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Environmental engagement and stock price crash risk: Evidence from the European banking industry

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ABSTRACT

This paper investigates the impact of banks' environmental engagement on their future stock price crash risk. Given the strong commitment of European institutions towards a low carbon economy, we focus on European banks, which are expected to be crucial actors in driving this challenge. Using a sample of 447 bank-year observations across 22 European countries from 2015 to 2021, we find a negative relationship between banks' environmental engagement and future stock price crash risk, in accordance with the signalling theory, suggesting that a high level of environmental engagement corresponds to high ethical standards of bank managers and high levels of financial transparency.

1. Introduction

Climate change poses major challenges for a global society, requiring interventions coming from both the public and private sectors. Policymakers have started to recognise that climate change and environmental degradation embody a pressing threat to the future. The 2015 Paris Agreement is the first comprehensive climate deal that explicitly recognises the need to make finance flows compatible with a pathway towards low greenhouse gas emissions and climate-resilient development. The attention to climate change is particularly high in the European Union (EU) which defined a strategy aimed at transforming the continent to net greenhouse gas emissions equal to zero by 2050. The EU assigns a pivotal role to the financial sector, as established in the 2018 EU Action Plan to finance sustainable growth with the aim of increasing investment in sustainable projects and promoting the integration of Environmental, Social, and Governance (ESG) criteria in risk management.

The pivotal role of banks in facing climate change is not immediately evident, as greenhouse gas emissions stemming from the financial sector are very low and banking activities do not directly produce a negative effect on the environment. Indeed, there are three main reasons that make banks central in achieving environmental goals. First, the financial sector is indirectly exposed to environmental risks by lending to Non-Financial Corporations (NFCs) that are usually exposed to extreme weather events or are affected by the transition to a more sustainable economy (Bolton, Despres, Pereira Da Silva, Samama, & Svartzamn, 2020). For example, extreme weather events may damage physical assets that are generally used by NFCs as collateral in bank lending (Fiordelisi, Baltas, & Mare, 2022).

Second, financial intermediaries play a pivotal role in fund allocation and their lending and investing decisions play a key role in achieving a sustainable economic growth (Levine, 2005; Scholtens, 2006 and 2009). Thus, via credit selection, banks can channel resources either to "green" or "brown" projects, affecting the likelihood and the speed of transition to a low-carbon economy.

Third, a healthy and stable banking system is necessary for sustained prosperity (King & Levine, 1993) and there is growing evidence that transition and physical risks arising from climate change represent a material threat to its stability (de Guindos, 2021; Lamperti, Bosetti, Roventini, Tavoni, & Treibich, 2021), to the extent that banking supervisors are paying much attention to climate change.

Not surprisingly, there is a growing interest to climate change from

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policy makers, financial intermediaries, and the academic literature. The Basel Committee on Banking Supervision (BCBS, 2021) pays attention to the importance of ESG strategies within risk management processes and Central Banks are increasingly interested in understanding how climate risks translate into financial risks and how adverse climatic events can propagate within the financial system.[1] The implications of climate change for financial stability pose significant challenges to financial regulators (Campiglio et al., 2018). The interplay between climate transition risks and market conditions has been analysed by Roncoroni, Battiston, Escobar-Farfán, and Martinez-Jaramillo (2021), concluding that financial institutions would benefit from the transition occurring as early as possible. Even if financial actors and markets seemed not to have yet internalised the knowledge about climate change risks in prices and risk metrics (Battiston, Dafermos, & Monasterolo, 2021), banks and other financial intermediaries should include sustainability in their strategies and investment decision-making processes, favouring a forward-looking approach in which sustainability risks and opportunities are fully priced, while unethical speculation by managers could lead to severe crashes of the system and deep economic recessions. In final, there is growing attention to sustainable banking (Aracil, Nájera-Sánchez, & Forcadell, 2021). The COVID-19 pandemic has reinforced the need to evaluate and address highly disruptive environment-related events, as well as the strategic importance of sustainable finance in the upcoming years (Bolton et al., 2020).

Most of the papers initially focus on the sustainability effect on banks' financial performance measures (e.g., Simpson & Kohers, 2002; Soana, 2011), but reach mixed evidence, either in favour of a positive (e.g., Bolton, 2013; Cornett, Erhemjamts, & Tehranian, 2016; García-Sánchez & García-Meca, 2017; Wu & Shen, 2013), a negative (e.g., Di Tommaso & Thornton, 2020; Forgione, Laguir, & Staglianò, 2020), or even a non-linear relationship (Azmi, Hassan, Houston, & Karim, 2021). Surprisingly, a limited number of papers focus on the sustainability effect on bank risk-taking (Chiaramonte, Dreassi, Girardone, & Piserà, 2021; Galletta & Mazzù, 2022; Gangi, Meles, D'Angelo, & Daniele, 2019), even less than for NFCs (e.g., Bouslah, Kryzanowski, & M'Zali, 2018; Jo & Na, 2012; Sharfman & Fernando, 2008). As far as we are aware, there are no papers showing the role played by a greater bank environmental engagement on the probability of future stock crashes and, hence, on the stability of the whole banking sector. This is what our paper does. We focus on the environmental pillar since both investors and regulators have an increasing attention on climate change, especially in banking, which plays a key role to finance sustainable economic growth. Being in the spotlight may provide incentives for greater transparency, but also for moral hazard and greenwashing, so the ultimate effect on banks' riskiness remains a fundamental empirical question. Specifically, we analyse the relationship between environmental performance and banking stability measured as crash risk, i.e., the risk of extreme negative values in the distribution of bank-specific returns, after adjusting for the return portions that co-move with common factors. Extreme negative events can impose significant losses on investors; in addition, while the volatility risk (or the second-moment risk) encompasses both losses and gains, the crash risk refers to the likelihood of incurring huge losses that cannot be diversified away (Chen, Hong, & Stein, 2001; Du, Song, & Wu, 2016; Ibragimov & Walden, 2007).

The crash risk perspective provides readers with interesting insights when applied to the banking industry for various reasons. First, a stock crash has more severe consequences in the banking industry than in other industries since one bank's crash may cause a chain reaction and threaten the stability of the entire financial system and the global economy (Abedifar, Li, Johnson, Song, & Xing, 2019; Du et al., 2016). Not only a bank crash may propagate in the financial system and affect other banks (Balla, Ergen, & Migueis, 2014), but it is also more likely that this happens when the crashed bank has a prominent and central role in the financial system (Kosmidou, Kousenidis, Ladas, & Negkakis, 2017). Second, large crises involving financial markets, such as the Great Financial Crisis and the COVID-19 pandemic, have exacerbated the attention to extreme (negative) events and highlighted the investors' asymmetric treatment of downside risk versus upside uncertainty (Caporale & Gil-Alana, 2012). Finally, crash risk has been related to several firm features, leading to bad news hoarding, opacity and lack of transparency (Habib, Hasan, & Jiang, 2018) and the banking business is notably particularly opaque (Morgan, 2002). Sustainability reporting, from which most information to build ESG scores are drawn, may increase this lack of transparency and be opportunistically used by managers. Even though sustainability reporting became compulsory after the publication of the NFRD directive (2014/95/UE) for listed firms or financial companies with specific dimensional requirements, there are remaining problems in comparability between countries and different usage of non-financial reporting frameworks (Breijer & Orij, 2022). Then, sustainability disclosure could act as leverage action to communicate what suits better, given the fact that there are not yet mandatory requirements like in financial reporting. This means that the increasing attention of investors and policymakers to non-financial reporting does not necessarily act in the direction of more transparency about the ESG performance and, hence, the reduction of crash risk. It may also have unintended consequences, leading bank managers to opportunistically exploit information asymmetries. The existence of this possible adverse effect is supported by recent episodes of greenwashing in the financial industry (e.g., DWS, Bank of Montreal, whose managers misled investors about their ESG "green" investments), and also suggested by the growing literature on ESG uncertainty (Avramov, Cheng, Lioui, & Tarelli, 2022) and disagreement on ESG ratings (Gibson Brandon, Krueger, & Schmidt, 2021; Serafeim & Yoon, 2022). Hence, the assessment of stock price crash risk becomes very important not only from the perspective of financial stability but also for risk management purposes and investment decision-making (Kim, Li, & Li, 2014).

A second relevant contribution is related to the investigated sample. Similarly to Chiaramonte et al. (2021), we concentrate on Europe for two main reasons. Firstly, ESG is particularly relevant in this area (Ho, Wang, & Vitell, 2012) because of the Action plan on sustainable finance. Secondly, there is still limited research linking ESG to risk within Europe. Differently from Chiaramonte et al. (2021), our analysis covers a more recent period, starting in 2015, a key year when the global community became aware that there was no more time to deal with climate change, also thanks to two crucial events, both the 2030 Agenda and the COP21. Our investigated time interval, ending in 2021, also includes very turbulent times for financial markets, due to the spread of the COVID-19 pandemic. On the one hand, past literature seems to suggest that, in case of contagion, ESG can mitigate the negative effects in financial markets (Cerqueti, Ciciretti, Dalò, & Nicolosi, 2021) and especially during turbulent times the building of firm-specific social capital could be thought of as an insurance policy that pays off when investors and the overall economy face a severe crisis of confidence (Lins, Servaes, & Tamayo, 2017), which is also confirmed by Chiaramonte et al. (2021) in the specific context of the relationship between ESG engagement and bank risk. On the other hand, the increasing attention to ESG scores may give incentives to managers' opportunistic behaviour, since one of the strategic responses to ESG ratings could be the manipulation and resistance to externally assigned rankings (Clementino & Perkins, 2021). The relationship with increased regulation is also uncertain: on the one hand, firms operating in countries with fewer climate-related regulations show a higher propensity to engage in greenwashing (Mateo-Márquez, González-González, & Zamora-Ramírez, 2022). On the other hand, if Corporate Social Responsibility (CSR) activities are not genuine and are merely undertaken for legal reasons

[1] In Europe, the European Banking Authority (EBA) has an important role in monitoring market practices related to sustainability as well as engaging with relevant stakeholders and the banking industry. The European Central Bank (ECB) has also contributed with other climate-related deliverables (for instance, the launch of a supervisory climate risk stress test in 2022).

they might increase downside risk (Diemont, Moore, & Soppe, 2016). Consequently, providing new evidence on banks, including the most recent period, is very relevant since the financial system plays a pivotal role in the economic transformation process to a resource-efficient economy (Neitzert & Petras, 2021).

We examine a sample of almost 450 year-observations related to European listed banks, during the period from 2015 to 2021. While we do not find any evidence of a strong relationship between banks' overall ESG performance and crash risk, we show a significantly negative association between banks' environmental score and future stock price crash risk. This finding contrasts with the conclusions of Wang, Liu, and Wu (2021) for the social component and is consistent with the argument that environmental score can be more likely to provide transparent information, leading to lower future stock price crashes. Conversely, banks with lower environmental performances and less attention to disclosing their contribution to reducing their impact on climate change are more prone to crash risk. Results are robust to several model specifications dealing with endogeneity concerns and alternative definitions of the interest variable. We also find that the divergence between ESG scores provided by different providers is a source of opacity and increases stock price crash risk.

The remainder of the paper proceeds as follows. Section 2 presents the literature review and Section 3 describes the research design. Section 4 presents our main findings. Moreover, Section 5 provides further results and Section 6 discusses the main conclusions and implications.

2. Literature review

Our paper contributes to two main research streams: the first one is related to the relationship between ESG scores and bank performance, while the second one is devoted to crash risk in the banking industry.

2.1. ESG and bank risk

The existing literature has long emphasised the links between sustainability and firm value (for an extensive literature review on ESG with an emphasis on corporate finance, see Clark & Viehs, 2014; Gillan, Koch, & Starks, 2021), where a positive relationship seems to be predominant, because of a minor overall risk of high ESG firms (Hasan, Lynch, & Siddique, 2022), both idiosyncratic (Chen, Hung, & Wang, 2018; Sassen, Hinze, & Hardeck, 2016) and systemic (Eccles, Ioannou, & Serafeim, 2014; El Ghoul, Guedhami, Kwok, & Mishra, 2011; Gregory, Tharyan, & Whittaker, 2014). Recently, as shown by Cardillo, Bendinelli, and Torluccio (2023) in a large sample of European companies, commitment to ESG criteria has been an important driver of resilience in turbulent times, such as during the COVID-19 pandemic. Focusing on the financial industry, the literature on ESG and bank risk is still developing, especially for studies dealing with environmental performance, receiving less attention before 2015 (Galletta, Mazzù, & Naciti, 2022). Regarding the relationship between the overall CSR performance and bank risk, an important contribution is provided by Chiaramonte et al. (2021) which study all the ESG dimensions, including the environmental one, in a sample of European banks from 2005 to 2017. During crisis periods, engaging in sustainable activities is associated with lower default risk. Thus, banks that combine ESG practices mitigate instability during financial slowdowns. Moreover, they observe that CSR has a different impact on financial stability depending on countries and on banks' characteristics (e.g., being subject to the EBA's stress tests).

Other papers only focus on one pillar of ESG. Gangi et al. (2019) motivate the inverse relationship between environmental engagement and bank risk under three main perspectives: the financial benefits of financing environmentally friendly borrowers; the efficient use of resources within the bank as an organization; and the lowering of reputational risks, providing empirical evidence of the risk reduction effect in a sample of 142 banks from 35 countries covering the period between 2011 and 2015.

Considering the nature and the function of banks, it is likely that the first perspective proposed by Gangi et al. (2019), i.e. the one related to lending, is the most relevant one in influencing bank risk. Several studies deal with the impact of climate issues on bank loans (Javadi & Masum, 2021; Reghezza, Altunbas, Marques-Ibanez, d'Acri, & Spaggiari, 2022), also raising the issue of possible lending disparity (Basu, Vitanza, Wang, & Zhu, 2022; Chen, Hasan, Lin, & Nguyen, 2021). Since investors do not have enough information on the identity of borrowers and their CSR performance, the non-financial disclosure provided by banks may have an important role also for overcoming the opacity of the lending business. As pointed out by Houston and Shan (2022), lenders may have both financial and reputational incentives to pressure borrowers to improve their ESG performance. Not only can higher ESG engagement reduce credit risk, but banks are also heavily regulated and often at the centre of public condemnation, making them particularly concerned about reputational damage, including from dealing with poor ESG borrowers. In the same direction, Degryse, Goncharenko, Theunisz, and Vadasz (2023) provide empirical evidence of a "green-meets-green" effect after the Paris agreement of 2015 (i.e., green firms enjoy more favourable lending terms, especially when they meet green banks). Thus, the application of political pressure aimed at strengthening environmental regulations involves a measurable impact on the conditions of debt financing, resulting in an improvement of allocative efficiency within financial markets. Lenders' ability to "discipline" borrowers and encourage their ESG engagement is consistent with the pivotal role of banks in monitoring and improving information (Wu & Lai, 2020).

2.2. Crash risk in the banking industry

Several research contributions focus on the idea that opaque assets are related to stock price crash risk. As outlined in previous studies (Jin & Myers, 2006), managers tend to withhold bad news for as long as possible, to safeguard their job and protect their compensation (Kothari, Shu, & Wysocki, 2009). However, there is an upper limit to the amount of bad news that managers can absorb. When the accumulated bad news reaches this upper limit, it will come out all at once, leading to a large and sudden price decline. Large negative stock returns, or stock price crashes, are more common than large positive stock price movements (Chen et al., 2001). Concerning the banking literature, Cohen, Cornett, Marcus, and Tehranian (2014) provide evidence that earnings management and financial statements opacity increase crash risk in banks as in other industries. However, earnings management has a small predictive power for downside risk during normal times, which increases significantly during crisis periods. Dewally and Shao (2013) measure the opacity of banks' operations with the use of interest rate and foreign exchange financial derivatives, finding a positive relationship with crash risk. Battaglia, Buchanan, Fiordelisi, and Ricci (2021) assess the effect of securitization, finding that the originator bank's crash risk reduces in the year the bank securitizes, but increases the following year. Both within and outside the banking industry, crash risk has often been associated with opaque assets, for which the lack of a universally accepted valuation standard can lead to high information asymmetry and managerial discretion (Wu & Lai, 2020). To our knowledge, there are a few papers investigating the relationship between ESG performance and stock price crash risk: while some articles deal with the overall ESG score in global samples and are not specific to the banking industry (Feng, Goodell, & Shen, 2022; Kim et al., 2014; Murata & Hamori, 2021; Pereira da Silva, 2022), the paper of Wang et al. (2021) analyses the banking industry and focuses on the social component of the ESG score, finding a positive relationship between banks' social engagement and future stock price crash risk. This evidence reveals a negative side of banks' social activities, suggesting that engaging in social activities may facilitate bank managers' bad news hoarding behaviour and increase future stock price crash risk in the banking industry.

Table 1
Variables description.

Variable	Symbol	Description
Dependent variables		
Crash numbers	N_CRASH	The number of crashes in a given year
Negative conditional skewness	NCSKEW	The negative of the third moment of firm-specific weekly returns, divided by the cube standard deviation
Down-to-up volatility	DUVOL	The natural logarithm of the ratio of the standard deviation in the down weeks to the standard deviation in the up weeks
Independent variables		
ESG Combined score [1]	ESGC	The weighted average relative score of a firm. It proxies Environmental, Social and Governance overall performance, weighted by controversies, in a given year
Environmental score [1]	ENV	The weighted average relative firm score based on reported environmental information
Social score [1]	SOC	The weighted average relative firm score based on reported social information
Governance score [1]	GOV	The weighted average relative firm score based on reported governance information
Environmental emissions score [1]	ENV_Emiss	The environmental category score that measures a firm's commitment and effectiveness towards reducing environmental emissions
Environmental resource use score [1]	ENV_ResUse	The environmental category score that reflects a firm's performance and capacity to reduce the use of materials, energy or water
Environmental innovation score [1]	ENV_Innov	The environmental category score that reflects a firm's capacity to reduce the environmental costs
Sustainable Development Goal 13 [1]	SDG13	It indicates reported commitment to SDG 13 on climate action
Environmental disclosure score [3]	ENV_DISCL	The environmental disclosure score derives from available environmental information, including websites, CSR reports, annual reports and Bloomberg surveys.
Social disclosure score [3]	SOC_DISCL	The social disclosure score derives from available social information, including websites, CSR reports, annual reports and Bloomberg surveys.
Governance disclosure score [3]	GOV_DISCL	The governance disclosure score derives from available governance information, including websites, CSR reports, annual reports and Bloomberg surveys.
Environmental spread [1,3]	ENV_SPREAD	It indicates when ENV_DISCL is greater than ENV.
Tier 1 ratio [2]	Tier1	The tier 1 capital as a percent of risk-weighted assets on a fully loaded basis as reported by the bank
Cost-to-income ratio [2]	CostIncome	The ratio between operating expenses and operating revenues
Size [2]	Size	The natural logarithm of total assets
Market-to-book ratio [2]	MTB	The ratio between market capitalisation and total equity
Liquid asset ratio [2]	Liquidity	The ratio between liquid assets and total assets
Return on assets [2]	ROA	The ratio between net income and total assets
Risk-weighted assets intensity ratio [2]	RWA	The ratio between risk-weighted assets and total assets
Loan loss provision ratio [2]	LLP	The ratio between loan loss provision and total loans

This table reports, respectively, variables name, symbol and description, used in our empirical analyses. [1], [2], [3] indicate that data source is Refinitiv, BankFocus and Bloomberg, respectively.

As outlined by Wang et al. (2021), prior literature presents different views on the implications of CSR activities for information transparency and the managerial opportunistic behaviour of concealing bad news about the firm, which leads to conflicting predictions about the association between banks' non-financial performance and future stock price crash risk. On the one hand, the signalling theory suggests that high CSR engagement could correspond to high ethical standards of bank managers that are less likely to manage earnings (Dhaliwal, Li, Tsang, & Yang, 2011; Kim, Park, & Wier, 2012), to hide negative information from investors (Dewally & Shao, 2013; Du et al., 2016; Kim, Li, & Zhang, 2011b) and prone to the release of high-quality ESG disclosure (Hummel & Schlick, 2016; Pereira da Silva, 2022), especially with CSR performance considered as social rating (Kim et al., 2014). On the other hand, following the agency theory, bank managers may use CSR activities to opportunistically pursue self-interests and cover up corporate misbehaviour or unethical practices such as earnings management or unethical lending decisions, thereby leading to a less transparent and reliable information environment (Friedman, 1970; Hemingway & Maclagan, 2004; Jensen & Meckling, 1976; Petrovits, 2006).

The existence of these two competing views is particularly relevant if related to climate issues. On the one hand, the increasing attention of regulators and supervisors to climate issues may lead to perverse incentives for bank managers towards a kind of vicious circle where environmental policies could represent a form of greenwashing. Ramus and Montiel (2005) suggest this may happen because companies are not required by law to publish environmental policy statements or to verify that these statements are true using independent third parties, so that external stakeholders often wonder when a published commitment to a policy translates into actual policy implementation.

On the other hand, measures of environmental responsibility may be less subject to managerial discretion and based on indicators which are not easy to manipulate. As suggested by Bolton (2013) and Borghesi, Houston, and Naranjo (2014), some CSR activities, such as environmental ones, could allow less managerial discretion than other types, like social ones (Wang et al., 2021). The positive signal may be reliable because green commitment to reduce pollution produces observable outcomes and targets need to be practical and achievable (Liu, Wang, Xue, Linnenluecke, & Cai, 2021). Thus, investing in CSR environmental activity may increase bank value and reduce bank risk, as long as those investments are aimed at improving the bank's fundamental CSR activities (Bolton, 2013).

Overall, the relationship between banks' environmental responsibility and the risk of a stock price crash remains an open empirical question that is still largely unexplored. Negative effects from the moral hazard theory and positive effects from the signalling theory are not mutually exclusive and may coexist. Moreover, since the issue is still substantially unexplored, we do not have enough information to predict which theory will prevail. As a result, we formulate the following hypothesis:

H1. *Banks environmental scores affect future stock price crash risks.*

To test this hypothesis, in the next section, we examine the research strategy to explain the empirical identification.

3. Research design

3.1. Data and sample

Our data collection begins with all publicly listed banks based in Europe and is covered by Datastream during the period 2015–2021. We use Datastream to collect stock prices and obtain ESG scores from Refinitiv Eikon. Our sample begins in the year 2015 when the ESG coverage started to gradually increase due to the growing amount of non-financial information published in the sustainability reports. Finally, we integrate with bank balance sheet information drawn from Moody's Analytics BankFocus. After merging all data, our final sample

Table 2
Sample distribution.

Country	2015	2016	2017	2018	2019	2020	2021	Total
AT	2	2	2	2	1	1	1	11
BE	1	1	1	1	1	1	1	7
CH	3	4	3	7	6	6	7	36
CZ	1	1	2	2	2	2	2	12
DE	3	3	3	4	4	6	6	29
DK	2	3	3	2	4	5	5	24
ES	4	5	5	5	6	6	6	37
FI	0	0	0	0	2	2	2	6
FR	3	3	2	2	2	2	2	16
GB	6	7	6	7	9	7	9	51
GR	3	3	3	4	4	4	2	23
HU	1	1	1	1	1	1	1	7
IE	1	0	0	3	4	4	4	16
IT	5	6	5	7	9	13	12	57
LI	0	0	0	0	1	2	2	5
NL	1	2	1	2	2	2	2	12
NO	0	0	0	0	5	5	5	15
PL	3	4	4	4	5	5	5	30
PT	1	1	1	1	1	1	1	7
RO	0	0	0	0	1	1	1	3
RU	2	2	2	2	2	3	3	16
SE	3	3	3	3	5	5	5	27
Total	45	51	47	59	77	84	84	447

This table reports the sample distribution by country (on rows) and year (on columns), respectively. The country names are identified by their country ISO code. The values are represented in absolute terms, as firm count.

Table 3
Summary statistics.

Variables	Mean	SD	p1	p25	Median	p75	p99
N_CRASH_t	0.181	0.403	0.000	0.000	0.000	0.000	1.000
$NCSKEW_t$	0.075	0.773	−1.655	−0.345	0.000	0.398	2.718
$DUVOL_t$	0.038	0.499	−1.035	−0.295	0.023	0.314	1.633
$ESGC_t$	0.558	0.139	0.201	0.465	0.544	0.661	0.864
ENV_t	0.602	0.279	0.035	0.351	0.666	0.849	0.967
SOC_t	0.654	0.174	0.19	0.541	0.692	0.783	0.917
GOV_t	0.591	0.200	0.139	0.463	0.603	0.745	0.924
$Tier1_t$	0.16	0.035	0.090	0.134	0.158	0.180	0.279
$CostIncome_t$	0.644	0.162	0.362	0.538	0.624	0.729	1.137
$Size_t$	11.605	1.653	8.082	10.379	11.31	13.023	14.491
MTB_t	0.915	0.78	0.118	0.465	0.72	1.203	4.837
$Liquidity_t$	0.271	0.121	0.071	0.185	0.252	0.327	0.629
ROA_t	0.006	0.009	−0.021	0.002	0.005	0.009	0.027
RWA_t	0.454	0.195	0.171	0.293	0.423	0.574	1.055
LLP_t	0.009	0.018	−0.003	0.001	0.004	0.009	0.132

This table presents the summary statistics for variables used in the main regression analyses. The sample comprises 447 observations representing 90 unique banks from 22 countries during 2015–2021.

consists of 447 year-observations representing 90 unique banks from 22 countries over the period from 2015 to 2021.

3.2. Measuring stock price crash risk

We construct three measures for firm-level stock crash risk following prior research (An, Chen, Li, & Xing, 2018; Ben-Nasr & Ghouma, 2018; Chen et al., 2001; Habib et al., 2018; Kim et al., 2011b, 2014; Kim, Li, & Zhang, 2011a). The measures are calculated based on bank-specific weekly stock returns, which ensures our stock crash risk proxies reflect specific movements caused by idiosyncratic factors rather than broad market trends. Following Hutton, Marcus, and Tehranian (2009), bank-specific returns are obtained running an augmented market model, including lag and lead terms for market returns to remove the impact of common factors and obtain bank-specific returns:

$$r_{i,t} = \alpha_i + \beta_1 r_{m,t-2} + \beta_2 r_{m,t-1} + \beta_3 r_{m,t} + \beta_4 r_{m,t+1} + \beta_5 r_{m,t+2} + \varepsilon_{i,t} \quad (1)$$

where $r_{i,t}$ is return for bank i in week t and $r_{m,t}$ is the contemporaneous market index return. Then, we define the *Firm-Specific Weekly Return* as the log of one plus the residual return from Eq. (1) to have a roughly symmetric distribution that allows us to consider negative crashes and positive jumps symmetrically.

Our first measure of crash risk is *N_CRASH*, which is calculated as the number of crashes in a given year. Following prior research (Fiordelisi, Pennacchi, & Ricci, 2020; Hutton et al., 2009) a crash occurs when the weekly bank-specific return is 3.09 standard deviations below the mean of the bank's residual returns (the opposite event when the bank-specific return is 3.09 standard deviations above the mean is defined as a jump).

As outlined by Battaglia et al. (2021), crashes are not effective realizations, but they represent bank-specific extreme price movements over and above those due to common risk factors. So, every crash is defined from an idiosyncratic perspective and identifies an extreme event with respect to the bank-specific distribution of returns, which are those not explained by general market movements.

In addition to the number of crashes in a year, similarly to Murata and Hamori (2021), and Wang et al. (2021), we consider the negative conditional skewness and the down-up volatility.

The negative coefficient of skewness of bank-specific weekly returns over the year (*NCSKEW*) is calculated by taking the negative of the third

Table 4
Pairwise correlation coefficients.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) $ESGC_t$	1.000														
(2) ENV_t	0.491	1.000													
	(0.000)														
(3) SOC_t	0.606	0.713	1.000												
	(0.000)	(0.000)													
(4) GOV_t	0.466	0.295	0.357	1.000											
	(0.000)	(0.000)	(0.000)												
(5) ENV_DISCL_t	0.276	0.629	0.513	0.243	1.000										
	(0.000)	(0.000)	(0.000)	(0.000)											
(6) SOC_DISCL_t	0.399	0.540	0.563	0.194	0.586	1.000									
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)										
(7) GOV_DISCL_t	0.276	0.515	0.501	0.317	0.493	0.359	1.000								
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)									
(8) $Tier1_t$	0.005	−0.063	−0.082	0.085	−0.013	0.007	0.020	1.000							
	(0.924)	(0.233)	(0.125)	(0.111)	(0.810)	(0.893)	(0.720)								
(9) $CostIncome_t$	−0.211	0.051	0.052	0.044	0.161	−0.148	0.186	−0.215	1.000						
	(0.000)	(0.337)	(0.327)	(0.400)	(0.004)	(0.007)	(0.001)	(0.000)							
(10) $Size_t$	0.174	0.637	0.628	0.349	0.451	0.334	0.476	−0.195	0.129	1.000					
	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)						
(11) MTB_t	0.004	−0.213	−0.224	0.024	−0.302	−0.107	−0.062	0.389	−0.299	−0.325	1.000				
	(0.939)	(0.000)	(0.000)	(0.655)	(0.000)	(0.050)	(0.253)	(0.000)	(0.000)	(0.000)					
(12) $Liquidity_t$	−0.140	0.259	0.084	0.059	0.254	0.122	0.294	−0.036	0.295	0.321	−0.044	1.000			
	(0.008)	(0.000)	(0.113)	(0.267)	(0.000)	(0.025)	(0.000)	(0.497)	(0.000)	(0.000)	(0.406)				
(13) ROA_t	0.029	−0.177	−0.114	−0.069	−0.237	−0.003	−0.117	0.149	−0.414	−0.259	0.465	−0.055	1.000		
	(0.588)	(0.001)	(0.030)	(0.194)	(0.000)	(0.963)	(0.030)	(0.005)	(0.000)	(0.000)	(0.000)	(0.297)			
(14) RWA_t	0.011	−0.366	−0.204	−0.195	−0.299	−0.105	−0.310	−0.410	−0.247	−0.436	−0.067	−0.337	0.279	1.000	
	(0.828)	(0.000)	(0.000)	(0.000)	(0.000)	(0.055)	(0.000)	(0.000)	(0.000)	(0.000)	(0.204)	(0.000)	(0.000)		
(15) LLP_t	0.006	−0.141	−0.048	−0.076	0.001	0.132	−0.019	−0.022	−0.108	−0.233	0.061	−0.205	−0.093	0.359	1.000
	(0.914)	(0.007)	(0.366)	(0.153)	(0.984)	(0.016)	(0.729)	(0.672)	(0.040)	(0.000)	(0.245)	(0.000)	(0.076)	(0.000)	

This table reports pairwise correlation coefficients of the independent variables used, with significance level in brackets.

Table 5
Banks' ESG performances and stock price crash risk.

	(1)	(2)	(3)	(4)	(5)	(6)
	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL
ESGC $_{t-1}$	0.0342	0.0443	0.0296	0.0173	−0.0364	−0.0215
	(0.0290)	(0.0554)	(0.0301)	(0.0490)	(0.0863)	(0.0469)
Tier1 $_{t-1}$	−0.0107	−0.0376	−0.0436	−0.0475	−0.0490	−0.0864
	(0.0384)	(0.0652)	(0.0430)	(0.0814)	(0.1400)	(0.0913)
CostIncome $_{t-1}$	0.0443	−0.0193	−0.0714	0.0304	−0.1139	−0.1574*
	(0.0478)	(0.0757)	(0.0500)	(0.0938)	(0.1332)	(0.0876)
Size $_{t-1}$	0.0005	0.0202	−0.0212	0.5465	2.1754***	1.7279***
	(0.0333)	(0.0669)	(0.0414)	(0.4341)	(0.7312)	(0.5076)
MTB $_{t-1}$	−0.0056	0.0498	0.0241	0.1853*	0.5356	0.2985**
	(0.0397)	(0.1120)	(0.0592)	(0.0961)	(0.3363)	(0.1479)
Liquidity $_{t-1}$	−0.0464	−0.0529	0.0137	0.0799	0.1622	0.1156
	(0.0392)	(0.0745)	(0.0467)	(0.1547)	(0.2914)	(0.1824)
ROA $_{t-1}$	0.2672***	0.7589***	0.4370***	0.0164	0.2335	0.0745
	(0.0837)	(0.1954)	(0.1176)	(0.1073)	(0.3864)	(0.1437)
RWA $_{t-1}$	−0.0075	0.0239	−0.0227	−0.0535	−0.2640	−0.2233
	(0.0311)	(0.0736)	(0.0444)	(0.1312)	(0.2163)	(0.1478)
LLP $_{t-1}$	0.0383**	0.0755**	0.0436*	−0.0581	0.0591	0.0203
	(0.0150)	(0.0370)	(0.0224)	(0.0514)	(0.0726)	(0.0508)
Constant	0.2013*	−0.1837	−0.1201	−0.0747	−1.0165**	−0.9150***
	(0.1197)	(0.2788)	(0.1616)	(0.2605)	(0.4559)	(0.3103)
Observations	447	447	447	447	447	447
Number of ID	90	90	90	90	90	90
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the regression results of the relation between banks' ESG performances and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. ESG Combined Score is the weighted average relative score of a company based on publicly available and auditable data. It proxies Environmental, Social and Governance firm overall performance in a given year. It is provided by Refinitiv Eikon. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

moment of bank-specific weekly returns, divided by the cube standard deviation (see, for example, Callen & Fang, 2015). So, the *NCSKEW* for bank *i* is calculated using the following equation:

$$NCSKEW_i = -\frac{n(n-1)^{3/2}\sum_{i=1}^{n}\varepsilon_{i,t}^3}{(n-1)(n-2)\left(\sum_{i=1}^{n}\varepsilon_{i,t}^2\right)^{3/2}} \tag{2}$$

where n denotes the number of weekly returns during the week t and $\varepsilon_{i,t}$ are the bank-specific weekly returns.

The third measure of crash risk is the down-to-up volatility measure (*DUVOL*) of the crash likelihood. Firm-specific weekly returns for firm j over a fiscal year period t are divided into two groups: "down" weeks and "up" weeks. Down (up) weeks refer to weeks when the bank-specific return is below (above) the mean. The standard deviation of firm-specific weekly returns is calculated separately for each of the two groups. *DUVOL*, which is the down-to-up volatility, is measured as the natural logarithm of the ratio of the standard deviation of bank-specific weekly returns in the down weeks to the standard deviation in the up weeks:

$$DUVOL_i = ln\left[\frac{(n_{up}-1)\sum_{down}\varepsilon_{i,t}^2}{(n_{down}-1)\sum_{up}\varepsilon_{i,t}^2}\right] \tag{3}$$

where n_{up} denotes the number of up weeks occurred in the year and n_{down} denotes the number of down weeks. The higher the value of *DUVOL*, the more significant the crash risk.

3.3. ESG scores

Following prior studies (Albuquerque, Koskinen, Yang, & Zhang, 2020; Drempetic, Klein, & Zwergel, 2020; Dyck, Lins, Roth, & Wagner, 2019; Murata & Hamori, 2021; Wang et al., 2021), we proxy CSR performance using the ESG scores provided by Refinitiv, as the main provider of non-financial data. Although there are various data providers, Refinitiv is widely used in the accounting and finance literature, as documented in the review paper by de Villiers, Jia, and Li (2022). The key strength of the Refinitiv ESG score is the percentile ranking methodology used to construct it, which allows for relative comparisons between companies (Gigante & Manglaviti, 2022). Furthermore, Refinitiv's methodology is publicly available and transparent in its collection and verification of ESG information, allowing researchers to understand how data is sourced and assessed. The data is also highly granular, covering a wide range of firm-level ESG indicators and providing broad coverage of financial firms over time. ESG measures can affect capital allocation, through changing return expectations (Gibson Brandon et al., 2021) and divestment (Krueger, Sautner, & Starks, 2020). Moreover, the evolving regulatory landscape could increase the magnitude of those effects, because ESG ratings are likely to become a data source for risk evaluations in the European banking sector.[2]

According to Refinitiv, ESG scores reflect the underlying ESG data framework and are a data-driven assessment of firms' relative sustainability performance and capacity, integrating and accounting for industry materiality and company size bias. Refinitiv Eikon provides the ESG Combined Score as a holistic evaluation and its calculation is based on publicly available and auditable data, resulting from two components: the ESG Score (a weighted average relative score of a company that includes Environmental Pillar Score, Social Pillar Score and Governance Pillar Score) and the ESG Controversies Score. The raw scores range from 0 to 100. To ease interpretation, we scale the ESG scores by 100. Therefore, the values range from 0 to 1, with a higher

[2] https://www.eba.europa.eu/sites/default/documents/files/document_library/Publications/Reports/2021/1015656/EBA%20Report%20on%20ESG%20risks%20management%20and%20supervision.pdf

Table 6
Banks' environmental performance and stock price crash risk.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL
ENV $_{t-1}$	−0.0751***	−0.1932***	−0.1303***	−0.0584*	−0.1453**	−0.1136***	−0.1189*	−0.2240*	−0.1779**
	(0.0286)	(0.0673)	(0.0429)	(0.0310)	(0.0627)	(0.0384)	(0.0656)	(0.1344)	(0.0786)
SOC $_{t-1}$	0.0861**	0.1725**	0.1124**	0.0836*	0.1835**	0.1398***	0.0863	0.0937	0.1016
	(0.0347)	(0.0821)	(0.0542)	(0.0433)	(0.0847)	(0.0537)	(0.0786)	(0.1463)	(0.0958)
GOV $_{t-1}$	−0.0148	0.0211	0.0331	−0.0088	0.0222	0.0369	0.0061	−0.0232	0.0382
	(0.0228)	(0.0513)	(0.0340)	(0.0239)	(0.0584)	(0.0346)	(0.0476)	(0.0940)	(0.0547)
Tier1 $_{t-1}$				−0.0164	−0.0610	−0.0689	−0.0329	−0.0266	−0.0673
				(0.0383)	(0.0662)	(0.0445)	(0.0810)	(0.1384)	(0.0896)
CostIncome $_{t-1}$				0.0309	−0.0422	−0.0893*	0.0357	−0.1056	−0.1521*
				(0.0485)	(0.0748)	(0.0507)	(0.0945)	(0.1344)	(0.0894)
Size $_{t-1}$				−0.0058	−0.0141	−0.0634	0.6595	2.3538***	1.8426***
				(0.0472)	(0.1012)	(0.0580)	(0.4330)	(0.7380)	(0.5149)
MTB $_{t-1}$				−0.0049	0.0394	0.0108	0.1777*	0.5267	0.2834*
				(0.0436)	(0.1213)	(0.0654)	(0.0956)	(0.3333)	(0.1451)
Liquidity $_{t-1}$				−0.0146	0.0261	0.0784	0.0812	0.1583	0.1112
				(0.0460)	(0.0811)	(0.0508)	(0.1528)	(0.2919)	(0.1793)
ROA $_{t-1}$				0.2594***	0.7475***	0.4295***	0.0356	0.2665	0.1081
				(0.0821)	(0.2100)	(0.1125)	(0.1054)	(0.3828)	(0.1387)
RWA $_{t-1}$				−0.0105	0.0061	−0.0438	−0.0311	−0.2333	−0.1804
				(0.0326)	(0.0794)	(0.0471)	(0.1346)	(0.2217)	(0.1532)
LLP $_{t-1}$				0.0356**	0.0798**	0.0497**	−0.0338	0.1003	0.0635
				(0.0149)	(0.0405)	(0.0228)	(0.0517)	(0.0824)	(0.0546)
Constant	0.1157	−0.4644**	−0.3201**	0.2006**	−0.1389	−0.0649	−0.1278	−1.0711**	−0.9712***
	(0.0864)	(0.2213)	(0.1392)	(0.0945)	(0.2396)	(0.1288)	(0.2556)	(0.4456)	(0.3052)
Observations	447	447	447	447	447	447	447	447	447
Number of ID	90	90	90	90	90	90	90	90	90
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	No	No	No	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the regression results of the relation between banks' ESG performances and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. Environmental Score is the weighted average relative firm score based on reported environmental information. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

value indicating a higher level of non-financial performance.

3.4. Model specification

To test the relationship between ESG (or specific environmental) performance and stock crash risk in the banking industry, we develop the following empirical model:

$$CrashRisk_{i,j,t} = \beta_0 + \beta_1 ESG_{i,j,t-1} + \sum \beta_k Controls_{i,j,t-1} + YearFE + \varepsilon_{i,j,t}, \quad (4)$$

where *i* indexes bank, j indexes country and t indexes fiscal year. The dependent variable *CrashRisk* is proxied by *N_CRASH, NCSKEW* or *DUVOL*, as described in section 3.2. A one-year lag between the dependent and independent variables is used to investigate whether bank's non-financial activities in year *t-1* can predict its future stock crash risk in year *t*.

The key variable of interest is non-financial performance. Before focusing on the environmental component, we first explore the relationship with the overall *ESG* score. A positive (negative) and significant coefficient for *ESG* indicates banks' sustainable activities increase (decrease) future stock crash risk. Then, we focus on environmental activity, and we consider the three components of the ESG score separately. All ESG scores are winsorized at the first and ninety-ninth percentiles to mitigate the effect of outliers.

We control for Tier 1 ratio (*Tier1*), Cost-to-income ratio (*Cost Income*), Liquid asset ratio (*Liquidity*), Return on assets (*ROA*), Risk-weighted assets intensity ratio (*RWA*) and Loan loss provisions over total loans (*LLP*). Since the effect of banks' capital adequacy and profitability on crash risk documented in the literature is inconclusive (Andreou, Louca, & Petrou, 2017; Ben-Nasr & Ghouma, 2018; Dewally & Shao, 2013), we do not predict the sign of their coefficients.

Further, we control for bank size (*SIZE*), calculated as the natural logarithm of total assets. Given that prior research has reported conflicting evidence on the effect of firm size on crash risk (Chen et al., 2001; Harvey & Siddique, 2000), we do not predict the sign of the coefficient on size measure.

Chen et al. (2001) suggest that a high market-to-book ratio also creates a large bubble, which may result in a stock crash when the market value decreases to normal, so the market-to-book ratio (*MB*) is also controlled for. *MTB* is calculated as the market value of equity divided by its book value. We expect the coefficient on *MTB* to be positive.

Finally, year-fixed effects (YearFE) are included to control for variation in stock crash risk across years. As in Wang et al. (2021), we also include country fixed effects; additionally, we also try an alternative specification with bank fixed effects to control for unobservable time-invariant bank specific features. All financial independent variables are winsorized at the first and ninety-ninth percentiles to mitigate the effect of outliers. All variables used in our empirical analysis are described in Table 1.

4. Main findings

4.1. Sample distribution

Our sample comprises 447 observations from 22 countries, with Italy (12.69%) and Great Britain (12.04%) being the most represented countries (Table 2). The number of banks gradually increases from 46 banks in 2015 to almost double in 2021 over the sample period, reflecting the attention to sustainability issues and increasing coverage

Table 7
Robustness tests for the potential serial correlation of crash risk and reverse causality with environmental performance.

	(1)	(2)	(3)	(4)	(5)	(6)
	N_CRASH	NCSKEW	DUVOL	ENV	ENV	ENV
N_CRASH $_{t-1}$	0.0080			0.0080		
	(0.0465)			(0.0523)		
NCSKEW $_{t-1}$		0.0517			0.0093	
		(0.0448)			(0.0331)	
DUVOL $_{t-1}$			0.0672			0.0140
			(0.0454)			(0.0508)
ENV $_{t-1}$	−0.0560*	−0.1356**	−0.1075***			
	(0.0306)	(0.0599)	(0.0380)			
SOC $_{t-1}$	0.0760*	0.1815**	0.1357**	0.4021***	0.4005***	0.4013***
	(0.0427)	(0.0813)	(0.0544)	(0.0800)	(0.0796)	(0.0797)
GOV $_{t-1}$	−0.0015	0.0328	0.0349	0.0529	0.0522	0.0519
	(0.0236)	(0.0565)	(0.0335)	(0.0545)	(0.0554)	(0.0559)
Tier1 $_{t-1}$	−0.0256	−0.0887	−0.0722	−0.0026	−0.0018	−0.0021
	(0.0419)	(0.0696)	(0.0489)	(0.0814)	(0.0817)	(0.0813)
CostIncome $_{t-1}$	0.0271	−0.0594	−0.0858	−0.0576	−0.0582	−0.0580
	(0.0536)	(0.0798)	(0.0536)	(0.0877)	(0.0875)	(0.0876)
Size $_{t-1}$	−0.0006	−0.0228	−0.0563	0.5583***	0.5607***	0.5605***
	(0.0469)	(0.0970)	(0.0571)	(0.1398)	(0.1407)	(0.1405)
MTB $_{t-1}$	0.0005	0.0310	0.0148	−0.0341	−0.0344	−0.0339
	(0.0467)	(0.1180)	(0.0638)	(0.0656)	(0.0640)	(0.0645)
Liquidity $_{t-1}$	−0.0205	0.0186	0.0742	0.1448	0.1477	0.1469
	(0.0458)	(0.0756)	(0.0487)	(0.1577)	(0.1596)	(0.1592)
ROA $_{t-1}$	0.2425***	0.7768***	0.4170***	0.0632	0.0694	0.0673
	(0.0821)	(0.2193)	(0.1093)	(0.0981)	(0.0968)	(0.0962)
RWA $_{t-1}$	−0.0146	−0.0169	−0.0454	−0.0550	−0.0543	−0.0537
	(0.0338)	(0.0795)	(0.0483)	(0.1082)	(0.1086)	(0.1092)
LLP $_{t-1}$	0.0380**	0.0823**	0.0532**	0.1569***	0.1569***	0.1565***
	(0.0159)	(0.0391)	(0.0236)	(0.0554)	(0.0551)	(0.0556)
Constant	0.2063**	−0.0976	−0.0708	0.3964	0.4020	0.3994
	(0.0998)	(0.2397)	(0.1271)	(0.2807)	(0.2823)	(0.2823)
Observations	442	442	442	365	365	365
Number of ID	90	90	90	89	89	89
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	No	No	No
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table presents both the results for the potential serial correlation of crash risk between two consecutive years following, by also controlling for the lag value of N_CRASH, NCSKEW and DUVOL, respectively, and the regression results in which the dependent variable is a measure of crash risk (proxied by N_CRASH, NCSKEW and DUVOL, respectively) and the main independent variable is the bank's environmental performance, in order to deal with the potential issue of reverse causality. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. Environmental Score is the weighted average relative firm score based on the reported environmental information. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

of Refinitiv data, well-established in the literature (Bofinger, Heyden, & Rock, 2022; Flammer, 2021).

4.2. Summary statistics

As we can see from Table 3, the 99% of banks record at most one crash per year. However, if the distribution of bank-specific returns were normal, the frequency of a crash would be 0.1% each week or about 5% in a year, while the average value of *N_CRASH* is consistent with a much higher frequency in our sample, as also observed in previous studies on crash risk (Hutton et al., 2009). Furthermore, summary statistics for *NCSKEW* and *DUVOL* show a very large standard deviation, consistently with similar previous studies on European banks (Battaglia et al., 2021; Fiordelisi et al., 2020). Ranging from 0 to 1, the average of the overall ESG Combined score (*ESGC*) is 0.558 where the worst contribution, in relative term, is given by the corporate governance pillar (*GOV*), lower than the average values of the environmental and social pillar scores. We also observe that the Environmental score (*ENV*) is more volatile than the other two pillar measures. While the distribution of the *ESGC* is positively asymmetrical, the three pillar scores distributions are negatively asymmetrical. We remind that the value of the ESG Combined score is not only given by the weighted mean of three pillar scores but it may be also influenced by the ESG Controversies score.

Table 4 reports pairwise correlation coefficients. Unlike what happens with very high correlation (0.99) among credit ratings (Berg, Koelbel, & Rigobon, 2022), we note ESG disagreement from different providers (i.e., Refinitiv and Bloomberg) with correlations ranging from 0.317 to 0.629. Even though Refinitiv scores are related to ESG performance and Bloomberg scores to ESG disclosure, this confirms previous studies outlining that ESG rating agencies provide noisy information (Berg et al., 2022; Chatterji, Durand, Levine, & Touboul, 2016).

4.3. Main results

Table 5 shows regression results when we study the relationship between our crash measures and the overall sustainability score. We observe no significant relationships between the ESG Combined score (*ESGC*) and crash measures. These results could suggest that the overall non-financial score is influenced by different drivers, and this could bring to inconsistent conclusions. We also observe similar results in untabulated models for the ESG score without the controversies

Table 8

Robustness test to address potential endogeneity concerns - IV approach.

	(1)	(2)	(3)	(4)
	First Stage	Second Stage	Second Stage	Second Stage
	ENV	N_CRASH	NCSKEW	DUVOL
ENVregion $_{t-2}$	0.1349***			
	(0.0342)			
ENV $_{t-1}$		−1.0775**	−2.0899**	−1.4356**
		(0.4399)	(0.9408)	(0.6215)
SOC $_{t-1}$	0.5503***	0.6246**	1.1414**	0.8078**
	(0.0648)	(0.2576)	(0.5606)	(0.3700)
GOV $_{t-1}$	0.0563	0.0461	0.0546	0.0907
	(0.0423)	(0.0662)	(0.1151)	(0.0777)
Tier1 $_{t-1}$	0.1062**	0.0741	0.1817	0.0731
	(0.0480)	(0.1017)	(0.1855)	(0.1226)
CostIncome $_{t-1}$	0.0369	0.0731	−0.0329	−0.1031
	(0.0523)	(0.0952)	(0.1742)	(0.1133)
Size $_{t-1}$	0.7738**	1.5031**	3.9957***	2.9492***
	(0.3425)	(0.6608)	(1.3133)	(0.8852)
MTB $_{t-1}$	−0.0733	0.1226	0.4195	0.2112
	(0.0709)	(0.1113)	(0.2830)	(0.1437)
Liquidity $_{t-1}$	0.0421	0.0858	0.1672	0.1172
	(0.1332)	(0.1846)	(0.3497)	(0.2328)
ROA $_{t-1}$	0.1952	0.1911	0.5692	0.3121
	(0.1333)	(0.1856)	(0.5315)	(0.2640)
RWA $_{t-1}$	0.1576	0.1310	0.0822	0.0323
	(0.1010)	(0.1691)	(0.3436)	(0.2255)
LLP $_{t-1}$	0.2077	0.1578	0.4732*	0.3148*
	(0.0601)	(0.1151)	(0.2502)	(0.1672)
Observations	447	447	447	447
F-statistic 1st stage	15.61			
Number of ID	90	90	90	90
Cluster SE	Banks	Banks	Banks	Banks
Bank Fixed Effects	Yes	Yes	Yes	Yes
Country Fixed Effects	No	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes

This table presents the results of 2SLS regressions. The instrument variable used in the first stage regression is the mean of Refinitiv Environmental Pillar Scores of all banks in sample (including the bank itself) that are located in the European region in a given year (ENVregion t-2). N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. Environmental Score is the weighted average relative firm score based on the reported environmental information. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

component.[3]

Then we split the ESG score in its main components to focus on environmental performance and report results in Table 6. We mainly find that banks' environmental engagement is negatively associated with future stock price crash risk as measured by *N_CRASH*, *NCSKEW* and *DUVOL*. Columns 1, 2, and 3 show results using as regressors only the ESG scores where the environmental effect on each crash measure is negative and highly statistically significant ($p < 0.01$). If we add bank-specific controls, Columns 4, 5, and 6 show a significantly negative relationship at the 10% level for *N_CRASH*, at the 5% level for *NCSKEW*, and at the 1% level for *DUVOL*. While including bank fixed effects, Columns 7, 8, and 9 show a significantly negative relationship between Environmental (*ENV*)[4] and crash risk measures, at the 10% level for *N_CRASH* and *NCSKEW*, and at the 5% level for *DUVOL*. This evidence supports the signalling theory, suggesting that high CSR engagement could result in high ethical standards of bank managers that are less likely to hide negative information from investors. Previous studies note that environmental disclosure has a deterrent effect and reduces crash risk, making firms more transparent (Zhang, Su, Wang, & Zhang, 2021; Zhang, Tan, & Chan, 2021). Liu et al. (2021) also show that solid green commitment significantly reduces stock price crash risk, according to the signalling theory which suggests that green-oriented firms deliver a positive signal to the market, favouring investors sensitive to environmental topics. Similarly to Wang et al. (2021), we also observe a significant positive relationship between Social (*SOC*) and crash risk in the European banking industry, confirming that the empirical evidence is in favour of the agency theory with respect to the social pillar, even if we do not observe a significant relationship when firm fixed effects are applied. The governance pillar does not result to impact future stock price crash risk, with coefficients that are much lower in magnitude and not statistically significant with respect to other pillars.

The exit of the United Kingdom from the European Union was a significant shock to the European financial market (Berg, Saunders, Schäfer, & Steffen, 2021). Thus, UK may be left out of the European debate on the decarbonisation. To face this issue, we run a robustness check by excluding UK bank-year observations from our sample.[5] We show that our main results are confirmed. This is consistent with the UK's approach to meeting the net-zero target by 2050 aligns, which is not very far from the European Green Deal.[6]

4.4. Robustness checks

In our main regression models, we use one-year lagged bank environmental performance (*ENV*) to mitigate endogeneity problems arising from reverse causality or simultaneity. However, since ESG scores are quite sticky across years (Kim et al., 2014), this approach might not be able to fully address endogeneity concerns. In this section, we provide several additional tests to strengthen the robustness of our results.

First, following Chiaramonte et al. (2021) and Wang et al. (2021), we control for the lag value of our dependent variable, to account for the potential serial correlation of crash risk between two consecutive years. As reported from Column (1) to (3) in Table 7, the coefficient for our main independent variable (*ENV*) remains negative and statistically significant at the 10% level for *DUVOL*, at the 5% level for *NCSKEW*, and at the 1% level for *N_CRASH*.

Second, we deal with the potential issue of reverse causality, i.e., with the possibility that it is the level of (crash) risk driving the environmental score and not the other way around. To discard this possibility, which would be more consistent with the agency theory (e.g., riskier banks try to distract investors by showing great environmental concern), we run a series of regression models in which the dependent variable is the banks' environmental score, and the main independent variable is a measure of crash risk. Table 7 shows that in Columns 4, 5, and 6, there is no statistical significance for crash risk proxies' coefficients, and we can reject the hypothesis that bank environmental scores depend on one-year lagged crash measures.

Furthermore, we run an instrumental variable (IV) approach to address endogeneity concerns. Following previous studies (Ferrell, Liang, & Renneboog, 2016; Kim et al., 2014; Wang et al., 2021), we employ a 2SLS regression analysis.

We use the mean of the Refinitiv Environmental Scores of all banks in our sample that are headquartered in the same European region

[3] Results are available from the authors upon request. Galletta and Mazzù (2022) show that banks with a lower number of ESG controversies have lower risk-weighted assets and higher *Z*-scores.

[4] Results are substantially confirmed even if we only include *ENV*, as our target variable, without considering the other two pillar scores, both *SOC* and *GOV*.

[5] Results are available from the authors upon request.

[6] https://www.gov.uk/government/publications/net-zero-strategy.

Table 9
Banks' environmental disclosure score and stock price crash risk.

	(1)	(2)	(3)	(4)	(5)	(6)
	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL
ENV_DISCL $_{t-1}$	−0.0657**	−0.1603**	−0.1049**	−0.0574*	−0.1043*	−0.0560
	(0.0309)	(0.0773)	(0.0512)	(0.0346)	(0.0572)	(0.0444)
SOC_DISCL $_{t-1}$	0.0779**	0.1257*	0.0802*	0.0663**	0.0625	0.0393
	(0.0322)	(0.0711)	(0.0434)	(0.0306)	(0.0632)	(0.0379)
GOV_DISCL $_{t-1}$	−0.0162	−0.0266	0.0110	−0.0134	−0.0192	0.0158
	(0.0285)	(0.0559)	(0.0425)	(0.0304)	(0.0534)	(0.0398)
Tier1 $_{t-1}$				−0.0319	−0.0545	−0.0348
				(0.0375)	(0.0544)	(0.0415)
CostIncome $_{t-1}$				0.0216	−0.0590	−0.0933*
				(0.0577)	(0.0794)	(0.0565)
Size $_{t-1}$				0.0169	0.0113	−0.0544
				(0.0413)	(0.0608)	(0.0397)
MTB $_{t-1}$				−0.0082	−0.0380	−0.0192
				(0.0307)	(0.0796)	(0.0447)
Liquidity $_{t-1}$				−0.0343	−0.0154	0.0254
				(0.0494)	(0.0689)	(0.0475)
ROA $_{t-1}$				0.2634***	0.8864***	0.5007***
				(0.0731)	(0.1745)	(0.1013)
RWA $_{t-1}$				−0.0176	−0.0096	−0.0346
				(0.0366)	(0.0736)	(0.0478)
LLP $_{t-1}$				0.0362**	0.0801**	0.0337
				(0.0179)	(0.0325)	(0.0219)
Constant	0.2045*	−0.0832	−0.2075	0.2656**	0.2498	0.0567
	(0.1227)	(0.3306)	(0.2348)	(0.1344)	(0.3160)	(0.2151)
Observations	401	401	401	401	401	401
Number of ID	80	80	80	80	80	80
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	No	No	No
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the regression results of the relation between banks' ESG disclosure scores and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. Environmental Disclosure Score derives from all available firm information, including websites, CSR reports, annual reports and Bloomberg surveys. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

(Northern,[7] Eastern,[8] Southern[9] or Mid-Western group[10]) in a given year (*ENVregion*) as the instrument for *ENV*. We further distinguish sample banks as systematically important (O-SII[11]) or not. As banks from areas with greater attention to environmental engagement are likely to engage in a better sustainability disclosure to conform to green norms and expectations, *ENVregion* is expected to be positively associated with *ENV*. Given this instrument is related to all banks' environmental activities in the region and it is lagged one year with respect to *ENV* (hence, it is calculated in t-2), it should have no significant effect on the bank's specific stock crash risk and therefore can be viewed as exogenous because it could be intended as an aggregate banking indicator of green engagement for specific geographic areas. In the first stage of the 2SLS model, we regress *ENV* on *ENVregion* and the control variables included in our baseline model. The corresponding first-stage results presented in Column (1) of Table 8 show a significant positive coefficient for *ENVregion* (F-test = 15.61), which is consistent with our expectation that banks from regions that are more green-oriented tend to engage in more environmental activities. In the second stage, we use the first stage fitted value for *ENV* and estimate again the baseline model. As indicated in Columns (2), (3), and (4) of Table 8, the coefficients on the fitted value of *ENV* remain negative and statistically significant at least at the 5% confidence level for all the three crash proxies, suggesting that the negative association between banks' green activities and crash risk holds after controlling for endogeneity using the 2SLS approach.

Since the article investigates whether ESG could impact stock price crash risk and the latter is mainly studied about transparency and opacity reporting, we consider other ESG scores released by another information provider to minimize any bias resulting from a unique source. As other academic studies do (Huang, Li, Lin, & McBrayer, 2022; Li, Gong, Zhang, & Koh, 2018; Yu & Van Luu, 2021), we consider ESG disclosure scores from Bloomberg.

In Table 9, we observe that the coefficients on *ENV_DISCL* are significantly negative for each stock crash risk measures at least at the 5% level, without considering other financial independent variables. Otherwise, the coefficient remains negative and statistically significant at the 10% confidence level for two crash measures, *N_CRASH* and *NCSKEW*. These results provide similar evidence as in Table 6, supporting the signalling theory which suggests that green-oriented firms deliver a positive signal to the market, despite the main independent variable of interest is the environmental score deriving from another ESG data provider. We also note that results may be influenced by a smaller number of observations with respect to the baseline model's sample with scores drawn by Refinitiv Eikon.

Overall, environmental scores appear negatively related to future stock price crash risk regardless the rating provider considered. This is consistent with Alessi, Ossola, and Panzica (2021), showing that what is priced by the market is not only green activity but the combination of both environmental performance and environmental transparency. However, it is interesting to test what happens in case of rating disagreement. Some past studies suggest that a potential sign of greenwashing is when firms disclose large quantities of ESG information but

[7] The Northern region comprises Denmark, Finland, Great Britain, Ireland, Norway and Sweden.
[8] The Eastern region comprises Czech Republic, Hungary, Poland, Romania and Russian Federation.
[9] The Southern region comprises Greece, Italy, Portugal and Spain.
[10] The Mid-Western region comprises Austria, Belgium, France, Germany, Liechtenstein, Netherlands and Switzerland.
[11] According to list of O-SIIs notified to the EBA in 2020.

Table 10
Banks' greenwashing alert and stock price crash risk.

	(1)	(2)	(3)
	N_CRASH	NCSKEW	DUVOL
ENV_SPREAD $_{t-1}$	0.0897	0.2232*	0.1469**
	(0.0572)	(0.1273)	(0.0669)
Tier1 $_{t-1}$	−0.0436	−0.0419	−0.0816
	(0.0794)	(0.1384)	(0.0901)
CostIncome $_{t-1}$	0.0217	−0.1377	−0.1729**
	(0.0904)	(0.1271)	(0.0838)
Size $_{t-1}$	0.5859	2.1518***	1.7162***
	(0.4175)	(0.7243)	(0.4878)
MTB $_{t-1}$	0.1850*	0.5292	0.2944**
	(0.0933)	(0.3287)	(0.1419)
Liquidity $_{t-1}$	0.1029	0.1961	0.1386
	(0.1486)	(0.2955)	(0.1852)
ROA $_{t-1}$	0.0185	0.2413	0.0796
	(0.1066)	(0.3832)	(0.1382)
RWA $_{t-1}$	−0.0596	−0.2555	−0.2185
	(0.1268)	(0.2066)	(0.1476)
LLP $_{t-1}$	−0.0550	0.0796	0.0333
	(0.0488)	(0.0712)	(0.0514)
Constant	−0.1354	−1.1283**	−0.9898***
	(0.2551)	(0.4791)	(0.3183)
Observations	447	447	447
Number of ID	90	90	90
Cluster SE	Banks	Banks	Banks
Bank Fixed Effects	Yes	Yes	Yes
Country Fixed Effects	No	No	No
Year Fixed Effects	Yes	Yes	Yes

This table presents the regression results of the relation between banks' greenwashing alert and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. ENV_SPREAD is a dummy variable that assumes value equals to 1 if Environmental disclosure score (ENV_DISCL) is greater than Environmental performance score (ENV); it is 0 otherwise. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

have poor ESG performance (Yu, Van Luu, & Chen, 2020). Consistently with this idea, we measure the quantity of information provided using the Environmental disclosure score (*ENV_DISCL*) released by Bloomberg and we proxy the environmental performance using the *ENV* score drawn from Refinitiv Eikon. As suggested by Zhang (2022), we calculate a normalized measure of a bank's position relative to its peers in the distribution of the Environmental disclosure score (*ENV_DISCL*) and a normalized measure of a bank's position relative to its peers in the distribution of its ESG real-performance score (*ENV*). Then, we proxy the greenwashing alert with *ENV_SPREAD*, a dummy variable that assumes a value equal to 1 if the normalized measure of *ENV_DISCL* is greater than the normalized measure of *ENV*, and 0 otherwise. Table 10 shows regression results in which we consider *ENV_SPREAD* as the main interest independent variable, to test whether this spread is a measure of opacity increasing stock price crash risk. Including time and firm fixed effects, we observe that the coefficients of *ENV_SPREAD* are positive for each stock crash risk measure and statistically significant at least at the 10% confidence level, except for the model reported in Column (1) where the *p*-value is equal to 0.110 and then is very close to the significance threshold. This positive association with crash risk measures shows that when the quantity of information disclosed is not accompanied by a consistent high environmental performance, there is an increase in the future bank's stock price crash risk. This result provides evidence in favour of the signalling and the agency theories being both at work and supports the idea to use the Bloomberg-Refinitiv spread as an alert for possible greenwashing behaviour.

5. Opening the black (environmental) box

5.1. Components of environmental performances and banks' stock price crash risk

After documenting a negative relationship between the aggregate environmental activity measure and future crash risk, we further explore how future crash risk is affected by different dimensions of environmental activities. The Environmental Pillar Score (*ENV*) is the relative sum of three category scores (Emissions Score, Resource Use Score and Innovation Score) which vary per industry. The first comprises emission policies, targets and waste management. The second refers to environmental management systems and supply chain systems. The third aggregates data on green project financing and ecological product innovation. These three category scores are measured using the corresponding Refinitiv scores scaled by 100, with higher values indicating better performance.

In this section, regression results are reported using respectively *ENV_Emiss*, *ENV_ResUse* and *ENV_Innov* as the main independent variables replacing *ENV*. As reported in Table 11, the coefficient of every environmental independent variable remains negative consistently with previous result for the whole environmental pillar score and supporting the signalling theory. From Columns (1) to (6), the main interest variable is *ENV_Emiss*, included in the model with or without bank-specific controls; the same applies for Columns (7)–(12) and Columns (13)–(18) where the main interest variable is, respectively, *ENV_ResUse* and *ENV_Innov*. Consistently with previous research contributions finding a positive relationship between environmental pillar and the management of risk, both in non-financial firms (Cheng, Ioannou, & Serafeim, 2014; Feldman, Soyka, & Ameer, 1997) and banks (Chiaramonte et al., 2021; Gangi et al., 2019), we document a negative association between environmental engagement and crash risk. Furthermore, it is important to evidence the role of finance in the promotion of green investments (Dikau & Volz, 2018; Raberto, Ozel, Ponta, Teglio, & Cincotti, 2019) and supporting sustainable growth over long term period, in line with international commitments on climate and ecological transition objectives.

As show in Table 11, the most important component of the environmental score is the one related to innovation: coefficients for *ENV_Innov* are significantly negative for each stock crash risk measures at least at the 5% level, without considering other financial independent variables. Otherwise, the coefficient remains negative and statistically significant at the 5% confidence level just for the DUVOL model. This result is consistent with a previous study by Zaman, Atawnah, Haseeb, Nadeem, and Irfan (2021) noting that an increase in environmental innovation is associated with a reduction in stock price crash risk. According to this view, eco-innovative firms could attract more institutional investors and equity analysts following the firms, leading to an increase in information disclosure and, hence, to a reduction in stock price crash risk, as the signalling theory also suggests. In contrast, we do not find a significant relationship between environmental activities (related to resource use or emissions reduction) and future crash risk, indication that the most influence in green performance is directed by the environmental assets under management and development in providing environmentally conscious solutions.

5.2. Additional contribution to 2030 Agenda

In September 2015, the UN General Assembly approved the Agenda,[12] consisting of the 17 Sustainable Development Goals (SDGs) to be achieved by 2030. In terms of business strategy, the commitment to the SDGs is increasingly important, since it reflects whether firms'

[12] https://sustainabledevelopment.un.org/post2015/transformingourworld/publication

Table 11
Banks' environmental components and stock price crash risk.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Variables	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL
ENV_Emiss $_{t\text{-}1}$	−0.0145	−0.0738	−0.0303	−0.0019	−0.0641	−0.0320												
	(0.0351)	(0.0629)	(0.0425)	(0.0357)	(0.0717)	(0.0446)												
ENV_ResUse $_{t\text{-}1}$							−0.0285	−0.0943	−0.0493	−0.0143	−0.0771	−0.0483						
							(0.0399)	(0.0811)	(0.0532)	(0.0404)	(0.0726)	(0.0479)						
ENV_Innov $_{t\text{-}1}$													−0.0666**	−0.1538**	−0.1055***	−0.0413	−0.0820	−0.0777**
													(0.0268)	(0.0603)	(0.0375)	(0.0288)	(0.0566)	(0.0341)
SOC $_{t\text{-}1}$	0.0113	0.0311	0.0083	0.0200	0.0724	0.0387	0.0226	0.0547	0.0250	0.0269	0.0870	0.0516	0.0557*	0.1106	0.0731	0.0455	0.0979	0.0747
	(0.0313)	(0.0579)	(0.0429)	(0.0379)	(0.0647)	(0.0476)	(0.0373)	(0.0764)	(0.0523)	(0.0431)	(0.0796)	(0.0546)	(0.0310)	(0.0687)	(0.0475)	(0.0393)	(0.0785)	(0.0531)
GOV $_{t\text{-}1}$	−0.0232	0.0136	0.0240	−0.0163	0.0186	0.0269	−0.0215	0.0190	0.0271	−0.0157	0.0217	0.0291	−0.0234	0.0139	0.0246	−0.0179	0.0152	0.0242
	(0.0236)	(0.0499)	(0.0346)	(0.0245)	(0.0577)	(0.0363)	(0.0232)	(0.0495)	(0.0346)	(0.0244)	(0.0575)	(0.0365)	(0.0232)	(0.0484)	(0.0331)	(0.0246)	(0.0579)	(0.0359)
Tier1 t-1				−0.0003	−0.0536	−0.0640				0.0003	−0.0502	−0.0625				−0.0061	−0.0639	−0.0746
				(0.0368)	(0.0618)	(0.0436)				(0.0370)	(0.0626)	(0.0440)				(0.0377)	(0.0643)	(0.0454)
CostIncome t-1				0.0585	−0.0097	−0.0710				0.0574	−0.0099	−0.0725				0.0524	−0.0159	−0.0798
				(0.0470)	(0.0705)	(0.0490)				(0.0475)	(0.0707)	(0.0496)				(0.0478)	(0.0706)	(0.0496)
Size t-1				−0.0087	−0.0243	−0.0468				−0.0059	−0.0194	−0.0424				0.0005	−0.0157	−0.0345
				(0.0500)	(0.1047)	(0.0650)				(0.0486)	(0.1046)	(0.0647)				(0.0484)	(0.1060)	(0.0640)
MTB t-1				−0.0066	0.0326	0.0201				−0.0072	0.0316	0.0200				−0.0079	0.0345	0.0193
				(0.0391)	(0.1155)	(0.0653)				(0.0397)	(0.1165)	(0.0665)				(0.0415)	(0.1199)	(0.0695)
Liquidity t-1				−0.0495	−0.0311	0.0048				−0.0456	−0.0356	0.0058				−0.0331	−0.0288	0.0215
				(0.0405)	(0.0816)	(0.0532)				(0.0425)	(0.0796)	(0.0545)				(0.0429)	(0.0778)	(0.0527)
ROA t-1				0.2683***	0.7592***	0.4088***				0.2703***	0.7604***	0.4095***				0.2595***	0.7305***	0.3865***
				(0.0799)	(0.2073)	(0.1161)				(0.0806)	(0.2099)	(0.1155)				(0.0788)	(0.2201)	(0.1216)
RWA t-1				0.0055	0.0074	−0.0399				0.0053	0.0085	−0.0398				0.0022	0.0031	−0.0449
				(0.0321)	(0.0748)	(0.0461)				(0.0322)	(0.0762)	(0.0471)				(0.0320)	(0.0764)	(0.0468)
LLP t-1				0.0302**	0.0831**	0.0526**				0.0312**	0.0808**	0.0523**				0.0304**	0.0754**	0.0491**
				(0.0148)	(0.0361)	(0.0234)				(0.0143)	(0.0369)	(0.0237)				(0.0143)	(0.0380)	(0.0237)
Constant	0.1206	−0.4166	−0.3081*	0.1818	−0.1088	−0.0857	0.1224	−0.4305	−0.3094*	0.1879	−0.1261	−0.0903	0.1183	−0.4422**	−0.3084**	0.1849*	−0.1611	−0.1062
	(0.1087)	(0.2857)	(0.1799)	(0.1160)	(0.2964)	(0.1792)	(0.1051)	(0.2720)	(0.1726)	(0.1149)	(0.2820)	(0.1707)	(0.0842)	(0.2150)	(0.1333)	(0.0996)	(0.2559)	(0.1432)
Observations	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455	455
Number of ID	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91	91
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the regression results of the relation between banks' environmental components and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. Environmental Emissions Score measures a company's commitment and effectiveness towards reducing environmental emissions in its production and operational processes. Environmental Resource Use Score reflects a firm's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management. Environmental Innovation Score reflects a firm's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes, or eco-designed products. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 12
Banks' SDG 13 commitment and stock price crash risk.

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	N_CRASH	NCSKEW	DUVOL	N_CRASH	NCSKEW	DUVOL
SDG13 $_{t-1}$	−0.1844***	−0.3257**	−0.1815**	−0.1568*	−0.3780**	−0.2223**
	(0.0663)	(0.1427)	(0.0900)	(0.0822)	(0.1701)	(0.1044)
SOC $_{t-1}$	0.0408	0.0511	0.0537	0.0227	−0.0503	0.0058
	(0.0356)	(0.0739)	(0.0473)	(0.0652)	(0.1322)	(0.0823)
GOV $_{t-1}$	−0.0098	0.0362	0.0360	0.0228	0.0115	0.0326
	(0.0265)	(0.0632)	(0.0390)	(0.0534)	(0.0967)	(0.0596)
Tier1 $_{t-1}$	0.0009	−0.0232	−0.0375	−0.0601	−0.0297	−0.0690
	(0.0385)	(0.0679)	(0.0466)	(0.0838)	(0.1498)	(0.0965)
CostIncome $_{t-1}$	0.0403	−0.0561	−0.1047*	0.0042	−0.1576	−0.1911*
	(0.0526)	(0.0790)	(0.0546)	(0.1067)	(0.1635)	(0.1045)
Size $_{t-1}$	0.0115	−0.0059	−0.0830	0.8497	1.9845*	1.3056*
	(0.0517)	(0.1098)	(0.0673)	(0.5849)	(1.0376)	(0.7457)
MTB $_{t-1}$	−0.0290	−0.0155	−0.0202	0.1755*	0.5078	0.2729*
	(0.0412)	(0.1051)	(0.0525)	(0.0968)	(0.3451)	(0.1438)
Liquidity $_{t-1}$	−0.0302	0.0070	0.0582	0.0683	0.2863	0.1752
	(0.0439)	(0.0735)	(0.0491)	(0.1617)	(0.3166)	(0.2059)
ROA $_{t-1}$	0.3124***	0.8699***	0.4894***	0.0469	0.3208	0.1288
	(0.0871)	(0.1829)	(0.0987)	(0.1041)	(0.3898)	(0.1474)
RWA $_{t-1}$	−0.0058	0.0317	−0.0283	0.0590	−0.0015	−0.0693
	(0.0331)	(0.0825)	(0.0499)	(0.1397)	(0.2388)	(0.1671)
LLP $_{t-1}$	0.0461***	0.0764**	0.0401*	−0.0392	0.0685	0.0080
	(0.0166)	(0.0349)	(0.0211)	(0.0496)	(0.0796)	(0.0581)
Constant	0.3382***	0.3079	0.1357	−0.0862	−0.4311	−0.4180
	(0.1235)	(0.3571)	(0.2235)	(0.3485)	(0.5994)	(0.4135)
Observations	402	402	402	402	402	402
Number of ID	90	90	90	90	90	90
Cluster SE	Banks	Banks	Banks	Banks	Banks	Banks
Bank Fixed Effects	No	No	No	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes	No	No	No
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the regression results of the relation between banks' ESG performances and stock price crash risk proxied by N_CRASH, NCSKEW and DUVOL, respectively. N_CRASH indicates the number of crashes in a given year. NCSKEW is the negative coefficient of skewness of bank-specific weekly returns over the year. DUVOL is the natural logarithm of the ratio of the standard deviation in the down weeks to that in the up weeks. SDG13 is a dummy variable that assumes value equals to 1 if bank reports commitment on the specific goal; it is 0 otherwise. All the employed independent variables are standardized. Robust standard errors in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

activities positively affect society, contributing to enhance corporate reputation (Deegan, 2002). Only few studies have examined the adoption of these criteria in banks' CSR practices (Avrampou, Skouloudis, Iliopoulos, & Khan, 2019; Cosma, Venturelli, Schwizer, & Boscia, 2020; Gallego-Sosa, Gutiérrez-Fernández, Fernández-Torres, & Nevado-Gil, 2021), while others use different ways to measure "green" performance, e.g., the environmental engagement and shareholder activism (Hoepner, Oikonomou, Sautner, Starks, & Zhou, 2022).

Consistently with the aim of this study, we analyse whether the commitment to SDGs related to climate change has an impact on stock price crash risk. We focus on the SDG 13, which intends to introduce climate change as a primary issue on the political agenda, in the strategies and programs of national and regional governments, businesses and civil society, improving the response to the problems generated, such as natural disasters, and by encouraging education and awareness of the entire population. Its firm contribution could be based on specific indicators (e.g., external audit of co2 emissions, investments in renewable energies).

Table 12 shows regression results in which we consider *SDG13* as the main interest independent variable, instead of *ENV*. *SDG13* is a dummy variable that assumes a value equal to 1 if the bank discloses commitment to this specific goal, and 0 otherwise. We observe that the coefficients of *SDG13* are negative for each stock crash risk measures and statistically significant at least at the 10% level. These results provide further evidence in favour of a negative relationship between environmental engagement and banks' stock price crash risk.

6. Conclusions

Stock price crashes in the banking industry can severely damage the stability of the entire financial system and compromise economic growth (Balla et al., 2014; Kosmidou et al., 2017). Our paper adds to the growing literature on CSR in the financial industry and its impact on banking stability (Chiaramonte et al., 2021; Gangi et al., 2019), showing that environmental engagement can reduce future stock price risk.

We analyse a sample of European banks in a very interesting period, from 2015 to 2021, characterised by an unprecedented evolution towards sustainable finance. Since the 2015 Paris agreement, European institutions have moved several steps towards a more sustainable growth, with a significant involvement for the financial sector. Consistently, ESG criteria have gained much more weight in driving investors' decisions, and banking supervisors are rapid including environmental considerations in their assessment of risk. All these pressures suggest revisiting the two alternative theories proposed by previous studies about the relationship between environmental performance and banking risk (Gangi et al., 2019).

On the one hand, the agency theory suggests that bank managers may opportunistically use green engagement as a mean for diverting shareholders' attention and engage more easily in bad news hoarding activities (Friedman, 1970; Petrovits, 2006). In contrast, the signalling theory suggests that increased environmental activities are expected to be related to less bad news hoarding behaviour since bank managers actively and effectively engage in CSR activities, committing to high ethical standards and maintaining the transparency of financial operations and disclosures (Dhaliwal et al., 2011; Hummel & Schlick, 2016).

These two alternative views are not mutually exclusive and both negative and positive effects could be at work at the same time: our empirical evidence suggests that positive effects prevail, supporting the signalling theory about banks' environmental activities. Specifically, we find a significant negative association between banks' green activities and future stock price crash risk, measured by the crash occurrence, the negative skewness, and the down-to-up volatility of stock returns. Our results are robust to accounting for potential endogeneity concerns and to the use of different variables to measure environmental engagement. However, we also find that stock price crash risk is higher for banks disclosing a large amount of ESG information without a high consistent level of performance, supporting that the spread between the Bloomberg ranking in terms of disclosure and the Refinitv one in terms of performance may be used as an alert for potential greenwashing.

Environmental issues in the banking sector remained hidden until financial institutions were recognised as key actors in addressing the challenges of climate change (Galletta et al., 2022). New research on ESG engagement and performance in the banking sector is therefore needed. Firstly, further work is needed to improve our understanding of the complex interactions between lenders and borrowers (Houston & Shan, 2022) in order to better assess the potential role of banks in leading the transition. A complementary avenue for future research could be to explore the impact of ESG metrics on banks' risk management strategies and portfolio diversification techniques. In addition, further research into the integration of ESG factors into credit risk assessment models and the impact on the pricing and availability of credit could provide valuable insights into the long-term sustainability of the banking industry. Finally, there is a need to explore the regulatory frameworks and institutional factors that shape the adoption and implementation of ESG policies by banks in order to better understand the incentives and constraints associated with sustainable banking practices.

Our findings are informative to policymakers, regulators, auditors, and market participants who are concerned about preventing banks' stock price crashes and promoting international financial markets stability together with a sustainable economic growth. They also suggest that environmental engagement should be further encouraged, also through the promotion of a better non-financial disclosure. As outlined by Krueger (2022) future regulation should apply to non-financial disclosure the same principles that generally govern financial disclosure, which is mandatory, standardized, available in regulated disclosure documents, and audited.

Declaration of Competing Interest

None.

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