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Climate Stress Tests, Bank Lending, and the Transition to the Carbon-neutral Economy*

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Abstract

We ask if bank supervisors' efforts to combat climate change affect banks' lending and their borrowers' transition to the carbon-neutral economy. Combining information from the French supervisory agency's climate pilot exercise with borrowers' emission data, we first show that banks that participate in the exercise increase lending to high-carbon emitters but simultaneously charge higher interest rates. Second, participating banks collect new information about climate risks, and boost lending for green purposes. Third, receiving credit from a participating bank facilitates borrowers' efforts to improve environmental performance. Our findings establish a hitherto undocumented link between banking supervision and the transition to net-zero.

Keywords: banking supervision, carbon risk, climate stress test, green finance, syndicated loans

JEL classification: G21, G28, K11

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1 Introduction

Central banks and regulatory and supervisory agencies are at the forefront of the fight against climate change.[1] Droughts and floods pose physical risk, and changing policies and preferences in economic agents' behavior that affect the valuation of assets and liabilities pose transition risk when banks' borrowers are ill-prepared for the decarbonization of their business models. Therefore, supervisory agencies start to conduct climate stress tests to assess the resilience of banking systems to climate change. Despite the key role of supervisory agencies to combat climate change, little is known about how such efforts affect bank lending and if they play a role for the transition to the carbon-neutral economy.

In this paper, we exploit plausibly exogenous variation in climate stress tests, approximated by banks' participation in the French banking regulators' climate pilot exercise, as a proxy for supervisory efforts to tackle climate change. Our aim is to estimate the effect of banking supervision on borrowers' environmental performance via banks' lending decisions. While climate stress tests are primarily driven by financial stability concerns, we characterize climate stress tests as an information production exercise that uncovers new information about banks' exposure to climate change. We then combine data from the French climate pilot exercise with borrower-specific information on carbon emissions to understand whether banks' participation in this climate pilot exercise affects borrowers' environmental performance.

Our approach is econometrically appealing because it enables us to examine how supervisory efforts to understand risks arising from climate change affect lending decisions conditional on borrowers' exposure to transition risk. Our setup also allows disentangling the information value contained in carbon emissions of borrowers from the incremental reduction in information asymmetries related to transition risk arising from participation

[1] Regulation focuses on the development and promulgation of rules under which financial intermediaries operate (Eisenbach et al., 2016), whereas supervision is concerned with the monitoring of financial firms to ascertain compliance with laws and regulations to ensure safe and sound operations. The organization of regulation and supervision varies across jurisdictions, with regulation and supervision being either orchestrated within the central bank or by separate authorities. While climate change affects all dimensions of the regulatory and supervisory environment, climate stress tests are typically performed by supervisory agencies, and we therefore refer to 'supervisory efforts' or 'supervisory actions' to combat climate change in this research.

in the climate pilot exercise. This information advantage enables banks to improve their understanding, assessment, and management of the long-term consequences of transition risk. To do so, we compare bank lending to high-carbon emitters (brown borrowers) with bank lending to low-carbon emitters conditional on whether banks participate in the French bank supervisors' climate pilot exercise.

We find that the climate pilot exercise informs participating banks' lending decisions above and beyond the publicly available information on borrower-specific exposure to transition risk, approximated by carbon emissions. Most importantly, high carbon emitters whose banks take part in the climate pilot exercise obtain more credit, albeit at higher loan rates. Such borrowers also take actions to make their business models more resilient toward transition risk. In contrast, borrowers whose banks do not participate receive less credit, and show little progress to decarbonize their business models. A further novel insight from our research is that we are able to empirically document the production of new information following the climate pilot exercise. We present evidence that participating banks display a significantly higher tendency to discuss climate stress test scenarios in their earning calls, communicate more frequently with borrowers about transition risk issues, and discuss carbon emissions more often in their earning calls.

While a growing literature examines how banks incorporate climate change into lending decisions (Murfin and Spiegel, 2020; Nguyen et al., 2022; Ouazad and Kahn, 2022), little is known about how borrowers' business models are affected by bank supervisors' actions to address climate change. Borio et al. (2023) argue that it is unrealistic to expect financial institutions to finance the green transition without clear expectation on regulatory changes. Oehmke and Opp (2022) find that carbon related capital requirements allow banks to manage transition risk, but that these requirements are inferior to carbon taxes in reducing carbon emissions. By leveraging data from the French supervisory agency and combining them with borrowers' exposure to transition risk, our analysis of lending decisions allows establishing a hitherto undocumented mechanism through which supervisory actions related to climate change affect bank borrowers in their efforts to transform their businesses on the way to the carbon-neutral economy.

Our starting points are theories by Goldstein et al. (2014) that predict stress tests reduce information asymmetries, uncover and release new information, and by Dang et al. (2009) and Gorton and Ordonez (2014) that posit that sudden information shocks trigger information production.

We hypothesize that new information collected during the climate pilot exercise influences how banks lend to brown firms. Changes in bank lending can either facilitate or impede borrowers' transition to a carbon-neutral economy. While borrowers' carbon emissions allow banks to assess borrowers' transition risk, we argue that participation in the climate pilot exercise reduces information asymmetries beyond the information obtained via public information about borrowers' carbon footprints. The information collected during the climate pilot exercise, together with supervisory feedback, deepens and refines participating banks' understanding of climate change and the long-term consequences of transition risk. This may motivate banks to support borrowers in the transformation of their business models by continuing to provide credit. In contrast, non-participating banks are more likely to evaluate transition risk with a short-term perspective and reduce their exposures to such borrowers.

Our findings underscore that supervisory efforts concerning climate change affect borrowers' actions related to climate change. Concerning short-term adjustments, we show that high-carbon emitters that received loans from banks participating in the climate pilot exercise are more likely to have eco-friendly products, develop emission policies, are more likely to commit to carbon emission reduction targets, and have higher Environmental, Social, and Governance (ESG) Scores, compared to borrowers of non-participating banks. Regarding adjustments that require a longer time to achieve, we document that borrowers of participating banks use higher shares of renewable energy. However, such borrowers do not show improvements in total carbon emissions or direct carbon emission growth. They neither terminate supply chains with environmentally harmful suppliers, nor do they source more environmentally friendly materials.

Funding by banks that participate in the climate pilot exercise is the key driver behind these changes. Despite these borrowers' greater transition risk, banks increase lending by

38% but simultaneously incorporate a transition risk premium of 16 basis points (bsp).[2] Our tests underscore an undocumented role of climate stress tests beyond the identification of banks' vulnerabilities to climate change. Reading through conference calls of banks in our sample, we find that climate stress tests encouraged banks to communicate more with their borrowers about carbon risk, collect more information on borrowers' carbon emissions, and discuss more about climate risk scenarios. As a result, participating banks' deeper understanding of climate change, and transition risk in particular, enables them to support their borrowers on the way to reducing carbon emissions. Evidence on the origination of green loans supports our hypothesis. Climate stress-tested banks is more likely to grant loans to brown borrowers with green purposes or with sustainability-linked provisions compared to non-stress-tested banks. These loans also have longer maturity, reflecting that it is more likely to be used for strategically important projects.

Climate stress tests, approximated in our setting with the French supervisors' climate pilot exercise, are ideal for examining supervisory efforts to address climate change. While similar to financial stability stress tests in terms of resource intensity and objective of identifying vulnerabilities, climate stress tests take a longer-term horizon to evaluate potential losses when borrower activities do not align with the transition to a carbon-neutral economy. They also do not trigger capital charges, and consequently do not mechanically affect the cost of lending.[3] However, they shift attention to climate change, and, importantly, require participating banks to collect extensive information about exposures to physical and transition risk using scenarios based on carbon prices. This focus on carbon prices reinforces our choice to capture transition risk with borrowers' total carbon emissions. Climate stress tests therefore can also promote the transition towards the carbon-neutral economy because the information acquired during the climate pilot exercise raises banks awareness of and improves their ability to assess climate transition

[2] After the climate pilot exercise, participants charge high carbon emitters 8% higher interest rates compared to low carbon emitters. As the mean loan spread in our sample is 202 bsp, this effect is equivalent to 8*202/100 = 16.16 bsp.

[3] Oehmke and Opp (2022) show that regulating bank capital to address climate risks may not reduce carbon emissions. Higher capital requirements for carbon-intensive borrowers may crowd out lending to green borrowers and increase bank fragility.

risks, with corresponding effects on banks' business strategies and risk-management, reflected in their lending practices.

To isolate the causal effect of the climate pilot exercise, we built a novel data set. We exploit the first climate stress test whose data are publicly available from the French Prudential Supervision and Resolution Authority (Autorité de contrôle prudentiel et de résolution, ACPR), and combine it with syndicated loan data for banks and borrowers, and merge this information with borrowers' carbon emissions, data on borrowers' environmental performance from Refinitiv, and transcripts of banks' conference calls from S&P Capital IQ.

The participating nine banking groups operate a universal banking model and represent 85 percent of total assets in the French banking system. Our sample is also representative of other banking systems. Similarly to other European countries, France has a highly developed bank-based financial system with hundreds of smaller banks that, together with foreign banks and a limited number of large institutions supervised by the Single Supervisory Mechanism, provide credit to the economy. These large French banks account for the vast proportion of total assets in the banking system, are represented in our sample, and participated in the climate pilot exercise. Importantly, the availability of data from the climate pilot exercise helps identifying the role of banking supervision for the transition to the carbon-neutral economy, that is distinct from prior work that examines banks' commitments to reducing carbon emissions (Kacperczyk and Peydró, 2021), carbon emission intensity (Ehlers et al., 2020), banks' responses to information about physical risk (Correa et al., 2022; Nguyen et al., 2022; Meisenzahl, 2023), or news about borrowers harming the environment (Chava, 2014; Anginer et al., 2021).

A critical step in our identification strategy is to assess whether our estimates truly reflect lenders' updating beliefs about carbon transition risk as the result of climate stress tests instead of capturing the effects of differences in bank characteristics or other shocks affecting high and low carbon emitters differently. Placebo tests indicate that lending and pricing behaviours to brown firms of banks that do not participate in climate stress tests do not change. We also rule out that our results are driven by the ECB climate

stress tests, or other events happening in our research periods such as the Covid-19 crisis or the Ukraine-Russia war. Heckman's selection model shows that our results are not biased because of banks selected themselves into participating the climate stress tests. Alternative measurements of transition risk such as the use of carbon emission intensity, the Sautner et al. (2023)'s transition risk measures, and Reprisk's environmental risk index do not change our findings. We also find no evidence that our results can be explained by differences in borrowers' financial constraints or bank characteristics.

Further analyses reveal heterogeneity in the data. Banks that are members of the United Nations Environment Programme (UNEP) and banks with higher shares of institutional investors are the ones that respond more strongly to climate stress tests.

Our research is important because banks in the EU generate more than 65 percent of their interest income from carbon intensive industries (European Central Bank, 2022). Equally, it is important to evaluate whether actions by bank supervisors that predominately focus on financial stability concerns arising from climate change also play a role for the transition to the carbon-neutral economy. Moreover, although many banks already started incorporating sustainability concerns into lending activities, they currently lack detailed business strategies, risk management processes, and governance systems to address challenges related to climate change. They also reveal deficiencies about how to quantify transition risk correctly (European Central Bank, 2022). Our work illustrates how supervisory agencies, via climate stress tests, contribute to reducing uncertainties related to climate change, and influence banks to promote an orderly transition to the carbon-neutral economy. Finally, in contrast to previous studies that document negative effects for borrowers arising from transition risk, our work highlights that banks that participate in a climate stress test reaffirm their commitment to borrowers despite such borrowers' exposure to transition risk. This finding underscores that banking supervision can actively support the transition to a carbon-neutral economy.

We contribute to several different strands in the literature. First, numerous studies examine how supervisory resources and coverage (Eisenbach et al., 2016; Hirtle et al., 2020; Goldsmith-Pinkham et al., 2016; Ivanov et al., 2023), standards (Kiser et al., 2012; Bassett

et al., 2015), intensity (Agarwal et al., 2014; Rezende and Wu, 2014), and enforcement actions affect the performance of banks and their borrowers (Delis and Staikouras, 2011; Danisewicz et al., 2018). We contribute to this literature by estimating how supervisory efforts to address climate change produce new information that enables participating banks to better assess information about borrowers' transition risk and revise lending decisions accordingly.

Second, we also contribute to the literature on stress tests. Morgan et al. (2014) and Flannery et al. (2017) find that stress tests generate valuable information about participating banks. Acharya et al. (2018) and Cortés et al. (2020) show stress-tested banks reduce credit, reallocate lending towards safer borrowers, and raise interest rates for small and medium-sized firms, respectively. Gropp et al. (2019) document that stress-tested banks reduce risk-weighted assets to meet capital requirements, and Kok et al. (2023) find that banks participating in stress tests reduce credit risk. Unlike these studies, our research establishes a direct link from supervisors' climate stress tests to borrowers' actions to make their business models resilient to climate change via banks' lending decisions without triggering capital surcharges. Recently, Acharya et al. (2023) review climate stress scenarios employed by regulators and call for more research to be done in this topic to understand the real implications of climate stress tests.

Third, we advance the literature on how banks' lending behavior reacts to climate change. A paucity of studies shows banks respond to information that conveys signals about borrowers' climate change risk by reducing credit supply, charging higher interest rates, or securitizing loans (Chava, 2014; Delis et al., 2019; Anginer et al., 2021; Mueller and Sfrappini, 2022; Mueller et al., 2022; Kacperczyk and Peydró, 2021; Nguyen et al., 2022; Correa et al., 2022; Meisenzahl, 2023). While our empirical work confirms prior findings that information shocks that signal greater transition risk trigger reductions in credit supply, banks that participate in in the climate pilot exercise increase lending. This result is consistent with the view advocated in the policy community that climate stress tests are a learning exercise for banks' to better understand and assess climate transition risk. They inform banks' business strategies with implications for lending behavior. Our

results therefore underscore the beneficial effect of conducting climate stress tests that goes beyond their immediate objective of preserving financial stability.

Finally, our work also speaks to the scant literature on the role of financial constraints for firms' propensity to decarbonize their business models. Accetturo et al. (2022) highlight that credit availability is a key impediment to borrowers' willingness to invest into green technologies. Unlike their work, we show that credit availability increases as a result of banks' participation in the climate pilot exercise, underscoring real effects of supervisory efforts to tackle climate change.

2 Institutional background

2.1 The French climate pilot exercise

The climate pilot exercise in France, conducted between July 2020 and April 2021, is the first one of its kind. Its findings inform activities by various other central banks and international bodies concerning climate change. The main objectives of the pilot climate exercise are to boost banks' and insurance companies' understanding of climate change risks and strengthen the ability to anticipate and manage such risks in the long run. Another benefit is to identify gaps in terms of data availability related to climate change. Contrary to financial stability stress tests, the pilot exercise does not establish the solvency of the participating institutions. Therefore, the exercise cannot be failed. It also does not trigger regulatory capital requirements, and no bank-specific results are published. These characteristics of the climate pilot exercise avoid regulators' reputation-building behavior in traditional stress tests documented by Zeng and Shapiro (2022) that result in soft or tough stress test regimes that trigger corresponding changes in banks' lending behavior.

Appendix B gives information on the 9 bank groups in France that participated in the climate pilot exercise. The intention of this pilot exercise is to raise awareness of physical and transition risks among financial institutions. However, the exercise uncovered a lack of data concerning physical risk, which requires modeling the impact of rising temperatures between 1.4 and 2.6°C by 2050. One problem arises from the lack of location information

of funded or collateralized retail and corporate properties. A further problem arises from lack of data on the location of businesses' production sites and value chains. Both these problems resulted in a focus on banks' exposure to transition risk in the pilot exercise.[4] The French setting is therefore particularly well-suited for our analysis that centres on borrowers' environmental risk profiles that convey information about transition risk.

To establish the effects of transition risk, the climate pilot exercise required banks to simulate three different scenarios based on recommendations by the Network for Greening the Financial System (NGFS) and described in detail in Appendix A. The scenarios concentrate primarily on the evolution of carbon prices over a 30-year period from 2020-2050. Although carbon prices are the main drivers of the transition (Bolton and Kacperczyk, 2023), and climate stress tests focus on them, prices of other non-renewable energy sources such as oil, gas, and coal, and any industry using these sources are affected by them (European Central Bank, 2022). Therefore, carbon prices have vast ranging implications for banks and their borrowers. In particular, they affect the long-term viability of borrowers' business models, their creditworthiness, and the values of assets and collateral (Baudino and Svoronos, 2021).

The French climate pilot exercise is forward-looking, follows a bottom-up approach, and combines qualitative and quantitative approaches. The qualitative aspect of the climate pilot exercise highlights the learning dimension for banks and supervisors. Throughout the duration of the exercise, the participating institutions took part in Q&A sessions, culminating in bilateral interviews and feedback sessions that helped clarify, refine, and correct risk assessments and issues related to methods, data, reporting consistency, and exposures. Moreover, this process improved banks' understanding of the limits of existing risk management models, bolstered their comprehension of the role of climate change for business models, and mobilised resources to tackle climate change.

The quantitative dimension requires banks to estimate losses they may incur for credit and market risk based on the three transition scenarios, assess their impact, and carry out balance sheet projections. Unlike traditional stress tests that use time frames of three

[4] ACPR (2020) states banks' assessments of physical risk significantly lagged the analysis of transition risk, reflecting difficulties related to precise information of the geographical location of their exposures.

to five years, the French climate pilot exercise takes a long-term perspective from 2020 to 2050 to better accommodate the effects of climate change. It therefore combines a static balance sheet assumption until 2025 with a dynamic balance sheet assumption from 2025 to 2050. The former requires projections for banks' credit risk based on changes in carbon prices applied to loan and investment portfolios. The latter involves predicting losses using not only changes in carbon prices but also changes in balance sheet composition. This allows analyzing banks' strategies taken to mitigate climate risks by enabling them to consider new risks and corrective actions. Another distinct feature of the exercise is its granular focus. While financial stability stress tests use aggregate asset classes to model expected losses, the climate pilot exercise examines 55 activity sectors to consider heterogeneities across different businesses in the transition to the carbon-neutral economy.

3 Empirical Implications

Our goal of is twofold. First, we aim to establish how the climate pilot exercise initiated by bank supervisors, with its feedback effects to participating banks, shapes banks' view of transition risk and affects lending decisions. Second, we wish to estimate the causal effect of banks' participation in the climate pilot exercise on their borrowers' environmental performance.

3.1 Implications: Bank lending

Of course, it is plausible to expect that the emphasis of the climate pilot exercise on raising banks' awareness for climate risks with feedback sessions and bilateral interviews fosters a profound understanding of climate change in participating banks. Therefore, the climate pilot exercise has potential to motivate banks to reconsider policies and revenue generation in their lending business with borrowers that display high transition risk, resulting in either favourable or unfavourable adjustments in loan contract terms.

The effort of collating data concerning risk exposures generates new and private information that facilitates loan monitoring, and the availability of such information

may also trigger loan reviews. Our argument is nested in theories by Goldstein et al. (2014); Dang et al. (2009); Gorton and Ordonez (2014) according to which stress tests and sudden shocks produce new and unique information. It is also consistent with the theory by Diamond (1984) and corresponding empirical evidence by James (1987), and Lummer and McConnell (1989) that highlight the role of banks for reducing information asymmetries by monitoring borrowers, and, importantly, for using such information to renegotiate loan contract terms.

Moreover, the climate pilot exercise also facilitates information flows with feedback effects for banks, supervisors, and borrowers, and enables revealing and quantifying hitherto undocumented risks. The exercise also reduces opacity related to transition risks. The interactions between supervisors and banks also spread best practices about assessing and managing climate change risks. Banks' participation in the climate pilot exercise may also affect employees' attitudes, beliefs, and values concerning climate change. Further, insights about limits of current risk management models, granular sectoral exposures, insufficient data, and incomplete reporting systems that do not allow assessing climate change risk may result in additional technology investments and greater sensitivity towards climate change risk. Prior work reinforces this view. Hirtle et al. (2020) state that supervisory concerns related to risk management motivate banks to make technology investments. Tarullo (2019) underscores that supervisory expectations related to stress tests encourage banks to upgrade information and risk management systems, boosting the efficiency of lending decisions and allowing more precise assessments of borrowers' transition risk with a long-term perspective.

The specific nature of transition risk further adds to the complexity of assessing borrowers' exposure to such risks. Banks need to consider two key aspects. One, they need to form an opinion about borrowers' ability, willingness, and likelihood to decarbonize their business models, and simultaneously gauge the evolution of carbon-neutral technologies over the maturity of a loan (Bolton and Kacperczyk, 2023; Mueller and Sfrappini, 2022; Mueller et al., 2022). Two, the fact that banks generate more than 65 percent of their interest income suggests that banks also need to consider

the high dependency from and correlated exposures to carbon-intensive sectors which carries considerable potential for loan losses during the transition process (European Central Bank, 2022). Banks' lending decisions, therefore, should not only consider current levels of carbon emissions but should also reflect on whether borrowers are able to reduce carbon emissions in the transition process over the long run, consistent with the 30-year horizon of the climate pilot exercise. Related to this concern, in robustness checks, we also use other measurements of borrowers' exposure to transition risk such as the index developed by Sautner et al. (2023) that captures opportunities and risks firms face related to climate change, and the Reprisk Environmental Index that signals whether borrowers are struggling with the transition to the carbon-neutral economy (Duan et al., 2023).

Against this background, it remains an empirical question whether the reduction in information asymmetries related to borrowers' transition risk arising from the climate stress test triggers changes in bank lending behavior.

If the climate pilot exercise shifts banks' awareness for transition risk towards greater risk-sensitivity, increases uncertainty about borrowers' future cash flows from the projects funded by loans, collateral values, and aggravates concerns about stranded assets, participating banks may initiate reviews of their lending relationships with high-transition risk borrowers. The new information signals acquired during the climate pilot exercise may highlight a systematic underestimation of transition risk, and result in reductions of exposures to borrowers with high-transition risk and higher risk-premiums. Such negative effects from tougher supervision for bank lending have been documented in prior work by Peek and Rosengren (1995), and Ivanov et al. (2023).

On the other hand, the greater awareness for climate change risks with its corresponding investments in better risk management systems, and an evolving culture towards helping borrowers in the transition to the carbon-neutral economy, may dominate the greater risk-sensitivity for these risks. To the extent that the reduction in information asymmetries triggered by the climate pilot exercise results in a favourable updating of banks' beliefs about borrowers' ability to adjust to the carbon-neutral economy, banks may expand lending to such borrowers, potentially at lower loan rates. Supervision could,

in line with Chaly et al. (2017), therefore contribute to a stable provision of financial services.

These two countervailing effects will only be reflected in the data as long as other factors, such as resource constraints, executives' personal views on climate change and short-term incentives that shape banks' lending policies, concerns about inflating green bubbles, long-term relationships with high-transition risk borrowers, and legacy assets do not interfere with and mute the information signals gleaned during the climate pilot exercise. Another factor that may dampen the effect of the climate pilot exercise is that higher exposures to climate risks do not attract regulatory capital surcharges. Our empirical estimates will pick up the net effect of these competing forces.

3.2 Implications: Borrowers' environmental performance

We next turn to the effect of banks' participation in the climate pilot exercise on their borrowers' environmental performance. Answering this question illuminates a key issue in the debate on climate change – whether the banking sector, and bank supervision more specifically, can help the transition to the carbon-neutral economy.

A widely accepted view among economists is that supervision imposes costs and constraints on banks (Bernanke et al., 2006). Even in the absence of capital requirements as in our setting, these costs and constraints transmit via banks' lending decisions to the real economy (Ivanov et al., 2023). Costs arise from investments in data collection related to climate change risk, enhancements of information and risk management systems, and, importantly, a review of exposures motivated by revisions of the estimates on credit and market risk during the transition process. Constraints come in the form of banks' greater awareness for climate change risks reflected in higher expectations and pressure on borrowers to decarbonize their business models, and banks' anticipation of future capital requirements against climate-related losses that result in reductions in credit supply. In response, it is plausible to expect that borrowers of banks that participate in the climate pilot exercise try to and are encouraged to boost environmental performance.

Whether borrowers of banks participating in climate stress tests indeed boost environmental performance is however an open question. It is equally plausible that borrowers face formidable obstacles and impediments in the transition to the carbon-neutral economy, and make therefore little or no efforts to make their business models resilient to climate change. Potential challenges range from executives' short-term incentives who delay restructuring business models and shy away from investments that deplete earnings in the short run, lack of control of supply chains, and immaturity of carbon-neutral technologies and infrastructure, to industry-specific reasons where the transition to net zero is difficult to achieve, e.g. in coal mining.

4 Data and descriptive statistics

We combine several different data sets for this research. We start by manually collecting the list of banks that participate in the French climate pilot exercise conducted by the ACPR from the Banque de France. The climate stress tests take place on the parent- or headquarter level. We carefully check each bank's name and location details to identify these banks.

Participation in the climate exercise is described in official documents by the ACPR as "voluntary". Despite this official stance, our frequent discussions within the policy community suggest that participation for these nine banks was effectively mandatory. This discrepancy underscores pressure on banks to comply, regardless of the formal presentation of voluntariness. Appendix B provides an overview of the 9 participants in the climate pilot exercise.

To understand whether banks' participation in the climate pilot exercise affects borrowers' actions to decarbonize their business models, we establish a link between banks and their borrowers via lending activities. We retrieve data on loan contracts from Thomson Reuters LPC's Dealscan. We include all Euro-denominated syndicated loans provided by all French and non-French banks extended to French borrowers between 2015 and 2023. Syndicated loans are well-suited for our analysis because Gustafson et al. (2021) show that such loans are actively monitored with lead banks demanding information from

borrowers on a regular basis. We exclude SIC codes from 6000 to 6999 to remove financial firms, and focus on lead arranger(s) following the approach used by Ivashina (2009). Participants are excluded from our sample because lead arrangers play the key role in setting and negotiating loan terms with borrowers before turning to participant lenders that can be characterized as passive investors (Correa et al., 2022).

Our unit of observation to test bank lending behavior is the loan level. We allocate a loan into the treatment group if the name(s) of the participating bank(s) in the climate pilot exercise matches the name of the lead arranger(s) in the Dealscan data. The control group consists of loans provided by French banks that did not participate in the climate pilot exercise, and banks headquartered outside France that cannot participate in the climate pilot exercise but supply credit to French borrowers. The benefit of this setup is that we can compare borrowers operating in the same macroeconomic environment that differ in terms of their lenders' awareness and ability to comprehend and assess risks arising from climate change.

We further augment the loan-level data with bank characteristics using the Dealscan-Compustat link from Schwert (2018) for the period from 2015 to 2020 and manually check lenders that appear in the sample in the later period. Borrower characteristics are extracted from Compustat Global by manually checking all borrowers' names to identify their GVKEYs and ISINs.

For carbon emissions and environmental performance, we merge our loan level data with Refinitiv. In a robustness check, we also use the Environmental Risk Index from RepRisk and climate risk exposures as in Sautner et al. (2023) as alternative measurements of transition risk. Our final sample for the loan-level analyses consists of 1,673 unique loans that have information on loan amount, spread, borrower carbon emissions, and borrower characteristics.

Table 1 reports summary statistics for our main variables and Appendix C shows variable descriptions for 1,673 French loans in our sample. Our sample consists of 43.8% of loans originated by banks that participated in the climate stress tests. The average

loan amount granted to French borrowers over the sample period is 600 million USD, with an average maturity of 5 years and an average loan spread of 202 basis points.

[Insert Table 1]

Figure 1 shows average carbon emissions across eight industries. Mining, oil, and gas, followed by transportation and utilities have the highest carbon emissions (9.97 million, and 6.47 tons of carbon dioxide per firm, respectively). On the contrary, on average, wholesale trading and services have the lowest carbon emissions.

[Insert Figure 1]

A further goal of this research is to compare borrowers' environmental performance conditional on their banks' participation in the climate pilot exercise. For this purpose, we retrieve detailed data from Refinitiv for 2015 to 2023 on 'short-term' and 'long-term' dimensions of borrowers' environmental profiles. As Refinitiv only provides annual information on firms' environmental performance, we aggregate information from syndicated loans to the firm-year level to observe whether a firm gets at least one loan from a participating bank at year *t-1* and merge this information into the borrower-year level information from Refinitiv. We focus on whether borrowers have eco-friendly products, experience changes in ESG, Environmental, and Emission Scores, have emission policies, set emission reduction targets in their production process and view them as short-term performance dimensions because such dimensions are likely to reflect borrowers' efforts to address climate change in the short run. In contrast, we classify the use of renewable energy over total energy sources, total emissions growth, direct emissions growth, the probability of having supply chain environmental policies, terminations of contracts with suppliers who are considered to be environmentally unfriendly as well as having environmental criteria for material sourcing as longer-term dimensions as it may take longer time until one can observe these changes.

Table 1 illustrates substantial heterogeneity across borrowers' environmental performance. While 85% of firms have carbon emission policies, only 63% have a target of for how much carbon emissions should be reduced by 2050. On average, firms in our

sample have an ESG score of 64, an Emission score of 78, total carbon emissions growth of 1.6%, direct carbon emissions growth of 1.8%, and 32% of our firms terminate contracts with suppliers that are considered environmentally unfriendly. Our final data set for the analyses of borrowers' environmental performance results in 843 observations from 7 industries between 2015 and 2023.

5 Identification strategy

5.1 Borrowers' transition risk and bank lending

We start with a simple model that explores the relationship between banks' lending behavior and borrowers' carbon emissions in the absence of participation in the climate pilot exercise for the period between 2015 and 2023. Results from this initial analysis inform us about how banks decide on credit supply and loan pricing depending on public information about firms' exposure to transition risk without the influence of the climate pilot exercise.

$$Y_{lbft} = \beta \times CarbonEmissions_{f,t-1} + \gamma F_{ft} + \theta L_{lbft} + \delta_b + \delta_{it} + \delta_l + \varepsilon_{lbft}, \qquad (1)$$

where Y_{lbft} is the loan volume or loan spread for a given loan by bank b to a borrower f at time t. $CarbonEmissions_{f,t-1}$ is the natural logarithm of total carbon emissions (measured in tons) of firm f the year before; γF_{ft} is a vector of quarterly borrower characteristics including firm size, and firm leverage; θL_{lbft} is loan maturity. For regressions with loan volume as a dependent variable, we also control for loan amount and vice versa.

We include bank-fixed effects, δ_b, to capture bank-specific time-invariant effects; δ_l are loan-type fixed effects to ensure that our results do not reflect differences in loan contract features such as whether a loan is revolving or a term loan. In addition, industry-year fixed effects δ_{it} capture differences in loan demand across different industries and industry characteristics over time during our sample period. A further benefit of including the

interaction of industry and year-fixed effects is that our sample period coincides, at least partially, with the COVID-19 episode (which affects services and manufacturing in particular), rising inflation rates, and the war in Ukraine (that affects energy, oil, and gas). These factors have varying effects on different industries that are absorbed by these fixed effects. ε_{lbft} is the idiosyncratic error term. We double-cluster standard errors at the bank and borrower level to reflect that participation in the climate pilot exercise is at the bank level but carbon emission are measured on the borrower level. The main coefficient of interest is β, which identifies whether banks change loan volume or spread if borrowers' carbon emissions change.

5.2 Difference-in-difference-in-differences specification

The ideal setup to establish the causal effects of the climate pilot exercise on bank lending and its corresponding effects on borrowers' environmental performance assigns the climate pilot exercise to banks in a random fashion. The institutional setup with participation in the climate exercise officially described as voluntary but characterized in the policy community as de facto mandatory constitutes an empirical challenge. Banks could nudged to participate in the climate exercise for reasons that may correlate with their lending policies and the composition of the loan portfolio.[5]

Our most feasible empirical approximation to generate plausibly exogenous variation in the assignment of the climate pilot exercise is therefore to compare the participating (treatment group) banks with French and non-French (control group) banks that cannot participate in the exercise but also provide credit to borrowers in France. The composition of this control group mitigates concerns that foreign banks retrench to their home countries

[5]To mitigate concerns about a possible selection problem embedded in the participation of the climate exercise, Appendix D Table D.1 presents a Heckman (1979)'s selection model, where our first stage models participation in the pilot exercise using a dummy variable Green lender that takes on the value of one if a bank signed the UN Principles for Responsible Banking (0 otherwise) prior to the climate pilot exercise before 2020. This predictor variable can be plausibly excluded from the second stage because being a signatory has no bearing on a banks' overall lending activity. Table D.1 shows that the green lender dummy is significant and intuitively related to participation in the climate exercise. However, the inverse Mills ratio remains insignificant, supporting our argument that no selection problem exists.

during a shock like the Ukraine crisis and that such behavior (Giannetti and Laeven, 2012) interferes with our key coefficients of interest.

Having restricted our sample to participating French banks and non-participating French and foreign banks, we apply a triple difference strategy. Ultimately, we are interested in the causal relationship between the French climate pilot exercise and banks' lending behavior towards borrowers with different levels of transition risk reflected in their carbon emissions. We identify this relationship with the following equation:

$$\begin{aligned} Y_{lbft} = {} & \beta_1 \times HighEmitter_f \times Post_t \times Treated_b + \\ & + \beta_2 \times HighEmitter_f \times Post_t + \beta_3 \times HighEmitter_f \times Treated_b \\ & + \beta_4 \times HighEmitter_f + \beta_5 \times Post_t \\ & + \gamma F_{ft} + \theta L_{lbft} + \delta_b + \delta_l + \delta_{it} + \varepsilon_{lbft} \end{aligned} \tag{2}$$

where $Post_t$ is a dummy variable equal to 1 for the period after the French climate climate pilot exercise (2020Q3 onwards), 0 otherwise; $Treated_b$ is a dummy taking on the value 1 for a bank participating in the climate pilot exercise, 0 otherwise; all other variables are identical as in Equation 1, except for $HighEmitter_f$ which is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. Using pre-shock measurement of borrowers' carbon emissions allows us to capture the direct effect of the climate pilot exercise rather than the change in firms' risk exposure. Thus, our main coefficient of interest is now β_1 which indicates whether banks that participate in the climate pilot exercise change loan volume or spread for higher carbon emitters compared to lower carbon emitters, holding everything else constant.

Last, using annual borrower-level information on their environmental performance from Refinitiv, we explore the relationship between the climate pilot exercise and changes in borrowers' environmental performance. We use the following specification:

$$\begin{aligned} Y_{ft} = {} & \beta_1 \times HighEmitter_f \times Post_t \times Treated_{f,t-1} \\ & + \beta_3 \times HighEmitter_f \times Post_t + \beta_4 \times HighEmitter_f \times Treated_{f,t-1} \\ & + \gamma F_{ft} + \alpha_f + \tau_t + \varepsilon_{ft} \end{aligned} \tag{3}$$

where Y_{ft} captures either short-term adjustments for environmental performance such as having eco-friendly products, having emission policies, having emission targets, ESG, Environmental, and Emission Scores, or longer-term adjustments such as the share of Renewable Energy, Total Emissions Growth, Direct Emissions Growth, having Supply Chain Environmental Policies, Termination of Environmentally Unfriendly Suppliers, Materials Sourcing Environmental Criteria of borrower f at time t; $Treated_{f-1}$ is a dummy taking on the value 1 if borrower f received any loan from a participating bank the year before, 0 otherwise; $HighEmitter_f$ is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise.; γF_{ft} is a vector of borrower characteristics including firm size, and leverage; α_f and τ_t are firm- and time-fixed effects, respectively.

5.3 Parallel trends

A causal interpretation of the parameters in Equation 2 relies on the parallel trends assumption. This assumption states that, in the absence of the climate pilot exercise, participating banks and non-participating banks provide loans to borrowers of similar environmental risk profiles and their characteristics evolve in similar fashions. We examine the evolution of loan, firm, and bank characteristics using t-tests.

First, we ask whether changes in bank lending and interest rates from treated and control banks differ before the climate pilot exercise. If they do, one may be worried about differences in business models between these groups of banks. Table 2 shows loan volumes and interest rates of treated and control banks are similar before the climate pilot exercise. Likewise, changes in the share of high carbon emitting borrowers linked to the two groups of banks are similar prior to the climate pilot exercise. We also compare other bank and firm characteristics (size, equity ratio, leverage ratio, and profitability) and find that these characteristics evolved in similar patterns before the climate pilot exercises.

[Insert Table 2]

Next, we ask whether changes in bank lending and interest rates to High Emitters compared to Low Emitters from treated and control banks differ before the climate pilot

exercise. The concern here would be that our results may be driven purely by green preferences of these two groups of banks. Following the convention in the literature, we test this assumption by inspecting the dynamic effects of the climate pilot exercise on lending to High vs Low Emitters for all years before the exercise. In Table 3, we interact $HigherEmitter$ and $Treat$ with a set of yearly dummies between 2015 and 2019 and find that treated banks and control banks lend and price loans in similar patterns for *High Emitters* compared to *Low Emitters*.

[Insert Table 3]

6 Results

Our first test focuses on how banks react to their borrowers' carbon emissions. Next, we evaluate the effect of the climate pilot exercise on bank lending to brown borrowers. As part of this analysis, we also explore heterogeneous adjustments by inspecting the role of green banks and ownership structures. A further analysis explores whether banks indeed produce new information during the climate pilot exercise. The final set of tests explores whether the climate pilot exercise has real effects and whether lending by participating banks triggers behavioral changes among their borrowers.

6.1 Bank lending and firms' exposure to transition risk

Table 4 reports the results from estimating Equation (1) using data between 2016Q1 and 2020Q2 when no climate pilot exercise had taken place yet. Standard errors are clustered at the bank level.

Column (1) and Column(2) show the effect of firms' carbon emissions on loan volumes (in natural logs) whereas Column (3) and Column(4) focus on loan spreads (in natural logs). In Column (1) and Column (3), we perform the estimation with loan characteristics, bank-fixed effects, loan-type fixed effects, and industry-year fixed effects without controlling for firm characteristics. We include a vector of borrower control characteristics including size, leverage, ROA in Columns (2) and Column (4). The result

from this exercise illustrates that in the absence of the climate pilot exercise, there is no evidence that banks limit their exposure to high transition firms by reducing credit supply or increasing loan rates.

[Insert Table 4]

6.2 Bank lending after the climate pilot exercise

We now turn to our analysis that focuses on how participation in the climate pilot exercise affects lending to high-transition risk firms compared to low-transition risk firms.

We estimate Equation (2) and report the results in Table 5. Column (1) and (2) report on loan volumes (in natural logs) and Column (3) and (4) examine loan spreads (in natural logs). We control for loan characteristics, bank-fixed effects, loan-type fixed effects, and industry-year fixed effects in all specifications. Additionally, we control for borrower characteristics in Column (2) and (4), our preferred specifications.

[Insert Table 5]

The estimates for our coefficient of interest, β_1, are significant and positive for both dependent variables. Following the climate pilot exercise, participating banks increase loan volumes significantly by 38% for High Carbon Emitters. They also significantly increase loan spreads by 8% (equivalent to 16 bps), ceteris paribus. This result indicates that banks adjust their risk pricing to reflect the greater transition risk in sticking with brown borrowers.

We do not view our results to contradict prior findings by Kacperczyk and Peydró (2021) that banks reduce credit for high-transition risk firms. In contrast, we propose that the climate pilot exercise with its long-term horizon changes banks' risk perspective. Instead of immediately reducing exposure to transition risk, participating banks may want to aid borrowers in the transition towards greener activities. Given their exposure to potential financial losses in future if borrowers fail to adopt their business models for the carbon-neutral economy, they stick with these firms and provide larger loan volumes. To compensate for the greater risk, they in turn demand higher spreads.

6.3 Do participating banks aid the transition to net-zero?

Next, we ask whether banks involved in the climate pilot exercise are more willing to help the transition to net-zero. To this end, we first investigate if participating banks provide loans with longer maturity to their borrowers after the climate pilot exercise. The rationale behind this test is that green investments may take time, and if loans given to brown borrowers have longer maturity, they have a higher chance to be loans with positive impacts. Given the average maturity of approximately 5 years of the syndicated loans in our sample, we split the data into loans with a maturity of 3 years or less. Columns (1) - (4) illustrate that our findings are driven by loans with maturities above 3 years, suggesting that the lending activities that are of greater relevance for the green transition have longer maturities.

Second, we examine if the climate pilot exercise leads to a higher likelihood of banks providing green loans for their brown borrowers. We define a loan that is green if it is a sustainability linked loan where the loan contract terms indicate borrowers' cost of funding change depending on future environmental performance, or, alternatively, if the loan is originated to fund energy efficiency projects. Typical examples for sustainability linked loans are ones with higher interest rates if borrowers do not commit to net-zero scientific targets. Typical examples for loans with green purposes are ones to fund investment in windmills, production of solar panels, or energy-efficient products. We obtain this information by performing textual analysis on tranches and deal remarks from the Dealscan data.

[Insert Table 6]

Columns (5) and (6) of Table 6 examine the likelihood of a green loan being originated. The two columns differ in their inclusion of control variables for borrower characteristics. After the climate pilot exercise, treated banks are 7.6 to 9.1 pp more likely to provide a green loan for high carbon emitters. Given that 10% of our loans are classified as green loans, the magnitude of the effect is big and equivalent to 76% increase in the probability that a bank provides a green loan to aid their brown borrowers in the transition to

net-zero. In Columns (7) and (8) that again differ in terms of the inclusion of borrower control variables, we aggregate the data to the bank-quarter level to test whether the climate pilot exercise provokes participating banks to supply more green credit to brown borrowers. We find that the share of green loans over total loans that participating banks provide increases by 4.3 to 4.6 pp after the pilot exercise, suggesting some rebalancing of the loan portfolio towards green lending.

6.4 Further heterogeneities

Next, we explore additional heterogeneities in the data. It is plausible to assume that banks that are signatories of the UN Principles for Responsible Banking prior to their participation in the climate exercise are more willing to support borrowers in the transition to net-zero. The intuition is that such banks already have a positive predisposition towards being green relative to banks that did not sign up to these principles.

Table 7 supports this assertion. The tests in Columns (1) and (3) highlight that our results are driven by signatories of the UN Principles for Responsible Banking. This subsample of banks displays statistically greater responsiveness in terms of lending volumes and loan spreads. In contrast, our key coefficients of interest in Columns (2) and (4) are rendered insignificant.

Likewise, ownership structure may play a role for the observed effects. The remaining tests in Table 7 split the sample at the level of institutional investors. Columns (5) and (7) highlight that the effects on loan volumes and spreads are concentrated in banks whose ownership structure is dominated by institutional investors whereas the effects cannot be observed in Columns (6) and (8). This is consistent with Krueger et al. (2020) and Ceccarelli et al. (2024)' findings that institutional investors believe that climate risks have financial implications for their portfolios and actively engage in pricing these risks as well as adjusting their holdings towards low carbon stocks.

[Insert Table 7]

6.5 Climate pilot exercise and information production

We characterize the climate pilot exercise as an information production exercise, and this new information is crucial to update beliefs of banks and their borrowers about how climate change affects borrower business models with corresponding knock-on effects on banks' lending activities.

This subsection provides empirical support to back up this claim. To this end, we retrieve information about conference calls by all banks in our sample from S&P Capital IQ between 2015 and 2023 and manually read 2,322 transcripts. Next, we collapse the data into the bank-quarter level to reflect that large banks often have multiple conference calls per quarter. This results in 1,125 observations. We construct three variables to capture banks' awareness for the climate pilot exercise. First, our variable "*Mention climate stress test*" takes on the value of one if the transcript mentions the term "climate stress test" or "climate pilot exercise" (0 otherwise). Analogously, the dummy variables for borrower communication on transition risk take on the value of one (0 otherwise) if the transcripts highlight the bank mentions discussions with their borrower concerning issues related to transition risk. The variable Discussion about Emissions is the number of times that banks discussed about carbon emissions in their earning calls. Appendix E provides some examples of texts that we collected from conference calls related to these issues.

Our results in Table 8 reinforce this view. Participating banks display a significantly higher probability of mentioning the climate stress test after the exercise took place. They are also significantly more likely to communicate with their borrowers about transition risks. Finally, they discuss more often about carbon emissions in their earning calls.

[Insert Table 8]

6.6 Firms' environmental performance

Our final set of analyses homes in on the question of whether borrowers whose banks changed loan volumes and spreads following the climate pilot exercise changed their

behavior in terms of adjusting environmentally relevant dimensions. Table 9 reports the results from estimating Equation 3. Our tests on the borrower level use annual data, reflecting the frequency of the availability of borrower information related to environmental performance.

We find our coefficient of interest, β_1, is significant and positive for all short-term adjustments. After getting a loan from a participating bank, higher carbon emitters are 25 pp more likely to have eco-friendly products, their ESG scores improve by 12 points, Environmental Scores improve by 15 points, and Emission Scores improve by 20 points. They are also 23 pp more likely to have emission policies and 49 pp more likely to have targets for carbon emission reduction.

[Insert Table 9]

In contrast, Table 10 does not show convincing signs of improvement in dimensions that require longer-term transitioning towards becoming more environmentally friendly or sourcing environmentally friendly materials. While borrowers of participating banks increase 15 pp in their usage of renewable energy, they show little or no signs of reducing their total or direct emission growth. They also do not terminate supply chain links to environmentally unfriendly suppliers or try to source more environmentally friendly raw materials. A potential explanation for this result is that these dimensions take greater effort and, therefore, take a longer time to show in the data.

[Insert Table 10]

7 Robustness checks

7.1 Falsification tests

We perform falsification tests to establish that the treatment effects are not observable in the absence of participation in the climate pilot exercise. To do so, we randomly assign banks that did not participate in the climate pilot exercise tests to be participants. Column (1) and (2) of Table 11 show that the key coefficient is rendered insignificant.

[Insert Table 11]

7.2 Alternative measurements of transition risk

While carbon emissions are a standard measurement of carbon transition risk in contemporary literature (Bolton and Kacperczyk, 2023), one critique for using carbon emissions to gauge borrowers' exposure to transition risk would be that our measurement picks up other firm characteristics such as size or how much forward looking firms are in their estimation of carbon emissions (Aswani et al., 2023; Zhang, 2024). We alleviate this concern by using carbon emission intensities which are calculated as borrowers' carbon emissions divided by borrowers' total assets to assign High vs Low Carbon Emitters. We report the results in Columns (1) and (2) of Table 12. We continue to find that participating banks increase loan volumes (17%) and spreads (7%) for high carbon emitters.

In Columns (3) and (4), we consider that carbon emissions do not reflect how advanced borrowers are in the transition to a low-carbon economy. Thus, we employ the exposure to climate transition index by Sautner et al. (2023) to capture net opportunities and challenges that firms face related to climate change. We still find that borrowers with higher exposure to climate change get more credit, albeit at higher prices after their banks participated in the climate pilot exercise.

Finally, in Columns (5) and (6), we use the Reprisk Environmental Risk Index to capture borrowers' transition risk. Previous literature shows that Reprisk is one of the few sources of ESG data that is not subject to green-washing bias because it relies entirely on negative news coverage by external sources (Berger et al., 2020). Our findings remain intact.

[Insert Table 12]

7.3 Borrowers' financial constraints

Heider and Inderst (2022) show that financial constraints may limit borrowers' ability to fund green projects. One concern would be that our high carbon emitters could also be

financially constrained borrowers, thus the results we observe would be due to differences in borrowers' characteristics rather than be causally attributable to participation in the climate pilot exercise. We therefore include a measure of borrower financial constraints, the Hadlock and Pierce (2010) size-age index, into our regressions. Although firms with greater financial constraints receive less credit at higher interest rates, our key inferences in Table 13 remain unaffected.

[Insert Table 13]

7.4 Bank characteristics

One may argue that our results are driven by other bank characteristics such as size, capital, and profitability rather than because of participation in the climate pilot exercise. We tackle this issue by gradually introducing sets of bank characteristics into our main regressions and reports results in Table 14.

In Column (1), we include bank size (natural logarithm of total assets). In Column (2), we further include capital ratios (total equity capital over total assets). In Column (3), we include ROA. In all instances, our inferences remain unaffected.

[Insert Table 14]

7.5 Disentangling different climate stress tests

We address one final concern relating to anticipation of other climate stress tests. While the climate pilot exercise by the ACPR was the first comprehensive climate stress test, other central banks like the Bank of England and the European Central Bank followed suit with climate stress tests shortly thereafter in 2021 and 2022. In particular, the latter climate stress test poses a potential confounding event as some of the large French banks (and banks from the control group) that participated in the French climate pilot exercise are also subject to scrutiny by the Single Supervisory Mechanism from the European Central Bank. Given that the ECB climate stress test was conducted in 2022, our coefficients may therefore reflect these banks' anticipation of the ECB climate stress test

rather than represent an exclusive reaction to the climate pilot exercise conducted by the ACPR. To avoid that we erroneously attribute our coefficients to the French climate exercise, we replicate in Table 15 our main tests but remove all observations for the years 2022 and 2023. Our inference remains qualitatively unaffected.

[Insert Table 15]

8 Conclusion

Bank supervisors are pressuring banks to protect themselves from the effects of climate change, and this pressure also affects bank borrowers. We exploit data from the climate pilot exercise conducted by the French prudential regulatory agency that serves as a plausibly exogenous shock to these banks' information production efforts to understand the effects of climate change, and combine it with data on these banks' borrowers' carbon emissions to capture their exposure to transition risk. This enables us to investigate how supervisory activities that affect banks' lending policies shape the transition to the carbon-neutral economy and affect borrowers' actions to decarbonize their business models.

By comparing loan contract features and environmental performance from borrowers whose banks participate in the French climate pilot exercise with such outcomes from borrowers whose banks do not participate, we can establish the causal effect of the climate pilot exercise on banks' lending behavior, and, ultimately, on borrowers' transition paths.

Our work illustrates that climate stress tests can be viewed as a learning exercise for banks. We show that the climate pilot exercise triggers reassessments of banks' lending policies because it produces new information signals that improve banks' comprehension of the long-run implications of climate change. Therefore, banks are better able to assess borrowers' transition risk. In other words, supervision, in the form of climate stress tests, is valuable as an information collection exercise that has ramifications not just for loan contracting decisions but also for real outcomes.

Our first novel finding is that banks that take part in the climate pilot exercise increase lending to borrowers despite their higher transition risk. While it is plausible for participating banks to facilitate the transition to the carbon-neutral economy, their support to high-transition risk borrowers does not come for free because they raise loan rates at the same time. This result contrasts with banks that do not participate in the climate pilot exercise. These banks reduce credit supply. The latter finding does not seem surprising. Non-participating banks are not required to spend time and effort collecting information about borrowers' transition plans to assess the long-term effects of climate change, and therefore evaluate transition risk with a short-term perspective.

What is surprising and, importantly, also encouraging is our result that participation in climate stress tests reverses banks' assessment of borrowers that are considered more exposed to climate transition risk. These banks update their beliefs about borrowers because of the information acquired during the climate stress tests, this is also reflected in our second novel insight that participating banks significantly increase their focus on climate change in conference calls and information collection efforts related to borrowers' carbon emissions. Rather than reducing credit, participating banks' deeper comprehension of the transition process results a greater willingness to commit funds to borrowers and support their transition to the carbon-neutral economy.

Our third set of novel findings further reinforces this view. The tests of borrowers' environmental performance show that brown borrowers of participating banks are more likely to have emission policies and set carbon emission targets, and use more renewable energy. The probability that these borrowers have eco-friendly products is also higher. ESG, Environmental, and Emission Scores of these borrowers also improved after receiving loans from climate stress tested banks. These positive developments need, however, to be considered in light of other findings concerning environmental dimensions that are more difficult to adjust in the long run. We neither observe reductions in direct carbon emissions nor do borrowers terminate contracts with suppliers that are flagged as environmentally unfriendly.

Taken together, our results illustrate the role of climate stress tests beyond their primary objective of identifying vulnerabilities in the financial system related to climate change. Climate stress tests are valuable because they reduce information asymmetries between banks and borrowers related to how to measure the effect of climate change, and therefore can also be justified on the grounds that they support the transition to a carbon-neutral economy. They boost banks' understanding of transition risk to engage in 'greener' lending and facilitate borrowers' efforts in the process of making their businesses more resilient towards climate change. To that extent, our research helps advance the understanding of the role of banking supervision in the context of climate change.

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Tables

Table 1: Summary statistics

This table reports the summary statistics for the variables used in Equation (1). The initial sample consists of 1,673 loan observations between 2015 and 2023 from the DealScan database matched with borrower financial information from Compustat Global and borrower environmental performance from Refinitiv, Reprisk, and Sautner et al. (2023). The latter part of the table shows the variables on soft and hard dimensions of firms' environmental profiles. Appendix C provides the variable definitions in detail.

Variable	Mean	Std. Dev.	Min.	Max.	N
Loan-level data					
Loan Amount (Ln)	6.43	1.30	1.89	8.74	1,673
Spread (Ln)	5.01	0.87	3.22	6.55	1,673
All In Spread Drawn (bps)	202.00	136.42	25.00	600.00	1,673
Treat	0.45	0.50	0.00	1.00	1,673
Post	0.41	0.49	0.00	1.00	1,673
Maturity	4.62	1.88	0.17	14.00	1,673
High Emitter	0.22	0.42	0.00	1.00	1,673
Carbon Emission (Ln)	7.20	6.19	0.00	15.02	1,673
High Climate Change Exposure	0.36	0.48	0.00	1.00	1,673
High Reprisk ERI	0.79	0.41	0.00	1.00	1,673
Borrower Size	14.15	6.71	4.82	25.07	1,673
Borrower Leverage (%)	14.75	19.90	0.01	58.83	1,673
Borrower ROA (%)	1.91	2.93	-1.00	15.59	1,673
Bank size	20.34	0.96	15.77	28.64	1,673
Bank Equity (%)	8.73	6.23	2.75	78.51	1,673
Bank ROA (%)	0.51	0.37	-0.59	5.13	1,673
Green	0.12	0.33	0.00	1.00	1,673
Green share	0.13	0.30	0.00	1.00	749
SA Index	-3.84	0.38	-4.39	-2.57	1,425
Bank-level data					
Mentioning Climate Stress Test	0.007	0.084	0	1	1,125
Communication with Borrowers	0.005	0.073	0	1	1,125
Discussion about Emission Data	0.173	1.092	0	18	1,125
Firm-level data					
Treat	0.56	0.50	0.00	1.00	943
Post	0.40	0.49	0.00	1.00	943
Eco-Friendly Product	0.29	0.45	0.00	1.00	943
ESG Score	0.62	0.17	0.02	0.91	943
Environmental Score	0.69	0.22	0.00	0.99	943
Emission Score	0.78	0.23	0.00	1.00	943
Emission Policies	0.85	0.36	0.00	1.00	943
Target Emission	0.63	0.48	0.00	1.00	943
Renewable Energy	0.12	0.20	0.00	0.90	943
Total Emission Growth (%)	1.60	26.94	-50.33	142.30	943
Direct Emission Growth (%)	1.88	23.90	-50.46	114.91	943
Supply Chain Policy	0.77	0.42	0.00	1.00	943
Termination of Env. Unf. Suppliers	0.32	0.47	0.00	1.00	943
Materials Sourcing Criteria	0.65	0.48	0.00	1.00	943

Table 2: Comparisons between treated and control banks

This table reports statistics of relevant variables over the period 2015 to 2020 dividing the sample between treated and control banks. Column (1) reports the mean of changes in characteristics among treated banks. Column (2) reports the mean of changes in characteristics among control banks. All loan, firm, and bank characteristics are reported as first differences. For loan and firm characteristics, we aggregate the mean of these variables to the bank-year level. In Column 3, we report the mean differences of changes in characteristics of treated and control banks. Column 4 reports t-statistics. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Mean Treated	Mean Control	Diff.	t-stat
Loans Characteristics				
Δ Loan Amount (Ln)	-0.043	0.084	-0.126	-0.49
Δ Spreads (Ln)	0.099	0.186	-0.087	-0.48
Banks' characteristics				
Δ Share of High Emitting Borrowers	0.024	0.008	0.016	0.15
Δ Bank size	0.657	-0.222	0.881	0.98
Δ Equity/Total Assets	-0.093	-0.403	0.310	0.29
Δ Loans Growth (%)	-0.338	-0.391	0.052	0.06
Δ ROA	-0.018	-0.022	0.004	0.05
Firms' characteristics				
Δ Firm size	0.657	-0.222	0.880	0.98
Δ Leverage	-0.001	0.230	-0.232	0.05
Δ ROA	0.103	0.044	0.059	0.12

Table 3: Parallel Trends

This table tests for parallel trends in loan amounts and spreads given to High Emitters compared to Low Emitters between 2015 and 2019. $Y2015$, $Y2016$, $Y2017$, $Y2018$, and $Y2019$ are dummy variables equal to 1 if the loan is originated in the year 2015, 2016, 2017, 2018, and 2019, respectively, and 0 otherwise. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Loan Amount (Ln)	(2) Spread (Ln)
Treat × High Emitter × Y2015	0.041	0.046
	(0.113)	(0.074)
Treat × High Emitter × Y2016	-0.127	0.022
	(0.168)	(0.069)
Treat × High Emitter × Y2017	-0.424	-0.042
	(0.335)	(0.124)
Treat × High Emitter × Y2018	-1.387	-0.128
	(0.914)	(0.191)
Treat × High Emitter × Y2019	0.000	0.053
	(0.123)	(0.064)
Observations	992	992
Loan Controls	Yes	Yes
Firm Controls	Yes	Yes
Bank FE	Yes	Yes
Loan Type FE	Yes	Yes
Industry × Year FE	Yes	Yes
Adjusted R^2	0.872	0.888

Table 4: How do banks respond to firms' carbon emissions

This table shows the relationship between banks' lending behavior and firms' total carbon emissions. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *Carbon Emissions (Ln)* is the firm total carbon emissions from Refinitiv database. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Loan amount (Ln)		Spread (Ln)	
Carbon Emission (Ln)	0.066	0.068	-0.002	-0.005
	(0.042)	(0.042)	(0.023)	(0.024)
Maturity	0.016	0.018	0.063	0.066
	(0.103)	(0.106)	(0.052)	(0.049)
Borrower Size		0.006		0.017
		(0.014)		(0.014)
Borrower Leverage		-0.001		-0.001
		(0.004)		(0.003)
Borrower ROA		-0.028		-0.026
		(0.018)		(0.016)
Loan Amount (Ln)			-0.236**	-0.232***
			(0.088)	(0.083)
Loan Spread	-0.722***	-0.724***		
	(0.134)	(0.139)		
Observations	992	992	992	992
Bank FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.874	0.875	0.888	0.891

Table 5: Climate pilot exercise and bank lending to brown firms

This table shows the effect of participation in the climate pilot exercise on banks' lending behavior. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *Treated* is a dummy taking on the value 1 if a bank participates in the climate pilot exercise and 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate pilot exercise (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Loan amount (Ln)		Spread (Ln)	
Treat × High Emitter × Post	0.390**	0.380**	0.082**	0.080**
	(0.190)	(0.186)	(0.031)	(0.033)
Treat × High Emitter	-0.326*	-0.321*	-0.050*	-0.049*
	(0.179)	(0.176)	(0.027)	(0.028)
High Emitter × Post	-0.039	-0.039	-0.034***	-0.033**
	(0.059)	(0.059)	(0.009)	(0.013)
High Emitter	-0.256	-0.293	-0.394**	-0.419**
	(0.520)	(0.512)	(0.163)	(0.167)
Spread (Ln)	-0.521***	-0.524***		
	(0.148)	(0.151)		
Maturity	-0.141	-0.140	0.103*	0.106**
	(0.115)	(0.117)	(0.052)	(0.050)
Borrower Size		0.004		0.011
		(0.009)		(0.010)
Borrower Leverage		-0.001		-0.002
		(0.003)		(0.003)
Borrower ROA		-0.027*		-0.015
		(0.014)		(0.010)
Loan Amount (Ln)			-0.152**	-0.152**
			(0.074)	(0.073)
Observations	1,673	1,673	1,673	1,673
Bank FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.855	0.856	0.906	0.907

Table 6: Does the climate pilot exercise aid the green transition?

We investigate whether the climate pilot exercise aids the transition to net zero. Columns (1) and (3) show the effect of the exercise on loan volumes and spreads for brown borrowers compared to green borrowers for loans with maturity of more than 3 years. Columns (2) and (4) show the effect of the climate pilot exercise on loan volumes and spreads for loans with maturity of 3 years and less. Columns (5) and (6) show the effect of the exercise on the probability that a bank originates a green loan to brown borrowers. Column (5) excludes control variables for firm characteristics. Column (6) includes these borrower control variables. Columns (7) and (8) show the effect of the exercise on the share of green loans to total loans a bank originates. Column (7) excludes control variables for borrower characteristics. Column (8) includes these controls. In Columns (1) - (6) we run regressions at the loan level. In Columns (7) and (8), we aggregate data at the bank-year level to obtain the share of green loans to total lending. *Treated* is a dummy taking on the value 1 if a bank participates in climate stress tests and 0 otherwise. *High Emitter* is a dummy equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate pilot exercise (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and borrower level for Columns (1) - (6) and at the bank level for Columns (7) and (8) and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Loan Amount (Ln)		Spreads (Ln)		P (Green)		Green Share	
Sample	> 3Y	<= 3Y	> 3Y	<= 3Y	All	All	All	All
Treat × High Emitter × Post	0.379**	-0.228	0.107***	0.021	0.076*	0.091*	0.046**	0.043**
	(0.180)	(0.145)	(0.039)	(0.026)	(0.041)	(0.051)	(0.022)	(0.018)
Treat × High Emitter	-0.259*	0.193	-0.067**	-0.018	-0.025	-0.041	-0.026**	-0.023**
	(0.154)	(0.137)	(0.032)	(0.024)	(0.025)	(0.034)	(0.012)	(0.011)
High Emitter × Post	0.257	0.000	0.167	0.000	0.015	0.068	-0.112	-0.180**
	(0.880)	(0.000)	(0.208)	(0.000)	(0.154)	(0.145)	(0.075)	(0.069)
Treat × Post	-0.013	0.278	-0.004	-0.026	-0.015	-0.008	-0.008	-0.009
	(0.037)	(0.187)	(0.011)	(0.032)	(0.014)	(0.014)	(0.006)	(0.010)
High Emitter	-0.797	0.000	-0.324*	0.000	0.180	0.197*	-0.035	-0.024
	(0.533)	(0.000)	(0.178)	(0.000)	(0.113)	(0.103)	(0.033)	(0.034)
Post	0.000	0.000	0.000	0.000	-0.276***	-0.287***	-0.712***	-0.689***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.097)	(0.084)	(0.054)	(0.091)
Observations	1,288	408	1,288	408	1,673	1,673	749	749
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Industry FE	No	No	No	No	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	No	No	No	No
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	No	Yes	No	Yes

Table 7: Heterogeneity analysis

This table explores whether banks that sign the UN Principles for Responsible Banking and banks with high proportion of institutional investors affects the magnitudes of the key coefficients of interest. Columns (1) to (4) show the differences between signatories and non-signatories of the UN Principles for Sustainable Banking affects lending behavior towards their brown borrowers. Columns (3) and (4) show the effect of banks' institutional ownership (IO) on their lending behavior to brown borrowers. *Treated* is a dummy taking on the value 1 if a bank participates in climate stress tests and 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent Variable	Loan Amount (Ln)		Spreads (Ln)		Loan Amount (Ln)		Spreads (Ln)	
Sample	UNEP	Non-UNEP	UNEP	Non-UNEP	High IO	Low IO	High IO	Low IO
Treat × High Emitter × Post	0.550**	0.241	0.107**	0.042	0.712**	0.093	0.105**	0.081
	(0.190)	(0.174)	(0.048)	(0.039)	(0.341)	(0.085)	(0.049)	(0.065)
Treat × High Emitter	-0.502***	-0.167	-0.082**	-0.023	-0.639*	0.013	-0.058	-0.042
	(0.150)	(0.174)	(0.035)	(0.041)	(0.316)	(0.026)	(0.041)	(0.038)
High Emitter × Post	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Treat × Post	-0.140	0.020	-0.051**	-0.037*	-0.113	-0.000	-0.056***	-0.004
	(0.107)	(0.038)	(0.022)	(0.020)	(0.093)	(0.040)	(0.019)	(0.028)
High Emitter	-0.257	-0.333	-0.415**	-0.335*	-0.098	-1.170***	-0.391**	-0.100
	(0.503)	(0.532)	(0.150)	(0.177)	(0.559)	(0.222)	(0.164)	(0.103)
Post	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	644	1037	636	1037	881	806	867	806
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	No	No	No	No	No	No	No	No
Year FE	No	No	No	No	No	No	No	No
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: Information production during the climate pilot exercise

This table reports how the climate pilot exercise affects the probability of banks discussing issues related to transition risk such as scenarios of climate stress tests, and communication with borrowers on transition risk, and the number of times that banks discussed about carbon emissions in their earning calls. Data on discussions of these issues are hand-collected from conference calls of all banks in our sample. *Treated* is a dummy taking on the value 1 if a bank participates in climate stress tests and 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are clustered at the bank level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Mentioning Climate Stress Tests	(2) Communication with Borrowers on Transition Risk	(3) Discussion about Emissions
Post	0.031	0.018	-0.073
	(0.028)	(0.026)	(0.060)
Treat × Post	0.045**	0.097***	0.513*
	(0.022)	(0.017)	(0.281)
Observations	1,125	1,125	1,125
Bank FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Adjusted R^2	0.035	0.053	0.041

Table 9: Short-term adjustments: Environmental performance

This table reports regression results for whether a borrower with loans from banks participating in the climate pilot exercise changes environmental performance from a short-term perspective. Short-term adjustments in borrowers' environmental profiles include *eco-friendly products*, *ESG Score*, *Environmental Score*, *Emission Score*, *Emission Policy*, and *Target Emission*. The analysis of borrowers' environmental performance uses annual frequency of the data. *Treated* is a dummy taking on the value 1 if a borrower has at least 1 loan from a bank participating in the climate pilot exercise from 2021 onwards and 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate pilot exercise (2021 onwards), 0 otherwise. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Eco-Friendly Product	(2) ESG Score	(3) Env. Score	(4) Emission Score	(5) Emission Policies	(6) Target Emissions
Treat × Post × High Emitter	0.251*	0.129**	0.155*	0.202**	0.232**	0.404**
	(0.145)	(0.059)	(0.091)	(0.094)	(0.097)	(0.200)
Treat × Post	-0.059	0.016	0.046	0.061**	-0.035	-0.008
	(0.075)	(0.028)	(0.028)	(0.028)	(0.038)	(0.088)
Treat × High Emitter	-0.203	0.009	0.086	0.105	0.120	-0.183
	(0.196)	(0.072)	(0.092)	(0.112)	(0.107)	(0.191)
Post × High Emitter	-0.196*	-0.110**	-0.108	-0.157*	-0.158*	-0.348*
	(0.106)	(0.047)	(0.081)	(0.082)	(0.087)	(0.182)
Treat	0.264**	0.031	0.031	0.022	0.065	0.037
	(0.108)	(0.040)	(0.050)	(0.050)	(0.046)	(0.106)
High Emitter	0.114	-0.040	-0.094	-0.112	-0.147	0.196
	(0.156)	(0.063)	(0.081)	(0.099)	(0.101)	(0.153)
Observations	943	943	943	943	943	943
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.305	0.140	0.221	0.151	0.595	0.244
Number of Firms	151	151	151	151	151	151
Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Table 10: Long-term adjustments: Environmental performance

This table reports regression results for whether a borrower with loans from a bank participating in the climate pilot exercise changes environmental performance from a long-term perspective. Long-term adjustments in borrowers' environmental profiles include *Renewable Energy Investments (%)*, *Total Emissions Growth*, *Direct Emissions Growth*, *Supply Chain Environmental Policies*, *Termination of Environmentally Unfriendly Suppliers* and *Materials Sourcing Environmental Criteria*. *Treated* is a dummy taking on the value 1 if a borrower has at least 1 loan from a bank taking part in the climate pilot exercise from 2021 onwards 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate pilot exercise (2021 onwards), 0 otherwise. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Renewable Energy (%)	(2) Total Emission Growth	(3) Direct Emission Growth	(4) Supply Chain Policy	(5) Termination of Env. Unf. Suppliers	(6) Materials Sourcing Criteria
Treat × Post × High Emitter	0.158*	-2.941	5.172	-0.022	0.076	0.241
	(0.084)	(13.116)	(9.987)	(0.097)	(0.149)	(0.155)
Treat × Post	-0.014	2.091	-2.674	0.142***	0.231**	-0.075
	(0.042)	(6.627)	(3.732)	(0.050)	(0.091)	(0.085)
Treat × High Emitter	0.029	-2.314	-5.117	0.176	0.145	-0.064
	(0.073)	(6.523)	(6.554)	(0.113)	(0.221)	(0.185)
Post × High Emitter	-0.066	-1.843	-8.287	0.027	-0.003	-0.142
	(0.065)	(10.719)	(8.031)	(0.085)	(0.117)	(0.130)
Treat	-0.006	4.142	4.297	0.040	-0.094	0.298***
	(0.045)	(3.967)	(2.660)	(0.070)	(0.117)	(0.106)
High Emitter	-0.059	-0.226	3.985	-0.115	-0.104	0.070
	(0.062)	(4.760)	(5.068)	(0.093)	(0.171)	(0.155)
Observations	943	943	943	943	943	943
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.150	0.024	0.011	0.458	0.153	0.330
Number of Firms	151	151	151	151	151	151
Clustering	Firm	Firm	Firm	Firm	Firm	Firm

Table 11: Falsification tests

This table explores the effect of the climate pilot exercise on banks' lending behavior towards brown firms but on the basis of a sample that comprises randomly assigned participation in the climate pilot exercise (*Placebo Treat*). *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. Standard errors are double clustered at the bank and the borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Loan Amount (Ln)	(2) Spread (Ln)
Placebo Treat × High Emitter × Post	-0.030	0.007
	(0.106)	(0.066)
Observations	1,673	1,673
Loan Controls	Yes	Yes
Firm Controls	Yes	Yes
Bank FE	Yes	Yes
Loan Type FE	Yes	Yes
Industry × Year FE	Yes	Yes
Adjusted R^2	0.855	0.907

Table 12: Robustness checks: Alternative measurements of transition risk

This table reports robustness checks using different measurements for borrowers' exposure to transition risk including the level of carbon emission intensity, the exposure to transition risk index by Sautner et al. (2023), and the Environmental Risk Index ERI from Reprisk. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Emission Intensity		Exposure to Transition Risk		Reprisk Index	
	Loan Amount	Spread	Loan Amount	Spread	Loan Amount	Spread
Treat × Post × High Transition Risk	0.150***	0.031 ***	0.375***	0.113***	0.154*	0.095***
	(0.047)	(0.020)	(0.126)	(0.040)	(0.077)	(0.027)
Observations	1,673	1,673	1,673	1,673	1,673	1,673
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry -Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.858	0.906	0.856	0.915	0.855	0.907

Table 13: Robustness check: Borrowers' financial constraints

This table explores the effect of the climate pilot exercise on banks' lending behavior towards brown firms controlling for borrowers' financial constraints. We measure borrowers' credit constraints using the Size-Age (SA) index (Hadlock and Pierce, 2010). *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and the borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1) Loan Amount (Ln)	(2) Spread (Ln)
Treat × Post × High Emitter	0.226**	0.118***
	(0.103)	(0.038)
SA Index	-1.044**	1.229***
	(0.499)	(0.147)
Observations	1,425	1,425
Loan Controls	Yes	Yes
Firm Controls	Yes	Yes
Bank FE	Yes	Yes
Industry × Year	Yes	Yes
Loan Type FE	Yes	Yes
Adjusted R^2	0.855	0.949

Table 14: Robustness check: Bank characteristics

This table explores the effect of participation in the climate pilot exercise on banks' lending behavior towards brown firms controlling for bank characteristics such as size, capital ratio, and ROA. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and the borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	Loan Amount (Ln)			Spread (Ln)		
Treat × Post × High Emitter	0.373**	0.357**	0.359**	0.086**	0.073**	0.073**
	(0.181)	(0.176)	(0.174)	(0.035)	(0.034)	(0.034)
Lender Size	-0.013	-0.009	-0.008	0.013***	0.016***	0.016***
	(0.019)	(0.015)	(0.015)	(0.004)	(0.006)	(0.006)
Lender Capital		0.002	0.005*		0.002**	0.002
		(0.001)	(0.003)		(0.001)	(0.001)
Lender ROA			-0.047*			0.002
			(0.027)			(0.013)
Observations	1,673	1,673	1,673	1,673	1,673	1673
Loan Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry × Year	Yes	Yes	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.856	0.856	0.856	0.907	0.907	0.907

Table 15: Disentangling the French climate pilot exercise from the ECB climate stress test

This table shows the effect of the climate pilot exercise on banks' lending behavior towards brown firms. In these tests, we remove observations from 2022 onwards and only use data for 2015 to 2021 to avoid that our coefficients of interest reflect anticipation of the climate stress test performed by the ECB in 2022. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. *Treated* is a dummy taking on the value 1 if a bank participates in climate stress tests and 0 otherwise. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of borrower f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are double clustered at the bank and borrower level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)	(3)	(4)
	Loan amount (Ln)		Spread (Ln)	
Treat × High Emitter × Post	0.345**	0.333**	0.096***	0.094**
	(0.170)	(0.165)	(0.035)	(0.036)
Treat × High Emitter	-0.296*	-0.291*	-0.055*	-0.053*
	(0.168)	(0.165)	(0.029)	(0.030)
High Emitter × Post	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
High Emitter	-0.311	-0.350	-0.383**	-0.411**
	(0.499)	(0.493)	(0.173)	(0.176)
Observations	1,277	1,277	1,277	1,277
Loan controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Loan Type FE	Yes	Yes	Yes	Yes
Adjusted R^2	0.840	0.841	0.883	0.885

Figures

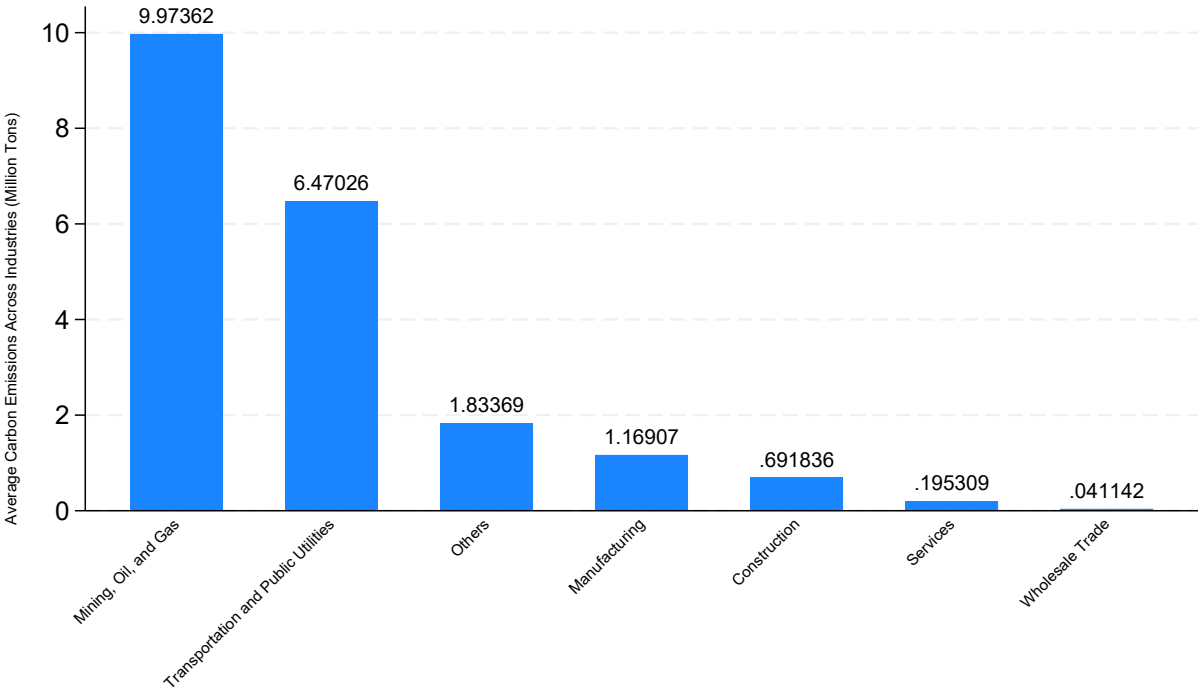

Figure 1: Average carbon emissions across industries

Appendix A. French climate pilot exercise

Preceding the actual climate exercise, the preparatory phase of the pilot published in April 2019 was based on questionnaires. In total, 15 insurance and 9 banking groups got involved. Institutions participated as part of a system-wide exercise where scenarios and assumptions were provided by the authorities, a classical bottom-up approach in stress-testing. The 9 banking groups that we focus on cover 85 percent of French banks' total assets illustrating high added value of the sector and underlining the representative nature of results as these groups represent a very significant part of the banking activity in France. Due to the complex interactions with economic and social systems involved, there are several modifications in contrast to standard stress-testing procedures. [6]

First, the exercise adds a forward-looking view of risks over a long-term horizon conditional on the implementation of several alternative scenarios. In particular, the exercise looks at a 30-year horizon ranging from 2020-2050 containing three transition scenarios[7]. Different from the 3-5 years that are considered in traditional stress testing scenarios this period is sufficiently long to integrate the effects of climate change. However, the long time horizon requires a revision of the static balance sheet assumption. Therefore, the pilot exercise combines two assumptions: First a "static balance sheet" assumption until 2025, following a "dynamic balance sheet" from 2025-2050 to analyse the strategies of financial institutions and the actions implemented to mitigate the effects of climate change allowing financial institutions to take new risks into consideration and assess corrective actions. Second, geographical and sectoral scopes are expanded. Due to the fact that the activities of institutions have international impact climate-related risks have to be considered differently based on the geographical areas. Additionally, aggregated asset classes are split into 55 activity sectors allowing for a more granular analysis.

The baseline transition scenario corresponding to an orderly transition is consistent with the narrative of the SNBC, France's roadmap for fulfilling commitments made

[6] See details here

[7] The network of central banks and supervisors for greening the financial sector (NGFS) serves as a guideline on the construction of climate change scenarios and serves as a basis for two of the scenarios published by the NGFS in June 2020. The third one is a physical risk scenario.

under the Paris Agreement. It includes a significant increase in the price of carbon where financial institutions face different CO2 emission trajectories. To compare to the baseline, there are two disorderly transition scenarios. The first one is referred to as "late transition". It relies on the assumption that the target for reducing greenhouse gas emissions is not met by 2030 assuming that carbon sequestration technologies are less efficient than expected.

This scenario replicates the aggregate level of emission, carbon price and GDP trajectories of the representative scenario for a "disorderly" transition. It is based on a very high increase in the carbon price in 2030 to maintain carbon neutrality target in 2050 (in particular it rises from 14$ to 704$ per ton of CO2). The second scenario is called the "sudden transition" scenario and combines a sharp increase in the price of carbon that reaches 917$ per ton of CO2 in 2050 and a less favourable evolution of productivity than in the baseline scenario from 2025 onwards. Moreover, renewable-energy technologies are less efficient than expected, implying even higher energy prices and additional investment. It is important to note that contrary to usual stress-testing exercises the scenarios on CO2 emission trajectories do not trigger an economic downturn by 2050 but slower economic growth combining different assumptions in terms of carbon tax trajectories and total productivity levels.

The scenarios on CO2 emission trajectories are based on a set of assumptions modelling the interactions between socio-economic systems and the climate. The three scenarios combine assumptions in terms of trajectory on carbon tax and total productivity levels. The main objective is to measure the consequences of these scenarios that materialise via transition risk on bank balance sheets.

Among the variety of risk categories, they chose to focus on two important financial risks: credit and market risk. For credit risk projections, the banking groups were asked to measure the impact of the various transition scenarios on expected credit losses. They approximate the annual cost of credit risk[8]. In general, institutions were requested to perform credit risk projections on three portfolios: (i) a corporate portfolio including

[8]expressed in basis points and calculated by dividing the total annualised provisioning flows for each time interval by the average exposure over the same time interval.

SMEs; (ii) a retail portfolio; (iii) and a sovereign portfolio using benchmark probabilities of default provided by the ACPR.

Market risk focuses on analysing the impact of financial shocks caused by the implementation of energy transition policies. Specifically, institutions looked at (i) the fair value revaluation of the trading book following an instantaneous market shock induced by the valuation of assets under adverse transition scenarios; and (ii) the impact of market shocks on the counterparty risk in the most sensitive sectors.

Counterparty risk was measured by using the impact of default of the two largest counterparties of the institution. This is especially useful for identifying substantial market positions on carbon intensive counterparties.

Appendix B. Climate pilot exercise participants

Appendix Table B.1. French climate pilot exercise participants

This table shows an overview about the 9 banking groups that participated in the French climate pilot exercise in 2020.

Number	Bank Name
1	AGENCE FRANÇAISE DE DÉVELOPPEMENT
2	BNP PARIBAS
3	BPCE
4	CAISSE DES DÉPÔTS
5	CREDIT AGRICOLE
6	CREDIT MUTUEL
7	LA BANQUE POSTALE
8	SOCIÉTÉ GÈNÉRALE
9	SOCIÉTÉ DE FINANCEMENT LOCALE

Appendix Table C: Variable descriptions

Appendix Table C.1: Variable definitions

Variable	Description	Source
Loan Amount (Ln)	Natural log of loan amount	Dealscan
Loan Spreads	Spread in basis points over Libor	Dealscan
Loan Maturity (Years)	Loan maturity in years	Dealscan
Green Loan	Dummy that equals 1 if a loan is a sustainability-linked loan or for green purposes, 0 otherwise	Dealscan
Treated	Dummy that equals 1 if a bank participated in the French climate pilot exercise, 0 otherwise	Authors' Collection
Post	Dummy that equals 1 if after 2020Q3, 0 otherwise	Authors' Collection
High Emitter	Dummy that is equal to one if firms' emissions between 2015 and 2019 is above mean and zero otherwise	Refinitiv
Borrower Size	Natural log of borrowers' total assets	Compustat
Borrower Leverage	Ratio of borrowers' total debts over total assets	Compustat
Borrower ROA	Borrowers' returns on total assets	Compustat
SA Index	SA Index	Compustat
Lender Size	Natural log of borrowers' total assets	Compustat
Lender Capital	Ratio of lenders' equity capital over total assets	Compustat
Lender Deposits	Ratio of lenders' deposits over total assets	Compustat
Lender ROA	Lenders' returns on total assets	Compustat
Green Lender	Dummy that equals 1 if a bank joined the United Nations Environment Programme (UNEP) before 2020, 0 otherwise	Authors' Collection
Institutional Ownership	Percentage of institutional ownership	Bloomberg
Eco-Friendly Product	Dummy that equals 1 if a firm produces eco-friendly products, 0 otherwise	Refinitiv
ESG Scores	ESG scores	Refinitiv
Environmental Scores	Environmental scores	Refinitiv
Emission Policies	Dummy that equals 1 if a firm has emission policies, 0 otherwise	Refinitiv
Target Emissions	Dummy that equals 1 if a firm has target emissions, 0 otherwise	Refinitiv

Appendix Table C.1: Variable definitions

Variable	**Description**	**Source**
Renewable Energy	Dummy that equals 1 if a firm invests in renewable energy technologies, 0 otherwise	Refinitiv
Emissions Score	Emission scores	Refinitiv
Total Emissions Growth	Growth in total emissions	Refinitiv
Direct Emissions Growth	Growth in scope 1 emissions	Refinitiv
Termination of Environmentally Unfriendly Suppliers	Dummy that equals 1 if a firm terminates contracts with suppliers who are environmentally unfriendly, 0 otherwise	Refinitiv
Materials Sourcing Criteria	Dummy that equals 1 if a firm claims to use environmental criteria to source material, 0 otherwise	Refinitiv
Mentioning Climate Stress Test	Dummy that equal 1 if a bank mentions climate stress tests during their conference calls	S&P Capital IQ
Communication with Borrowers on Transition Risk	Dummy that equal 1 if a bank mentions that the bank communicates with borrowers on transition risk during their conference calls	S&P Capital IQ
Discussion about Emission Data	A number of times that a bank discusses information about emissions	S&P Capital IQ

Appendix D. Heckman Selection Model

Appendix Table D.1: Heckman Selection Model

This table explores the effect of climate stress tests on banks' lending and pricing behavior towards brown firms, controlling for possible selection bias. *Loan Amount (Ln)* and *Spread (Ln)* are dependent variables. Green lender is a dummy variable that takes on the value of one if a bank signed the UN Principles for Responsible Banking (0 otherwise) prior to the climate pilot exercise before 2020. *High Emitter* is a dummy variable equal to 1 if the average carbon emissions of firms f before 2020 is above the median, and 0 otherwise. *Post* is a dummy variable equal to 1 for the period after the French climate stress test (2020Q3 onwards), 0 otherwise. Standard errors are clustered at the bank and firm level and reported in parentheses. *, ** and *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

	(1)	(2)		(3)
	Second Stage Result		First Stage Result	
Dept. Var.	Loan Amount (Ln)	Spreads (Ln)		P(Treat)
Treat × Post × High Emitter	0.350*	0.079**	Green Lender	0.503*
	(0.175)	(0.038)		(0.293)
Treat × High Emitter	-0.339*	-0.038	Lender Size	-0.247
	(0.184)	(0.038)		(0.377)
Treat × Post	0.185	-0.074	Lender Capital	-0.119
	(0.165)	(0.052)		(0.182)
High Emitter × Post	0.000	0.000	Lender Deposit	-0.031
	(0.000)	(0.000)		(0.040)
High Emitter	-0.394	-0.298**		
	(0.504)	(0.132)		
Post	0.000	0.000		
	(0.000)	(0.000)		
Inverse Mills Ratio	-0.073	0.015		
	(0.061)	(0.017)		
Observations	1,696	1,696		698
Loan Controls	Yes	Yes		No
Firm Controls	Yes	Yes		No
Bank FE	Yes	Yes		Yes
Industry Year FE	Yes	Yes		No
Year FE	No	No		Yes
Loan Type FE	Yes	Yes		No
Country FE	No	No		Yes
Adjusted R^2	0.837	0.884		-
Pseudo R^2	-	-		0.849
Clustering	Bank, Firm	Bank, Firm		Bank

Appendix E. Sample transcripts from conference calls

"So at this stage, for us, it's a way to work on stress test on climate risk. It doesn't lead into additional capital yet. But of course, it prepares us to handle all the upcoming stress tests, which are going to be led by regulators and supervisors. It's part also of our disclosures, and it will prepare us also in terms of segmentation of clients that are information and reporting when we will have to align also with the various regulations." (*Société Générale Société anonyme, Q3 2020 Earnings Call, Nov 05, 2020*)

"And then on your other question of the Net-Zero Banking, it is what you see, and it will even be further strengthened in all the climate stress tests that are ongoing. So there is – we at BNP Paribas, we really have embarked already since years. The fact that one has to evolve. And of course, you have to be sure that you yourself as a bank are carbon neutral, but you have to accompany the clients for this to happen." (*BNP Paribas SA, Q3 2021 Earnings Call, Oct 29, 2021*)

" We therefore maintain an increasingly close dialogue with our clients on CSR issues with the aim of analyzing and understanding their specific needs, assisting them in their own projects with positive impacts, selecting or structuring appropriate offers, all of this is in compliance with the group's own commitments." (*Société Générale Société anonyme - Shareholder/Analyst Call, May 17, 2022*)

"Our CO2 emission reduction targets are fed by the constant dialogue we're having with our clients. Meeting the target depends on our working hand-in-hand with those clients on the execution of their transition strategies, which in turn depends on the competence and effectiveness of our teams." *(BNP Paribas SA, Q1 2023 Earnings Call, May 03, 2023)*

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