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Altunbas, Yener; Reghezza, Alessio; Marques-Ibanez, David; Rodríguez d'Acri, Costanza; Spaggiari, Martina

Journal of Financial Stability

DOI:
https://doi.org/10.1016/j.jfs.2022.101049

Published: 01/10/2022

Peer reviewed version

Do banks fuel climate change? [1]

Alessio Reghezza
(University of Genoa)
Yener Altunbas
(Bangor Business School)
David Marques-Ibanez
(European Central Bank)
Costanza Rodriguez d'Acri
(European Central Bank)
Martina Spaggiari
(European Central Bank)

Abstract

Do climate-oriented regulatory policies affect the flow of credit towards polluting firms? We match loan-level data to firm-level greenhouse gas emissions to assess the impact of the Paris Agreement. We find that, following this agreement, European banks reallocated credit *away* from polluting firms in relative terms. Specifically, euro area banks' loan share to more polluting firms decreased by about 3 percentage points compared to less polluting (or "green") firms after the 2015 Paris Agreement (COP21). This result is stronger for banks that are well capitalized, have lower credit quality, and are less profitable.

Keywords: Climate change; Paris Agreement; loan-level data; difference-in-differences
JEL classification: E51, G28, H23

[1] We are very grateful to three anonymous referees, as well as to Barbara Casu, Laura Chiaramonte, Franco Fiordelisi, Stefano Giglio, Claudia Girardone, Sofia Johan, Simone Manganelli, Philip Molyneux, Alessandra Mongiardino, Jose-Luis Peydro, Alex Popov, Stefano Piserà, Nick Rowe, Glenn Schepens and participants at seminars at the Essex Business School, European Central Bank, European Finance Association, Saudi Arabia Rias King Faisal University, Qatar Centre for Global Banking and Finance and Dundee Business School for their helpful comments. Alessio Reghezza is at University of Genoa, Yener Altunbas (y.altunbas@bangor.ac.uk) is at the Bangor Business School. Costanza Rodriguez d'Acri (Costanza.Rodriguez@ecb.europa.eu) and Martina Spaggiari (Martina.Spaggiari@ecb.europa.eu) are at the Directorate General Macroprudential Policy and Financial Stability at the European Central Bank. David Marques-Ibanez (david.marques@ecb.europa.eu) works at the Directorate General Research at the European Central Bank. Contacting author: Alessio Reghezza (email: alessio.reghezza@edu.unige.it).

1. Introduction

Climate change poses major risks to the global economy. It affects, for example, the availability of resources, influencing the price of energy and the value of companies. The Intergovernmental Panel on Climate Change (IPCC) concluded that the level of emissions observed since the mid-twentieth century would probably lead to global warming reaching 1.5°C above pre-industrial levels between 2030 and 2052 (IPCC, 2018). This would cause long-lasting changes, increasing the likelihood of severe, pervasive, and irreversible impacts on ecosystems and people. In this direction, the number of natural disasters worldwide and the value of (insured and uninsured) accompanying economic losses have risen over the last four decades (Charts 1 and 2).

In turn, policymakers have started to recognize that climate change represents a major and pressing threat (Carney, 2015; ESRB, 2016). The Paris Agreement (COP21), signed in December 2015, represents a milestone: countries responsible for 97% of global greenhouse emissions agreed to take action in order to keep global warming below 2°C above pre-industrial levels. Furthermore, COP21 invited nations to publicly communicate their mid and long-term strategies for reducing gas emissions through "Intended Nationally Determined Contributions" (INDCs). COP21 represents the first comprehensive climate deal that explicitly recognizes the need to "make finance flows compatible with a pathway toward low greenhouse gas emissions and climate-resilient development". This means pushing for a reorientation of capital allocation (Article 2.1(c)). It also increases peer pressure regarding meeting global warming targets, as signatories are committed to rapidly reducing CO_2 emissions to achieve zero net emissions in the second half of the twenty-first century.[2,3]

Being a major provider of credit, the banking sector is a key player in these efforts. The momentum established by COP21 enlarges the set of available investment opportunities to finance green projects and renewable energy. Indeed, investments in renewable energies have increased sharply in recent years (Chart 3), and are expected to grow enormously also in terms of market share (IEA, 2015; International Renewable Energy Agency, 2016). This increase is driven by a growing consensus in moving towards a low-carbon economy and technological improvements that lead to

[2] In particular, the European Union (EU) has committed to reducing its greenhouse gas emissions by 40% by 2030, the United States by 26-28% by 2025, and China and India by 60-65% and 33-35% per unit of GDP respectively. More information on the Paris Agreement is available at https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf.

[3] Central banks and national governments have supported climate change efforts. For instance, the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) seeks to support the transition to a low-carbon economy by raising awareness and pursuing efforts towards improving the pricing and management of climate change risks in the financial sector.

cost reductions in renewable energy, making alternatives to fossil fuel more appealing (Mazzucato and Perez, 2015; Krueger et al., 2020).

At the same time, banks face new risks in this respect, in particular physical and transition risks.[4] Physical risks arise from weather and climate-related catastrophes, such as floods, droughts, storms and sea-level rises (Nordhaus, 1977; Stern, 2008; Nordhaus, 2019).[5] Transition risks arise from adjustments made towards developing a green economy and depend on the timing and speed of this process. Unanticipated changes in climate policies, regulation, technologies and/or market sentiment could provoke a repricing of the value of banks' assets (CISL, 2019; Hong et al., 2019). Consequently, banks exposed to climate-sensitive sectors could be forced to conduct fire sales of carbon-intensive assets, leading to liquidity problems (Pereira da Silva, 2019a). This could generate uncertainty and procyclicality, ultimately increasing banks' market risk (BoE, 2018). Transition risks could also affect banks' credit risk if new technologies or changes in consumer behavior towards "environmentally friendly" sectors lowered carbon-intensive firms' profitability, further increasing their default risk (Krueger et al., 2020).[6] Although transition risks are difficult to quantify, the market valuation of the top US coal producers fell by 95% over the 2010-2017 period highlighting that disruptive changes to technology can cause sharp fluctuations in the valuation of "stranded assets" (Adrian et al., 2020).[7]

In this paper we focus on transition risk by considering a major climate change policy event to investigate whether European banks have started to change their lending by distinguishing between more and less polluting firms. We focus on two main hypotheses. The first poses that the Paris Agreement might have encouraged banks to lend *even more* to more polluting firms. As banks are not legally constrained by the agreement to lend to any sector, they might have a greater incentive to "cream off" the market and step up their lending to more polluting firms while they are still allowed to do so. The idea here is that banks could benefit from free riding on a negative externality (pollution), by increasing their lending to more polluting (but potentially more profitable) firms while they can.

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[4] Another type of risk that is often mentioned is liability risk (Carney, 2015), which consists of the future impact arising when parties who have suffered losses seek compensation from those responsible. For our purposes, these costs are often considered to be part of either transition or physical risks.

[5] Physical risks have increased sharply in recent years, rising from USD 10 billion in the 1980s to USD 138 billion in 2017 (computed as annual global weather-related insured losses; Adrian et al., 2020).

[6] Firms' profitability could be affected by the implementation, for instance, of a carbon tax.

[7] Stranded assets include assets such as coal, gas and oil reserves which should remain unused or unextracted to keep global warming below the target of 2°C. As such, they may suffer from sudden write-downs, devaluations, or conversion to liabilities.

According to the second hypothesis, however, COP21 had suasion effects on banks, driving them to lend less to polluting firms in anticipation of more stringent climate policies in the future. While COP21 may not have an immediate effect on banks' exposure to physical risks, it could affect the profitability and viability of more carbon-intensive firms, which face high transition costs. Firms producing disproportionately high levels of CO_2 emissions may, for example, find themselves exposed to carbon pricing risk and other regulatory interventions introduced to curtail their emissions (Bolton and Kacperczyk, 2020). Transition risks may eventually be perceived by banks as a systematic risk factor if regulatory interventions to curb firms' emissions are broadly applied (e.g. in the spirit of a carbon tax). Since the exposure of banks' loan portfolios to climate-relevant sectors is large (Battiston et al., 2017), banks could try cushioning climate shocks by starting to take them into account and anticipating transition risks.

To this end, we matched granular information on euro area banks' large exposures to individual counterparties – taken from supervisory reporting – to firm-level greenhouse gas emission intensities. We ran loan-level difference-in-differences estimations over the 2014-2018 period and find that banks reallocated their credit *away* from polluting corporations following the COP21. Specifically, euro area banks' loan share to the more polluting firms decreases by about 3 percentage points compared with the less polluting (or "greenest") firms after COP21. We show that this result is stronger for banks that are well capitalized, have lower credit quality and are less profitable. Our results are robust to the inclusion of bank and firm-specific characteristics and are saturated with industry*time, bank and country fixed effects. We contend that climate change regulatory initiatives can push banks towards greener businesses.

This paper contributes to a growing literature on climate change and the financial sector which supports the view that financial markets, corporations and the housing market are starting to take physical and transition climate risks into account. For instance, French firms subjected to greater climate risks reduced their leverage following COP21 (Ginglinger and Moreau, 2020). For housing, it has been shown that homes exposed to sea-level rises sell for about 7% less than equivalent houses (Bernstein et al., 2019), that energy-efficient properties are less likely to go into payment arrears than energy-inefficient ones (Guin et al., 2022), that differences in beliefs surrounding climate change affect house prices (Baldauf et al., 2020), and that areas more likely to be affected by climate change pay higher yields when issuing long-term municipal bonds (Painter, 2020). There is also evidence

that investors already incorporate information on climate-related risks when assessing risk profiles (Ilhan et al., 2021).

We contribute to the literature that analyses the effect of climate change on bank lending. A recent survey (Krueger et al., 2020) reveals that concerns about climate change are already on bankers' minds: 50% of financial institutions state that climate risks have already started to materialize, while only 10% believe that climate risks will materialize in ten years or more. There is evidence that banks already charge higher lending rates to firms with below-average levels of corporate social responsibility (Goss and Roberts, 2011), that create environmental concerns (Chava, 2014), or that are more opaque on their carbon emissions (Kleimeier and Viehs, 2016). On the syndicated loan market banks have charged higher lending rates (i.e. premium) to account for climate risk (De Greiff et al., 2022), while greener firms (i.e. with greater environmental consciousness) have been shown to borrow at lower rates (Degryse et al., 2020). Banks also started to price in climate policy exposure by raising the cost of credit for fossil fuel-based firms, determined (again) by an increased awareness of transition risks (Delis et al., 2018).

Our paper is probably closer to De Haas and Popov (2019) and Mesonnier (2019). De Haas and Popov find evidence of lower CO_2 emissions in economies that are more equity-funded and argue that stock markets contribute to a reallocation of investment towards less polluting sectors. We complement De Haas and Popov (2019) findings on equity funding by investigating the bank credit market. We additionally complement Mesonnier (2019) findings, that show that in France banks reduced credit provision to fossil-based sectors over the 2010-2017 period, moving to loan-level credit exposures and pollution of individual firms in a multi-country setting which enhances the granularity of the assessment and allows us to dig deeper into the findings.[8]

While our approach is very granular, we do not attempt to pin-down the exact mechanisms for our findings. We pose that this shift in lending composition driven by governments' policy announcements about climate change might be due to moral suasion and/or increased awareness of the unpredictability of both physical and transition risks. These factors are likely driving financial institutions to curtail lending to the more polluting firms to avoid major damages or outright catastrophes and their associated reputational risks (Pindyck, 2020). While some banks may only perceive a weak short-term direct impact from climate change, policy announcements (such as

[8] The ECB's Financial Stability Report (May 2020, Box 3) shows different findings, using sectoral and firm-level approaches. This vouches for the usefulness of firm-level information when analysing banks' exposures in a climate context, particularly for large firms – those more prevalent in our dataset.

COP21) would make them aware that the horizon of regulators and financial agents is becoming much shorter (Bolton et al., 2020). Hence, once rating agencies and/or banking supervisors include climate change in their credit risk assessments, unprepared banks might face added costs very quickly. In this respect this paper has policy implications on the role to be played by the banking sector on climate change.

The paper proceeds as follow. Section 2 introduces our methodology, Section 3 the data and Section 4 the results, while several robustness checks are presented in Section 5. Section 6 offers a conclusion.

2. Methodology

In order to ascertain whether European banks allocated their lending to more or less polluting firms following COP21 we employ loan-level *DiD* estimates. Our baseline regression takes the following form:

$$Y_{ijt} = \alpha_i + \tau_k + \delta_b + \beta_1 \, Polluted_{jt} * Post_t + \beta_2 X_{it} + \beta_3 Z_{jt} + \varepsilon_{ijt} \qquad [1]$$

Where reporting banks are denoted by *i*, borrowing firms by *j*, country of a borrowing firm by *b*, corporate sector by *k* and time by *t*. *Y* defines our dependent variable (loan share) which is the share of the bank's total lending to a specific firm. *Polluted* is a dummy variable computed across sectors which takes the value 1 if a firm is polluting, otherwise 0. Specifically, polluting firms are those which have an above-median level of CO_2 emissions.[9] *Post* is a dummy which takes the value 1 after the introduction of COP21, otherwise 0.[10] β_1, our main coefficient of interest, represents the average difference in a bank's loan share between more and less polluting firms after the introduction of COP21. *X* and *Z* are vectors of the bank and firm-specific control variables respectively. We use them to capture and assess how cross-bank and firm heterogeneity over time affects bank lending. As bank-specific variables, we employ the logarithm of bank total assets (Size), the ratio of equity to total assets (E/TA), the non-performing loans ratio (NPLs), the ratio of fees and commissions income to operating income (Business model) and the ratio of cash and cash equivalents to total assets (Liquidity). At the firm level, we include the logarithm of firm total assets (Firm Size), the ratio of long-term debt to total assets (LTD/TA), the current ratio (Firm Liquidity), the return on equity (Firm

[9] Where the median level is 2,093,000 tonnes of CO2 per year. Further specifications will be provided in the robustness check section.

[10] As the Paris Agreement was signed in December 2015, the Post dummy takes the value 0 for the years 2014 and 2015 and the value 1 for the years 2016, 2017 and 2018.

ROE) and the interest coverage ratio (INTcover).[11] Robust standard errors are double-clustered at the bank and the firm levels (Behn et al., 2016; Jiménez et al., 2017) so that we allow standard errors to be correlated within bank-firm pairs but not across them.[12] To tighten the identification, we also include bank fixed effects (α) to control for unobservable bank-specific factors. We also employ sector, sector*time (τ) and country fixed effects (δ) to take unobservable heterogeneity into account across sectors and countries.

Our difference-in-differences estimators require several assumptions to hold. First, treatment assignment has to be exogenous to bank lending. In other words, the policy action ("intervention") should affect bank lending – not the other way around. It is reasonable to expect this to hold as COP21 is not driven by bank lending – it is driven by a direct assessment of the potential effects of global warming on economies and societies. Second, the *DiD* approach is only valid under the restrictive assumption (the "parallel trend assumption") whereby changes in the outcome variable over time would be similar in both the treatment (more polluting firms) and the control groups (less polluting firms) (Bertrand et al., 2004; and Imbens and Wooldridge, 2009). Chart 4 depicts banks' loan share from 2014 to 2018 for both more and less polluting firms. Loan share moves in the same direction prior to COP21, indicating that the parallel trend assumption holds. Since the agreement in December 2015, banks' share of lending to more polluting firms has fallen steadily over the sample period, while it has stayed constant for less polluting firms.

3. Data

To investigate the impact of COP21 on bank lending, we construct a granular dataset combining confidential supervisory and public data. Information on euro area banks large exposure data to individual counterparties is obtained from supervisory reporting (COREP 27-31) which requires banks to convey to the SSM (i.e. Single Supervisory Mechanism, or SSM, hosted by the ECB and in charge of supervising large banks in the euro area) detailed information on their credit exposures since 2014.[13] Firm-level CO_2 total emissions are taken from Refinitiv Eikon. Balance sheet information on the largest euro area banks is drawn from the ECB supervisory statistics and cover more than 80% of total lending in the euro area. Balance sheet data of non-financial corporations comes from Amadeus, a private data provider. Our final bank-firm matched sample covers 185 large

[11] A more detailed definition of the variables employed is provided in Table A1 in the Appendix.
[12] We tested the control variables for multicollinearity using the Variance Inflation Factor (VIF). A mean VIF of 1.05 suggests that our controls are not highly correlated (a correlation matrix is provided in Table A2 in the appendix).
[13] Common Reporting (COREP) is the standardised reporting framework issued by the EBA for CRD reporting. It covers credit risk, market risk, operation risk, own funds and capital adequacy ratios.

euro area banks and 230 corporations from 13-euro area countries and the United States over the 2014-2018 period, leading to a total of 5,193 observations. Table 1 displays the number of banks and firms as well as the number of observations by country, economic sector and pollution dummy. Table 2 shows the summary statistics and t-tests for bank loan shares, other balance sheet variables reported for polluting and for non-polluting firms, prior to and after the introduction of COP21.

3.1 Corporate carbon emissions data

CO_2 total emissions, measured in tonnes of CO_2 per year, are reported at the firm level. Refinitiv Eikon follows the Greenhouse Gas Protocol which sets the standard for measuring firm emissions.[14] It distinguishes between various sources of (annual) emissions: Scope 1 emissions refer to direct emissions from sources that are owned or controlled by the company and include emissions from fossil fuels employed in the production process. Scope 2 emissions stem from the consumption of purchased energy (heat, steam, and electricity) sourced upstream from the firm. In this paper, we use scope 1 and scope 2 emissions to identify companies' level of CO_2 emissions. Although firm-level CO_2 emission intensities are estimated by different data providers (CDP, Trucost, MSCI and Sustainalytics), recent research (Busch et al., 2018) has shown that there is little variation in the emissions data across providers (the correlation for scope 1 emissions data is, on average, 0.99 while it is 0.98 for scope 2 emissions data). The median firm in our sample produces 2.092 million tonnes of CO_2 emissions (scope 1 and scope 2). In Table 3, we report descriptive statistics on pollution by sector. We use the sector classification provided by FTSE Russel classification which relies on the Industry Classification Benchmark (ICB).[15] "Industrial metals and mining", "Electricity" and "Gas, oil and coal" produce, on average, the highest level of CO_2 emissions while "Real estate investment trust", "Media" and "Technology" produce the lowest. Our decision to consider firm-level CO_2 emission intensities instead of sectoral breakdowns is motivated by the significant heterogeneity in the level of pollution across firms within each sector. Table 3 shows that companies belonging to the cleanest sectors display levels of CO_2 emissions that are much higher than the median level of 2.092 million tonnes of CO_2.

[14] See https://ghgprotocol.org

[15] The ICB uses a system of 11 industries, partitioned in 20 super sectors which are further divided into 25 sectors that include 173 sub-sectors. We classify out sectors based on the super sector classification. More detailed information is available at: https://content.ftserussell.com/sites/default/files/support_document/ICB%20Taxonomy%20overview%20Cut%20Sheet_V03.pdf.

3.2 Large-exposure data

Our loan-level data are collected under the large-exposure regulatory regime. Introduced in the EU in 2014, the regime aims to ensure that risks arising from large exposures are kept at bay by limiting the maximum loss a bank can incur in case of a sudden counterparty failure. According to Article 393 of the Capital Requirements Regulation (CCR), an exposure to a single client (or a connected group of clients) is considered to be a large exposure when, before the application of credit risk mitigation measures and exemptions, it is higher than €300 million (or 10% of an institution's eligible capital). While confidential, this dataset offers several advantages over the syndicated loan market datasets commonly used in the empirical banking literature. First, it has a far larger coverage. Second, it is easier to isolate banking shocks as it is not limited to multiple bank lending relationships. Our dataset encompasses detailed information on exposures (e.g. instruments) and reporting entities (e.g. legal entity identifiers, LEIs, and classifications for country and sector), which allows us to link the large-exposure dataset to other data sources. The large-exposure templates used in our analysis are reported at the highest level of consolidation and, for the most relevant group sub-structures, at individual level. Detailed information on banking groups available at the ECB allows us to refine the dataset, allocating exposure to specific group components and eliminating duplicates. Panels A and E of Table 2 present the descriptive statistics for our dependent variable (loan share), reported for more and for less polluting firms before and after COP21. As mentioned in Section 2, the loan share is computed as the share of the bank's total lending to a specific firm. This allows us to investigate the allocation of loans by each bank (loan share) between more and less polluting firms. A primary inspection of the data shows that the average loan share to more polluting firms decreased from 10.8% to 10.2% after COP21, while increasing by about 0.1 percentage points for less polluting firms.

3.3 Bank and firm balance sheet data

Panels B and F of Table 2 show summary descriptive statistics for bank balance sheet data. We include bank size (Size), computed as the logarithm of bank total assets, as large bank lending is generally more insulated from adverse shocks and displays a greater degree of diversification (Gambacorta and Marques-Ibanez, 2011; Jiménez et al., 2014; Popov and Van Horen, 2015). We employ the equity to total assets (E/TA) ratio to control for differences in the level of bank capitalization. The effect of bank capital on lending is not clear-cut. On the one hand, recent studies (Gobbi and Sette, 2015; Michelangeli and Sette, 2016; Bolton et al., 2016; Gambacorta and Shin, 2018) demonstrate that banks with a larger equity base tend to lend more. On the other hand, we cannot exclude that a weakly capitalized bank could boost lending (specifically risky lending) to increase earnings which, if retained, could bolster bank equity (Caleb and Rob, 1999). We proxy bank

business models by using the ratio of fee and commission to operating income (Business model). A higher ratio would suggest greater reliance on non-interest income activities and probably less lending. We also control for the effect of asset quality in banks' loan portfolios by employing the non-performing loans ratio (NPLs) (Altunbas et al., 2012) as banks should be able to insulate themselves from credit supply shocks and reallocate loans according to changes in the economic environment and regulations. Finally, we use the ratio of cash (and cash equivalents) to total assets (Liquidity) as larger volumes of liquid assets could ease the transfer of resources to more profitable or less risky assets (Acharya and Naqvi, 2012).

Panels C and G of Table 2 display summary descriptive statistics for firm balance sheet data. Similarly, to Jiménez et al. (2017), we control for a variety of firm-specific factors that can affect demand for bank loans. Specifically, we control for size (Firm Size), measured by the logarithm of firm total assets, solvency which we compute by employing both the ratio of long-term debt to total assets (LTD/TA) and the ratio of earnings before interest and taxes to interest expenses (INTcover), profitability, which we calculate as net income divided by equity (ROE) and liquidity (Current ratio), which is captured by the current ratio – a measure of a firm's ability to cover its short-term obligations with its current assets.

4. Results

Columns 1-5 of Table 4 report the results for the loan-level *DiD* regression prior to and after COP21 (equation 1). All the results are presented with the inclusion of several combinations of fixed effects and control variables.

Table 4, first column, shows that European banks' loan share to more polluting firms fell by about 3 percentage points compared to less polluting firms (Polluting*COP21). We progressively tightened the econometric specifications by adding country, bank and industry fixed effects in columns 2 and 3. Moreover, we used bank-specific characteristics (column 4), firm-specific controls (column 5) and industry*time fixed effects (column 6), thereby including time-varying observable and unobservable factors that could affect the supply of and demand for bank credit. Although in some estimations the coefficient is slightly smaller in size, the statistical significance is that of the other econometric specifications.

In columns 7 and 8, we also use a different cut-off for the polluting dummy by considering, the first and the last percentiles instead of the median. This allows us to control for non-linearities in

the level of CO_2 emissions regarding bank loan shares. Specifically, we labelled as *super green* those firms that have a level of CO_2 emissions which is less than (or equal to) 398,553 tonnes of CO_2 per year (the first quartile of the CO_2 emissions distribution), and as *strong polluters* those companies which produce CO_2 emissions more than (or equal to) 12,700,000 tonnes of CO_2 per year (the last quartile of the CO_2 emissions distribution). The base dummy is represented by those firms which lie between the first and the last percentiles (which we labelled as *mid-polluters*). The results indicate that, while the share of lending to the more polluting companies decreased, in line with the baseline results, the share of lending to the "greenest" companies rose by 4.57 percentage points in comparison with *mid-polluters* after COP21. This finding provides further evidence that banks have been reallocating their credit away from polluting firms and have been investing increasingly in greener companies since COP21.

We interpret this result as showing that the recent climate change initiatives, as well as improved awareness of climate change-related risks, are pushing banks towards greening their business out of climate-sensitive firms in favor of more climate-resilient activities. Carbon-intensive investments may be subject to environmental and regulatory risks which include the risk of stranded assets and the long-term tail risks associated with catastrophes related to global warming (Andersson et al., 2016; Dafermos et al., 2018). Moreover, banks and financial institutions are subject to more intense public scrutiny about the environmental effects of their investment decisions. As suggested by some studies (see, among others, McCahery et al., 2016; Dyck et al., 2018), socially responsible investments are a powerful force in shaping banks' behavior.

Regarding the control variables, we observe a positive coefficient of bank capitalization (E/TA) on lending (column 4). This result is in line with recent studies (Gobbi and Sette, 2016; Michelangeli and Sette, 2016; Bolton et al., 2016; Gambacorta and Shin, 2018) which show that banks with a larger equity base lend more. In addition, we find that smaller and less leveraged firms represent a higher share of bank lending.

4.1. Impact of bank characteristics on lending responses to climate policy changes

We also split the sample by bank-specific characteristics to investigate whether the heterogeneity of bank capitalization, credit quality and profitability affects banks' reallocation of credit towards less polluting corporations. For instance, banks with deteriorated credit quality and low profits may perceive the risks stemming from climate change to be more expensive and, so, may be motivated to reallocate credit away from polluting firms. These banks may, in general, have fewer concerns when

investing in newer (and greener) business – representing an attempt to "gamble for resurrection". The same logic applies to less well capitalized banks (Dell'Ariccia et al., 2014). In this section, we show that banks with deteriorated credit quality and low profits increased their share of lending to greener firms, while less capitalized banks did not, as the result is not statistically significant. We also find that well capitalized banks decreased their share of lending to polluting companies after COP21. This result is probably attributable to the availability of a "capital space" (i.e. additional capital on top of requirements) allowing banks to include climate risk considerations in their medium-term capital planning and to take corporate social responsibilities into account.

The results are displayed in Table 5 (panels A to F). In panels A and B, we split the sample on the basis of capitalization by using the common equity tier 1 ratio (CET1) and the median CET1 value to define as "well capitalized" those banks with a CET1 ratio of more than 12.34%. On the one hand, well capitalized banks reallocated their credit away from polluting firms, decreasing the share of lending to polluting firms by around 2.7 percentage points after COP21 (the result is statistically significant at the 5% level). On the other hand, the result for less capitalized banks is not statistically significant, suggesting that less capitalized banks have limited room for maneuver to assume greater risks in an attempt to increase earnings, which, if retained, could bolster bank equity, thereby improving soundness (Caleb and Rob, 1999).

Panels C and D show the results based on the sample split by bank credit quality. We employed the ratio of non-performing loans to gross loans (NPL) and split the sample according to the median level, defining as the sub-sample of low (high) credit quality those banks that had an NPL ratio of below (above) 3.06%. As expected, banks with deteriorated credit quality switched their lending to less polluting firms (by 2.5 percentage points). It is less risky for them to abandon existing borrowers in favor of new borrowers, given the already impaired ability of the former to repay debts. The result is also in line with other studies (see, for instance, Gonzalez, 2005; Delis and Kouretas, 2011) which find that higher credit risk limits new risk-taking.

Panels E and F display the split results based on bank profitability. We use the return on asset (ROA), measured as net income by total assets, and again split the sample according to the median level, defining as the sub-sample of low (how) profitability those banks with a ROA of below (above) 0.36%. We find that less profitable banks switch from more to less polluting corporations (statistically significant at the 1% level) suggesting that less profitable banks have greater incentives to adjust their lending away from climate riskier corporations. Concerns over corporate social responsibility are

combined here with the need to adjust portfolios and to look for more profitable investments in new businesses.

These results suggest that banks' characteristics play a vital role in affecting their decisions to incorporate climate risk considerations into their investment choices and to assume the related social responsibilities. It also helps in understanding our baseline results, which appear to be driven by banks with deteriorated credit quality, low profits, and comparably high capital levels.

5. Robustness checks

5.1 Results based on CO_2 emission intensities

As a first robustness check, in the spirit of Bolton and Kacperczyk (2020), we replace our dummy of interest (*Polluting*) with the CO_2 emissions to total assets ratio, expressed as a continuous variable.[16] Relative CO_2 emissions, which measure the carbon intensity of a company, are computed as tonnes of CO_2 emissions (scope 1 + scope 2) divided by the company's total assets. For this exercise, the econometric specification takes the following form:

$$Y_{ijt} = \alpha_i + \tau_{kt} + \delta_b + \eta CO2\_Totassets_{jt} + \omega Post_t + \beta CO2\_Totassets_{jt} * Post_t + \gamma X_{it} + \mu Z_{jt} + \varepsilon_{ijt} \quad (2)$$

where, as in equation (1), reporting banks are denoted by i, borrowing firms by j, country of a borrowing firm by b, corporate sector by k and time by t. CO2_Totassets is the only variable that differs from equation (1) and represents the CO_2 emissions to total assets ratio. β is our coefficient of interest as it indicates whether, after COP21, banks reallocate their lending depending on firms' level of CO_2 emissions. For consistency, we saturate the model with the same combination of bank- and firm-specific characteristics as well as with the inclusion of bank, country and industry*time fixed effects.

The results are displayed in Table 6 (columns 1-5). The interaction coefficients are always negative and statistically significance (at the 5% and 10% level depending on the econometric specification) suggesting that the higher the level of CO_2 emissions post COP21 the lower the lending share compared to the period before the Agreement.

[16] Table A3 in the Appendix present summary descriptive statistics of the CO2 emissions to firm total assets by economic sector.

To investigate whether the effect on bank loans' share is economically meaningful, we plot in Figure 5 the relationship between CO_2 emissions intensity (x-axis) and the estimated difference in loan share from prior to after COP21 (y-axis). For the selection of CO_2 emission intensity, we rely on the descriptive statistics and select the 10th (0.3% tonnes CO_2 emissions/total assets), 25th (1.03% tonnes CO_2 emissions/total assets), 50th (3.71% tonnes CO_2 emissions/total assets), 75th (24.36% CO_2 emissions/total assets) and 90th (70.01% CO_2 emissions/total assets) percentiles of the related distribution. As shown in Figure 5, for firms with CO_2 emissions intensity below the median (50th percentile) the decrease in lending share Post Agreement is negligible, i.e. ranging between -0.01% to -0.13%. However, for firms with levels of CO_2 emission intensity equal to the 75th and 90th percentile, we find that banks after COP21 reduce their lending share by about 0.87% and 2.5%, respectively.

This check strengthens the baseline results which appear to be robust to the inclusion of a continuous variable of CO_2 emission intensity. As in the baseline specification, banks after COP21 appear to reallocate credit away from more polluting firms. Specifically, we find that this effect is stronger for firms with an-above 75th percentile of CO_2 emissions to total assets.

5.2 Results based on scope 1 CO_2 emissions

As a second robustness check, we remove scope 2 CO_2 emissions from the computation of the dummy *Polluting*, i.e. we consider only scope 1 CO_2 emissions. According to Kacperczyk & Peydró (2021), scope 1 CO_2 emissions are easier to track for banks as they refer to direct emissions over a one-year period from sources that are owned or controlled by the company, and include emissions from fossil fuel employed in the production process. Hence, they may represent a better screening metrics for creditors. Consequently, we run a robustness check to make sure that the results hold also when considering only scope 1 CO_2 emissions. In line with the baseline specification in equation (1), we consider treated those firms that have an above-median level of scope 1 emissions, where the median level is 581,703 tonnes of CO_2 emissions.

The results shown in Panel A of Table 7 are interesting for two reasons. First, the interaction coefficient (Polluting (Scope1)*COP21) is still negative and statistically significant (at the 10% level) suggesting the validity of our baseline findings. Second, the coefficient for scope 1 + scope 2 emissions reported in Table 4 is basically double of that estimated for only scope 1 CO2 emissions. This suggests an additional lending reallocation away from firms that present high level of both direct and indirect CO2 emissions following the agreement.

5.3 Accounting for banks' greener preferences

As a third robustness check, we use an additional control variable to capture banks' green preferences. Specifically, and following Degryse et al. (2021), we use banks' membership in the United Nations' Environment Program Finance Initiative (UNEP FI). The UNEP FI aims to "mobilize private sector finance for sustainable development" and since its establishment in 1991 more than 160 banks signed and joined the initiative. For this exercise, we hand-collected the information on the UNEP FI member banks from the official website.[17] Since in our sample 50 banks signed the UNEP FI initiative, we create a dummy variable labelled responsible which is equal to 1 for those 50 banks that joined the UNEP FI, and 0 otherwise.

The results of the inclusion of this additional control variable in the estimation is presented in Panel B of Table 7. The dummy *Responsible* does not affect the coefficient of interest (Polluting*COP21) which retains sign and statistical significance providing further reliability to the baseline findings.

5.4 Removing France

As a fourth robustness check, we removed France from the sample. According to Ginglinger and Moreau (2020), Article 173 of France's Law on Energy Transition for Green Growth, which was adopted in August 2015, establishes new climate risk reporting requirements for French credit institutions and investors. It is therefore possible that French banks reallocated their credit away from polluting corporations, not because of COP21, but rather as a reaction to the new regulation that was adopted in France in the same year (2015) that the Agreement was signed.

The results displayed in panel C of Table 7 are still statistically significant and of a magnitude which is in line with the baseline, further corroborating our main findings.

5.5 Placebo test

As a final robustness check, we use a placebo test to rule out that banks' share of lending between more and less polluting firms may have altered prior to the introduction of COP21 – e.g. in anticipation of other climate-related policies/shocks or for some bank-specific reason – thereby invalidating our choice of DiD estimation. We included the introduction of a "fake" COP21 one year prior to the actual event. If the estimated coefficient for the "false" COP21 is not statistically

[17] https://www.cdp.net/en/companies-discloser

significant, we can be more confident that the baseline coefficient captures a genuine policy shock. Panel D of Table 7 shows that the coefficient of COP21 is still negative, although it is smaller and is not statistically significant, adding further support to the validity of our baseline estimation.

6. Conclusion

We investigate the impact of a major climate change-related policy, e.g. the Paris Agreement (December 2015), on European banks' lending behavior towards polluting versus non-polluting corporations. This has been largely unexplored in the literature, which focuses mainly on assessing banks' exposures to climate-related risks and investigating the price reaction to climate change-related events. The credit dimension of banks' reaction to climate change policies remains scant and has been analyzed at the sectoral level for individual countries.

We offer robust evidence that European banks' loan share to more polluting firms decreased by about 3 percentage points, in relation to less-polluting firms, after the announcement of the Paris Agreement. We contend that recent climate change initiatives appear to push banks out of climate-sensitive sectors and towards greener business, at least in relative terms, probably in anticipation of more stringent policies and improved awareness of climate change-related risks. We also show that banks with lower credit quality, low profits and high capital levels are the drivers behind our main results, as they are reacting more strongly to climate policy actions.

Our work has important policy implications, as it underlines the pivotal role of banks in the adoption of significant climate change policies. It follows that green banking regulations could make a significant contribution to improving climate change and, therefore, central banks and banking authorities could play a role in shaping this debate.

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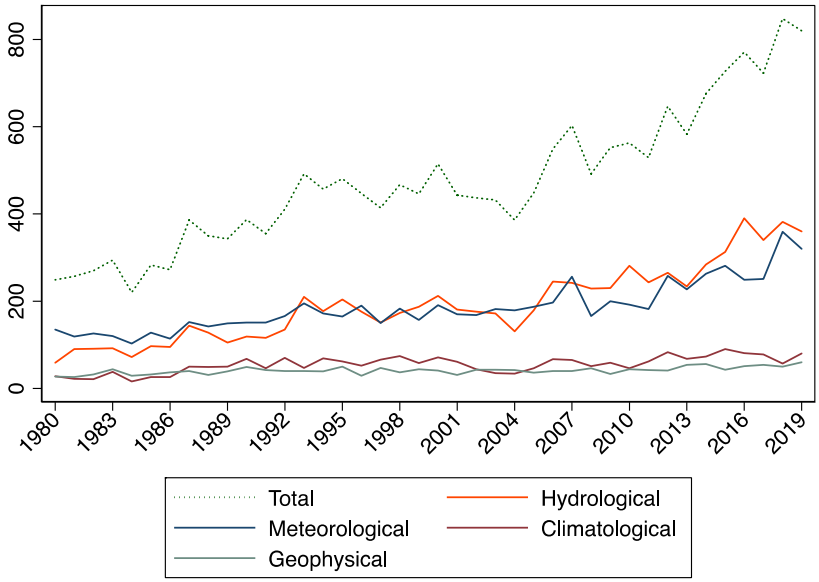
Figure 1. Number of major natural catastrophes worldwide over the 1980-2019 period

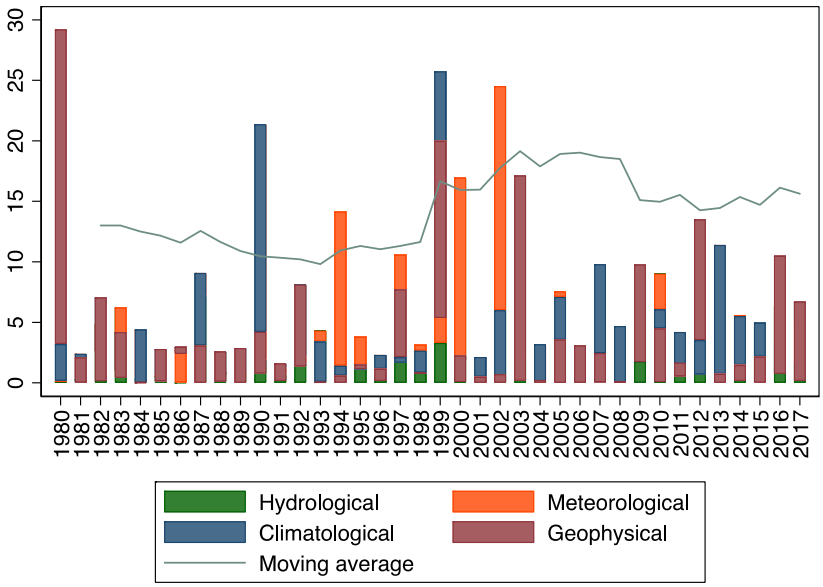
(number of events; year)



Source: Munich RE (https://www.munichre.com/en/risks/natural-disasters-losses-are-trending-upwards.html).

Figure 2. Economic losses from extreme climate-related events in Europe over the 1980-2017 period

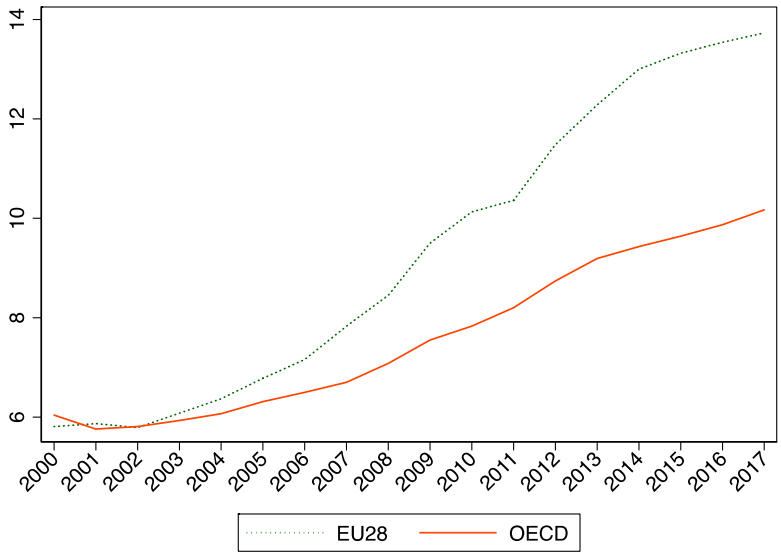
(EUR billions, 2017 values)



Note**:** The moving average is calculated over a ten-year period. The stacked bars are divided into different segments indicating the economic losses by type of event.
Source: European Environment Agency (https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2).

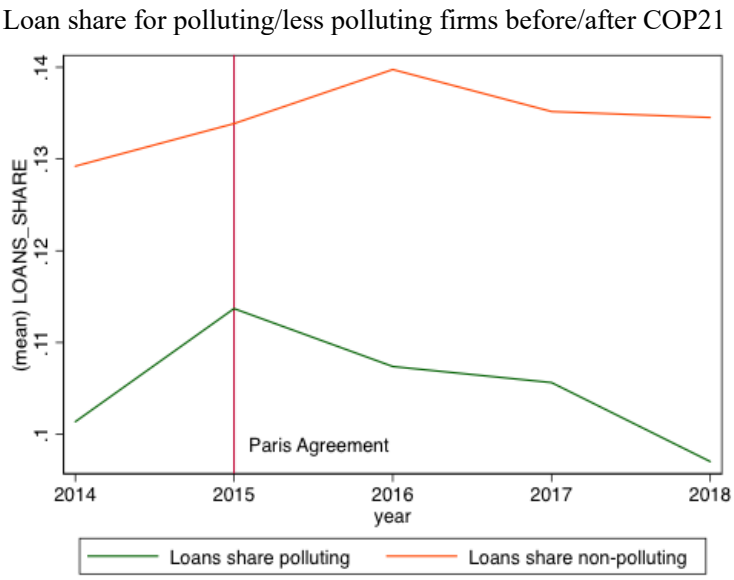
Figure 3. **Renewable energy as a percentage of total primary energy supply over the 2000-2017 period**

(percentages)



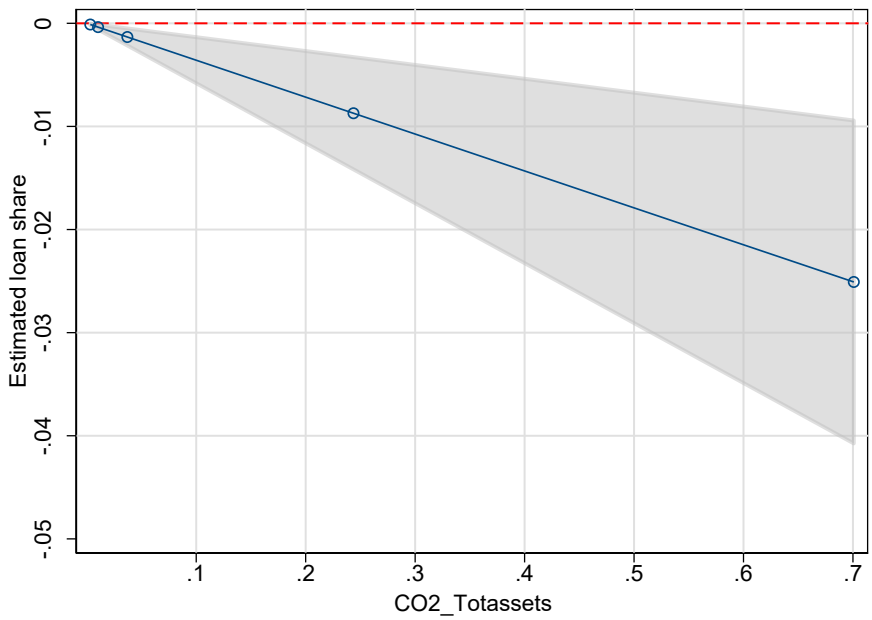
Notes: Renewable energy includes the primary energy of hydro, geothermal, solar, wind, tide and wave sources. Energy derived from solid biofuels, biogasoline, biodiesels, other liquid biofuels, biogases and the renewable fraction of municipal waste are also included.
Source: OECD (https://data.oecd.org/energy/renewable-energy.htm).

Figure 4. Loan share between polluting and less polluting firms over the 2014-2018 period
(left-hand scale: average loan share)



Notes: Loan share is computed as bank lending to a single firm divided by bank total loans.

Figure 5. Estimated relationships between CO_2 emissions intensity and loan share



Notes: the y-axis refers to the estimated difference in loan share from prior to after COP21. Loan share is computed as bank lending to a single firm divided by bank total loans, while the x-axis indicates the CO_2 emissions over firm total assets. The red dashed line marks the zero loan share. The blue circle indicates CO_2 emissions over firm total assets at the 10th, 25th, 50th, 75th, and 90th percentile.

Table 1. Number of banks and firms and number of observations by country, economic sector and pollution dummy

Countries	N.banks (obs.)	N.firms (obs.)	REIT	Media	Tech	Consumer products & services	Healthcare	Tele	Food	Travel	Industrial goods & services	Autos & parts	Retailers	Materials	Chemicals	Utilities	Oil, gas & coal	Electricity	Metals
Austria	8	6	2								1						1	1	1
	(16)	(56)	(10)								(12)						(12)	(12)	(10)
Belgium	15	6			1			1	1						1	1			1
	(201)	(129)			(4)			(6)	(55)						(38)	(19)			(7)
Germany	22	30	3		1	2	1	1		1	6	4	1	1	2	1	1	3	2
	(875)	(738)	(38)		(17)	(41)	(70)	(30)		(11)	(110)	(172)	(17)	(13)	(65)	(33)	(5)	(65)	(51)
Greece	1	1						1											
	(4)	(4)						(4)											
Finland	7	5			1									2			1	1	
	(29)	(50)			(16)									(14)			(5)	(15)	
France	59	48	6	3	3	5	3	2	3	2	5	3	3	4		2	1	2	1
	(1,985)	(1,932)	(239)	(49)	(113)	(160)	(147)	(116)	(83)	(42)	(111)	(95)	(100)	(267)		(106)	(63)	(230)	(11)
Ireland	1	0																	
	(32)	(0)																	
Italy	24	9						1			2			1		3	1	1	
	(627)	(421)						(90)			(45)			(6)		(60)	(107)	(113)	
Luxembourg	7	2						1											1
	(52)	(73)						(11)											(62)
The	15	8		1	1				1				1		2	1		1	
Netherlands	(557)	(84)		(21)	(5)				(15)				(7)		(11)	(10)		(15)	
Portugal	7	6						1			1		1	1			1	1	
	(147)	(100)						(6)			(7)		(7)	(5)			(16)	(59)	
Slovenia	5	2						1			1								
	(31)	(36)						(23)			(13)								
Spain	14	10	1			1		1			2			1		1	1	2	
	(636)	(429)	(22)			(10)		(76)			(89)			(72)		(15)	(26)	(119)	
United		97	1	3	18	4	16	5	5	1	10	3	7	3	5	4	4	5	3
States		(1,141)	(6)	(29)	(218)	(36)	(128)	(62)	(79)	(5)	(171)	(55)	(65)	(40)	(48)	(88)	(37)	(52)	(22)
Total	185	230	13	7	25	12	20	15	10	4	28	10	13	13	10	13	11	17	9
	(5,193)	(5,193)	(315)	(99)	(373)	(247)	(345)	(424)	(232)	(58)	(558)	(322)	(196)	(417)	(162)	(331)	(271)	(680)	(163)
Polluting		99	1	0	2	2	1	5	3	3	9	6	8	7	9	8	10	17	8
		(2,598)	(2)	(0)	(13)	(35)	(70)	(101)	(78)	(27)	(176)	(173)	(148)	(324)	(150)	(231)	(244)	(670)	(156)
Non-polluting		148	13	7	24	10	19	12	7	2	21	4	7	8	3	7	2	1	1
		(2,595)	(313)	(99)	(360)	(212)	(275)	(323)	(154)	(31)	(382)	(149)	(48)	(93)	(12)	(100)	(27)	(10)	(7)

Notes: “REIT” is a real estate investment trust; “Media” is media; “Tech” is technology; “Consumer products & services” is consumer products & services; “Healthcare” is healthcare; “Tele” is telecommunications; “Food” is food, beverage and tobacco; “Travel” is travel and leisure; “Industrial goods & services” is industrial goods and services; “Autos & parts” is automobile and parts; “Retailers” is retailers; “Materials” is construction and materials; “Chemicals” is chemicals; “Utilities” is gas, water and multi-utilities; “Oil, gas and coal” is oil, gas and coal; “Electricity” is electricity; “Metals” is industrial metals and mining. Observations are reported in parentheses.

Table 2
Summary statistics

	More polluting (=>2,092,000 Tonnes-CO_2/year)									
	Pre-COP21					Post-COP21				
	Obs.	Mean	Std	1st	99th	Obs.	Mean	Std	1st	99th
Panel A. Dependent variable										
Loan share	975	0.108*	0.243	0.000	1.000	1,576	0.102***	0.102	0.00	1.000
Panel B. Bank balance sheet variables										
Size	1,013	26.742***	1.722	21.557	28.271	1,585	26.923	1.512	21.949	28.261
E/TA	1,013	0.073***	0.045	0.055	0.266	1,585	0.068	0.030	0.055	0.179
Business model	1,013	0.404**	0.129	0.122	0.796	1,585	0.421**	0.136	0.117	0.796
NPLs	1,013	0.047**	0.036	0.014	0.139	1,585	0.037	0.027	0.014	0.139
Liquidity	1,013	0.046***	0.030	0.003	0.124	1,585	0.077	0.047	0.005	0.289
Panel C. Firm balance sheet variables										
Firm size	1,013	18.315***	0.953	15.622	20.286	1,585	18.233***	0.960	14.950	19.942
LTD/TA	1,013	0.234***	0.087	0.018	0.453	1,585	0.245	0.079	0.022	0.495
Current ratio	1,013	1.382***	0.640	0.540	3.620	1,585	1.324*	0.565	0.560	3.470
ROE	1,103	8.751***	13.05	-24.94	36.66	1,585	10.731***	14.701	-47.900	39.320
INTcover	1,103	3.562***	3.599	-1.620	15.160	1,585	5.814***	6.190	-4.440	31.160
	Less polluting (=<2,092,000 Tonnes-CO_2/year)									
	Pre-COP21					Post-COP21				
Panel E. Dependent variable										
Loan share	930	0.131*	0.270	0.000	1.000	1,656	0.132***	0.265	0.000	1.000
Panel F. Bank balance sheet variables										
Size	932	27.04***	1.515	22.195	28.271	1,663	26.875	1.572	21.921	28.261
E/TA	932	0.065***	0.026	0.055	0.154	1,663	0.068	0.023	0.055	0.169
Business model	932	0.417**	0.126	0.105	0.694	1,663	0.432**	0.135	0.105	0.796
NPLs	932	0.044**	0.033	0.014	0.139	1,663	0.036	0.025	0.014	0.139
Liquidity	932	0.051***	0.031	0.002	0.122	1,663	0.077	0.046	0.004	0.266
Panel G. Firm balance sheet variables										
Firm size	932	17.055***	1.427	12.649	19.237	1,663	17.199***	1.388	13.058	19.313
LTD/TA	932	0.270***	0.164	0.001	0.768	1,663	0.259	0.146	0.002	0.650
Current ratio	932	1.268***	0.950	0.280	4.770	1,663	1.268**	1.112	0.280	6.890
ROE	932	11.671***	13.668	-37.660	56.370	1,663	13.338***	10.495	-23.290	50.560
INTcover	932	9.083***	19.606	-5.420	124.900	1,663	12.639***	24.502	-5.230	134.150

Notes: *Polluting* is a dummy variable that takes a value of 1 if a firm is polluting, otherwise 0. Specifically, polluting firms are those firms which have an above-median level of CO_2 emissions, where the median level is 2,093,000 tonnes of CO_2 per year. Loan share is computed as the share of a bank's total lending to a specific firm. Size is the logarithm of bank total assets. E/TA is the ratio of equity to total assets. Business model is the ratio of fees and commissions to operating income. NPLs is the ratio of non-performing loans to total loans. Liquidity is the ratio of cash and cash equivalents to total assets. Firm size is the logarithm of firm total assets. LTD/TA is the ratio of long-term debt to total assets. Current ratio is the current ratio. ROE is the ratio of net income to total equity. Interest coverage ratio is earnings before interest and taxes divided by interest expenses. T-test of difference in means between the treatment and the control group period and after COP21 is also reported. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

Table 3
Summary statistics: CO_2 emissions per year by economic sector (tonnes)

	Sector	N. Obs.	Mean	STD	Min.	Max.
1	Real estate investment trust	215	94,894	236,099	231	2,397,932
2	Media	72	381,992	627,854	12,767	1,925,397
3	Technology	272	893,859	3,445,949	1035	30,200,000
4	Consumer products and services	176	1,285,202	2,193,085	46,854	7,100,000
5	Healthcare	251	1,352,966	1,670,147	4,368	5,540,000
6	Telecommunications	302	1,744,332	2,061,186	11,399	8,801,366
7	Food, beverage and tobacco	162	2,543,849	2,163,238	62	6,180,000
8	Travel and leisure	35	2,545,428	2,256,314	32,415	7,919,844
9	Industrial goods and services	391	3,188,189	7,553,638	16,133	40,300,000
10	Automobiles and parts	200	3,771,219	3,257,347	259	9,510,000
11	Retailers	130	4,280,164	5,471,299	180,436	21,900,000
12	Construction and materials	288	5,207,292	4,880,488	33,940	13,000,000
13	Chemicals	120	20,300,000	10,500,000	309,874	37,400,000
14	Gas, water and multi-utilities	228	25,500,000	41,300,000	290,549	155,000,000
15	Oil, gas and coal	185	39,700,000	28,300,000	26,574	117,000,000
16	Electricity	479	61,500,000	36,800,000	1,349,000	124,000,000
17	Industrial metals and mining	120	85,700,000	85,300,000	633,704	194,000,000

Table 4. Baseline Results COP21

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Loan_share	**Loan_share**	**Loan_share**	**Loan_share**	**Loan_share**	**Loan_share**	**Loan_share**	**Loan_share**
Polluting*COP21	-0.0304***	-0.0259***	-0.0226***	-0.0214***	-0.0223***	-0.0374**		
	(0.0075)	(0.0062)	(0.0076)	(0.0082)	(0.0075)	(0.0173)		
Super Green*COP21							0.0457***	
							(0.0172)	
Strong Polluters*COP21								-0.0403*
								(0.0250)
Size				0.0249				
				(0.0205)				
E_TA				0.7169**				
				(0.4091)				
Business model				0.0082				
				(0.0708)				
NPLs				0.0952				
				(0.3407)				
Liquidity				-0.0837				
				(0.1058)				
Firm Size					-0.0063**	-0.0218**	-0.0215***	-0.0407***
					(0.0025)	(0.0109)	(0.0073)	(0.0095)
LTD/TA					-0.0153***	-0.0074	-0.0074	-0.0074
					(0.0050)	(0.0099)	(0.0082)	(0.0054)
Current ratio					0.0005	0.0057	0.0055	-0.0011
					(0.0023)	(0.0087)	(0.0060)	(0.0080)
ROE					0.0001	0.0002	0.0002	-0.0001
					(0.0001)	(0.0006)	(0.0004)	(0.0004)
INTcover					-0.0001	-0.0011***	-0.0012***	-0.0011***
					(0.0001)	(0.0002)	(0.0002)	(0.0003)
Observations	5,105	5,105	5,105	5,105	5,105	5,109	5,105	5,105
Cluster	bank-firm	bank-firm	bank-firm	bank-firm	bank-firm	bank-firm	bank-firm	Bank-firm
Industry FE	Yes	No	Yes	Yes	Yes	No	No	No
Country FE	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	No	No	No
Industry*time FE	No	No	No	No	No	Yes	Yes	Yes

Notes: Loan share is computed as the share of a bank's total lending to a specific firm. *Polluting* is a dummy variable which takes a value of 1 if a firm is polluting, otherwise 0. Specifically, polluting firms are those that have an above-median level of CO_2 emissions, where the median level is 2,093,000 tonnes of CO_2 per year. *COP21* is a dummy variable which takes a value of 1 after COP21, otherwise 0. Size is the logarithm of bank total assets. E/TA is the ratio of equity to total assets. Business model is the ratio of fees and commissions to operating income. NPLs is the ratio of non-performing loans to total loans. Liquidity is the ratio of cash and cash equivalents to total assets. Firm size is the logarithm of firm total assets. LTD/TA is the ratio of long-term debt to total assets. Current ratio is the current ratio. ROE is the ratio of net income to total equity. Interest coverage ratio is earnings before interest and taxes divided by interest expenses. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

Table 5
Results by bank characteristics

	(1) Loan_share	(2) Loan_share
Panel A. Well capitalised		
Polluting*COP21	-0.0269**	
	(0.0136)	
Panel B. Less capitalised		
Polluting*COP21		-0.0072
		(0.0068)
Observations	2,548	2,604
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes
Panel C. High credit quality		
Polluting*COP21	-0.0111	
	(0.0105)	
Panel D. Low credit quality		
Polluting*COP21		-0.0247**
		(0.0118)
Observations	2,544	2,556
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes
Panel E. More profitable		
Polluting*COP21	-0.0042	
	(0.0142)	
Panel F. Less profitable		
Polluting*COP21		-0.0231***
		(0.0086)
Observations	2,503	2,593
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes

Notes: The table is divided into three panels. Panel A displays loan-level difference-in-differences regression results obtained by splitting the sample according to the median level of CET1. Well capitalised banks are those banks with a CET1 of more than 12.34, with the opposite for less capitalised banks. Panel B presents loan-level difference-in-differences regression results obtained by splitting the sample according to the median level of NPL. High credit quality banks are those banks with NPLs below 3.06%, and the opposite for low credit quality banks. Panel C reports loan-level difference-in-differences results obtained by splitting the sample according to the median level of ROA. More profitable banks are those banks with a ROA of more than 0.32 %, with the opposite for less profitable banks. Loan share is computed as the share of the bank's total lending to a specific firm. *Polluting* is a dummy variable which takes a value of 1 if a firm is polluting, otherwise 0. Specifically, polluting firms are those firms which have an above-median level of CO_2 emissions, where the median level is 2,093,000 tonnes of CO_2 per year. *COP21* is a dummy variable which takes a value of 1 after COP21, otherwise 0. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

Table 6. Results based on emission intensities

	(1)	(2)	(3)	(4)	(5)
	Loan_share	Loan_share	Loan_share	Loan_share	Loan_share
CO2_Totassets*COP21	-0.0357**	-0.0326**	-0.0189*	-0.0172**	-0.0164*
	(0.0174)	(0.0156)	(0.0110)	(0.0056)	(0.0095)
Size				-0.1015***	
				(0.0081)	
E_TA				0.0979	
				(0.6683)	
Business model				-0.0732	
				(0.0751)	
NPLs				0.2550	
				(0.4310)	
Liquidity				-0.1263	
				(0.2630)	
Firm Size					-0.0066*
					(0.0038)
LTD/TA					-0.0159***
					(0.0052)
Current ratio					0.0038
					(0.0046)
ROE					0.0000
					(0.0002)
INTcover					-0.0000
					(0.0001)
Observations	5,105	5,105	5,105	5,105	5,105
Cluster	Bank-firm	Bank-firm	Bank-firm	Bank-firm	Bank-firm
Industry*time FE	Yes	Yes	Yes	Yes	Yes
Country FE	No	Yes	Yes	Yes	Yes
Bank FE	No	No	Yes	Yes	Yes

Notes: Loan share is computed as the share of a bank's total lending to a specific firm. CO2_totalassets is the CO_2 emissions to firm total assets ratio. COP21 is a dummy variable which takes a value of 1 after COP21, otherwise 0. Size is the logarithm of bank total assets. E/TA is the ratio of equity to total assets. Business model is the ratio of fees and commissions to operating income. NPLs is the ratio of non-performing loans to total loans. Liquidity is the ratio of cash and cash equivalents to total assets. Firm size is the logarithm of firm total assets. LTD/TA is the ratio of long-term debt to total assets. Current ratio is the current ratio. ROE is the ratio of net income to total equity. Interest coverage ratio is earnings before interest and taxes divided by interest expenses. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

Table 7
Additional Robustness checks

	(1) Loan_share
Panel A. Regression scope 1 CO_2 emissions	
Polluting (scope 1)*COP21	-0.0183*
	(0.0072)
Observations	5,137
Cluster	bank-firm
Industry FE	Yes
Bank FE	No
Firm controls	Yes
Panel B. Controlling for banks' green preferences	
Polluting*COP21	-0.0301*
	(0.0166)
Responsible	-0.1577***
	(0.0561)
Observations	5,105
Cluster	bank-firm
Industry FE	Yes
Bank FE	No
Country FE	Yes
Firm controls	Yes
Panel D. Removing France	
Polluting*COP21	-0.0205**
	(0.0097)
Observations	3,199
Cluster	bank-firm
Industry FE	Yes
Bank FE	Yes
Country FE	Yes
Firm controls	Yes
Panel D. Placebo tests	
Polluting*COP21	-0.0052
	(0.0099)
Observations	5,105
Cluster	bank-firm
Industry FE	Yes
Bank FE	Yes
Country FE	Yes
Firm controls	Yes

Note: Loan share is computed as the share of a bank's total lending to a specific firm. *Polluting (scope 1)* is a dummy variable equal to 1 for those firms that have an above median level (581,703 tonnes) of scope 1 CO_2 emissions. Responsible is a dummy variable equal to 1 for banks that are member of the United Nations' Environment Program Finance Initiative (UNEP FI), and 0 otherwise. *COP21* is a dummy variable which takes a value of 1 after COP21, otherwise 0. Among the firms controls, we include: Firm size is the logarithm of firm total assets. LTD/TA is the ratio of long-term debt to total assets. Current ratio is the current ratio. ROE is the ratio of net income to total equity. Interest coverage ratio is earnings before interest and taxes divided by interest expenses. ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

Appendix

Table A1
Variable definition

Variables	Source	Description
Dependent variable		
Loan_share	Supervisory reporting (COREP 27-31)	Loan share is computed as bank lending to a single firm divided by bank total loans.
Climate change variables		
CO2 emissions total	Refinitiv Eikon	Total CO_2 and CO_2 equivalents emission in tonnes for firm *j and year t*. When a firm reports CO_2 and CO_2 equivalent emissions according to various protocols (i.e. Greenhouse Gas Protocol, Kyoto Protocol, EU Trading Scheme), the Greenhouse Gas Protocol takes priority over the others and is the one reported as a value.
Polluting dummy	Refinitiv Eikon and Authors' calculation.	*Polluted* is a dummy variable that takes a value of 1 if a firm *j* is polluting above median level of CO_2 emissions where the median level is 2.092 million tonnes of CO_2 for year *t*, otherwise 0.
Super green dummy	Refinitiv Eikon and Authors' calculation.	*Super green* is a dummy that takes a value of 1 if a firm has a level of CO_2 emissions which is equal to or smaller than 398,553 tonnes of CO_2 emissions for firm *j* and year *t*.
Strong polluter dummy	Refinitiv Eikon and Authors' calculation.	*Strong polluter* is a dummy that takes a value of 1 if a firm has a level of CO_2 emissions which is equal to or greater than 12,700,000 tonnes of CO_2 emissions for firm *j* and year *t*.
COP21	Author's calculation	*COP21* is a dummy variable which takes a value of 1 for the year 2015, after the Paris Agreement within the United Nations Framework Convention on Climate Change, dealing with greenhouse gas emissions mitigation, adaptation and finance, otherwise 0.
Bank-specific control variables		
Size	Moody's Analytics BankFocus	Bank size is the natural logarithm of total assets (EUR millions) for bank *i* and year *t*.
Capitalisation	Moody's Analytics BankFocus	Capitalisation (E/TA) is the ratio of total equity to total assets for bank *i* and year *t*.
Business model	Moody's Analytics BankFocus	Business model is the ratio of non-interest income (total fees and commissions) to total revenues for bank *i* and year *t*.
NPLs	Moody's Analytics BankFocus	The non-performing loans ratio (NPLs) is the ratio of non-performing loans to total loans for bank *i* and year *t*.
Liquidity	Moody's Analytics BankFocus	Liquidity is the ratio of cash and cash equivalents to total assets for bank *i* and year *t*.
Firm-specific control variables		

Firm Size	Refinitiv Eikon and Amadeus, Bureau van Dijk	Firm size is the natural logarithm of total assets (EUR millions) for firm *j* and year *t*.
Leverage ratio	Refinitiv Eikon and Amadeus, Bureau van Dijk	The leverage ratio (LTD/TA) is calculated by dividing long-term debts by total assets for firm *j* and year *t*.
Current ratio	Refinitiv Eikon and Amadeus, Bureau van Dijk	The current ratio is calculated by dividing current assets by current liabilities for firm *j* and year *t*.
ROE	Refinitiv Eikon and Amadeus, Bureau van Dijk	The return on equity (ROE) is the ratio of net income to total shareholder's equity for firm *j* and year *t*.
INTcover	Refinitiv Eikon and Amadeus, Bureau van Dijk	Interest coverage ratio is calculated by dividing the earnings before interest and taxes by interest expenses for firm *j* and year *t*.

Table A2
Correlation matrix between the variables used in the baseline regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Size		**-0.36**	**0.07**	**-0.12**	**0.21**	**0.11**	**-0.03**	0.02	**0.04**	**0.04**
E/TA	**-0.36**		0.00	**0.21**	**-0.10**	-0.00	-0.04	-0.01	-0.02	**-0.03**
Business model	**0.07**	0.00		**-0.20**	**0.20**	**0.03**	0.00	**-0.06**	-0.00	0.01
NPLs	**-0.12**	**0.21**	**-0.20**		**-0.24**	**-0.08**	0.00	0.00	-0.00	**-0.05**
Liquidity	**0.21**	**-0.10**	**0.20**	**-0.24**		0.08	-0.00	**0.02**	**0.03**	**0.05**
Firm size	**0.11**	-0.00	**0.03**	**-0.08**	0.08		**-0.05**	**-0.10**	-0.02	**-0.07**
LTD/TA	**-0.03**	-0.04	0.00	0.00	-0.00	**-0.05**		**-0.03**	-0.00	**-0.08**
Current ratio	0.02	-0.01	**-0.06**	0.00	**0.02**	**-0.10**	**-0.03**		**-0.02**	**0.07**
ROE	**0.04**	-0.02	-0.00	-0.00	**0.03**	-0.02	-0.00	**-0.02**		**0.16**
INTcover	**0.04**	**-0.03**	0.01	**-0.05**	**0.05**	**-0.07**	**-0.08**	**0.07**	**0.16**	

Notes: Correlations that are significant at (at least) the 5% level are reported using bold italics. The number on the horizontal axis indicates the variables on the vertical axis – each number matches the variable's position on the vertical axis. Size is the logarithm of bank total assets. E/TA is the ratio of equity to total assets. Business model is the ratio of fees and commissions to operating income. NPLs is the ratio of non-performing loans to total loans. Liquidity is the ratio of cash and cash equivalents to total assets. Firm size is the logarithm of firm total assets. LTD/TA is the ratio of long-term debt to total assets. Current ratio is the current ratio. ROE is the ratio of net income to total equity. Interest coverage ratio is earnings before interest and taxes divided by interest expenses.

Table A3
Summary of descriptive statistics: tonnes of CO_2 emissions to firm total assets by economic sector.

	Sector	N. Obs.	Mean	STD	Min.	Max.
1	Media	99	0.008	0.009	0.001	0.049
2	Real estate investment trust	315	0.012	0.041	0.000	0.264
3	Healthcare	345	0.021	0.203	0.000	0.102
4	Telecommunications	424	0.024	0.040	0.001	0.385
5	Automobiles and parts	322	0.024	0.026	0.000	0.164
6	Food, beverage and tobacco	232	0.033	0.022	0.000	0.090
7	Consumer products and services	247	0.043	0.077	0.001	0.439
8	Retailers	196	0.061	0.055	0.002	0.380
9	Industrial goods and services	558	0.086	0.240	0.002	1.938
10	Technology	373	0.129	1.015	0.000	9.295
11	Construction and materials	417	0.165	0.206	0.013	1.424
12	Travel and leisure	58	0.234	0.173	0.019	0.724
13	Chemicals	162	0.397	0.204	0.003	0.858
14	Gas, water and multi-utilities	331	0.480	0.572	0.007	2.002
15	Electricity	680	0.491	0.306	0.097	2.086
16	Oil, gas and coal	271	0.936	5.356	0.004	6.171
17	Industrial metals and mining	163	1.340	0.932	0.049	2.741