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**Do Banks Fuel Climate Change?**

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# Do banks fuel climate change? <sup>1</sup>

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## Abstract

Do climate-oriented regulatory policies affect the flow of credit towards polluting corporations? 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 the aftermath of President Trump's 2017 announcement that the United States was withdrawing from the Paris Agreement, lending by European banks to polluting firms in the United States decreased even further in relative terms. It follows that green regulatory initiatives in banking can have a significant impact combating climate change.

**Keywords:** Climate change; Paris Agreement; Trump; loan-level data; difference-in-differences;  
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## **Non-technical summary**

Climate change poses major risks to the global economy. Fortunately, policymakers have started to recognize climate change as a major and pressing threat (Carney, 2015; ESRB, 2016). In this vein, the Paris Agreement, signed in December 2015, 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”. As a major provider of credit, the banking sector is, potentially, a key player in these efforts. At the same time, these green initiatives are happening in a period in which banks themselves face new risks, some of them also linked to climate change, including physical and transition risks. As a result, lending away from polluting firms might be very costly.

In this paper we ask whether climate-oriented regulatory policies affect the flow of credit towards polluting corporations. We do this by examining two major climate change policy events to investigate whether European banks changed their relative lending towards polluting firms, possibly anticipating more stringent climate risk-related policies or more severe fluctuations in the asset values of polluting firms. To do this, we match an extensive loan-level dataset to detailed firm-level greenhouse gas emissions over time.

We find that, following the Paris Agreement, European banks reallocated credit away from polluting firms. Their loan share towards more polluting firms decreased significantly—by about 3 percentage points—after the announcement of the Paris Agreement. European banks’ loan share to more polluting US corporations also decreased by around 2.4 percentage points, after President Trump’s June 2017 decision not to uphold the Paris climate commitment. We contend that recent climate change initiatives, improved awareness of climate change-related risks, and the anticipation of more stringent policies are probably pushing banks out of climate-sensitive sectors towards greener business. We also show that banks which have lower credit quality and are less profitable drive our main findings by reacting earlier and more decisively to climate policy initiatives.

We believe our work has important policy implications, as it underlines the pivotal role of banks in the implementation of significant climate change policies. It follows that green banking regulations could have an impact on ameliorating climate change and, therefore, central banks and banking authorities could play a significant role in shaping this debate.

## 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) has concluded that the level of emissions observed since the mid-twentieth century will 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 a severe, pervasive and irreversible impact on people and ecosystems. Rising temperatures and changes in weather conditions would hit most sectors—most directly agriculture, fisheries, energy, tourism, and construction—with immediate consequences for national economies (EEA, 2012). The number of natural disasters worldwide and the value of (insured and uninsured) associated accompanying economic losses have risen over the last four decades (Charts 1 and 2).

Policymakers have, of late, 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 representing 97% of global greenhouse emissions agreed to respond to global warming by keeping global warming below 2°C. Furthermore, COP21 invites 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<sub>2</sub> emissions to achieve net zero emissions in the second half of the twenty-first century.<sup>2,3</sup>

As 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

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<sup>2</sup> In particular, the 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. The United States has, controversially, withdrawn from COP21. 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](https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf).

<sup>3</sup> 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.

consensus in support of moving towards a low-carbon economy and technological improvements that will lead to 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.<sup>4</sup> Physical risks arise from weather and climate-related catastrophes, such as floods, droughts, storms and sea-level rises (Nordhaus, 1977; Stern, 2008; Nordhaus, 2019).<sup>5</sup> These events can damage properties, lower agricultural productivity, and affect human labor and physical assets (Deryugina and Hsiang, 2014; O'Neill et al., 2017). Should this translate into a contraction of firms' profitability and a deterioration of their balance sheets, banks would be negatively affected in terms of asset values, collateral quality and, ultimately, credit risk exposure. In addition, banks suffering large losses could restrict lending, further exacerbating the financial impact of physical risks through a contraction in the lending supply. The nascent literature provides theoretical and empirical evidence that financial institutions should take physical risk into account in their investment decisions. For instance, Addoum et al. (2019) and Pankratz et al. (2019) provide evidence of a negative correlation between firms exposed to extreme temperatures and their corporate earnings. Balvers et al. (2017) show that firms subject to high temperature shocks have higher capital costs. There is evidence that extreme weather events are incorporated into stock and option market prices (Kruttili et al., 2019; Choi et al., 2020).<sup>6</sup>

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, regulations, technologies and/or market sentiment could provoke a repricing of the value of bank 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 also generate uncertainty and procyclicality, ultimately increasing bank market risk (BoE, 2018). Transition risks could also affect bank 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).<sup>7</sup> Although transition risks are difficult to quantify, the market valuation of the top US coal producers fell by 95% over the

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<sup>4</sup> 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.

<sup>5</sup> 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).

<sup>6</sup> For an overview of the literature on weather risk, see Dell et al. (2014).

<sup>7</sup> Firms' profitability could also be affected by the implementation, for instance, of a carbon tax.

period 2010-2017 highlighting the fact that disruptive changes to technology can cause sharp fluctuations in the valuation of “stranded assets” (Adrian et al., 2020).<sup>8</sup>

In this paper we focus on two major climate change policy events 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 directly 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.

According to the second hypothesis, however, COP21 might have had suasion effects on banks, driving them to lend less to polluting firms in anticipation of more stringent climate risk-related policies in the future. While COP21 may not have an immediate effect on banks’ exposure to physical risks, it could affect their exposure to transition risks by affecting the profitability and viability of more carbon-intensive firms, which face high transition costs. Firms producing disproportionately high levels of CO<sub>2</sub> 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 emissions apply equally to all emissions (e.g. in the spirit of a carbon tax). Since the exposure of banks’ loan portfolios to climate-relevant sectors is large and comparable to their capital base (Battiston et al., 2017), banks could try cushioning climate shocks by start to taking them into account and anticipating transition risks.

We also examine a second climate-change policy event to investigate whether European banks changed their lending behavior towards polluting US firms following Donald Trump’s announcement that the United States was withdrawing from COP21 on 1 June 2017.<sup>9</sup> On the one hand, European banks could have interpreted this announcement as a harbinger of reduced pressure to implement greener policies in the future or, also in this direction, simply concluded that it would be harder to

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<sup>8</sup> Stranded 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.

<sup>9</sup> The official speech is available at <https://www.whitehouse.gov/briefings-statements/statement-president-trump-paris-climate-agreement/>.

compete with their American counterparts if they restricted the set of investment opportunities to greener companies.

On the other hand, they could have interpreted the announcement as increasing the uncertainty surrounding the path of US climate policy actions, adding a further level of complexity to banks' capacity to manage transition risks. Indeed, this additional uncertainty regarding the timing and extent of future climate policies may lead to the mispricing of assets and price volatility (Petkov et al., 2015; HSBC, 2015).<sup>10</sup> In addition to transition risks, European banks may also face increased reputational risks if they keep their lending to US polluting corporations unchanged. As public awareness of climate change grows, misalignments between banks' lending decisions and public pressure in favor of a greener economy may taint banks' reputations.<sup>11</sup> Consequently, as a second research question, we investigated whether European banks anticipated (or not) these plausible risks by modifying the "climate intensity" of their loan portfolio to US firms, i.e. by switching away from more polluting US firms.

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 and triple-differences estimations over the 2014-2018 period. We find that banks reallocated their credit *away* from polluting corporations following both COP21 and President Trump's announcement. 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. Moreover, euro area banks' lending share to polluting US firms fell by about 2.3 percentage points following President Trump's announcement that the United States was withdrawing from COP21. Our results are robust to the inclusion of bank and firm-specific characteristics and are saturated with industry, bank and country fixed effects.

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<sup>10</sup> Moreover, it adds to trade tensions between countries that uphold climate commitments and those that do not. Indeed, in a letter to President Trump on 10 May 2017, the CEOs of some of the largest US corporations recognized that: "...there is strong potential for negative trade implications if the United States exits from the Paris Agreement". Available at <https://theconversation.com/why-trumps-decision-to-leave-paris-agreement-hurts-the-us-and-the-world-78707>. In this regard, the French government has already opposed any trade negotiations between the EU and countries outside the Paris Agreement (including the United States) (Reuters, 2019).

<sup>11</sup> Managing reputational risks requires skills such as prudence, anticipating needs and trends, and understanding stakeholders' and customers' needs (Rayner, 2004).

We contend that climate change regulatory initiatives can push banks towards greener businesses. This outcome however could be reversible as the reaction to Trump's withdrawal announcement suggests.

This paper contributes to a growing, but still scarce, literature on climate change and the financial sector. A recent body of research 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 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., 2018).

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 present on banks: 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 that have 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., 2018), 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).

We focused on the effect of COP21 on bank lending to polluting firms. We employ detailed loan-level exposure data from banks matched to firm-level CO<sub>2</sub> emission intensities. Moreover, we considered an additional policy "shock" in the opposite direction of COP21 (i.e. President Trump's announcement of withdrawal from COP21) which allowed us to better interpret possible patterns in banks' lending decisions across climate-related policies.



Our paper is probably closer to De Haas and Popov (2019) and Mesonnier (2019). De Haas and Popov find evidence of lower CO<sub>2</sub> emissions in economies that are more equity-funded and argue that stock markets contribute to a reallocation of investment towards less polluting sectors. We support De Haas and Popov (2019) findings on equity findings by investigating the bank credit market. We 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 propensities of individual firms in a multi-country setting which enhances the granularity of the assessment and allows us to dig deeper into the findings.<sup>12</sup>

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 probably driving financial institutions to curtail lending to the more polluting firms to avoid major damages or outright catastrophes (Pindyck, 2020). While some banks may only perceive a weak short-term direct impact from climate change, policy announcements (such as 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 International Monetary Fund recognizes that there are “massive financial stability challenges due to climate change...” as adjustments to a low-carbon economy are uncertain, non-linear and irreversible and affect a broad range of sectors, geographies and business models (Adrian et al., 2020, p. 45). Financially disruptive events (“green swans”) – coming from adverse global warming scenarios or a rapid transition to a low-carbon economy – could be behind the next financial crisis (Bolton et al., 2020). Consequently, the banking sector is facing strong incentives to anticipate climate risks by reallocating its lending in a more sustainable way as “there is a high degree of certainty that some combination of physical and transition risks will materialize in the future” (NGFS, 2019a, p4).

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.

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<sup>12</sup> 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.

## 2. Methodology

In order to ascertain whether European banks allocated their lending to more or less polluting firms following COP21 and President's Trump announcements we employ loan-level DiD and triple-differences estimates.

To investigate the reaction to the COP21 announcement, our baseline regression takes the following form:

$$Y_{ijt} = \alpha_i + \tau_k + \delta_b + \beta_1 \text{Polluted}_{jt} * \text{Post}_t + \beta_2 X_{it} + \beta_3 Z_{jt} + \varepsilon_{ijt} \quad [1]$$

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.  $\text{Polluted}$  is a dummy variable 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<sub>2</sub> emissions.<sup>13</sup>  $\text{Post}$  is a dummy which takes the value 1 after the introduction of COP21, otherwise 0.<sup>14</sup>  $\beta_1$ , 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 ROE) and the interest coverage ratio (INTcover).<sup>15</sup> 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.<sup>16</sup> To tighten the identification, we also include bank fixed effects

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<sup>13</sup> Where the median level is 2,093,000 tonnes of CO<sub>2</sub> per year. Further specifications will be provided in the robustness check section.

<sup>14</sup> 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.

<sup>15</sup> A more detailed definition of the variables employed is provided in Table A1 in the Appendix.

<sup>16</sup> 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).

( $\alpha$ ) to control for unobservable bank-specific factors. We also employ sector fixed effects ( $\tau$ ) and country fixed effects ( $\delta$ ) to take unobservable heterogeneity into account across sectors and countries.

To investigate our second research question, the effect of President's Trump announcement of withdrawal we considered an alternative econometric specification where we employed triple-difference interaction terms:

$$Y_{ijt} = \alpha_i + \tau_k + \beta_1 \text{Polluted}_{jt} * \text{Post Trump}_t * \text{US firms} + \beta_2 X_{it} + \beta_3 Z_{jt} + \varepsilon_{ijt} \quad [2]$$

where *Post Trump* and *US firms* are the only variables that differ from equation [1]. Specifically, *Post Trump* is a dummy variable that takes the value 1 after Trump's announcement to withdraw from COP21 in June 2017, otherwise 0. *US firms* is a dummy variable that takes the value 1 if a firm is headquartered in the US, otherwise 0.

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 neither COP21 nor President Trump's announcement are driven by bank lending– they are 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 (left-hand graph) 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. Chart 4 (right-hand graph) also shows that the loan share to more polluting US firms decreased markedly after Trump's announcement.

### 3. Data

To investigate the impact of COP21 and President's Trump announcement 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 in hosted by the ECB and in charge of supervising large banks in the euro area) detailed information on their credit exposures since 2014.<sup>17</sup> Firm-level CO<sub>2</sub> total emissions are taken from Thomson Reuters 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 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 and President Trump's announcement.

### **I. Corporate carbon emissions data**

CO<sub>2</sub> total emissions, measured in tonnes of CO<sub>2</sub> per year, are reported at the firm level. Thomson Reuters Eikon follows the Greenhouse Gas Protocol which sets the standard for measuring firm emissions.<sup>18</sup> It distinguishes between various sources of emissions: Scope 1 emissions refer to direct emissions over a one-year period 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. Although firm-level CO<sub>2</sub> 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 data is, on average, 0.99 while it is 0.98 for Scope 2 data). The median firm in our sample produces 2.092 million tonnes of CO<sub>2</sub> emissions (Scope 1 + Scope 2). In Table 3, we report descriptive statistics on pollution by sector.<sup>19</sup> "Industrial metals and mining", "Electricity" and "Gas, oil and coal" produce, on average, the highest level of CO<sub>2</sub> emissions while "Real estate investment trust", "Media" and "Technology" produce the lowest. Our decision to consider firm-level CO<sub>2</sub> emission intensities instead of sectoral breakdowns is motivated by the significant heterogeneity in the level of pollution across firms within each sector.

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<sup>17</sup> 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.

<sup>18</sup> See <https://ghgprotocol.org>

<sup>19</sup> We use the sector classification provided by FTSE Russell which is also used by Thomson Reuters Eikon. More detailed information is available at:

[https://content.ftserussell.com/sites/default/files/support\\_document/ICB%20Taxonomy%20overview%20Cut%20Sheet\\_V03.pdf](https://content.ftserussell.com/sites/default/files/support_document/ICB%20Taxonomy%20overview%20Cut%20Sheet_V03.pdf).

Table 3 shows that companies belonging to the cleanest sectors display levels of CO<sub>2</sub> emissions that are much higher than the median level of 2.092 million tonnes of CO<sub>2</sub>.

## **II. Large-exposure data**

Our loan-level data are collected under the large-exposure 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 data set 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. LEI 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, while panel H reports the same statistics before and after President Trump's announcement. As mentioned in Section 2, loan share is computed as the share of the bank's total lending to a specific firm. This allows us to investigate how 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 it increased by about 0.1 percentage points for less polluting firms. Similarly, after Trump's announcement to withdraw from COP21, loan share to more polluting firms fell, on average, by 0.5%, while it increased by 0.4% for less polluting firms.

## **III. 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 lend more. On the other hand, we cannot exclude that a weakly capitalized bank could boost lending (specifically risky lending) in order 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), while columns 1–3 of Table 5 report the results of the triple-differences prior to and after President's Trump announcement (equation 2). 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. Moreover, we used bank-specific characteristics (column 4) and firm-specific controls (column 5), including time-varying observable factors that could affect the supply of and demand for bank credit. Although slightly smaller in size, the statistical significance is that of the other econometric specifications. 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.

Table 5 displays the results of the triple-differences loan-level estimation of European banks' loan share for more versus less polluting firms before and after President's Trump announcement. The interaction coefficient (Polluting\*US firms\*Trump) indicates that European banks' loan share for US more polluting corporations decreased by around 2.4 percentage points after Trump's decision, in June 2017, not to uphold the climate commitment. Again, as in Table 4, we tightened the econometric specifications by controlling for bank and firm-specific characteristics.

We interpret these results 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.

### **I. 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 6 (panels A to F).<sup>20</sup> 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 are 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 and/or are assuming 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; 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

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<sup>20</sup> We used our sample split only for equation [1], as for equation [2] we have fewer observations.



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

As a first robustness check, we use a different cut-off for the polluting dummy by considering, instead of the median, the first and the last percentiles. This allowed us to control for non-linearities in the level of CO<sub>2</sub> emissions regarding bank loan share. Specifically, we labelled as *super green* those firms which have a level of CO<sub>2</sub> emissions which is equal to or less than 398,553 tonnes of CO<sub>2</sub> per year (the first percentile of the CO<sub>2</sub> emissions distribution), and as *strong polluters* those companies which produce CO<sub>2</sub> emissions equal to or more than 12,700,000 tonnes of CO<sub>2</sub> per year (the last percentile of the CO<sub>2</sub> 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 displayed in Table 7 (Panel A) 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 4.66 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.

As a second robustness check, we used a different computation of the dummy *Polluting* which in the baseline regression is based on an *absolute* measure of issuance at the firm level (i.e. direct and indirect tonnes of CO<sub>2</sub> emissions for each firm). Hence we included the dummy *Polluting/TA*, dividing CO<sub>2</sub> emissions by firm total assets.<sup>21</sup> In other words while the correlation coefficient between firm size and greenhouse gas intensities is 0.30, suggesting that the level of CO<sub>2</sub> emissions does not depend strongly on firm size,<sup>22</sup> we control for the possibility of size effects in the level of pollution which could affect our results. The results in Panel B of Table 7 discard this hypothesis as

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<sup>21</sup> In Table A3 in the Appendix, we report descriptive statistics for CO<sub>2</sub> emissions divided by firm total assets, by sector.

<sup>22</sup> Arguably, this may be due to the characteristics of our sample as we have loan-level large exposure data. Such large loans can only be advanced to large corporations – e.g. the average asset size of the companies in the sample is USD 90 billion.

both coefficients are negative and statistically significant (at the 5% and 1% level respectively) further confirming our baseline findings.

As a third 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 baseline findings.

As a fourth 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 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.

As a final robustness check, we tested whether banks reallocated lending *away* from relatively polluting sectors, i.e. by employing sectoral-level rather than firm-level, information. Specifically, we computed a new dummy labelled *Sec\_Pol* which is equal to 1 for polluting sectors (“Retailers”, “Automobiles and parts”, “Construction and materials”, “Chemicals”, “Gas, water and multi-utilities”, “Oil, gas and coal”, “Electricity”, “Industrial metals and mining”), and 0 for less polluting sectors. The results are reported in Panel E of Table 7. This shows that banks' share of lending to relatively more polluting sectors decreased after both COP21 and President Trump's Announcement, indicating that European banks had reduced their exposure to more climate-sensitive sectors.

## **6. Conclusion**

We have investigated the impact of climate change-related policies, e.g. the Paris Agreement (December 2015), on European banks' lending behavior towards polluting versus non-polluting corporations, and of President Trump's announcement to withdraw from the agreement (June 2017).

This has been largely unexplored in the literature, which focuses mainly on assessing banks' exposures to climate-related risks and investigating the price dimension of banks' reaction. The credit dimension of banks' reaction to climate change policies remains scant, and has been analyzed at the sectoral-level for individual countries. To the best of our knowledge, our paper is the first to evaluate the impact of climate change-related policies on euro area banks' lending behavior employing loan-level data matched to firm-level greenhouse gas emission intensities to provide quantitative evidence of euro area banks' reallocation of exposures.

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 complement this result with evidence that European banks' loan share to US more polluting corporations decreased by around 2.4 percentage points after President Trump's decision not to uphold the Paris climate commitment. We contend that probably recent climate change initiatives are pushing banks out of climate-sensitive sectors and towards greener business 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 earlier and 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 key role in shaping this debate.

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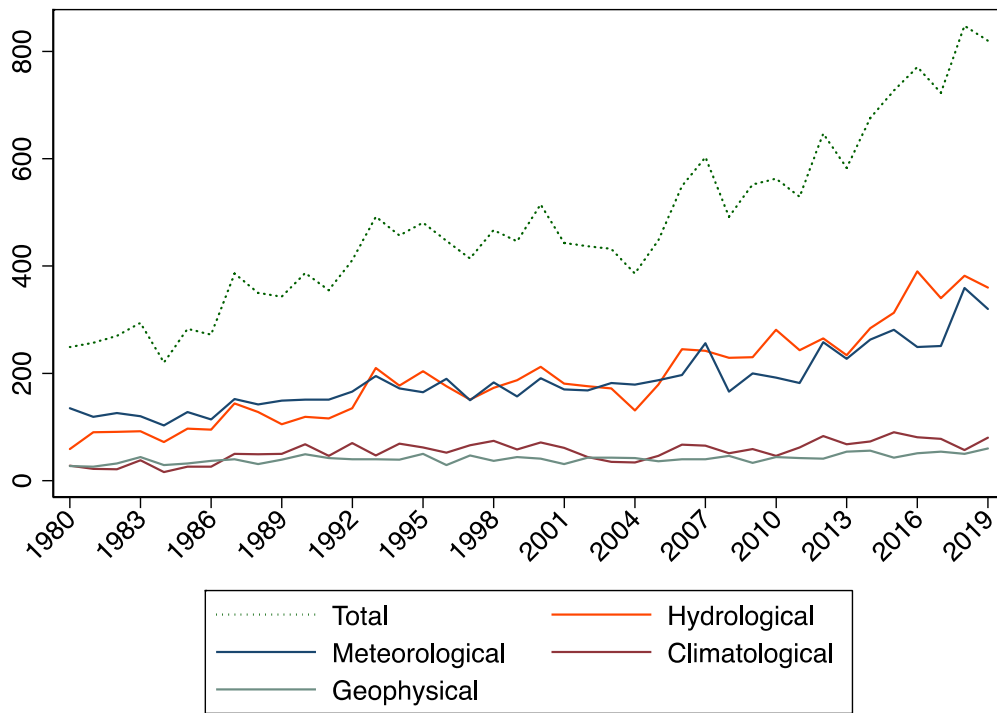
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### Chart 1

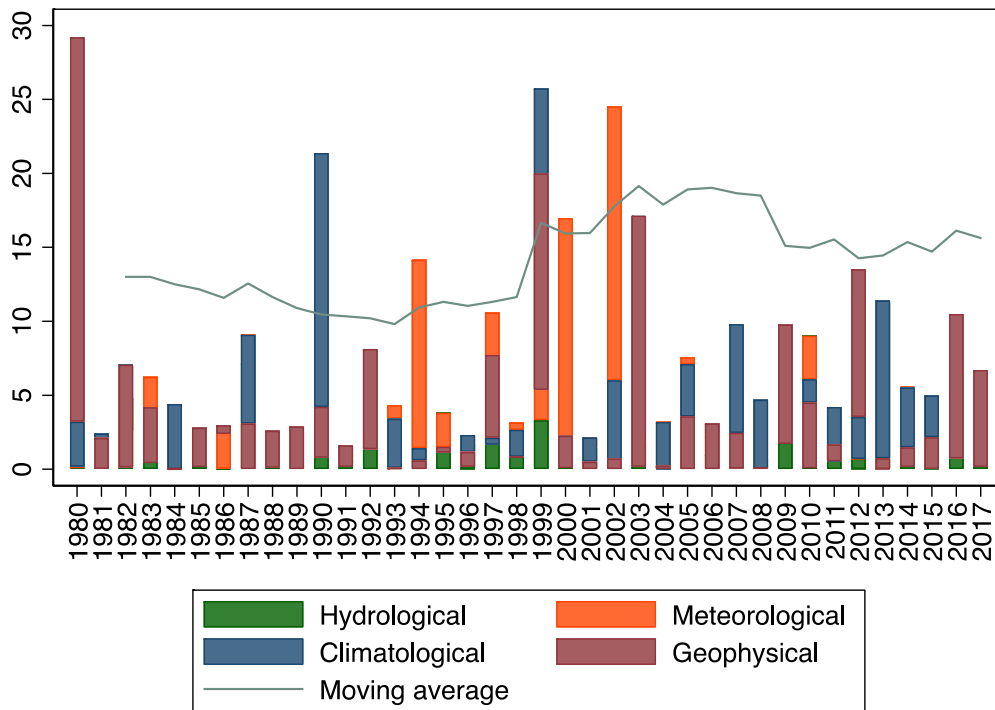
**Number of major natural catastrophes worldwide over the 1980-2019 period**  
(number of events; year)



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

## Chart 2

### Economic losses from extreme climate-related events in Europe over the 1980-2017 period (EUR billions, 2017 values)

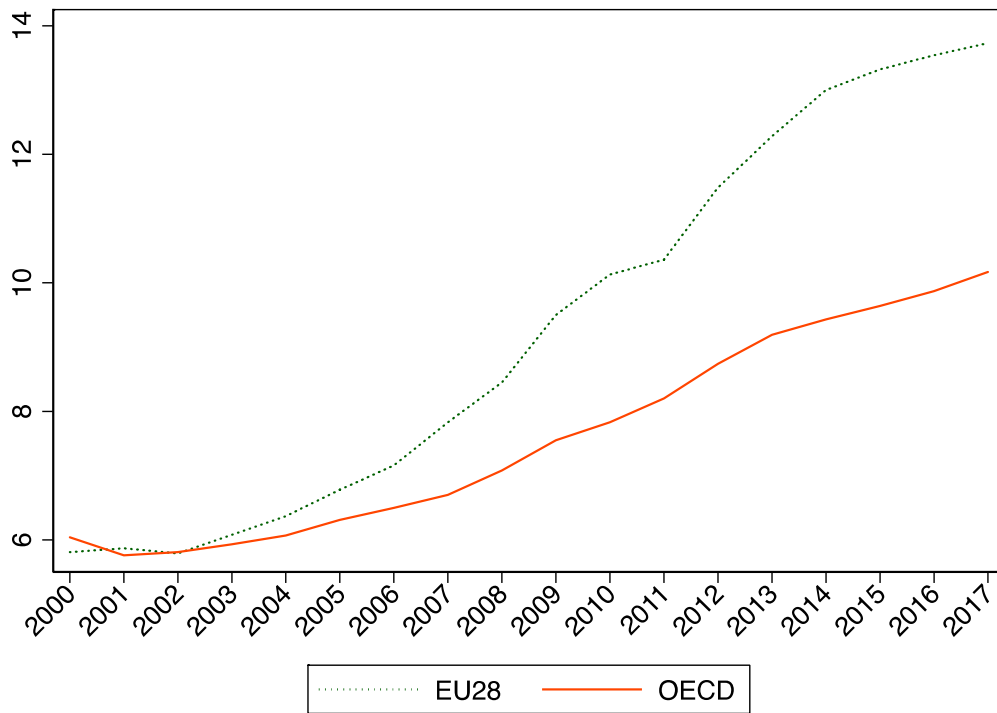


Note: The moving average is calculated over a ten-year period. The stacked bars are divided into different segments indicating the economic losses by type of event.

Source: European Environment Agency (<https://www.eea.europa.eu/data-and-maps/indicators/direct-losses-from-weather-disasters-3/assessment-2>).

### Chart 3

**Renewable energy as a percentage of total primary energy supply over the 2000-2017 period**  
(percentages)

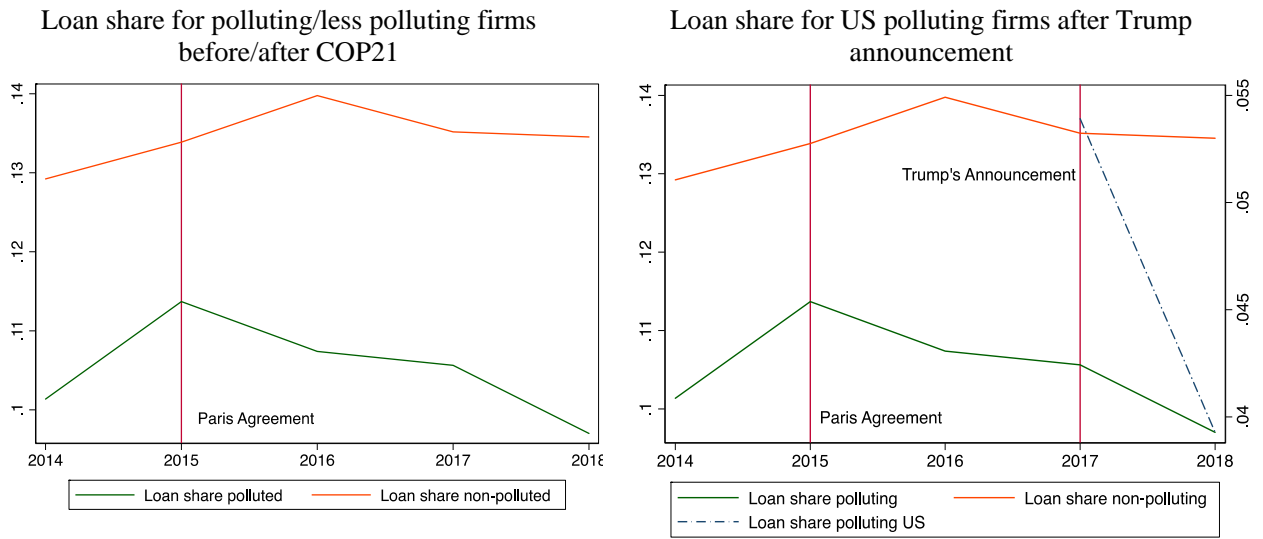


Notes: Renewable energy includes the primary energy of hydro, geothermal, solar, wind, tide and wave sources. Energy derived from solid biofuels, biogasoline, biodiesels, other liquid biofuels, biogases and the renewable fraction of municipal waste are also included.  
Source: OECD (<https://data.oecd.org/energy/renewable-energy.htm>).

### Chart 4

#### Loan share between polluting and less polluting firms over the 2014-2018 period

(left-hand scale: average loan share; right-hand scale: average loan share for US polluting firms)



Notes: The dashed-blue line shows the loan share for US polluting firms after President Trump's announcement to withdraw from COP21. Loan share is computed as bank lending to a single firm divided by bank total loans.

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

<b>More polluting (=&gt;2,092,000 Tonnes-CO<sub>2</sub>/year)</b>										
<b>Pre-COP21</b>						<b>Post-COP21</b>				
	<b>Obs.</b>	<b>Mean</b>	<b>Std</b>	<b>1st</b>	<b>99th</b>	<b>Obs.</b>	<b>Mean</b>	<b>Std</b>	<b>1st</b>	<b>99th</b>
<b>Panel A. Dependent variable</b>										
Loan share	975	0.108*	0.243	0.000	1.000	1,576	0.102***	0.102	0.00	1.000
<b>Panel B. Bank balance sheet variables</b>										
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
<b>Panel C. Firm balance sheet variables</b>										
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
<b>US pre-TRUMP</b>						<b>US post-TRUMP</b>				
<b>Panel D. Dependent variable</b>										
Loan share	341	0.046	0.134	0.000	1.000	258	0.041	0.118	0.000	1.000
<b>Less polluting (=&lt;2,092,000 Tonnes-CO<sub>2</sub>/year)</b>										
<b>Pre-COP21</b>						<b>Post-COP21</b>				
<b>Panel E. Dependent variable</b>										
Loan share	930	0.131*	0.270	0.000	1.000	1,656	0.132***	0.265	0.000	1.000
<b>Panel F. Bank balance sheet variables</b>										
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
<b>Panel G. Firm balance sheet variables</b>										
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
<b>US pre-Trump</b>						<b>US post-Trump</b>				
<b>Panel H. Dependent variable</b>										
Loan share	337	0.406	0.150	0.000	1.000	226	0.046	0.136	0.000	0.950

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<sub>2</sub> emissions, where the median level is 2,093,000 tonnes of CO<sub>2</sub> 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 both COP21 and Trump's announcement is also reported. \*\*\*, \*\*, \* indicate statistical significance at 1%, 5% and 10% respectively.

**Table 3**  
**Summary statistics: CO<sub>2</sub> 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)
	Loan_share	Loan_share	Loan_share	Loan_share	Loan_share
<b>Polluting*COP21</b>	-0.0304*** (0.0075)	-0.0259*** (0.0062)	-0.0226*** (0.0076)	-0.0214*** (0.0082)	-0.0223*** (0.0075)
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** (0.0025)
LTD/TA					-0.0153*** (0.0050)
Current ratio					0.0005 (0.0023)
ROE					0.0001 (0.0001)
INTcover					-0.0001 (0.0001)
Observations	5,105	5,105	5,105	5,105	5,105
R-squared	0.7034	0.7018	0.7049	0.7055	0.7058
Cluster	bank-firm	bank-firm	bank-firm	bank-firm	bank-firm
Industry FE	Yes	No	Yes	Yes	Yes
Country FE	No	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	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<sub>2</sub> emissions, where the median level is 2,093,000 tonnes of CO<sub>2</sub> 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**  
**Baseline results Trump's announcement**

	(1)	(2)	(3)
	Loan_share	Loan_share	Loan_share
<b>Polluting*US firms*Trump</b>	-0.0238*** (0.0083)	-0.0239** (0.0095)	-0.0140* (0.0088)
Size		0.0252 (0.0205)	
E_TA		0.7363* (0.4110)	
Business model		0.0233 (0.0800)	
NPLs		0.0414 (0.3550)	
Liquidity		-0.0818 (0.1057)	
Firm size			-0.0062** (0.0027)
LTD/TA			-0.0152*** (0.0050)
Current ratio			0.0008 (0.0025)
ROE			0.0001 (0.0001)
INTcover			-0.0001 (0.0001)
Observations	5,105	5,105	5,105
R-squared	0.7035	0.7049	0.7049
Cluster	bank-firm	bank-firm	bank-firm
Industry FE	Yes	Yes	Yes
Bank FE	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<sub>2</sub> emissions, where the median level is 2,093,000 tonnes of CO<sub>2</sub> per year. *US firms* is a dummy variable which takes a value of 1 if a firm is headquartered in the United States, otherwise 0. *Trump* 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 6**  
**Results by bank characteristics**

	(1)	(2)
	Loan_share	Loan_share
<b>Panel A. Well capitalised</b>		
Polluting*COP21	-0.0269** (0.0136)	
<b>Panel B. Less capitalised</b>		
Polluting*COP21		-0.0072 (0.0068)
Observations	2,548	2,604
R-squared	0.7035	0.6606
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes
<b>Panel C. High credit quality</b>		
Polluting*COP21	-0.0111 (0.0105)	
<b>Panel D. Low credit quality</b>		
Polluting*COP21		-0.0247** (0.0118)
Observations	2,544	2,556
R-squared	0.7250	0.7112
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes
<b>Panel E. More profitable</b>		
Polluting*COP21	-0.0042 (0.0142)	
<b>Panel F. Less profitable</b>		
Polluting*COP21		-0.0231*** (0.0086)
Observations	2,503	2,593
R-squared	0.6831	0.7496
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<sub>2</sub> emissions, where the median level is 2,093,000 tonnes of CO<sub>2</sub> 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 7**  
**Robustness checks**

	(1)	(2)
	Loan_share	Loan_share
<b>Panel A. Regression percentiles of CO<sub>2</sub></b>		
Super green*post_PARIS	0.0466*** (0.0122)	
Strong polluters*post_PARIS	-0.0278** (0.0116)	
Super green* US firms*Trump		-0.0037 (0.0286)
Strong polluters*US firms*Trump		-0.0547*** (0.0196)
Observations	5,137	5,137
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Firm controls	Yes	Yes
<b>Panel B. Weighted CO<sub>2</sub> measure</b>		
Polluting/TA*COP21	-0.0124** (0.0061)	
Polluting/TA*US firms*Trump		-0.0635*** (0.0202)
Observations	5,105	5,105
Cluster	bank-firm	bank-firm
Industry FE	Yes	Yes
Bank FE	Yes	Yes
Country FE	Yes	Yes
Firm controls	Yes	Yes
<b>Panel D. Removing France</b>		
Polluting*COP21	-0.0205** (0.0097)	
Observations	3,199	
Cluster	bank-firm	
Industry FE	Yes	
Bank FE	Yes	
Country FE	Yes	
Firm controls	Yes	
<b>Panel D. Placebo tests</b>		
Polluting*COP21	-0.0052 (0.0099)	
Observations	5,105	
Cluster	bank-firm	
Industry FE	Yes	
Bank FE	Yes	
Country FE	Yes	
Firm controls	Yes	
<b>Panel E. Sectoral analysis</b>		
Polluting*COP21	-0.0129** (0.0067)	
Polluting*US*Trump		-0.0132* (0.0081)
Observations	5,105	5,105
Cluster	bank-firm	bank-firm
Country FE	Yes	No
Bank FE	Yes	Yes
Firm controls	Yes	Yes

Note: Loan share is computed as the share of a bank's total lending to a specific firm. *Super green* is a dummy that takes a value of 1 if a firm has a level of CO<sub>2</sub> emissions which is equal to or smaller than 398,553 tonnes of CO<sub>2</sub> emissions per year. *Strong polluter* is a dummy that takes a value of 1 if a firm has a level of CO<sub>2</sub> emissions which is equal to or greater than 12,700,000 tonnes of CO<sub>2</sub> emissions 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.

## Appendix

**Table A1**  
**Variable definition**

Variables	Source	Description
<b>Dependent variable</b>		
Loan_share	Supervisory reporting (COREP 27-31)	Loan share is computed as bank lending to a single firm divided by bank total loans.
<b>Climate change variables</b>		
CO2 emissions total	Thomson Reuters Eikon	Total CO <sub>2</sub> and CO <sub>2</sub> equivalents emission in tonnes for firm <i>j</i> and year <i>t</i> . When a firm reports CO <sub>2</sub> and CO <sub>2</sub> 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	Thomson Reuters Eikon and Authors' calculation.	<i>Polluted</i> is a dummy variable that takes a value of 1 if a firm <i>j</i> is polluting above median level of CO <sub>2</sub> emissions where the median level is 2.092 million tonnes of CO <sub>2</sub> for year <i>t</i> , otherwise 0.
Super green dummy	Thomson Reuters Eikon and Authors' calculation.	<i>Super green</i> is a dummy that takes a value of 1 if a firm has a level of CO <sub>2</sub> emissions which is equal to or smaller than 398,553 tonnes of CO <sub>2</sub> emissions for firm <i>j</i> and year <i>t</i> .
Strong polluter dummy	Thomson Reuters Eikon and Authors' calculation.	<i>Strong polluter</i> is a dummy that takes a value of 1 if a firm has a level of CO <sub>2</sub> emissions which is equal to or greater than 12,700,000 tonnes of CO <sub>2</sub> emissions for firm <i>j</i> and year <i>t</i> .
COP21	Author's calculation	<i>COP21</i> 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.
Trump dummy	Author's calculation	<i>Trump</i> is a dummy variable which takes a value of 1 for the years 2017 and 2018, after President Trump' announcement to withdraw from the Paris Agreement, otherwise 0.
<b>Bank-specific control variables</b>		
Size	Moody's Analytics BankFocus	Bank size is the natural logarithm of total assets (EUR millions) for bank <i>i</i> and year <i>t</i> .
Capitalisation	Moody's Analytics BankFocus	Capitalisation (E/TA) is the ratio of total equity to total assets for bank <i>i</i> and year <i>t</i> .
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>i</i> and year <i>t</i> .
NPLs	Moody's Analytics BankFocus	The non-performing loans ratio (NPLs) is the ratio of non-performing loans to total loans for bank <i>i</i> and year <i>t</i> .
Liquidity	Moody's Analytics BankFocus	Liquidity is the ratio of cash and cash equivalents to total assets for bank <i>i</i> and year <i>t</i> .

## Firm-specific control variables

Firm Size	Thomson Reuters Eikon and Amadeus, Bureau van Dijk	Firm size is the natural logarithm of total assets (EURO millions) for firm $j$ and year $t$ .
Leverage ratio	Thomson Reuters 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	Thomson Reuters 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	Thomson Reuters 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	Thomson Reuters 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		<b>-0.36</b>	<b>0.07</b>	<b>-0.12</b>	<b>0.21</b>	<b>0.11</b>	<b>-0.03</b>	0.02	<b>0.04</b>	<b>0.04</b>
E/TA	<b>-0.36</b>		0.00	<b>0.21</b>	<b>-0.10</b>	-0.00	-0.04	-0.01	-0.02	<b>-0.03</b>
Business model	<b>0.07</b>	0.00		<b>-0.20</b>	<b>0.20</b>	<b>0.03</b>	0.00	<b>-0.06</b>	-0.00	0.01
NPLs	<b>-0.12</b>	<b>0.21</b>	<b>-0.20</b>		<b>-0.24</b>	<b>-0.08</b>	0.00	0.00	-0.00	<b>-0.05</b>
Liquidity	<b>0.21</b>	<b>-0.10</b>	<b>0.20</b>	<b>-0.24</b>		0.08	-0.00	<b>0.02</b>	<b>0.03</b>	<b>0.05</b>
Firm size	<b>0.11</b>	-0.00	<b>0.03</b>	<b>-0.08</b>	0.08		<b>-0.05</b>	<b>-0.10</b>	-0.02	<b>-0.07</b>
LTD/TA	<b>-0.03</b>	-0.04	0.00	0.00	-0.00	<b>-0.05</b>		<b>-0.03</b>	-0.00	<b>-0.08</b>
Current ratio	0.02	-0.01	<b>-0.06</b>	0.00	<b>0.02</b>	<b>-0.10</b>	<b>-0.03</b>		<b>-0.02</b>	<b>0.07</b>
ROE	<b>0.04</b>	-0.02	-0.00	-0.00	<b>0.03</b>	-0.02	-0.00	<b>-0.02</b>		<b>0.16</b>
INTcover	<b>0.04</b>	<b>-0.03</b>	0.01	<b>-0.05</b>	<b>0.05</b>	<b>-0.07</b>	<b>-0.08</b>	<b>0.07</b>	<b>0.16</b>	

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<sub>2</sub> 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



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