings S.A.	Greece		x					
National Bank of Greece S.A.	Greece		x					
Piraeus Financial Holdings S.A.	Greece		x					
Total		48	70	30	13	12	13	13

Sources: European Banking Authority (EBA) and Authors' calculation.

Table 1, Panel B: List of tested banks rated by LSEG (ESG score, Pillar E score)

Bank Name	Bank Country	2018 ST Sample	2023 ST Sample	CDS	Above ESG median	Below ESG median	Above E Pillar median	Below E Pillar median
Erste Group Bank AG	Austria	x	x					
Raiffeisen Bank International AG	Austria	x	x					
Belfius Banque SA	Belgium	x	x					
KBC Bank	Belgium	x	x	x		x	x	
Danske Bank A/S	Denmark	x	x	x		x		x
Jyske Bank	Denmark	x	x					
Nykredit Realkredit	Denmark	x	x					
OP Financial Group	Finland	x	x					
BNP Paribas SA	France	x	x	x	x		x	
Credit Agricole SA	France	x	x	x	x			x
Group Crédit Mutuel	France	x	x					
Groupe BPCE	France	x	x					
La Banque Postale	France	x	x					
Societe Generale	France	x	x	x	x		x	
Bayerische Landesbank	Germany	x	x	x				
Commerzbank AG	Germany	x	x	x	x		x	
Deutsche Bank AG	Germany	x	x	x	x		x	
DZ BANK AG	Germany	x	x					
Landesbank Badenwuerttemberg	Germany	x	x	x		x		x
Landesbank Hessen-Thueringen Girozentrale	Germany	x	x	x				
Norddeutsche Landesbank - Girozentrale -	Germany	x	x					
NRW.BANK	Germany	x						
OTP Bank Nyrt.	Hungary	x	x					
Allied Irish Banks plc	Ireland	x	x					
Bank of Ireland	Ireland	x	x	x		x		x
Banca Monte Paschi	Italy		x	x		x		x
Banco BPM SpA	Italy	x	x					
Intesa Sanpaolo Spa	Italy	x	x	x	x		x	

Mediobanca Spa	Italy		x	x		x		x
UniCredit SpA	Italy	x	x	x	x			x
Unione Di Banche Italiane SPA	Italy	x						
ABN AMRO Bank NV	Netherlands	x	x					
Cooperatieve Rabobank U.A.	Netherlands	x	x					
ING Bank N V	Netherlands	x	x	x		x	x	
N.V. Bank Nederlandse Gemeenten	Netherlands	x						
DnB ASA	Norway	x	x					
Bank Polska Kasa Opieki SA	Poland	x	x					
Powszechna Kasa Oszczednosci Bank Polski SA	Poland	x	x					
Banco Company Portugues	Portugal		x	x		x		x
Caixa Geral de Dipòsits	Portugal		x	x				
Banco de Sabadell	Spain	x	x	x	x		x	
Banco Santander SA	Spain	x	x	x	x		x	
BBV Argentaria SA	Spain	x	x	x	x		x	
Caixabank S.A.	Spain	x	x					
Nordea Bank AB (publ)	Sweden	x						
Skandinaviska Ensk BNKN	Sweden	x	x	x		x	x	
Svenska HB	Sweden	x	x	x		x	x	
Swedbank AB	Sweden	x	x	x		x	x	
BofA Securities Europe SA	France		x					
Sydbank A/S	Denmark		x					
Nordea Bank Abp	Finland		x					
Citigroup Global Markets Europe AG	Germany		x					
Deutsche Apotheker- und Ärztebank eG	Germany		x					
Goldman Sachs Bank Europe SE	Germany		x					
HASPA Finanzholding	Germany		x					
J.P. Morgan SE	Germany		x					
Morgan Stanley Europe Holding SE	Germany		x					
Volkswagen Bank GmbH	Germany		x					
Barclays Bank Ireland PLC	Ireland		x					
Citibank Holdings Ireland Limited	Ireland		x					
BPER Banca S.p.A.	Italy		x					
Cassa Centrale Banca - Credito Cooperativo Italiano S.p.A.	Italy		x					
Iccrea Banca S.p.A. – Istituto Centrale del Credito Cooperativo	Italy		x					
de Volksbank N.V.	Netherlands		x					
ABANCA Corporación Bancaria S.A.	Spain		x					
Bankinter, S.A.	Spain		x					
Kutxabank, S.A.	Spain		x					
Unicaja Banco, S.A.	Spain		x					
Länsförsäkringar Bank AB (publ)	Sweden		x					
SBAB Bank AB – group	Sweden		x					
Alpha Services & Holdings S.A.	Greece		x					
Eurobank Ergasias Services and Holdings S.A.	Greece		x					
National Bank of Greece S.A.	Greece		x					
Piraeus Financial Holdings S.A.	Greece		x					
Total		48	70	30	14	13	14	13

Sources: European Banking Authority (EBA) and Authors' calculation.

Table 2. Statistic descriptives explanatory variables

Explanatory variables include 2022 Bloomberg ESG score, Bloomberg E Pillar score, LSEG ESG score, LSEG E Pillar score, as well as accounting data net loans to total assets ratio (*NL_to_TA*), return in average equity (*ROAE*) and Core Tier 1 ratio (*CT1*) from BankFocus database (year 2021).

Variables	N	Mean	SD	Min	p50	Max
Bloomberg ESG	22	57.38	8.92	37.38	58.13	74.51
Bloomberg E	22	3.27	1.71	0.13	3.70	5.45
LSEG ESG	21	79.01	12.79	54.47	77.01	97.29
LSEG E	21	84.61	14.21	47.08	92.47	96.16
Net Loans to Total Assets	24	0.51	0.12	0.22	0.54	0.72
ROAE	24	0.07	0.04	0.00	0.08	0.14
Core Tier 1 ratio	24	0.15	0.02	0.12	0.14	0.20

Table 3. The effect of ECB Climate Stress Test results on banks' CDS spreads

This table displays the estimation of the CDS market response to announcement of ECB 2022 Climate risk stress test results for different CDS maturities. CAARs (%) are estimated in a [-2; +4] event window around the day of announcement (July, 8th 2022) with a 84-trading day estimation window. Panel A shows the estimations of CAARs (%), while Panel B demonstrates the results according to the LSEG ESG/E Pillar scores. Panel C shows estimation of CAARs (%) for the overall sample. *, **, ***, **** indicate statistical significance respectively at 10%, 5%, 1% and 0,1% levels estimated by Patell and BMP parametric tests.

Panel A. CAARs (%) by applying Bloomberg scores

ALL BANKS WITH A BLOOMBERG ESG/E PILLAR SCORE									
	CDS Maturity	N of banks	CAARs	Patell	BMP				
<i>All 22 banks</i>	6-Month	22	4.15	**	****				
	1-Year	22	4.07	***	****				
	2-Year	22	4.53	****	****				
	3-Year	22	3.85	****	****				
	4-Year	22	3.51	****	****				
	5-Year	22	3.29	****	****				
	7-Year	22	3.29	****	****				
	10-Year	22	3.04	****	****				
BLOOMBERG OVERALL ESG SCORE					BLOOMBERG E PILLAR SCORE				
	CDS Maturity	N of banks	CAARs	Patell	BMP	N of banks	CAARs	Patell	BMP
<i>Below the median</i>	6-Month	11	0.12			11	2.99	*	**
	1-Year	11	1.15		*	11	3.43	**	***
	2-Year	11	1.17		**	11	4.34	***	***
	3-Year	11	1.41		**	11	3.45	***	***
	4-Year	11	1.74	*	**	11	3.50	***	***
	5-Year	11	1.88		**	11	3.37	**	***
	7-Year	11	1.99	**	***	11	3.42	***	****
	10-Year	11	1.92	**	***	11	3.09	***	****
<i>Above the median</i>	6-Month	11	8.18	***	****	11	5.32	*	****
	1-Year	11	6.99	***	****	11	4.71	**	****
	2-Year	11	7.90	****	****	11	4.72	***	****
	3-Year	11	6.28	****	****	11	4.25	***	****
	4-Year	11	5.29	****	****	11	3.52	***	****
	5-Year	11	4.69	***	****	11	3.20	**	****
	7-Year	11	4.59	****	****	11	3.16	****	****
	10-Year	11	4.15	****	****	11	2.98	****	****

Panel B. CAARs (%) by applying LSEG scores

ALL BANKS WITH A LSEG ESG/ E PILLAR SCORES									
	CDS Maturity	N of banks	CAARs	Patell	BMP				
<i>All 21 banks</i>	6-Month	21	8.98		****				
	1-Year	21	8.83		****				
	2-Year	21	9.24		****				
	3-Year	21	8.46		****				
	4-Year	21	7.87		****				
	5-Year	21	7.58		****				
	7-Year	21	7.19		****				
	10-Year	21	6.96		****				
LSEG OVERALL ESG SCORE					LSEG E PILLAR SCORE				
	CDS Maturity	N of banks	CAARs	Patell	BMP	N of banks	CAARs	Patell	BMP
<i>Below the median</i>	6-Month	10	1.18			10	3.58		*
	1-Year	10	1.83			10	3.16	*	**
	2-Year	10	2.87	*		10	4.15	**	**
	3-Year	10	2.38		**	10	2.60	*	**
	4-Year	10	2.77		**	10	2.17	*	**
	5-Year	10	2.90	*	***	10	1.87		**
	7-Year	10	2.73	*	****	10	1.93	**	****
	10-Year	10	2.59	**	****	10	1.59	**	****
<i>Above the median</i>	6-Month	11	6.88	**	****	11	4.70	*	***
	1-Year	11	6.11	***	****	11	4.90	**	***
	2-Year	11	6.15	****	****	11	4.99	***	****
	3-Year	11	5.32	****	****	11	5.12	***	****
	4-Year	11	4.26	**	****	11	4.81	**	****
	5-Year	11	3.76	**	***	11	4.70	**	***
	7-Year	11	3.87	****	****	11	4.60	****	****
	10-Year	11	3.52	****	****	11	4.43	****	****

Panel C. CAARs (%) - Full sample of banks (all banks with CDS, with or without ESG / E Pillar scores)

	CDS Maturity	N of banks	CAARs	Patell	BMP
<i>Full Sample</i>	6-Month	24	3.78	**	***
	1-Year	24	3.71	***	****
	2-Year	24	4.13	****	****
	3-Year	24	3.51	****	****
	4-Year	24	3.20	****	****
	5-Year	24	3.00	***	****
	7-Year	24	3.00	****	****
	10-Year	24	2.77	****	****

Table 4. Determinants of market reaction considering the sustainability effect and without

This table reports results for CAR [-2; 4] regression models considering different CDS maturities and the sustainability effect in terms of overall ESG and E pillar scores of banks. Panel A reports results when considering Bloomberg ESG/E pillar scores of banks and Panel B – LSEG ESG/E pillar scores of banks. Panel C reports results without scores as a determinant. Control variables include net loans to total assets ratio (*NL_to_TA*), return in average equity (*ROAE*) and Core Tier 1 ratio (*CT1*). Number of observations is 22 in panel A, 21 in panel B and 24 in panel C. Standard errors in parenthesis. *, **, *** indicate statistical significance respectively at 10%, 5%, 1% levels.

Panel A. Regression results by applying Bloomberg scores

CDS Maturity	ESG	E	NL to TA	ROAE	CT1	Constant	R ² Adj
6-Month	0.00392*** (0.00648)		0.122 (0.191)	-0.0309 (0.916)	-0.966* (0.0809)	-0.0981 (0.304)	0.397
		0.00614 (0.422)	0.127 (0.301)	-0.0542 (0.875)	-1.142* (0.0860)	0.132** (0.0159)	0.0161
1-Year	0.00255*** (0.00406)		0.151** (0.0307)	0.0743 (0.719)	-1.093** (0.0100)	-0.0238 (0.681)	0.449
		0.00571 (0.310)	0.163** (0.0335)	0.0397 (0.854)	-1.229** (0.0107)	0.121*** (0.00757)	0.211
2-Year	0.00275*** (0.00209)		0.176** (0.0123)	-0.0792 (0.688)	-1.397*** (0.00126)	0.0137 (0.808)	0.611
		0.00337 (0.561)	0.175** (0.0249)	-0.0849 (0.730)	-1.509*** (0.00231)	0.178*** (0.00134)	0.366
3-Year	0.00183*** (0.00692)		0.166*** (0.00189)	0.212 (0.148)	-1.252*** (0.000247)	0.0217 (0.619)	0.616
		0.00541 (0.231)	0.181*** (0.000807)	0.172 (0.264)	-1.365*** (0.000131)	0.121*** (0.00441)	0.470
4-Year	0.000971 (0.178)		0.191*** (0.00187)	0.273* (0.0786)	-1.206*** (0.000333)	0.0430 (0.397)	0.553
		0.00451 (0.260)	0.208*** (0.000344)	0.233 (0.109)	-1.286*** (4.20e-05)	0.0904** (0.0282)	0.530
5-Year	0.000687 (0.428)		0.207*** (0.00319)	0.323* (0.0842)	-1.133*** (0.00161)	0.0344 (0.569)	0.477
		0.00474 (0.233)	0.227*** (0.00133)	0.277 (0.108)	-1.209*** (0.000285)	0.0629 (0.120)	0.487
7-Year	0.000544 (0.526)		0.184*** (0.00854)	0.316* (0.0995)	-1.127*** (0.00208)	0.0541 (0.381)	0.432
		0.00488 (0.193)	0.205*** (0.00464)	0.267 (0.116)	-1.201*** (0.000388)	0.0731* (0.0973)	0.458
10-Year	0.000363 (0.695)		0.175** (0.0159)	0.395* (0.0731)	-1.021*** (0.00590)	0.0445 (0.501)	0.343
		0.00508 (0.198)	0.199*** (0.00950)	0.342* (0.0804)	-1.093*** (0.00152)	0.0513 (0.234)	0.383

Panel B. Regression results by applying LSEG scores

CDS Maturity	ESG	E	NL to TA	ROAE	CT1	Constant	R ² Adj
6-Month	0.00187 (0.143)		0.138 (0.215)	-0.142 (0.726)	-0.489 (0.586)	-0.0925 (0.565)	0.104
		-0.000794 (0.509)	0.118 (0.360)	0.114 (0.789)	-1.269 (0.111)	0.229** (0.0446)	0.0363
1-Year	0.00136 (0.162)		0.168** (0.0224)	0.00838 (0.973)	-0.796 (0.209)	-0.0342 (0.786)	0.284
		-0.000405 (0.676)	0.152* (0.0778)	0.170 (0.558)	-1.339** (0.0224)	0.184** (0.0457)	0.211
2-Year	0.000911 (0.331)		0.183** (0.0232)	-0.118 (0.678)	-1.226* (0.0874)	0.0726 (0.589)	0.401
		-0.000616 (0.354)	0.175* (0.0541)	0.0394 (0.883)	-1.640*** (0.00631)	0.250*** (0.00464)	0.398
3-Year	0.001000 (0.181)		0.180*** (0.00163)	0.163 (0.363)	-1.047** (0.0303)	0.0121 (0.906)	0.495
		-1.26e-05 (0.984)	0.166*** (0.00811)	0.242 (0.236)	-1.404*** (0.00163)	0.147** (0.0346)	0.429
4-Year	0.000609 (0.383)		0.205*** (0.000833)	0.258 (0.125)	-1.140** (0.0175)	0.0331 (0.747)	0.534
		0.000117 (0.806)	0.195*** (0.00168)	0.288* (0.0918)	-1.339*** (0.000537)	0.104* (0.0836)	0.509
5-Year	0.000602 (0.411)		0.223*** (0.00188)	0.290 (0.150)	-1.036** (0.0468)	0.00474 (0.966)	0.480
		0.000296 (0.495)	0.212*** (0.00264)	0.294 (0.116)	-1.207*** (0.00201)	0.0580 (0.301)	0.467
7-Year	0.000585 (0.396)		0.200*** (0.00542)	0.296 (0.155)	-1.054** (0.0469)	0.0199 (0.853)	0.447
		0.000313 (0.473)	0.189*** (0.00732)	0.297 (0.116)	-1.217*** (0.00250)	0.0693 (0.254)	0.437
10-Year	0.000585 (0.427)		0.192** (0.0112)	0.373 (0.118)	-0.943* (0.0888)	-0.00105 (0.993)	0.360
		0.000357 (0.458)	0.180** (0.0151)	0.367* (0.0878)	-1.099*** (0.00668)	0.0444 (0.474)	0.353

Panel C. Regression results without ESG / E Pillar scores.

CDS Maturity	ESG	E	NL to TA	ROAE	CT1	Constant	R ² Adj
6-month	-	-	0.0888 (0.437)	0.0254 (0.942)	-1.065 (0.102)	0.151*** (0.00461)	0.0516
1-Year	-	-	0.127* (0.0870)	0.115 (0.614)	-1.157** (0.0153)	0.138*** (0.00135)	0.206
2-Year	-	-	0.149* (0.0636)	-0.0272 (0.913)	-1.454*** (0.00284)	0.187*** (0.000224)	0.363
3-Year	-	-	0.148*** (0.00691)	0.242 (0.152)	-1.297*** (0.000511)	0.137*** (0.000642)	0.416
4-Year	-	-	0.180*** (0.00162)	0.292* (0.0527)	-1.231*** (0.000190)	0.104*** (0.00330)	0.477
5-Year	-	-	0.198*** (0.00277)	0.337* (0.0544)	-1.153*** (0.000736)	0.0777** (0.0213)	0.445
7-Year	-	-	0.176*** (0.00844)	0.327* (0.0678)	-1.144*** (0.000941)	0.0884** (0.0160)	0.416
10-Year	-	-	0.169** (0.0158)	0.401** (0.0492)	-1.037*** (0.00278)	0.0678* (0.0621)	0.351