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Explosive financing? Bank share price reactions to carbon bomb exposure

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ABSTRACT

On 31 October 2023, a collaboration of international media houses and French non-profit organizations published a report on bank financing of fossil fuel extraction projects representing more than 1 gigaton of CO_2 emissions ("carbon bombs"). In this paper, we examine the value relevance of this information. We find that the market reaction is not explained by the incremental information about carbon bomb financing, but it was primarily influenced by the banks' ESG scores: the lower the pre-release ESG score, the more negative the market reaction, suggesting that a strong environmental reputation mitigates the negative reaction to the carbon bomb disclosure.

1. Introduction

On 31 October 2023, the newspapers *The Guardian* in the UK, *Le Monde* in France and *Der Spiegel* in Germany published exclusive reports exposing the bank financing of so-called "carbon bombs". On the same day, the CarbonBombs.org website went online, making available the data collected by the collaboration of these newspapers and non-profit organizations. The term carbon bomb had been introduced a year earlier by Kühne et al. (2022), who defined it as "a proposed or existing fossil fuel extraction project (a coal mine, oil or gas project) that would result in more than 1 gigaton of CO_2 emissions if its reserves were completely extracted and burnt" (p. 1). Kühne et al. (2022) identified 425 such projects and described their location and emissions potential. In 2020, 294 (69%) of the projects were ongoing, while 131 (31%) were still in the planning stage. The regional distribution shows a focus on Asia (264 projects), followed by Europe (52), North America (44), Oceania (23), Africa (22) and South America (20).

The new information about the financing structures seemed explosive, as major US, European and Asian banks continued to finance the projects with billions of US dollars. This is despite the fact that the impending carbon bomb emissions significantly exceed the remaining carbon budget to limit global warming to 1.5 °C (Kühne et al., 2022; DGE, 2023). Financing carbon bombs therefore does not seem to be in line with the green policies of most major banks and the requirements of sustainable finance (UNEP, 2024; BOCC, 2024b; IPCC, 2023; Bernardelli et al., 2022).

Our research question is whether the incremental information about carbon bomb financing, which is not yet included in the banks' ESG scores, is value relevant. We test the competing hypotheses that (1) the market reaction is naively negative; (2) the market reacts to the incremental information about carbon bomb financing; and (3) the market focuses on the ESG scores themselves when incorporating the carbon bomb information.

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Our findings indicate that the market reaction was neither naive nor driven solely by the incremental information about carbon bombs. Instead, it was primarily influenced by the banks' ESG scores: the lower the pre-release ESG score, the more negative the market reaction.

Our study contributes to the growing literature on the valuation implications of fossil fuel finance. Previous research has found that market participants generally reward positive environmental news and penalize negative disclosures (see, e.g. Flammer, 2013; Griffin et al., 2017; Pham et al., 2019; Alsaifi et al., 2020; Jung et al., 2021; Alessi et al., 2024), and that climate-related news leads to a stronger stock price reaction for firms with higher exposure to carbon-intensive assets (Ilhan et al., 2021). Banks involved in fossil fuel finance face reputational risks (Jung et al., 2021) and tend to have lower ESG ratings (Kotsantonis and Bufalari, 2019; Bernardelli et al., 2022; BOCC, 2024a). Conversely, fossil fuel divestment by financial institutions tends to improve their environmental reputation and market value (Bassen et al., 2021; Zori et al., 2022; Monaco, 2023). Nevertheless, the banking sector continues to finance the fossil fuel industry (BOCC, 2024a), suggesting that this lending is still considered profitable compared to green investments (see, e.g., Minetti (2011) and Beyene et al. (2022)).

Our contribution to this literature is to focus on the financing of carbon bombs, which by their nature are particularly important for global CO_2 emissions but have not yet been analyzed as a test case for banks' green policies in previous literature.

2. Data and variables measuring bank involvement

The collaboration that analyzed the financing of carbon bombs was led by the French nonprofit organizations *Data for Good* and *Éclaircies* and included major European media outlets. The researchers linked the carbon bombs database created by Kühne et al. (2022) to the companies that own or operate the projects using the Global Energy Monitor (GEM) database, which consists of two parts, the Global Oil and Gas Extraction Tracker and the Global Coal Mine Tracker. The researchers then matched these operating fossil fuel companies with the world's 60 largest banks using the Banking on Climate Chaos database (BOCC, 2024b), which covers lending, debt underwriting and equity issuance to companies in the fossil fuel industry. The final sample consists of 58 banks for which the relevant data were available.

Fig. 1 shows the network graph of the connections between banks (on the left), operating companies (in the middle) and carbon bomb projects (on the right), aggregated by world region. The width of the lines on the left indicates the amount of financing provided by banks based in a given region to operating companies in the region of the middle layer. The width of the lines on the right indicates the number of carbon bomb projects in a given region that are managed by operating companies in the region of the middle layer.

The graph highlights the large number of carbon bomb projects located in Asia, which are predominantly operated by Asian companies, as reflected in the strong Asia–Asia linkage on the project side of the figure. While these operating companies are primarily financed by Asian banks, they also receive substantial funding from European and North American banks. The importance of North American banks in funding the operating companies is substantially higher than the proportion of North American carbon bombs.

The detailed networks of banks to operating companies and carbon bombs contain many connections and are difficult to evaluate intuitively. To gain a better overview and make the banks comparable, we construct the following variables to measure bank involvement:

$Nb.C$: Number of fossil fuel companies financed

$FinVol$: Total financing volume from 2016 to 2022 in billion USD

ΔFin: Relative change of the financing volume in 2022 compared to the average financing volume from 2016 to 2021

$Nb.P$: Number of carbon bombs financed

$Rank$: Average rank according to the previous four indicators

Under our definition of the change variable ΔFin, a bank that has completely ceased financing oil companies by 2022 would have a value of −100%, clearly capturing a full withdrawal. However, a bank's ESG stance is only one of several factors that may influence changes in financing volumes over time. Therefore, as a robustness check, we recomputed all results using an alternative definition of ΔFin, measured as the relative change in the combined financing volume in 2020–2022 compared to the combined financing volume in 2016–2018. The results are very similar.

Our main focus is on the $Rank$ variable, which is a combined score that is defined as the mean value of the ranks that the bank achieves in a univariate ranking (in ascending order) by $Nb.C$, $FinVol$, ΔFin, and $Nb.P$. All five variables are designed in such a way that a higher value indicates a greater involvement in carbon bomb financing.

Table 1 shows the bank-specific values of the five variables based on all carbon bomb projects and based only on the projects that are not yet operational. The differences in bank involvement are large, ranging from a number of projects financed of 1 (Danske Bank) to 174 (Bank of China). There are 24 banks that are involved in more than 100 carbon bombs. Most banks have reduced their financing volume from 2016 to 2022, as indicated by the mostly negative ΔFin values.

The pairwise Pearson and Spearman correlation coefficients between $Nb.C$, $FinVol$ and $Nb.P$ are high (between 0.75 and 0.89), while these variables are not significantly correlated with ΔFin (see Table 2). This pattern may reflect common factors affecting

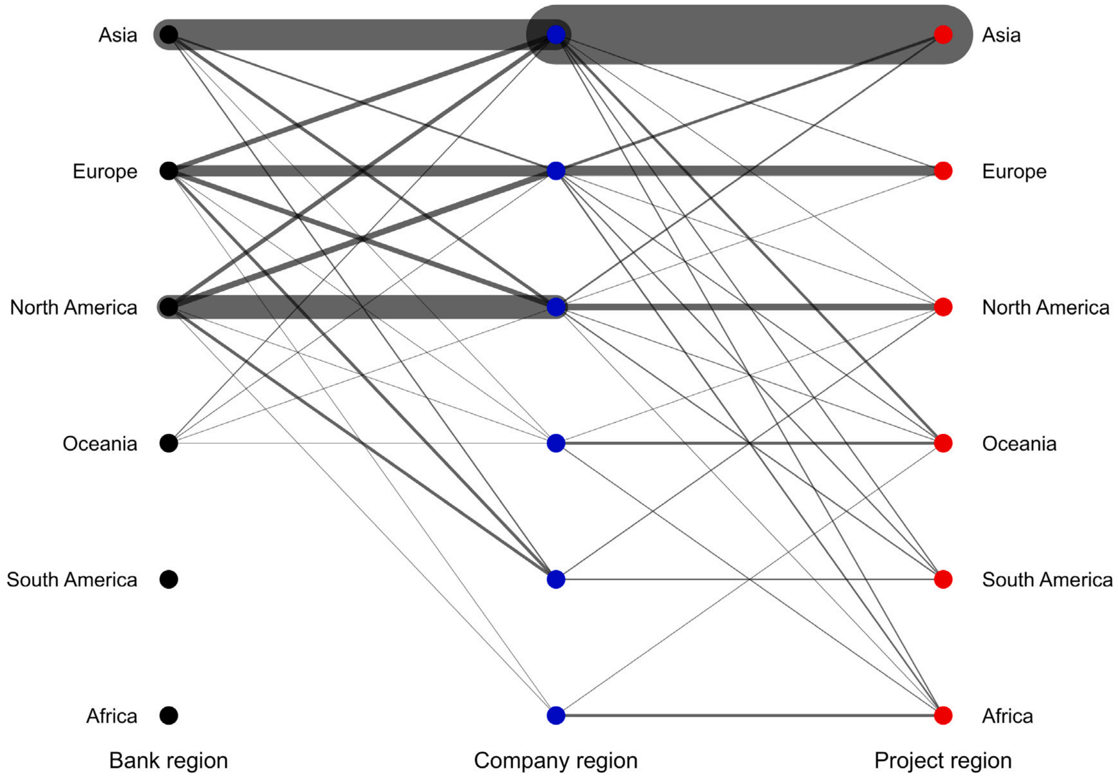

Fig. 1. Network graph. This figure shows the connections between banks (on the left), operating companies (in the middle) and carbon bomb projects (on the right), aggregated by world region. The width of the lines on the left indicates the amount of financing provided by banks based in a given region to operating companies in the region of the middle layer. The width of the lines on the right indicates the number of carbon bomb projects in a given region that are managed by operating companies in the region of the middle layer.

changes in financing volumes across banks, such as higher risk assessments, ESG-related considerations, or lower expected returns of oil and gas projects relative to clean energy technologies.

In addition to the carbon bomb data, we use stock return data and the ESG score from LSEG Datastream. This score ranges from 1 to 100. The ESG methodology is described in LSEG (2024).[1]

3. Pre-release ESG scores and carbon bomb financing

We first examine whether the carbon bomb financing was already partly reflected in the pre-release ESG scores. Possible reasons are that the carbon bombs were already explicitly taken into account when the scores were created, or that the financing of carbon bombs correlates with the financing of oil and gas extraction projects in general. Only the information that is not reflected in pre-release ESG scores should be relevant for the market reaction.

To examine the relationship, we regress the banks' ESG score on the variables of bank involvement in carbon bombs in univariate cross-sectional regressions:

$$ESG_i = a + bVar_i + \epsilon_i, \tag{1}$$

where ESG_i is the ESG score, $i \in \{1, \dots, 58\}$ is the bank identifier, $Var \in \{Nb.C, FinVol, \Delta Fin, Nb.P, Rank\}$, a and b are the regression coefficients, and ϵ is the error term.

We repeat estimation (1) for the components of the ESG score, i.e. the E, S and G scores. Panel A of Table 3 shows the results when the Var variables are based on all carbon bomb projects, Panel B when they are based on only the operational projects, and Panel C when they are based on only those projects that are still in the planning stage.

The $Rank$ variable has significantly negative coefficients in all panels, confirming that the extent to which a bank is involved in the financing of carbon bombs is negatively related to its pre-release ESG score. The number of projects financed, measured by $Nb.P$, also has a significantly negative relationship with ESG in all panels.

[1] The size bias in LSEG ESG scores shown by Dobrick et al. (2023) should be small because our sample only includes the world's largest banks.

Table 1
Descriptive statistics.
Variables measuring bank involvement in carbon bombs for the sample banks. $Nb.C$ is the number of fossil fuel companies financed; $FinVol$ is the total financing volume from 2016 to 2022 in billion USD; ΔFin is the relative change of the financing volume in 2022 compared to the average financing volume from 2016 to 2021; $Nb.P$ is the number of carbon bombs financed; and $Rank$ is the average rank according to the previous four indicators. Sorting by $Rank$ based on all carbon bomb projects.

			All carbon bomb projects ($N = 425$)					Projects not yet operational ($N = 131$)				
#	Bank	Country	$Nb.C$	$FinVol$	ΔFin	$Nb.P$	$Rank$	$Nb.C$	$FinVol$	ΔFin	$Nb.P$	$Rank$
1	Bank of China	China	42	65.7	−35.2	174	49.1	15	32.8	−49.1	104	45.8
2	Citi	United States	83	119.2	−56.4	144	49	23	37.4	−71.0	88	44.8
3	ICBC	China	30	92.2	14.4	131	48.6	11	49.5	28.2	87	46.8
4	MUFG	Japan	49	48.8	−30.5	139	48.1	18	10.8	−8.3	94	43.8
5	Mizuho	Japan	51	49.4	−27.1	113	46.5	22	16.1	−14.6	74	41
6	JPMorgan Chase	United States	78	141.8	−72.9	131	45.9	21	46.3	−70.0	81	43
7	Bank of America	United States	58	93.5	−69.5	108	43.2	16	32.1	−70.3	62	39.5
8	China Construction Bank	China	31	47.6	−39.5	140	43	14	30.1	−52.9	92	43.4
9	BNP Paribas	France	34	71.9	−30.9	88	42.4	10	12.7	85.9	50	37
10	Bank of Communications	China	25	28.5	30.9	133	41.9	10	18.8	64.4	82	42.1
11	Crédit Agricole	France	31	39.8	14.4	93	41.8	13	15.0	30.4	53	39.9
12	Goldman Sachs	United States	49	46.8	−78.8	146	41.8	19	13.8	−75.1	100	40.5
13	Industrial Bank	China	26	51.5	−37.3	118	41.5	12	31.6	−22.2	87	42.1
14	Morgan Stanley	United States	42	51.5	−81.5	146	41.5	17	21.9	−87.1	107	40.9
15	SMBC Group	Japan	36	36.3	8.4	93	41.1	10	7.1	102.0	44	35.2
16	Shanghai Pudong Dev. Bank	China	26	38.3	−16.5	118	41	14	18.1	−31.1	91	42.1
17	Agricultural Bank of China	China	25	49.4	6.9	102	40.6	10	26.7	15.0	78	40.8
18	China CITIC Bank	China	24	35.3	76.1	114	40.5	12	23.1	7.4	84	42.9
19	HSBC	UK	46	62.1	−72.7	105	40.1	15	16.6	−53.4	59	37.2
20	China Merchants Bank	China	26	34.6	−8.3	116	39.4	11	16.5	−20.4	83	38.5
21	Société Générale	France	34	36.8	−32.7	92	38.1	11	15.6	25.1	52	38
22	China Everbright Bank	China	21	34.9	−2.9	112	37	10	23.9	6.6	82	40.1
23	Deutsche Bank	Germany	46	28.2	−83.7	143	36.6	17	10.8	−75.4	89	37.6
24	Credit Suisse	Switzerland	43	24.5	−54.1	104	35.9	13	5.8	3.9	57	34.4
25	RBC	Canada	31	41.2	−42.1	61	35.5	8	7.6	17.7	35	30.9
26	Wells Fargo	United States	33	62.4	−44.3	34	35.2	6	9.8	5.4	14	25.4
27	Barclays	UK	36	54.4	−87.5	69	33.9	15	25.5	−87.9	54	34.5
28	Postal Savings Bank	China	20	9.4	−0.7	104	32.4	8	4.2	45.1	76	34
29	Standard Chartered	UK	26	10.7	−66.1	128	32.2	10	2.5	−88.8	90	27.8
30	Scotiabank	Canada	24	36.8	−37.7	59	31.8	7	5.3	6.4	21	25.6
31	Ping An Insurance Group	China	19	30.1	−53.9	109	31.1	8	9.4	−79.0	77	28.2
32	TD	Canada	19	39.8	−32.4	36	30.1	6	6.3	145.9	16	28.4
33	ANZ	Australia	14	7.2	81.4	57	28.4	6	1.9	−85.3	47	19.1
34	UBS	Switzerland	24	11.9	−91.1	128	27.1	9	4.9	−91.1	87	26.5
35	Santander	Spain	19	23.6	−55.5	66	26.6	6	2.9	−73.8	34	20.2
36	China Minsheng Bank	China	23	23.6	−77.2	93	26	10	7.6	−45.0	51	30.2
37	Intesa Sanpaolo	Italy	10	6.9	124.9	42	25.8	5	2.1	−8.6	32	20.8
38	PNC	United States	15	7.1	151.3	18	25.6	3	0.5	1,356.1	7	19.4
39	CIBC	Canada	19	23.2	−42.2	31	23.9	6	1.2	18.2	23	22.9
40	Bank of Montreal	Canada	28	14.6	−82.6	32	22.5	5	4.0	−93.0	19	14.1
41	US Bancorp	United States	11	3.1	157.2	10	21.6	1	0.1	100	3	14.2
42	BPCE/Natixis	France	13	5.9	−71.2	64	19.8	5	1.6	−67.4	35	18.5
43	BBVA	Spain	17	9.0	−75.6	47	19.5	5	2.4	−88.0	34	15.8
44	UniCredit	Italy	10	13.0	−69.3	41	19.5	5	6.6	−100	32	15.8
45	ING	Netherlands	16	7.7	−77.8	57	19.1	7	2.8	−89.7	42	19.4
46	NAB	Australia	5	1.1	10.9	14	17.2	3	0.7	−55.6	12	13.2
47	Commerzbank	Germany	11	4.4	−93.7	49	14.1	6	2.0	−85.9	38	18.4
48	State Bank of India	India	6	9.8	−74.4	14	14.1	2	1.3	147.3	10	20
49	KB Financial	South Korea	3	1.2	−43.1	21	13.2	1	0.4	7.0	1	12.2
50	NatWest	UK	10	4.2	−93.3	45	13	5	1.8	−83.7	33	15.6
51	Westpac	Australia	6	2.2	−65.2	12	12	2	0.3	27.3	7	14.9
52	CaixaBank	Spain	3	0.4	−33.5	8	11.6	1	0.4	−100	4	3
53	Commonwealth Bank	Australia	6	2.8	−89.8	18	9.4	3	1.1	−72.7	13	12.5
54	Lloyds	UK	5	3.5	−100	17	7.4					
55	DZ Bank	Germany	4	0.9	−100	20	6	2	0.7	−100	17	7.5
56	Nordea Bank	Finland	3	3.7	−100	8	5.1	2	0.4	−100	8	5
57	Danske Bank	Denmark	1	1.7	−100	1	2.8					
58	Rabobank	Netherlands	2	0.1	−100	11	2.8	2	0.1	−100	11	4.8

Table 2
Correlation matrix.
The top right triangle shows pairwise Pearson correlations, and the bottom left triangle shows Spearman correlations between variables measuring bank involvement, calculated on the basis of all carbon bomb projects. The results are similar for the subsamples of ongoing and planned projects. $Nb.C$ is the number of fossil fuel companies financed; $FinVol$ is the total financing volume from 2016 to 2022 in billion USD; ΔFin is the relative change of the financing volume in 2022 compared to the average financing volume from 2016 to 2021; and $Nb.P$ is the number of carbon bombs financed. Each correlation is based on 58 cross-sectional bank observations.

	$Nb.C$	$FinVol$	ΔFin	$Nb.P$
$Nb.C$	1	0.874***	−0.066	0.753***
$FinVol$	0.890***	1	−0.030	0.643***
ΔFin	0.177	0.244	1	0.008
$Nb.P$	0.802***	0.734***	0.190	1

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Table 3
ESG score and carbon bomb financing.
Regression results of univariate cross-sectional regressions $Y_i = a + bVar_i + \epsilon_i$, where $Y \in \{ESG, E, S, G\}$ and $Var \in \{Nb.C, FinVol, \Delta Fin, Nb.P, Rank\}$. $Nb.C$ is the number of fossil fuel companies financed; $FinVol$ is the total financing volume from 2016 to 2022 in billion USD; ΔFin is the relative change of the financing volume in 2022 compared to the average financing volume from 2016 to 2021; $Nb.P$ is the number of carbon bombs financed; and $Rank$ is the average rank according to the previous four indicators. Each regression is based on 58 bank observations. In Panel A, the bank involvement variables are calculated on the basis of all carbon bomb projects, in Panel B on the basis of ongoing projects and in Panel C on the basis of planned projects. The t-statistics are given in parentheses.

	ESG	R^2	E	R^2	S	R^2	G	R^2
	Panel A: All carbon bomb projects ($N = 425$)							
$Nb.C$	0.014	0.000	0.029	0.003	−0.030	0.001	0.032	0.001
	(0.124)		(0.377)		(−0.255)		(0.212)	
$FinVol$	−0.040	0.007	−0.020	0.004	−0.045	0.008	−0.045	0.005
	(−0.615)		(−0.445)		(−0.669)		(−0.500)	
ΔFin	−0.053	0.049	−0.052**	0.099	−0.050	0.040	−0.038	0.013
	(−1.645)		(−2.417)		(−1.492)		(−0.847)	
$Nb.P$	−0.093**	0.098	−0.072***	0.119	−0.120***	0.146	−0.060	0.021
	(−2.396)		(−2.676)		(−3.016)		(−1.073)	
$Rank$	−0.319**	0.081	−0.210**	0.072	−0.360**	0.093	−0.288	0.035
	(−2.167)		(−2.030)		(−2.332)		(−1.381)	
	Panel B: Ongoing projects ($N = 294$)							
$Nb.C$	0.026	0.001	0.038	0.004	−0.011	0.000	0.035	0.001
	(0.223)		(0.474)		(−0.088)		(0.217)	
$FinVol$	−0.035	0.005	−0.018	0.003	−0.039	0.006	−0.041	0.004
	(−0.536)		(−0.391)		(−0.567)		(−0.461)	
ΔFin	−0.054*	0.054	−0.053**	0.104	−0.054	0.048	−0.038	0.014
	(−1.739)		(−2.485)		(−1.635)		(−0.861)	
$Nb.P$	−0.095**	0.099	−0.073***	0.120	−0.122***	0.147	−0.062	0.022
	(−2.413)		(−2.686)		(−3.019)		(−1.094)	
$Rank$	−0.298**	0.072	−0.199*	0.066	−0.340**	0.084	−0.263	0.029
	(−2.025)		(−1.934)		(−2.204)		(−1.266)	
	Panel C: Projects not yet operational ($N = 131$)							
$Nb.C$	−0.307	0.014	−0.090	0.003	−0.628*	0.055	−0.018	0.000
	(−0.866)		(−0.366)		(−1.717)		(−0.036)	
$FinVol$	−0.359**	0.096	−0.237**	0.088	−0.436***	0.128	−0.262	0.027
	(−2.333)		(−2.223)		(−2.741)		(−1.185)	
ΔFin	−0.010	0.018	−0.006	0.017	−0.007	0.009	−0.013	0.016
	(−0.972)		(−0.925)		(−0.672)		(−0.907)	
$Nb.P$	−0.160***	0.127	−0.118***	0.146	−0.213***	0.203	−0.089	0.021
	(−2.721)		(−2.951)		(−3.606)		(−1.041)	
$Rank$	−0.515***	0.182	−0.268**	0.104	−0.597***	0.221	−0.462**	0.077
	(−3.373)		(−2.433)		(−3.805)		(−2.060)	

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

Looking at the ongoing carbon bombs, the change in the volume of financing (ΔFin) is more important for ESG than its level ($FinVol$). However, this relationship should not be interpreted as causal. It may reflect the fact that reductions in carbon-intensive financing are viewed favorably by ESG raters, that stronger ESG orientations lead banks to reassess their involvement in carbon bombs, or that both variables are jointly driven by other underlying factors.

We do not formulate explicit expectations for the S and G scores. There are plausible reasons why both dimensions may be associated with bank involvement in carbon bombs. For example, good governance could be a prerequisite for large-scale project financing, and the social dimension could be influenced by labor and community impacts of oil and gas exploration in certain regions. However, these links are less direct than those for the environmental dimension. Empirically, we find that the results for the S score are similar to those for the E score, whereas the G score is less well explained by banks' involvement in carbon bombs.

4. Market reaction to carbon bomb financing

To examine the value relevance of carbon bomb financing, we test the following hypotheses:

H1: (Naive reaction hypothesis) The average market reaction is negative.
H2: (Incremental information hypothesis) The market reacts more negatively if a bank is more involved in financing carbon bombs than its pre-release ESG score would suggest.
H3: (ESG reputation channel hypothesis) The market reacts more negatively if a bank has a lower pre-release ESG score.

Following common practice in event studies, we measure the market reaction to the carbon bomb information by the Cumulative Abnormal Return (CAR) over the event window. We choose a short event window [−1,1] from the day before to the day after the publication, because there is no uncertainty about the announcement date (31 October 2023), and the collaborating media houses ensured wide distribution on day 0. The abnormal performance on day t is defined as the market-adjusted stock return $AR_{it} = r_{it} - \beta_i r_{mt}$, where AR_i is the abnormal return of bank i, r_i is its stock return, r_m is the return of the market proxy and β_i is the slope of the characteristic line in the estimation window [−252, −2]. We use the most common country index in the country where a bank is headquartered as the market proxy. Due to missing stock price data or confounding events in the event window, 14 banks have to be excluded, leaving 44 banks for this part of the study.[2]

According to the naive reaction hypothesis H1, the market reaction should be negative on average. To test this hypothesis, we calculate the Cumulative Average Abnormal Return (CAAR) and apply the BMP t-test of Boehmer et al. (1991) and Kolari and Pynnönen (2010) to account for the fact that the event date is the same for all banks (see also Antoniuk and Leirvik, 2024). With a CAAR of −0.680% and a t-value of −0.289, there is clearly no support for this hypothesis.

Hypothesis H2 states that the market reacts to the part of a banks' involvement that is not yet captured by its ESG score. This could be implemented as a two-stage regression. The first-stage regression would be $Var_i = b_{10} + b_{11} ESG_i + \epsilon_i$, where b_{10} and b_{11} are the regression coefficients (with b_{11} expected to be negative). The residuals would be used as the explanatory variable in the second regression: $CAR_i = b_{20} + b_{21}\epsilon_i + \varepsilon_i$ with the expectation $b_{21} < 0$ (negative market reaction to higher bank involvement not explained by ESG). We integrate the two steps by inserting $\epsilon_i = Var_i - b_{10} - b_{11} ESG_i$ from the first stage into the second-stage equation, which gives $CAR_i = (b_{20} - b_{10} b_{21}) - b_{11} b_{21} ESG + b_{21} Var_i + \varepsilon_i$. We adopt the general structure of the equation in our regression model:

$$CAR_i = \alpha + \beta ESG_i + \gamma Var_i + \varepsilon_i. \quad (2)$$

Under H2, we expect γ to be significantly negative and β to be negative but small. Under H3, in contrast, β should be significantly positive while γ is insignificant.

The regression results in Table 4 clearly reject the incremental information hypothesis and confirm the ESG reputation channel hypothesis. The coefficient of ESG is significantly positive in all specifications while the Var coefficients are close to zero. Between 12% and 21% of the variation of CAR can be explained by ESG. The ESG coefficient of *Rank* for all projects is 5.7, which means that a one-standard-deviation increase of ESG would result in a 82 basis points increase in CAR.

Our results are robust to using the E score rather than ESG in Eq. (2). The results also remain robust when we augment Eq. (2) with a dummy variable, $NZBA$, which equals one if bank i is a member of the Net-Zero Banking Alliance (NZBA) and zero otherwise. Membership could arguably convey information about a bank's involvement in carbon bombs, similar to the role of ESG. However, the estimated $NZBA$ coefficients (untabulated) are statistically insignificant, while the ESG coefficients remain significant. This outcome is consistent with expectations: while ESG likely incorporates NZBA membership, it also reflects a broader set of information.

As an additional robustness check, we examine whether investors required more time to rationally process information beyond the initial market reaction to the media release. However, extending the event window to three days after the release provides no evidence in support of the incremental information hypothesis.

The media coverage was strongest in France, Germany, and the UK, suggesting that the market reaction might have been more pronounced in these countries. We test this hypothesis using an extended version of Eq. (2) that includes interaction terms between a dummy variable for these countries and ESG as well as Var. However, all interaction coefficients are small and statistically insignificant. Interpretation is limited by the small number of banks headquartered in these countries (12), which may result in insufficient test power.

5. Discussion

We find that the market reaction to the disclosure of the carbon bomb financing was based on the pre-release ESG score rather than the incremental information about the carbon bombs. The underlying assumption may have been that banks with high ESG

[2] The specific reasons for the exclusion of 14 banks are: quarterly earnings announcements in the event window (6); ex-dividend date in the event window (2); delisted bank shares (4); Chinese A-shares due to trading restrictions for international investors (2).

Table 4
Market reaction.
Regression results of cross-sectional regressions $CAR_i = \alpha + \beta ESG_i + \gamma Var_i + \varepsilon_i$, where CAR is the Cumulative Abnormal Return in the event window [−1,1] and $Var \in \{Nb.C, FinVol, \Delta Fin, Nb.P, Rank\}$. $Nb.C$ is the number of fossil fuel companies financed; $FinVol$ is the total financing volume from 2016 to 2022 in billion USD; ΔFin is the relative change of the financing volume in 2022 compared to the average financing volume from 2016 to 2021; $Nb.P$ is the number of carbon bombs financed; and $Rank$ is the average rank according to the previous four indicators. Each regression is based on 44 bank observations. In Panel A, the bank involvement variables are calculated on the basis of all carbon bomb projects, in Panel B on the basis of ongoing projects and in Panel C on the basis of planned projects. The slope coefficients are multiplied by 10^4. The t-statistics are given in parentheses.

	ESG	Var	R^2
Panel A: All carbon bomb projects ($N = 425$)			
$Nb.C$	5.180**	2.326	0.165
	(2.288)	(1.491)	
$FinVol$	5.455**	0.846	0.137
	(2.379)	(0.923)	
ΔFin	5.272**	−0.140	0.121
	(2.191)	(−0.291)	
$Nb.P$	5.468**	0.008	0.120
	(2.334)	(0.012)	
$Rank$	5.718**	1.418	0.127
	(2.441)	(0.612)	
Panel B: Ongoing projects ($N = 294$)			
$Nb.C$	5.167**	2.399	0.164
	(2.281)	(1.481)	
$FinVol$	5.449**	0.837	0.137
	(2.376)	(0.908)	
ΔFin	5.285**	−0.126	0.121
	(2.194)	(−0.266)	
$Nb.P$	5.461**	−0.004	0.120
	(2.330)	(−0.006)	
$Rank$	5.683**	1.311	0.127
	(2.431)	(0.574)	
Panel C: Projects not yet operational ($N = 131$)			
$Nb.C$	5.603**	9.170*	0.206
	(2.533)	(1.854)	
$FinVol$	5.969**	1.647	0.146
	(2.568)	(0.667)	
ΔFin	5.771**	0.016	0.136
	(2.453)	(0.115)	
$Nb.P$	5.840**	0.270	0.138
	(2.488)	(0.276)	
$Rank$	6.618***	3.382	0.172
	(2.803)	(1.305)	

Note: $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$.

scores can be more trusted to reduce their involvement in large fossil fuel projects in the future. This is consistent with the findings of Xu et al. (2012), Xu and Zhang (2024) that a strong environmental reputation mitigates the negative reaction to the disclosure of environmental fines (see similarly for a strong Corporate Social Responsibility reputation Godfrey, 2005). While significant, the ESG-related market reaction remains relatively small given the crucial role of carbon bomb projects in reducing CO_2 emissions and the importance of transparency about their financing.

The financing of carbon bombs is largely indirect, with banks financing the fossil fuel companies operating these projects rather than the projects themselves. This indirect financing structure obscures the relationship between banks and carbon bomb projects, allowing banks to remain involved (Cojoianu et al., 2021; Beyene et al., 2022; Rickman et al., 2024). As fossil fuel projects continue to be perceived as profitable (Kreibiehl et al., 2022), this dynamic creates strong incentives for continued investment. Consequently, as a policy implication, it may be prudent to consider introducing binding restrictions on indirect financing as well.

The main limitations of this study are the small sample size and the cross-sectional nature of the data. A larger sample size combined with time-series information on carbon bomb involvement would allow for more refined analyses, including tests of cross-country heterogeneity in investor responses to bank financing of carbon bombs. It would also be interesting to study the role of media coverage in greater detail, but such analyses are constrained by the small number of banks per country.

CRediT authorship contribution statement

Tim Ceresa: Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation, Conceptualization. **Martin Wallmeier:** Writing – review & editing, Writing – original draft, Software, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The authors do not have permission to share data.

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