BANCA D'ITALIA

EUROSISTEMA

Temi di discussione

(Working Papers)

Climate supervisory shocks and bank lending: empirical evidence from microdata

by Maria Alessia Aiello

October 2024

Number 1465

BANCA D'ITALIA
EUROSISTEMA

Temi di discussione

(Working Papers)

Climate supervisory shocks and bank lending: empirical evidence from microdata

by Maria Alessia Aiello

Number 1465 - October 2024

The papers published in the Temi di discussione *series describe preliminary results and are made available to the public to encourage discussion and elicit comments.*

The views expressed in the articles are those of the authors and do not involve the responsibility of the Bank.

ISSN 2281-3950 (online)

Designed by the Printing and Publishing Division of the Bank of Italy

CLIMATE SUPERVISORY SHOCKS AND BANK LENDING: EMPIRICAL EVIDENCE FROM MICRODATA

by Maria Alessia Aiello*

Abstract

In the absence of regulatory capital requirements for climate-related financial risks, this paper studies the short-term effects of how the increased focus on these risks by the Single Supervisory Mechanism (SSM) since 2020 has affected lending channels of European banks through credit reallocation and different credit spreads. By using an ad hoc methodology to infer firm-level emissions matched to supervisory microdata, I find that banks under the direct supervision of the SSM reallocated credit towards less polluting firms after the publication of the climate supervisory expectations. The results are robust to controlling for Covid-19 guaranteed loans, and the credit reallocation effect is entirely driven by the treated banks with climate commitments. The evidence is mixed when focusing on high-emitting borrowers who commit to reducing future carbon emissions, suggesting that forward-looking information plays a limited role for banks in the credit process. The results are useful for policymakers in assessing how supervisory actions could incentivize banks to manage climate-related risks better, and whether banks should divest from polluting companies or become more involved in supporting the transition.

JEL Classification: G28, G21, E58, D62, Q50.

Keywords: climate risk, climate stress test, carbon emissions, banking supervision, lending.

DOI: 10.32057/0.TD.2024.1465

* Bank of Italy, Directorate General for Financial Supervision and Regulation, Macroprudential Analysis Division.

1 Introduction[1]

Climate change has become one of the key topics in all major economies. This is mostly true for Europe, where many initiatives were set in the government agenda to reach carbon neutrality by 2050 (European Green Deal), among which a set of proposals to make the EU's climate, energy, transport, and taxation policies fit for reducing net greenhouse gas emissions by at least 55% by 2030 compared with 1990 levels (so-called Fit-for-55 package). The financial sector is crucial in supporting the transition, providing firms with adequate resources to invest in green technologies, making more efficient use of them, and helping industries shift to more sustainable production methods. The European Central Bank (ECB) has increased its attention to climate change, as risks may arise for the financial system. Especially if the transition is delayed and disorderly, climate risks may lead to potential threats to price stability, financial stability, and banking supervision. As part of its supervisory role, the Single Supervisory Mechanism (SSM) of the ECB has increasingly worked over the last very few years to incorporate climate change considerations into European supervision.

This paper analyses the short-term effects of the recent climate policies adopted by the SSM on the Italian banks' lending, by investigating the quantity and the pricing channels, as well as the role of banks' and firms' commitments and transition plans to reduce future emissions. Do Italian banks curtail lending to browner borrowers after the SSM inclusion of climate risks among its priorities? Do banks apply higher credit spreads? Are these effects similar for committed banks and polluting borrowers with emission reduction targets or commitments? To address these questions, I focus on two different events that might be considered relevant climate policy shocks and represented the increased awareness by supervisors of climate risks, i.e. the publication of the SSM Guide in November 2020 and the SSM announcement to directly supervised banks (Significant Institutions, SIs) about their official participation in the climate stress test (CST) one year later, in November 2021.

Since November 2020 with the publication of the Guide on climate-related and environmental risks (following the *Guide*), the SSM started to incorporate climate risk considerations in banking

[1]I am indebted to my Ph.D. advisors Andrea Polo and Marcello Bofondi for their invaluable guidance and support. For helpful comments and suggestions, I thank Paolo Angelini, Francesco Cannata, Antonio Di Cesare, Cristina Angelico, Ivan Faiella, Luca Citino, Andrea Fabiani, Paolo Santucci de Magistris, and two anonymous referees for useful comments. I also thank the ECB for the Best Young Researcher Paper Award at the 2024 Annual ECB Banking Supervision Research Conference (June 11-12, 2024). This paper should not be reported as representing the views of Banca d'Italia (BdI). The views expressed are those of the author and do not necessarily reflect those of the BdI.

supervision. The authority set out its expectations for sound and prudent management of climate and environmental risks, providing non-prescriptive guidance on how to incorporate such risks into the business model, strategic, governance, and risk management processes, as well as in the required disclosures to the public. The Guide outlines 13 expectations for how banks should integrate climate risks into their business strategy, management, and disclosure practices. Incorporating climate risk into the supervisory process has also helped to raise the industry's awareness and readiness to manage climate-related and environmental risks. Thus, the SSM took a closer look at banks' lending systems and could initiate supervisory actions if it is not fully satisfied with the result. From the end of 2020 onward, many other initiatives were defined by the SSM. Concurrently with the publication of the Guide, the SSM announced the intention to conduct the first climate supervisory stress test. Nevertheless, the announcement to banks regarding their official participation in the CST was in November 2021 through the 'Dear CEO letter'. The stress test was executed in the first half of 2022 and considered input balance-sheet data collected by banks (*constrained bottom-up* approach) referring to the situation as of the end of December 2021. Furthermore, in January 2022 SSM launched a thematic review of the banking system with a focus on the integration of climate and corporate risks, the results of which were published in November 2022. Since the publication of the Guide and the announcement of the CST represented relevant supervisory policy changes, this paper exploits plausibly exogenous variation in banks' credit lending and the related pricing from a supply-side perspective. I rely on one plausible null hypothesis: given the lack of stringent banking capital-based rules on climate risk exposures, I should not find any significant and material effect in terms of credit reallocation or spread charged by banks to polluting firms. Thus, I expect supervisory expectations and the CST to represent insufficient incentives for banks to mitigate transition risk, not directly requiring banks to set aside capital. A reasonable alternative hypothesis, however, is that banks do pay attention to supervisory expectations, anticipating more stringent prudential policies due to an increased awareness of climate change-related risks. Furthermore, while the outcome of the CST did not determine a direct impact on banks' capital, the results fed into the 2022 Supervisory Review and Evaluation Process (SREP) of individual SI banks in a qualitative and non-mechanistic way. Thus, analyzing these shocks is relevant since they both highlighted the increased awareness by supervisors of climate risks and, more importantly, the 2020 expectations represented the first time in which these risks were officially included as a top priority in the supervisory agenda.

I exploit a very rich dataset of individual bank-firm relationships: credit data are sourced by the granular credit register (AnaCredit) for all euro area banks; carbon emission data at the firm level are estimated according to the methodology developed by Faiella et al. (2022).[2] The advantage of relying on this approach is that it allows me to infer CO2 emissions at the firm level coherently with the majority of private data providers, as well as by internal models developed by banks.[3] The dataset contains detailed information on loan-level data for nearly all Italian firms, double-matched with firm and bank balance sheet information. The granularity of the database at the firm-bank-month level allows for looking at multi-bank credit relationships that are extended simultaneously to one firm by different banks, a very common practice in Italy. This ideal setting allows me to test whether a firm receives more or less credit from treated banks (the Italian SIs) by comparing credit before and after the shock. The smaller and less complex Italian banks (Less Significant Institutions, LSIs) were not affected by the shocks since these institutions are directly supervised by Banca d'Italia.[4] For the control group, I consider LSIs with similar business models compared to SIs and, in particular, I select banks for which the ratio of loans to total assets is within the range of banks classified as SIs. Thus, I compare more similar groups of banks by examining multi-bank borrowers operating within the same macroeconomic environment, but whose lenders face varying levels of supervisory pressure to incorporate climate risk considerations into their credit-granting process.[5] The same analysis is replicated to assess the impact of the SSM Guide and the CST on the pricing adjustment, defined as the spread charged on loan-level data by each bank to a given firm. Finally, I investigate whether the type of information obtained by banks on climate data might lead to different lending decisions for brown but committed firms; in this respect, I jointly consider both historical data on CO2 emissions estimated at the firm level (Faiella et al. (2022)) and the presence of forward-looking information regarding future emission reductions self-disclosed by the firm, when available.

Three novel findings emerge from this analysis. First, after the publication of the supervisory expectations, banks under the direct supervision of the ECB reallocated credit toward less pollut-

[2] More details in Section 3.2.

[3] Further information is available in ECB (2022a).

[4] Indeed, the 2020 SSM Guide identifies Supervisory expectations directly applied to all European SI. For the Italian LSIs, Banca d'Italia published climate and environmental risk supervisory expectations only several months later, in April 2022: https://www.bancaditalia.it/media/notizia/aspettative-di-vigilanza-sui-rischi-climatici-e-ambientali/ Furthermore, no climate stress test has been conducted on Italian LSI so far. The list of all significant banks under ECB direct supervision and less significant banks under its indirect supervision is available at the ECB website: https://www.bankingsupervision.europa.eu/banking/list/html/index.en.html.

[5] Results are robust when considering all LSIs as control banks.

ing firms compared to LSIs. These results are robust to controlling for the presence of Covid-19 guaranteed loans. The credit reallocation effect is entirely driven by treated banks committed to reducing future emissions (green banks), highlighting their stronger reaction to the supervisory shock. This work complements previous findings indicating that banks with climate commitments overemphasize their climate goals and continue their relationships with polluting firms (e.g. Sastry et al. (2024) and Giannetti et al. (2023)). The novelty of this paper is that it sheds light on the efficacy of voluntary commitments in the presence of supervisory shocks. Second, the announcement of the climate supervisory stress test did not result in a shift of lending from polluting firms to less polluting ones by the treated banks, indicating that the initial supervisory shock had a greater impact on the composition of lending. Third, when restricting the analysis to large and listed firms, non-unique evidence emerges on the role of forward-looking info in the credit process, likely due in part to the difficulty on the part of banks in assessing the reliability of this information and data gaps. In particular, after the publication of the Guide, treated banks did not similarly reallocate credit away from brown borrowers undertaking business strategies to reduce future emissions and reach a pre-determined target. On the contrary, after the stress test announcement, SI banks reallocated credit to brown and committed firms and charged higher spreads. Indeed, the exercise did not explicitly require banks to consider the exposure to climate risk with climate forward-looking data, when available. Thus, supervisory initiatives can differently affect lending policies and credit supply. The results are informative for policymakers to assess how supervisory actions could incentivize banks to manage climate-related risks better, as well as whether banks should divest from polluting companies or become more involved in supporting the transition. In this regard, banking supervision plays a pivotal role in avoiding unintended effects, such as credit contraction to firms currently undertaking green investments or increased cost of lending, that might effectively impair the transition to a low-carbon economy.

Contribution to the literature. This paper contributes to a growing empirical literature on banks' credit supply and climate transition risk[6] and - in particular - to two different strands of research. First, I relate more closely to the literature on the role of supervisory scrutiny associated with stress testing and the related effects on bank climate risk. Previous work largely focuses on the effect of bank stress tests in the US on bank credit supply, well documented by Acharya et al. (2018), while Kok et al. (2023) empirically find that supervisory scrutiny associated with stress

[6]See Giglio et al. (2021) and BIS (2023) for a review of this literature.

testing has a disciplining effect on bank credit risk. Literature explicitly assessing the effects of climate stress testing or supervision on banks' credit supply is still very scarce. Indeed, current research largely documents the effects on banks' lending after the climate policy shock identified as the ratification of the 2015 Paris Agreement. For the credit markets, the evidence is limited to the syndicated loan market, which only represents a segment of the whole market, mostly considering the largest and listed banks' counterparties, and with evidence that banks monitor firms less in syndicated lending than in standard non-syndicated lending (Heitz et al. (2023)). In these studies, climate data are sourced from firms' self-reported carbon emissions or firms' statements at annual general meetings to gauge variations in exposure to climate transition risk, which is only available for the biggest firms. Reghezza et al. (2022) find that following the Paris Agreement, European banks both reallocated credit away from polluting firms; after the U.S. withdrawal from the Paris Agreement, EU banks also reduced credit to the U.S. firms, possibly for reputational reasons or because of banks' shift of preferences. Bruno and Lombini (2023) confirm these evidences from the global loan syndication market. Additional studies, such as Mueller and Sfrappini (2022), also hint at a large heterogeneity in how banks react to the Paris Agreement depending on firms' exposure and location. They find that U.S. banks lend relatively more to firms that are likely to lose from future regulation; conversely, European banks shift credit supply to firms that consider themselves to benefit from future regulation, facilitating the transformation to a low-carbon economy. To the best of my knowledge, the effects of European climate banking supervision on banks are studied by Fuchs et al. (2024) and Beyer and Schreiner (2024). In particular, Fuchs et al. (2024) analyze the causal link between the French bank climate pilot exercise, conducted in mid-2020 by the French Prudential Supervision and Resolution Authority from the Banque de France, and the borrowers' reductions in transition risk. One of the main findings is that participating banks increased syndicated loan volumes and simultaneously charged higher spreads for brown borrowers. The voluntary nature of the exercise constitutes an empirical challenge in the identification of the shock to the treated (9 participant banks) and control banks (banks headquartered outside France that did not participate in the climate pilot exercise but supplied credit to French borrowers). Furthermore, since the results are based on a database of syndicated loans, it is not clear whether the increase in loan volumes and spreads to the browner firms by the French-treated banks would have been specific to the largest and listed counterparties or might be applied to the whole credit portfolio. The paper by Beyer and Schreiner (2024) empirically assesses the impact of the ECB

climate-risk-related supervisory efforts since 2020 on the European banks' self-reported ESG ratings and portfolio choices with a difference-in-difference approach. The authors find a positive impact on the Euro Area significant institutions' E-scores and an increase in green finance, as represented by banks' green bond issuance, ESG assets under management, and green lending. To measure banks' green lending activities, they use the share of green lending to the total lending of banks as a percentage scale, by classifying the debtors according to their Refinitiv Eikon environmental ratings. Unclassified debtors - which represent a significantly high portion of the credit portfolio - are treated as nonsustainable. Thus, as the authors rightly pointed out, these results should be interpreted with caution due to several limitations: data coverage, data quality (largely affected by self-reporting and the limited auditing currently applied mainly to large companies, leading to potential greenwashing), a lack of standardization and, consequently, comparability, as well as insufficient data granularity (such as the absence of distinct measurements for climate risk impact, exposure, management, and unmanaged risk). Whether banks granted more or less credit to more polluting borrowers or charged higher credit spreads after the change of pace in SSM banking supervision in 2020 remains, a priori, unclear and needs to be tested empirically. To overcome the empirical challenges mentioned above, I rely on a granular panel dataset for the entire Italian banks' loans[7] from AnaCredit matched with firm-level emissions estimated in a similar approach adopted by banks.

The second strand of literature I contribute relates to the role of banks' and firms' commitments and targets to reduce future emissions and credit lending. In current research, there is no agreement on whether green banks lend preferentially to low-emission firms. Kacperczyk and Peydro (2021) find that banks adhering to the Science Based Targets initiative (SBTi)[8] honored their commitments by lending less to high-emission firms in the syndicated loan market. Degryse et al. (2023) document that after 2015 committed banks lend preferentially to low-emission companies and offer cheaper syndicated loans. Altavilla et al. (2024) find that European banks charge higher interest rates to firms featuring greater carbon emissions, and lower rates to firms committing to lower emissions, controlling for their probability of default. The authors also show that both ef-

[7]In Italy, credit exposures to SMEs represent around half of total exposure to firms and around two-thirds of value added.

[8]The SBTi is a joint initiative by Carbon Disclosing Project (CDP), the UN Global Compact, the World Wide Fund for Nature (WWF), and the World Resources Institute (WRI), whose purpose is to define and promote net-zero targets in line with the climate science. The overall goal of the initiative is to induce companies to commit to decarbonization pathways, to increase the chance that global emissions are reduced to a level that limits average temperature rise below 1.5°C.

fects are larger for banks committed to decarbonization. In contrast, Giannetti et al. (2023) focus on the role of environmental disclosures, finding that banks that emphasize the sustainability of their lending policies in their investment reports lend more to brown firms and do not provide more credit to firms in green industries. Moreover, Ehlers et al. (2022) find that green banks do not price carbon risk differently from other banks, and Sastry et al. (2024) document that climate-aligned banks do not change their lending or loan pricing differentially compared to banks without climate commitments since relationships matter more for bank credit supply and pricing. Therefore, my contribution is twofold. On the one hand, I shed light on supervisory policy shocks directly impacting banks that have not been investigated yet in previous empirical studies, emphasizing the role of banks' and firms' commitments in the lending process. On the other hand, I perform a complete assessment of the whole banks' credit portfolio with granular supervisory microdata.

The remainder of the paper is organized as follows: Section 2 outlines the institutional framework for the empirical analysis; Section 3 describes the data and the panel construction; Section 4 presents the empirical strategy and discusses the related results, and Section 5 concludes.

2 Institutional framework

2.1 The risks and transmission channels of climate change on banks

Individual banks and the banking system are exposed to climate change through macro and microeconomic transmission channels that arise from two distinct types of climate risk drivers (BIS (2021), Demekas and Grippa (2021)). On the one hand, the economy and financial system can be hit by the effects of rising sea levels, changing agricultural production patterns, or the increasing severity and increased frequency of extreme weather events (*physical risk*). On the other hand, the economic effects of policies to mitigate climate change, notably increases in carbon pricing, on asset prices and financial markets, give rise to risk drivers (*transition risk*), such as shifts in government policies, technological advancements, and shifts in investor and consumer sentiment. In both scenarios, increased climate risk can manifest directly through banks' exposures to borrowers and countries facing climate-related shocks, or indirectly through the repercussions of climate change on the broader economy and the feedback effects within the financial system. These exposures become evident through amplified default risks in loan portfolios or decreased values of assets. Consequently, the impacts of these risk drivers on banks can be observed through "traditional"

risk categories, including credit risk. Against this backdrop, researchers and policymakers have outlined the need to define micro and macroprudential policy and supervisory tools to mitigate climate-related risks in the financial system. Banking supervision has made larger progress compared to regulation. No specific regulatory capital requirements from the Basel Committee on Banking Supervision (BCBS) have been defined so far, neither in the form of a green supporting factor nor a brown penalty. Radical steps to revise Pillar I regulations have not been implemented, partly due to a lack of reliable data and robust analysis (Cannata and Manzelli (2023)). The main orientation on how to incorporate climate risks into the current prudential framework involves a risk-based approach, which conceives climate risks as a different form of traditional risks and not as a category in its own right. In contrast, work under Pillar Two and Pillar Three is at a more advanced stage. Regarding the Second, the Basel Committee (BCBS) has begun work on monitoring the implementation of the Principles for Effective Management and Supervision of Climate Risks by Banks and Supervisors.[9] Rather, greater progress has been made from the supervision in the very last few years in Europe. Climate and environmental risks are, in fact, part of the SSM supervisory priorities and risk monitoring framework for the largest and most complex banks (SIs) in the euro area.

2.2 Banking supervisory policies to tackle climate-related financial risks

Starting in mid-2020, SSM concretely took significant steps to incorporate climate-related financial risk into the banking supervisory framework. The key milestone of this change is represented by the publication of the Guide that explains how SSM expects banks to safely and prudently manage climate-related and environmental risks and disclose such risks transparently under the current prudential framework. In summary, the SSM wanted banks to account for these risks given that they drive existing prudential risk categories and can substantially impact the real economy and banks. The guide specifies how SSM Banking Supervision expects banks to consider climate-related and environmental risks in their governance and risk management frameworks and when formulating and implementing their business strategy. It also outlines how the SSM expects banks to become more transparent by enhancing their climate-related and environmental disclosures.

[9] In *Principles for the effective management and supervision of climate-related financial risks* published on 15 June 2022, the Basel Committee on Banking Supervision published principles for the effective management and supervision of climate-related financial risks. The document forms part of the Committee's holistic approach to addressing climate-related financial risks to the global banking system and seeks to improve banks' risk management and supervisors' practices in this area.

Before the final publication, a public consultation on the Guide started on 20 May 2020, and ended four months later, on 25 September 2020.[10] The final Guide, whose application was immediate, was released in November 2020 on the SSM website and many other future actions were announced. Concretely, the SSM followed up with banks in two concrete steps after the publication of the Guide. In early 2021 it asked banks to conduct a self-assessment in light of the supervisory expectations outlined in the guide and to draw up action plans on that basis. The SSM then benchmarked the banks' self-assessments and plans and challenged them in the supervisory dialogue. In 2022 it conducted both a full supervisory review of banks' practices and took concrete follow-up measures where needed, and the first supervisory stress test based on banks' balance sheets with a reference date of the end of December 2021.

With the CST, the SSM wanted to analyze a wide set of qualitative and quantitative information such as governance-related aspects, data availability, adequacy of transmission channels, scenario development capacity, asset class coverage, concentrations of sectoral income, financed greenhouse gas emissions, and hypothetical stress test projections.[11] These actions represented a relevant policy change in banking supervision that could impact banks' credit lending and had not yet been explored in previous empirical research, as reported in the following sub-section.

3 Data and panel construction

The analysis combines several data sources to investigate the effects of the release of the SSM Guide and the announcement of the 2022 CST on bank lending from the supply-side perspective. In this section, I explain the data sources and the sample construction for the empirical analysis, as well as the methodological approach to infer firm-level information on climate data.

3.1 Construction of the panel dataset

I constructed a granular panel dataset combining both confidential supervisory information and public data. The data are drawn from different sources. I rely on AnaCredit, a proprietary

[10] As part of the consultation, which closed on 25 September 2020, the ECB received around 800 comments from 50 respondents, ranging from banks and banking associations to research institutes and non-governmental organizations. Most respondents expressed broad support for the supervisory expectations. Several common threads were running through the comments received. For example, respondents asked what the ECB's supervisory expectations are concerning the impact that banks have on the environment; how supervisory expectations can be met in the short term given the challenges related to data and risk measurement methodologies; and where the ECB guide fits within the broader regulatory developments.

[11] Further information are available in ECB (2022a).

and confidential database of the ECB and the national central banks of euro-area countries[12], to obtain loan-level information. The database considers only business loans, which account for around two-thirds of the Italian credit to the non-financial sector. For each instrument, I consider monthly information from May 2020 to June 2022 on the outstanding nominal and off-balance-sheet amounts[13] (net of transferred amounts), on the type of instruments and interest rate (i.e. either fixed or variable)[14], and on the annualized agreed rate by the issuing bank. Compared to previous studies in literature relying on syndicated loan markets, AnaCredit allows for a comprehensive analysis of the key features of the credit contracts, i.e. quantities (loan amounts) and related prices (interest rates), as well as any other loan characteristics (e.g. maturity).

To investigate the effect of the Guide on banks' credit supply from a short-term perspective, I consider a period comprising six months, from September 2020 to February 2021. The first three months are the pre-shock period, and the second one represents the post-shock period. During that period, the COVID-19 pandemic led to an abrupt disruption of economic activity, and - starting from March 2020 - a wide range of support measures have been introduced to help firms including public loan guarantees. These measures eased access to credit and, in conjunction with debt moratoria, aimed at relieving firms' liquidity needs. The overall effect was a large boost in the amount of credit in Italy (according to De Mitri et al. (2021), +8 percent from December 2019 to December 2021). Thus, I both selected a relatively narrow time window and control for the presence of COVID-19-guaranteed loans in all econometric specifications to minimize the impact that the deteriorated macroeconomic environment might potentially confound credit supplied by Italian banks (both SIs and LSIs) than supervisory policies.[15] Furthermore, I performed at the same time a series of falsification tests over a longer period to check for the existence of pre-trends.[16] Figure 1 plots the monthly values of the total amount of credit granted to Non-Financial Corporations (NFCs) and the subset of loans with Covid-19 guarantees of my dataset[17], at the

[12] AnaCredit is a granular (transaction-level) database that reports 94 loan-level attributes on a monthly frequency in a harmonized way for all euro-area countries. The minimum reporting threshold for loans to firms is set at 25,000 euros for all countries participating in the database. AnaCredit covers a comprehensive set of credit instruments: overdrafts, revolving credit, credit lines, and other loans, including term loans.

[13] Firms in default status at the beginning of each period are excluded, because these are officially classified as losses.

[14] All credit instruments are included in the analysis, except for those flagged in AnaCredit with a type of interest rate mixed or not applicable. They represent a negligible part of the whole credit portfolio (around 1 percent).

[15] A similar approach of selecting a short-time window to assess the credit supply effects is adopted by Bottero et al. (2022).

[16] More details in Section 4.

[17] Starting from the end of June 2020, information on the presence of public guarantees provided to firms to cope with the consequences economic consequences (so-called Covid-19 guarantees) at the credit instrument level is available in AnaCredit with specific evidence.

monthly frequency for the period comprising May 2020-June 2022. In the first six months analyzed - i.e. from September 2020 to February 2021 - the large increase in loans to NFCs was driven by the instruments with Covid-19 guarantees, which in my dataset represent around 6 percent of total loans to NFCs and reached a peak of 10 percent after June 2021. To investigate the effect of the CST announcement I similarly consider a time window comprising six months, from September 2021 to February 2022. The first three months are the pre-shock period, and the second ones represent the post-shock period since SI banks were officially informed in November 2021.

I focus on two key variables of interest: credit granted (outstanding nominal and off-balance-sheet amounts in logarithm) and the spread (expressed in basis points) charged by banks on their loan types over the contemporaneous duration-matched risk-free rates. Further technical details about the computation of the spread are given in Appendix A.1. I then aggregate all credit instruments that a firm has with the banks of the same group. This step is necessary since lending policies are typically decided at the group level. The initial sample comprises Italian banks at the highest level of consolidation, excluding branches of foreign banks and subsidiaries of foreign banking groups, some of which are classified as neither 'significant' nor 'less significant' for supervisory purposes. Since Italian SIs are under the direct supervision of the SSM and so had to adhere to the Guide expectations and participate in the CST, they represent the treatment group. I consider as a control group, the LSIs for which the ratio of loans to total assets is within the range of banks classified as SIs. This enables me to compare more similar groups of banks by comparing multi-bank borrowers operating in the same macroeconomic environment that differ in terms of their lenders' pressure by supervisors to include climate risk considerations in the credit granting process.[18]

To capture the differential behavior of SIs relative to LSIs on credit supplied before and after the publication of the Guide or the announcement of the CST, I select only firms borrowing from both of these two categories in at least one period considered.[19] Considering multi-relationship firms is also compatible with the inclusion of firm fixed effects to single out credit supply. The key identifying assumption is that firms do not have a bank-specific demand for credit (Bonaccorsi di Patti and Sette (2016), Jiménez et al. (2012), Khwaja and Mian (2008)). [20]

[18] All results are robust when considering as control group the whole sample of LSIs.

[19] The final multi-bank database is a representative sample that counts for one-third of the total AnaCredit exposures to NFC.

[20] One possible concern would relate to existing differences in bank-firm relationships. For instance, green (brown) firms may prefer to demand credit to green (brown) banks. To alleviate this issue, I obtained robust results when additionally including bank-firm fixed effects.

Credit data are then matched with balance sheet information as of December 2019 on both firms and banks from Cerved-Cebil (CC)[21] and harmonized supervisory statistics[22], respectively. In particular, these data are included to control for observed heterogeneity at bank and firm level and include yearly information on economic and financial variables for firms and banks, such as sector of economic activity, revenues, assets, measures of profitability, and indicators of business models (the complete list of these variables is available in Appendix A.3). These datasets are matched by the names and social security numbers (Tax ID codes) and ABI codes of all Italian firms and banks. The unique feature of the CC dataset is that, differently from other widely used datasets on individual companies, it has wide coverage of small and medium enterprises, almost all of which are unlisted. The dataset also considers the presence of banks' environmental commitment to reduce emissions. In this regard, I identify committed banks that signed a commitment letter in the context of the Science Based Targets initiative (SBTi), or developed medium-to-long-term targets for the reduction of its emissions with action plans before the shocks. This information is sourced from Refinitiv or the bank's website. Only a small number of Italian banks are committed before the shocks, with 3 SIs in total. For the first period considered (to assess the impact of the SSM Guide), the final bank-firm matched sample covers 38 Italian banks, of which 11 Significant (SI) and 27 Less Significant banks (LSI), and 44,190 firms. For the second (to assess the impact of the CST announcement), the final sample includes 38 Italian banks, of which 11 Significant (SI) and 27 Less Significant banks (LSI), and 45,078 firms.

3.2 Detecting the brownness of each firm

The SSM Guide prescribes banks to consider climate-related risks at all relevant stages of the credit-granting process[23] and also reports some key performance indicators for banks, such as the carbon emission footprint.[24] Furthermore, the CST announcement occurred in November 2021 but SIs had to provide the SSM with a wide set of qualitative and quantitative information as of

[21] CC is a proprietary database containing yearly data on balance sheets and income statements of the universe of Italian limited liability companies (about 800,000 firms). The information drawn from CC is typically collected and standardized from balance sheets deposited with local chambers of commerce, where limited liability companies are obliged to file.

[22] More information about ECB SSM Supervisory Statistics is available here: https://www.bankingsupervision.europa.eu/about/ssmexplained/html/supervisory_statistics.en.html.

[23] Expectation 8 states that institutions are expected to consider climate-related and environmental risks at all stages of the credit-granting process and to monitor the risks in their portfolios.

[24] The carbon footprint represents the total greenhouse gas or CO2 emissions associated directly or indirectly with a product, organization or service. This indicator is widely used by banks as reported in the 2022 SSM thematic review.

December 2021, including the concentration of banks' exposures toward polluting firms based on the generated emissions. Thus, I match loan-level data with climate information for each firm. This step is necessary to classify banks' counterparties according to the current and future emissions and, in particular, by considering both historical CO2 emissions generated by the firm and the planned CO2 reduction targets, when available.

To estimate CO2 emissions at the firm level, I build on the approach developed by Faiella et al. (2022) and similar to Emambakhsh et al. (2023). This methodology estimates direct (brown) energy and electricity emissions, derived from the energy consumption to derive historical CO2 emissions. These emissions refer to those directly produced by firms (i.e. Scope 1) by direct usage of brown energy sources in their production processes and indirect emissions (i.e. Scope 2) generated by their consumption of electricity.[25] Firm-level emissions are calculated for each energy source by combining firm-level consumptions with information on sector energy mix and energy-to-emissions conversion factors. In particular, the total energy consumed at the firm level is estimated with the sectoral information about energy consumption from Eurostat Physical energy flow accounts (PEFAs) for different energy sources:

$$e_{f,t} = \sum_{z=1}^{Z} w_{z,f,t}$$

where z=1,...,Z represents the energy sources and $w_{z,f,t}$ is defined as:

$$w_{z,f,t} = \frac{l_{f,t}}{L_t} \times E_{z,t}$$

where:

- $l_{f,t}$ denotes the number of number of employees for firm f at time t
- L_t denotes the total number of employees enrolled in the same sector as the one of the firm f at time t
- $E_{z,t}$ is the energy consumption (at the sector level of firm f) for energy source z at time t

CO2 emissions are computed with the energy conversion factors for electricity, natural gas (as a proxy of heating fuels), gasoline, and gasoil from official sources, i.e. ISPRA (2019) and

[25]The CO2 protocol accounts for a third category of emissions (Scope 3), which includes all indirect emissions that occur in the upstream and downstream activities of an organization. Since this information is less reliable, Scope 3 emissions were not included in the estimation of company-level energy consumption.

Ministero dell'Ambiente (2019).[26] Then, I match the firm-level emissions at the end of 2019, i.e. the period before the shock, with the panel dataset for bank-firm relationships to define a treatment variable that will be a binary proxy for the level of brownness. The variable takes 1 if the firm has CO2 emissions above the median values of the distribution across all industries, and 0 otherwise. The identification of the brown treatment binary variable is coherent with the literature. Reghezza et al. (2022) defines brown firms as those with values of emissions intensity and levels - sourced by external data providers - above the median of the distribution of emissions across sectors. In other studies, firms are classified as brown if they fall in the highest quintile of emission distribution (Giannetti et al. (2023)) or quartile (Carbone et al. (2021), Bruno and Lombini (2023)). Compared to the recursion of private providers' data, the advantages of this computational approach to infer firm-level emissions are twofold. First, it directly estimates CO2 emissions for the universe of firms, not only the largest and listed companies, by relying on public and reliable data. Second, the imputation of emissions from energy consumption is more precise compared to the direct recursion of CO2 emissions at the sector level, since the energy mix of each fossil fuel is taken into consideration. Furthermore, while this approach does not perfectly gauge within-sector variability, as it only depends on the number of workers, this methodology to infer emissions is coherent with the majority of private data providers (such as Refinitiv), as well as by internal practices developed by banks.[27]

Finally, following Carbone et al. (2021) and Altavilla et al. (2024), I construct a dummy variable that equals 1 if a given firm has disclosed an emission reduction target and 0 otherwise before the policy shock. This forward-looking information is self-disclosed by firms and is provided by Refinitiv.[28] In particular, these data are sourced or collected from the publicly available documents and websites of any particular company. Documents such as Non-Financial Reports, Sustainability Reports, Corporate Social Responsibility, Environmental Reports, and Annual Reports are taken into consideration for updating the information. Refinitiv applies the following rules to define a dummy variable at the company level (i.e. "TRUE/FALSE") in case the company sets targets or objectives in a given time frame to be achieved on emission reductions to land, air, or water from

[26] Further technical details are given in Appendix A.2.

[27] Further information is available in ECB (2022a) and ECB (2022b).

[28] Only a small number of non-financial companies have had their target reduction emission validated by STBi (Science Based Targets initiative), indicating it is aligned with the Paris Agreement goal. Since the patterns of emission reductions for firms with an SBTi verified target and self-disclosed ones are very similar as suggested by Carbone et al. (2021), I rely on self-disclosed emission reduction targets drawn from Refinitiv due to higher data coverage.

business operations. Finally, segmental or regional data can be considered, but the data provider always focuses on group data.[29] While this information is key to assessing the effective greenness of the firm over a planned time horizon that should be proportional to the lifetime of the credit instrument, only a very small number of firms have committed to reducing emissions in the future, i.e. a subset of large and listed companies. Firm commitments are not random, are a choice for firms, and largely depend on the business environment in which firms function. Anecdotally, firms commit to reducing future emissions because various stakeholders exert pressure on them to do so. The stakeholder pressure is generally multi-dimensional and includes climate policy strictness, the equity ownership structure, media sentiment, customer relations, or board characteristics (Busch et al. (2020). Over around 130 listed firms in the sample, only 24 Italian-listed firms have committed to reducing future CO2 emissions.

4 Measuring the effect of climate supervisory policies on banks' credit supply

In the following subsections, I present the empirical strategy to identify the impact of climate supervisory policies on banks' credit lending (Section 4.1), the main results of the impact of the SSM Guide (Section 4.2), and the announcement of climate stress test (Section 4.3), the role of banks' and firms' commitment (Section 4.4 and Section 4.5) and a set of robustness checks (Section 4.6).

4.1 Empirical strategy

The following triple difference-in-difference model (DDD) represents the main empirical specification:

$$Y_{b,f,t,l} = \alpha_1(Brown_f \times Post_t \times Tre_b) + \alpha_2(Brown_f \times Tre_b) + \\ + \alpha_3 Covid_{b,f,t} + \delta_{b,t} + \omega_{f,t} + \eta_{l,t} + \epsilon_{b,f,t,l} \quad (1)$$

[29] For instance, in the company report published by Dainippon Sumitomo Pharma Co Ltd there is a dedicated session on the Mid-term Environmental Plan (Fiscal 2011 — Fiscal 2014). In this section the company releases the following climate objectives: to reduce CO2 emissions for the whole company to the level of the benchmark year (FY2006) by FY2014; to improve the specific energy consumption and CO2 emission rate for the whole company by 1% or more per year; to promote energy saving and prevent global warming. Hence, since this company has Emission reduction objectives, it will be graded by Refinitiv as "TRUE".

where b, f, t, and l index banks, firms, months, and loan type respectively. I condition on bank-firm relationships in which each firm borrows from both SI and LSI categories in at least one period considered. This implies that I compare the amount of credit (in log terms) or the spread charged by the treated and control banks to the same firm (Khwaja and Mian (2008)). Firms having multiple lending relationships represent more than 12% of the whole Italian firms in AnaCredit data (more than 108,000 companies). Using firm-fixed effects, supply shocks are identified through the variation across lending of different banks to the same firm; this strategy is possible since the sample comprises only firms that have at least two bank relationships. The main explanatory variables are Tre_b, a dummy variable that is 1 for banks exposed to the SSM supervisory policy (i.e. SIs), and $Brown_f$, a dummy that is 1 if the CO2 emissions of the firm are above the median of the historical distribution across sectors in the year before the entry into force of the Guide (i.e. 2019) or the announcement of the CST (i.e. 2020). I use $Post_t$ as a dummy that indexes periods of three months. The periods of interest for the first shock are the three months preceding the publication of the Guide (2020-09 – 2020-11) and the period following the SSM release (2020-12 – 2021-2). For the second shock, the dummy is equal to 0 in the three months preceding the announcement of the CST (2021-09 – 2021-11), and 1 in the three months afterward (2021-12 – 2022-2). To control for the presence of Covid-19 guaranteed loans I include the variable $Covid_{b,f,t}$ which represents the sum of the credit (in log terms) instruments backed by Covid-19 guarantees aggregated at the bank level and granted to a given firm f in a given month t.[30]

To strengthen the identification I include the fixed-effects $\delta_{b,t}$, $\omega_{f,t}$, and $\eta_{l,t}$. The inclusion of bank-time fixed-effects ($\delta_{b,t}$) allows further control for monthly shocks common to all banks and idiosyncratic banks' characteristics. These fixed effects capture all observable and unobservable bank-specific and time-varying confounding supply dynamics that would impact firms according to their different level of emissions. Firm-time fixed effects ($\omega_{f,t}$) control for observable and unobserved time-varying characteristics of the firms that may influence both credit supplied by banks and their credit conditions (e.g. their business model and their industry). Additionally, loan-type times month fixed effects ($\eta_{l,t}$) to ensure that the results do not reflect differences in loan contract features over time such as whether a loan is revolving or a term loan. These fixed effects also capture the specific demand for each type of loan during the sample period.

[30] Results are robust when considering a control variable defined as a dummy variable for the presence of Covid-19 guarantees instead of the log amount of these credits.

When I do not include both the bank-time and firm-time fixed effects, I include a set of bank and firm controls, all measured in 2019 (further information is available in Appendix A.3). Standard errors are two-way clustered at the firm and bank-level to account for heteroscedasticity and serial correlation of error terms.[31] $Y_{b,f,t,l}$ is the dependent variable identifying the log amount of credit granted[32] or the average credit spread (in basis points) charged by banks on their loans over the contemporaneous duration-matched risk-free rate.

The coefficient of interest is α_1 on the triple interaction, which estimates the treatment effects on credit supplied or pricing for the subset of brown firms after the shock. The triple difference estimator can be viewed as the difference between two difference-in-differences estimators. In this context, it is the difference-in-differences estimate of the effect of SSM climate supervision on lending to brown firms, relative to the difference-in-differences estimate of the effect of SSM climate supervision on less polluting firms by comparing the differential effect of the treated and control banks:

$$[(\overline{Y}_{SI,Brown,Post} - \overline{Y}_{SI,Brown,Pre}) - (\overline{Y}_{LSI,Brown,Post} - \overline{Y}_{LSI,Brown,Pre})] -$$
$$[(\overline{Y}_{SI,NotBrown,Post} - \overline{Y}_{SI,NotBrown,Pre}) - (\overline{Y}_{LSI,NotBrown,Post} - \overline{Y}_{LSI,NotBrown,Pre})]$$

According to my first null hypothesis, the estimated coefficient value would not be significant and close to zero. In this case, I would not find any significant and material effect of the Guide publication regarding credit reallocation or spread charged by SI banks to brown firms. On the contrary, a plausible interpretation would be that banks did pay attention to supervisory expectations (both anticipating more stringent prudential policies and in light of increased awareness of climate change-related risks) and the information transmitted to SSM in the CST. To validate the results of the DDD in the baseline equation (1), I need to inspect the parallel-trend assumption, by estimating equation (1) separately for the first and the second shock, i.e. the Guide and the CST, respectively (see Figure 2 and 3).

One important aspect to investigate is the role of banks' commitment to credit quantity and related spreads after the two supervisory shocks. Following Kacperczyk and Peydro (2021) and Degryse et al. (2023), I consider a new dummy variable ($Bank\ Comm_b$) to account for the presence of banks' emission reduction targets, set in the previous year of the shock. This information is

[31] I also run a version with standard errors only clustered at the bank level.
[32] Results are similar when using the delta log changes.

sourced from the Refinitiv dataset and captures banks' environmental consciousness (greenness).[33] To this end, the following specification is defined.

$$Y_{b,f,t,l} = \alpha_1(Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b) + \alpha_2(Brown_f \times Post_t \times Tre_b) + \quad (2)$$
$$+\alpha_3(Brown_f \times Tre_b \times Bank\ Comm_b) + \alpha_4(Brown_f \times Tre_b) + \alpha_5 Covid_{b,f,t} +$$
$$+\delta_{b,t} + \omega_{f,t} + \eta_{l,t} + \epsilon_{b,f,t,l}$$

Equation (2) is a quadruple difference-in-difference where the coefficient of interest represents the differential effect on credit by treated and committed banks exposed to brown borrowers after the shock.

Finally, I define a different specification to check whether treated banks similarly modify credit quantity and prices to polluting firms committed to reducing future emissions. In the spirit of Altavilla et al. (2024), I consider historical and forward-looking information on CO2 emissions to check how this combined information affects banks' lending strategies after the supervisory policy shock. The dummy $Firm\ Comm_f$ is equal to 1 if the firm has disclosed an emission reduction target or commitment and 0 otherwise. I restrict the analysis to listed firms since this information is not available for smaller and non-listed companies.

$$Y_{b,f,t,l} = \alpha_1(Brown_f \times Post_t \times Tre_b \times Firm\ Comm_b) + \alpha_2(Brown_f \times Post_t \times Tre_b) + \quad (3)$$
$$+\alpha_3(Brown_f \times Tre_b \times Firm\ Comm_b) + \alpha_4(Brown_f \times Tre_b) + \alpha_5 Covid_{b,f,t} +$$
$$+\delta_{b,t} + \omega_{f,t} + \eta_{l,t} + \epsilon_{b,f,t,l}$$

Equation 3 is similar to 2, except for the explanatory variable, $Firm\ Comm_f$ that signals whether the firm is undertaking strategies to reduce its carbon footprint by disclosing specific emission targets set in the year before the shocks.

Table 1 reports summary statistics for the main variables to assess the impact of the SSM Guide (Panels A and B) and the announcement of the climate stress test (Panels C and D). The final samples of these two periods are similar both in terms of observations and descriptive statistics. Panels A and C of Table 1 report statistics for the variables used in Equation (1), with more than 900,000 observations. Panels B and D show the statistics for the variables used in

[33] The summary statistics of these variables are reported in Table 1.

Equation (2), with a sample size that significantly decreases (4,546 and 4,556 observations) since the analysis is restricted to Italian-listed firms. The sample features a highly heterogeneous and skewed distribution for emissions ($CO2emissions(firm)$), as reported in Table 1. The average firm produced around 2.49 million tons of CO2 emissions.[34]

4.2 Main results on banks' credit supply and pricing: the 2020 SSM Guide

I use equation (1) to estimate the effect on banks' credit supply after the supervisory policy shock and Table 2 Panel A shows the related results. Specifically, I consider as a dependent variable the credit amount (in log terms) with four different specifications. The first specification includes bank and time-fixed effects to control for monthly shocks common to all banks and idiosyncratic banks' characteristics; the second adds fixed effects to control for firms' unobserved time-varying characteristics that might affect credit lending; the third jointly considers bank-time and firm-time fixed effects. Finally the fourth is the augmented specification including all sets of fixed effects mentioned above, in addition to the fixed effects to control for different loan-type characteristics of credit instruments. According to the most demanding specification, treated banks (SIs) reallocated credit toward less polluting firms compared to LSIs after the publication of the Guide. The estimates for the coefficient of interest, α_1, are significant and negative for all the specifications. This means that the treated banks (SIs) decreased on average loan volumes significantly by 2.1% to the most polluting borrowers compared to LSIs after the publication of the SSM Guide. According to these findings, I can reject the null empirical hypothesis that supervisory expectations did not lead SIs to credit reallocation toward less polluting firms. These results are broadly in line with previous findings (e.g. Kacperczyk and Peydro (2021)) that banks reduce credit for high-transition risk firms, i.e. the most polluting companies. The novelty of these findings is mainly related to the identified shock. Indeed, while the reduction in credit supplied was observed after the Paris Agreement (e.g. Reghezza et al. (2022), Mueller and Sfrappini (2022)) over a very long period (4-5 years), this analysis focuses on the short-term effects on credit by banking supervision since the inclusion of climate risk considerations.

When considering the effects of the supervisory expectations on banks' average credit spread

[34]Following Kacperczyk and Peydro (2021), I compute the natural logarithm of $CO2emissions_f$ pre-shock, to better deal with such a highly non-linear distribution of emissions and obtain the relatively more normally distributed variable. As a consequence, I also compute the dummy variable $LogBrown_f$ as described in Appendix A.3. Since all the results in the analysis are robust when considering both $LogBrown_f$ and $Brown_f$, I report results including the variable $Brown_f$.

the coefficient of interest (α_1) is positive but not significant (Table 3 Panel A). Treated banks did not significantly increase the average credit spread to brown firms after the policy shock.

All in all, after the publication of the supervisory expectations, treated banks decreased loan volumes to firms with a relatively higher carbon emission footprint, without compensating for the greater risk through higher spreads. These findings present novel evidence on the effectiveness of climate supervisory policies in banks' credit behavior and complement existing research on the effect of climate transition policies. In particular, these results are intended to provide specific evidence of the effects of climate banking supervision in tackling climate-related financial risks, from a banks' supply side perspective.

4.3 Main results on banks' credit supply and pricing: the climate stress test

Panel B of Table 2 reports the main results of equation (1) to estimate the effect of bank lending after the announcement to banks of the climate stress test. Contrary to the publication of the SSM expectations, there is no significant effect in terms of credit reallocation by SI banks to less brown firms after the shock. Furthermore, looking at the estimates on banks' credit loan spread similar results are obtained in Panel B of Table B, suggesting that the CST announcement did not lead treated banks to significantly charge a different pricing adjustment to brown firms.

These results do not contradict previous findings by Fuchs et al. (2024), according to which banks increased credit volumes and simultaneously charged higher spreads to browner firms. On the one hand, the authors analyzed the effect on credit of a different supervisory shock, i.e. the voluntary participation of a sub-sample of French banks in the climate pilot exercise, conducted in mid-2020. On the other hand, while the results of Fuchs et al. (2024) are based on a database of syndicated loans, it is not clear whether the increase in loan volumes and spreads to the browner firms could be extended to the whole banks' credit portfolio or is specific to the largest and listed counterparties. Conversely, my analysis considers the universe of Italian limited liability companies, including small-medium enterprises. Finally, it should be noted that, while effectively conducted in the first half of 2022, the Climate Stress test was originally announced in conjunction with the release of the SSM Guide, in November 2020. Therefore, it is plausible that the main effect in terms of credit reallocations by the treated banks might have been triggered after the first supervisory shock, i.e. the release of the climate expectations.

4.4 The role of banks' commitments

The next question of interest is whether banks committed to climate objectives were similarly affected by the supervisory shock and, using equation (2), the effects on the credit supply are estimated in Table 4 Panel A. In column (1) the same results of equation (1) are reported, while column (2) shows the estimates of the most saturated version of equation (2). It is interesting to notice that the estimated coefficient of interest related to the quadruple interaction is negative and statistically significant (-2.6%), while the coefficient of the triple interaction loses significance. This suggests that committed banks entirely drive the credit reallocation effect of treated banks compared to LSIs after the publication of the supervisory expectation. The results highlight that green banks strongly reacted to the supervisory shock and that - despite their existing commitments to reduce future emissions - they reallocated credit to less polluting firms. This is in line with previous findings: Sastry et al. (2024) find that climate-aligned banks do not change their lending or loan pricing differentially compared to banks without climate commitments, suggesting they are not actively divesting. In another study by Giannetti et al. (2023) the authors find that banks overemphasize their climate goals and credentials while continuing their relationships with polluting borrowers. The novelty of this paper is that it sheds light on the reaction of committed banks to supervisory shock.

Table 5 Panel A confirms the results obtained in previous subsections, i.e. no differential effect in terms of price adjustment by treated banks exposed to polluting firms, nor by committed banks. Replicating the analysis for the effect of the announcement of the CST, the obtained results confirm previous findings, i.e. also for committed banks there was no effect in terms of credit reallocation and related price (Table 4 Panel B and Table 5 Panel B, respectively) compared to LSIs.

4.5 The role of firms' commitments

In the previous subsections, I provide evidence that the Italian banks reallocated credit toward less polluting firms after the first policy shock (climate expectations). Furthermore, the second policy shock (the announcement to banks of the climate stress test) did not produce any effect in terms of quantity and related price. One relevant aspect to be further investigated is whether there might be a different effect on banks' lending when restricting the analysis to listed firms for which forward-looking information about target plans to reduce future emissions or firms' commitment is available. The intuition is that treated banks could not have similarly reallocated credit to firms

that are considered brown according to their historical CO2 emissions but - at the same time - commit to a target level of emissions since they are currently undertaking actions to reduce their carbon footprint over a planned time horizon. The sample size significantly decreases since target emissions are generally available only for a subsample of large and listed firms.

Thus, I first estimate the DDD specification defined in equation (1) and then equation (3) to estimate both the quantity and the price effect of banks' credit supply.

These findings are interesting since they show that banks directly affected by the supervisory shock (SIs) did not reallocate credit away from brown borrowers undertaking business strategies to reduce future emissions and reach pre-determined targets (Table 4 Panel C) after the expectations. By not reallocating credit to brown and committing firms, banks continue to provide brown firms with adequate financial resources to invest in technologies enabling them to reduce their carbon emissions. Furthermore, when considering the effects of the supervisory expectations on banks' average credit spread, the coefficient of interest α_1 is negative and slightly significant, implying that treated banks simultaneously decreased credit spreads to committed firms compared to LSIs (Table 5 Panel C).

Replicating the analysis for assessing the impact of the announcement of CST, I found that SI banks reallocated credit away from large brown borrowers (Table 5 Panel D, column (2)) that are undertaking business strategies to reduce future emissions and reach pre-determined targets (Table 4 Panel D) and applied relatively higher credit spreads (Table 5 Panel D). One possible explanation for this different result is that, during the climate stress test, participating banks had to report in ad-hoc templates firms' emissions for the biggest counterparties, i.e. the top 15 largest counterparties by NACE sector in terms of the bank's exposure. In particular, banks were requested to provide a set of common climate-related metrics, regarding the sensitivity of banks' income to transition risk, their exposure to carbon-intensive industries, and the sustainability of the banks' business model using historical information on CO2/GHG emissions. The CST did not explicitly require banks to consider the exposure to climate risk with climate forward-looking data (i.e. emission targets or commitment).[35] Therefore, it is plausible that, for the largest brown firms, SI banks decided to reallocate credit to less polluting firms, despite the presence of emission reduction targets. In conclusion, climate supervisory actions can significantly affect banks' lending policies and credit supply.

[35]Further information is available here: https://www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.climateriskstresstest2021~a4de107198.en.pdf.

4.6 Robustness checks

This subsection examines the robustness of my findings concerning endogeneity concerns.

4.6.1 Different climate risk metrics: brown and green dummies based on different thresholds and CO2 emission intensity

As a first robustness check, I use equation (1) with a different cut-off for the brown dummy by considering, the first and the last quartile instead of the median. In particular, I construct the dummy $Green_f$ to identify those firms with a level of CO2 emissions that is less than or equal to 32,235 tonnes of CO2 (the first quartile of the CO2 emissions distribution at the end of 2019), and the dummy $Brown\ High_f$ if the firm has emissions higher or equal to 244,989.87 tonnes of CO2 (the third quartile). For consistency, I saturated the model with the same combination of bank and firm-specific characteristics as well as with the inclusion of bank-time, firm-time, and loan type-time fixed effects. Table 6 reports the related estimates for the effect of the SSM Guide, providing evidence that the estimated coefficient of interest is significant in three out of four specifications (Panel A) implying Italian SI banks reallocated credit away from high-polluting firms (those falling in the worse quartile of the CO2 distribution) by 2.3%, a slightly higher economic magnitude compared to the results obtained in Table 2 (-2.3% vs -2.1%) where brown firms are classified are those companies with emissions greater than the median value of the CO2 distribution. Results obtained for the $Green_f$ dummy do not confirm that green significant banks simultaneously increased their exposures to greener companies after the publication of the SSM Guide, compared to LSI (Table 6 Panel B). Consistently with the findings obtained for the effect of the CST announcement, the estimated coefficient of interest of the triple interaction is not significant (Panel C and D). In addition and in the spirit of Bolton and Kacperczyk (2023), I replace the dummy of interest ($Brown_{f,t}$) with the CO2 emission intensity ($CO2int_{f,t}$, computed as CO2 emissions over total revenues of the firm), expressed as a continuous variable. From Table 8 I see that the sign and the significance of the estimated coefficient of interest in the most saturated specification (column (4)) are coherent with the results obtained in Tables 2 and 3. Furthermore, I also use equation (1) with a different cut-off for the brown dummy by considering, the first and the last quartile instead of the median ($Brown\ High_f$ and $Green_f$), to assess the impact on credit spread. In particular, Table 7 reports the related results that confirm evidence obtained in previous subsections.

4.6.2 Test for the parallel trend assumption and falsification tests

To test whether the key identification assumption on parallel trends holds, Figures 2 and 3 plot the time-varying coefficients to analyze the Guide's effect and the CST launch on the bank lending composition of treated banks. In particular, Figure 2 shows an insignificant impact on bank lending to brown firms by the treated banks compared to LSIs before the release of the supervisory expectations (in November 2020) and a negative effect thereafter. In contrast, from Figure 3 there is no significant impact on bank lending to brown firms by the treated banks, neither before, nor after the official launch of the 2022 Climate Stress Test one year later, in November 2021.

Furthermore, I performed two different falsification tests in the spirit of Fuchs et al. (2024) to establish that the treatment effect is not observable in the absence of the supervisory shock.

First, I randomly assigned treated banks to identify those intermediaries that would have been impacted by the SSM Guide. Column (1) and Column (2) of Table 10 show that the key coefficient is rendered insignificant. Second, moving forward the period considered, i.e. from September 2020-February 2021 to December 2020-May 2021, leads to statistically insignificant effects in Column (3) and Column (4). In this case, I considered the effects of the Guide after March 2021.

4.6.3 Differences in bank-firm relationships

This paper analyses the effects on banks' credit supply after two supervisory shocks that directly impacted Italian Significant Institutions. One possible concern would relate to existing differences in bank-firm relationships. For instance, green (brown) firms may prefer to demand credit to green (brown) banks. To alleviate this issue, I estimate equations (1) and (2) in Table 11, additionally including bank-firm fixed effects. These further robustness checks confirm the main findings obtained in the previous subsections.

5 Conclusions and policy implications

This paper analyzes the effect of the increased awareness of climate risk from 2020 by the Supervisory Authority of banks in Europe (Single Supervisory Mechanism, SSM) affected bank lending, by investigating the quantity and the pricing channels and the role of banks' and firms' commitment to reduce future emissions. I focus on two different events that might be considered relevant policy shocks, i.e. the publication of the SSM Guide in November 2020 and the subsequent SSM

announcement to directly supervised banks (Significant Institutions, SIs) about their official participation in the first climate stress test (CST) one year later, in November 2021. I exploit very granular data at the loan level, matched with firm-level emissions inferred with an ad-hoc methodology, to understand whether Italian banks reallocated credit toward less polluting firms and if they charged a different credit spread. Three novel findings emerge from this analysis. First, after the publication of the supervisory expectations, banks under the direct supervision of the ECB supplied less to brown firms. The effect is entirely driven by treated banks with emission reduction targets (green banks). While this paper complements previous works highlighting the minor role of committed banks in bank lending decarbonization (Giannetti et al. (2023), Sastry et al. (2024)), a key contribution is that it sheds light on the efficacy of voluntary commitments in the presence of supervisory shocks. Second, the subsequent announcement of the climate supervisory stress test did not lead to credit reallocation from polluting to less polluting firms by treated banks, suggesting that the first supervisory shock impacted more lending composition. Third, when considering prospective information on companies' future emission reduction plans, where available, the results are not unique. After the publication of expectations, SIs did not similarly reallocate credit, while the CST led treated banks to reduce credit and charge higher spreads compared to LSI. Indeed, the exercise did not explicitly require banks to consider the exposure to climate risk with climate-forward-looking data. This work illustrates the pivotal role of banking supervision in supporting the transition. It provides the right incentives for banks to support firms in the green transition financially but also requires banks to identify better financial risks and vulnerabilities related to climate change (Hansen (2022)). Any unintended effect, such as credit contraction to firms that are currently undertaking green investments or increased cost of lending, needs to be avoided as they might effectively impair the transition to a low-carbon economy. Developments on the disclosure front in multiple international fora (primarily, BCBS, FSB and EBA) will play a key role in increasing the quality and availability of such prospective information and enabling proper assessment of climate risks by banks.

References

Acharya, V. V., A. N. Berger, and R. A. Roman (2018). Lending implications of U.S. bank stress tests: Costs or benefits? *Journal of Financial Intermediation 34*(C), 58–90.

Altavilla, C., M. Boucinha, M. Pagano, and A. Polo (2024, August). Climate risk, bank lending and monetary policy. Working Paper Series 2969, European Central Bank.

Beyer, A. and L. Schreiner (2024, July). The impact of ECB Banking Supervision on climate risk and sustainable finance. Working Paper Series 2952, European Central Bank.

BIS (2021). Climate-related risks drivers and their transmission channel. Technical Report 517, Basel Committee on Banking Supervision - Bank for International Settlements.

BIS (2023). The effects of climate change-related risks on banks: a literature review. Technical Report 40, Basel Committee on Banking Supervision - Bank for International Settlements.

Bolton, P. and M. Kacperczyk (2023). Global pricing of carbon-transition risk. *The Journal of Finance 78*(6), 3677–3754.

Bonaccorsi di Patti, E. and E. Sette (2016). Did the securitization market freeze affect bank lending during the financial crisis? Evidence from a credit register. *Journal of Financial Intermediation 25*(C), 54–76.

Bottero, M., C. Minoiu, J.-L. Peydró, A. Polo, A. F. Presbitero, and E. Sette (2022). Expansionary yet different: Credit supply and real effects of negative interest rate policy. *Journal of Financial Economics 146*(2), 754–778.

Bruno, B. and S. Lombini (2023). Climate transition risk and bank lending. *Journal of Financial Research*.

Busch, T., M. Johnson, and T. Pioch (2020, 04). Corporate carbon performance data: Quo vadis? *Journal of Industrial Ecology 26*.

Cannata, F. and G. Manzelli (2023). The challenges for banking regulation in the current market environment. *Journal of Italian Banking Association* (6).

Carbone, S., M. Giuzio, S. Kapadia, J. S. Krämer, K. Nyholm, and K. Vozian (2021, December). The low-carbon transition, climate commitments and firm credit risk. Working Paper Series 2631, European Central Bank.

De Mitri, S., A. D. Socio, V. Nigro, and S. Pastorelli (2021, December). Financial support measures and credit to firms during the pandemic. Questioni di Economia e Finanza (Occasional Papers) 665, Bank of Italy, Economic Research and International Relations Area.

Degryse, H., R. Goncharenko, C. Theunisz, and T. Vadasz (2023). When green meets green. *Journal of Corporate Finance 78*(C).

Demekas, D. G. and P. Grippa (2021). Financial regulation, climate change, and the transition to a low-carbon economy: A survey of the issues. Technical report, International Monetary Fund.

ECB (2022a, July). 2022 climate risk stress test. Technical report, European Central Bank.

ECB (2022b, November). Good practices for climate-related and environmental risk management. Observations from the 2022 thematic review. Technical report, European Central Bank.

Ehlers, T., F. Packer, and K. de Greiff (2022). The pricing of carbon risk in syndicated loans: Which risks are priced and why? *Journal of Banking Finance 136*, 106180.

Emambakhsh, T., M. Fuchs, S. Kördel, C. Kouratzoglou, C. Lelli, R. Pizzeghello, C. Salleo, and M. Spaggiari (2023, September). The Road to Paris: stress testing the transition towards a net-zero economy. Occasional Paper Series 328, European Central Bank.

Faiella, I., L. Lavecchia, V. Michelangeli, and A. Mistretta (2022). A climate stress test on the financial vulnerability of Italian households and firms. *Journal of Policy Modeling 44*(2), 396–417.

Fuchs, L., H. Nguyen, T. Nguyen, and K. Schaeck (2024, May). Climate stress tests, bank lending, and the transition to the carbon-neutral economy.

Giannetti, M., M. Jasova, M. Loumioti, and C. Mendicino (2023). Glossy green banks: The disconnect between environmental disclosures and lending activities. *Swedish House of Finance Research Paper No. 23-07, European Corporate Governance Institute – Finance Working Paper No. 919/2023*.

Giglio, S., B. Kelly, and J. Stroebel (2021). Climate finance. *Annual Review of Financial Economics 13*(1), 15–36.

Hansen, L. P. (2022). Central banking challenges posed by uncertain climate change and natural disasters. *Journal of Monetary Economics 125*, 1–15.

Heitz, A. R., C. Martin, and A. Ufier (2023, May). Bank Loan Monitoring, Distance, and Delegation. *AEA Papers and Proceedings 113*, 177–181.

Jiménez, G., S. Ongena, J.-L. Peydró, and J. Saurina (2012, May). Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review 102*(5), 2301–26.

Kacperczyk, M. and J.-L. Peydro (2021). Carbon emissions and the bank-lending channel. CEPR Discussion Papers 16778, C.E.P.R. Discussion Papers.

Khwaja, A. I. and A. Mian (2008, September). Tracing the Impact of Bank Liquidity Shocks: Evidence from an Emerging Market. *American Economic Review 98*(4), 1413–1442.

Kok, C., C. Müller, S. Ongena, and C. Pancaro (2023). The disciplining effect of supervisory scrutiny in the eu-wide stress test. *Journal of Financial Intermediation 53*, 101015.

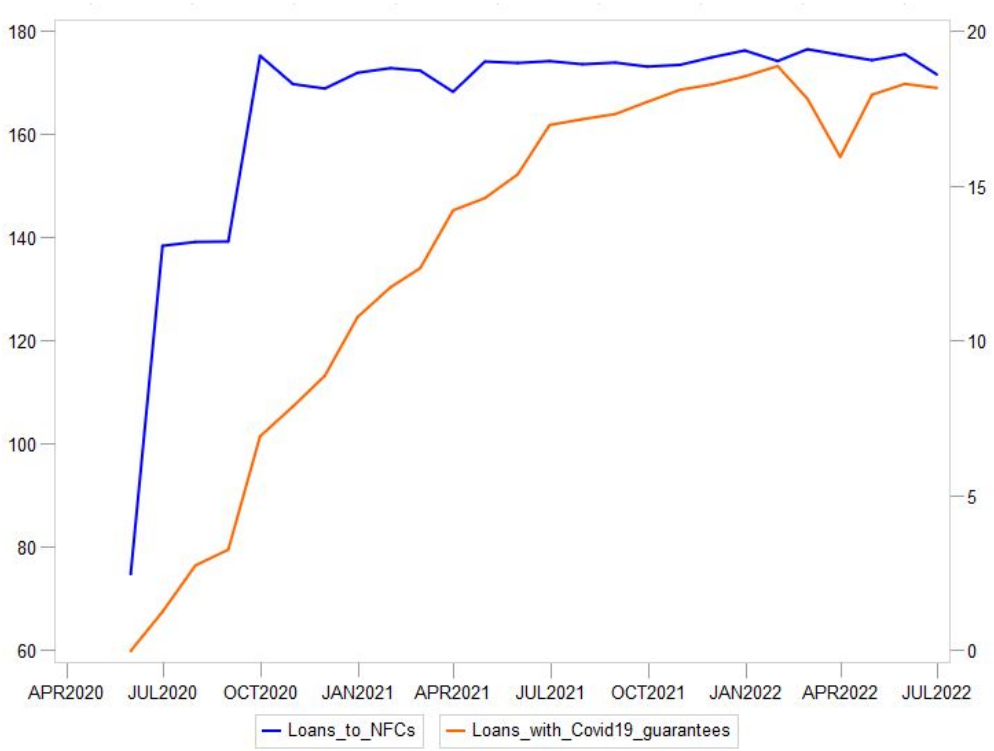
Mueller, I. and E. Sfrappini (2022, June). Climate Change-Related Regulatory Risks and Bank Lending. Working Paper Series 2670, European Central Bank.

Reghezza, A., Y. Altunbaş, D. Marques-Ibanez, C. d'Acri, and M. Spaggiari (2022, 07). Do banks fuel climate change? *Journal of Financial Stability 62*, 101049.

Sastry, P., E. Verner, and D. Marqués-Ibáñez (2024, March). Business as usual: bank climate commitments, lending, and engagement. Working Paper Series 2921, European Central Bank.

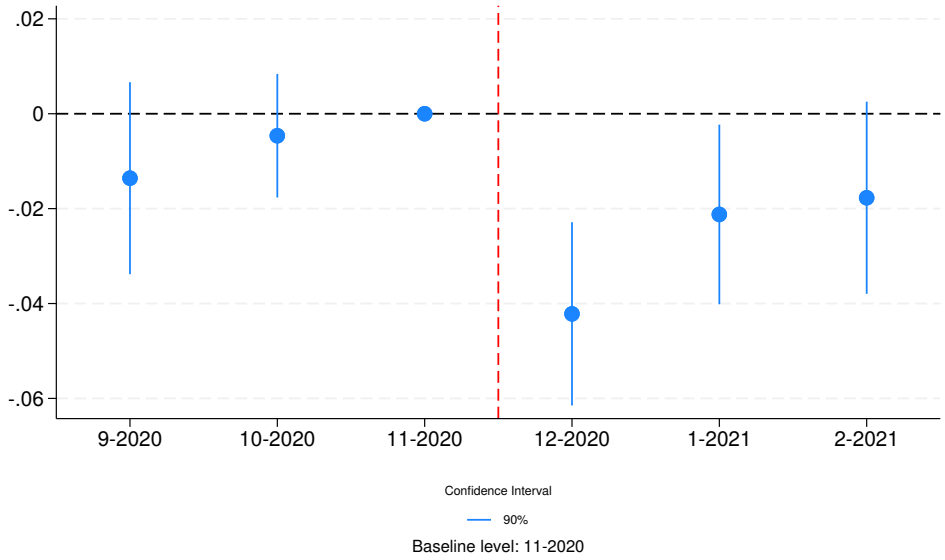
Figures

Figure 1: Loans to NFCs and loans to NFCs with Covid-19 guarantees



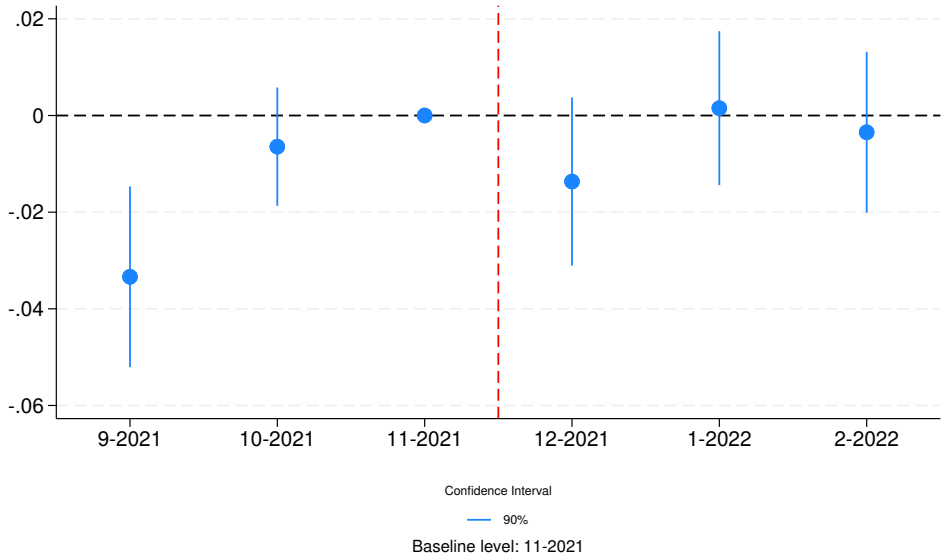
Notes: This figure plots the total amount of credit granted to Non-Financial Corporations (NFCs) and the subset of loans with Covid-19 guarantees (right-hand scale) in billions of euros, at the monthly frequency for the period comprising May 2020-June 2022, taking the end-month values. These supervisory data are sourced from AnaCredit.

Figure 2: Parallel Trends



Notes: This figure plots the coefficients from the time-varying version of the baseline regression in Equation (1) where the monthly loan credit amount (log) by bank b on loans to firm f in month t is the dependent variable, and the variable of interest is the dummy $Brown_f$ interacted with dummies for each period and the treated variable Tre_b. 2020-11 is the omitted base level and is one period before the publication of the Guide, indicated by the dashed red line. The regressions also include bank-time, firm-time and loan type-time fixed effects and controls for the loans backed by Covid-19 guarantees, as well as bank and firm balance-sheet characteristics in the pre-shock period. Standard errors are clustered at the bank-firm level and confidence intervals are 90%.

Figure 3: Parallel Trends



Notes: This figure plots the coefficients from the time-varying version of the baseline regression in Equation (1) where the monthly loan credit amount (log) by bank b on loans to firm f in month t is the dependent variable, and the variable of interest is the dummy $Brown_f$ interacted with dummies for each period and the treated variable Tre_b. 2021-11 is the omitted base level and is one period before the official launch of the Climate Stress Test, indicated by the dashed red line. The regressions also include bank-time, firm-time and loan type-time fixed effects and controls for the loans backed by Covid-19 guarantees, as well as bank and firm balance-sheet characteristics in the pre-shock period. Standard errors are clustered at the bank-firm level and confidence intervals are 90%.

Tables

Table 1: Summary statistics

This table reports the summary statistics for the variables used in Equation (1). The sample consists of 909,816 loan observations between September 2020 to February 2021 from AnaCredit database, matched with borrower and bank financial information from Cerved-Cebil (CC) and supervisory statistics, respectively. The table also shows the variables on firms' environmental profiles computed as described in Appendix A.2.

Panel A

	Mean	Std. Dev.	Q1	Median	Q3
Loan-level data					
Loan amount (log)	11.58	1.67	10.34	11.51	12.61
Loan amount Covid (log)	1.47	3.83	0.00	0.00	0.00
Loan spread (basis points)	442.43	343.86	196.44	343.70	589.45
Bank-level data					
Treated (bank)	0.79	0.41	1.00	1.00	1.00
Bank Committed (bank)	0.36	0.48	0.00	0.00	1.00
Net NPL ratio (bank)	4.34	2.31	3.24	4.44	5.59
Tier1 (bank)	19,678.75	21,524.44	2,088.84	9,928.56	45,637.54
Net interest margin (bank)	7,461.55	7,870.37	1,246.08	4,240.81	17,677.86
Non-interest income (bank)	3,920.22	4,174.66	762.45	1,916.03	9,013.80
Firm-level data					
Post (month)	0.52	0.50	0.00	1.00	1.00
Brown (firm)	0.49	0.50	0.00	0.00	1.00
CO2 emissions (firm)	1.94e+06	8.50e+07	32,235.51	83,812.32	244,989.87
log(CO2 emissions) (firm)	11.50	1.66	10.38	11.34	12.41
Leverage (firm)	16.98	3,532.07	3.23	5.50	9.82
ROA (firm)	-15.50	1,343.10	2.05	3.65	6.28
Net profit (firm)	828.81	34,977.71	6.00	35.00	166.00
Equity (firm)	11,886.55	439855.28	161.00	597.00	2,440.00
Total assets (firm)	44,952.86	1.19e+06	1,280.00	3,547.00	11,125.00
Revenues (firm)	29,203.19	359030.10	1,310.00	3,680.00	11,858.00
Revenues over tot assets (firm)	1.35	0.97	0.78	1.19	1.72
Observations	909,816				

This table reports the summary statistics for the variables used in Equation (2). The sample consists of 4,546 loan observations between September 2020 to February 2021 from AnaCredit database, matched with only listed borrower and bank financial information from Cerved-Cebil (CC) and supervisory statistics, respectively. The table also shows the variables on firms' environmental profiles computed as described in Appendix A.2.

Panel B

	Mean	SD	Q1	Median	Q3
Loan-level data					
Loan amount (log)	13.98	2.43	12.43	13.99	15.42
Loan amount Covid (log)	0.77	3.14	0.00	0.00	0.00
Loan spread (basis points)	313.98	290.31	138.10	238.50	399.80
Bank-level data					
Treated (bank)	0.81	0.39	1.00	1.00	1.00
Net NPL ratio (bank)	4.32	2.31	3.24	4.44	5.52
Tier1 (bank)	16,353.86	19,881.04	2,088.84	8,620.32	11,055.99
Net interest margin (bank)	6,238.88	7,275.30	977.06	3,405.34	4,253.47
Non-interest income (bank)	3,276.87	3,850.89	516.64	1,907.16	2,242.95
Firm-level data					
Post (month)	0.50	0.50	0.00	1.00	1.00
Brown_Comm (firm)	0.08	0.27	0.00	0.00	0.00
CO2 emission (firm)	2.49e+08	1.17e+09	509,321.04	1.70e+06	5.04e+06
log(CO2 emissions) (firm)	14.57	2.41	13.14	14.35	15.43
Leverage (firm)	1,214.13	9,790.93	2.72	4.09	6.53
ROA (firm)	5.03	11.77	2.66	3.92	6.46
Net profit (firm)	76,037.36	440600.78	196.00	1,274.00	4,957.00
Equity (firm)	1.12e+06	6.10e+06	8,331.00	27,279.00	110,766.00
Total assets (firm)	2.37e+06	1.23e+07	39,597.00	138116.00	417,570.00
Revenues (firm)	857,374.04	4.21e+06	23,601.00	44,865.00	156,250.00
Revenues over tot assets (firm)	0.74	0.61	0.18	0.57	1.16
Observations	4,546				

This table reports the summary statistics for the variables used in Equation (1). The sample consists of 986,677 loan observations between September 2021 to February 2022 from AnaCredit database, matched with borrower and bank financial information from Cerved-Cebil (CC) and supervisory statistics, respectively. The table also shows the variables on firms' environmental profiles computed as described in Appendix A.2.

Panel C

	Mean	Std. Dev.	Q1	Median	Q3
Loan-level data					
Loan amount (log)	11.59	1.70	10.32	11.51	12.64
Loan amount Covid (log)	2.17	4.54	0.00	0.00	0.00
Loan spread (basis points)	395.57	323.69	165.98	300.60	535.30
Bank-level data					
Treated (bank)	0.78	0.41	1.00	1.00	1.00
Net NPL ratio (bank)	4.39	2.22	3.27	4.63	5.59
Tier1 (bank)	18,769.42	20,975.21	2,088.84	8,620.32	45,637.54
Net interest margin (bank)	7,155.77	7,712.65	977.06	3,405.34	17,677.86
Non-interest income (bank)	3,812.15	4,174.69	516.64	1,907.16	9,013.80
Firm-level data					
Post (month)	0.50	0.50	0.00	0.00	1.00
Brown (firm)	0.49	0.50	0.00	0.00	1.00
CO2 emissions (firm)	1.79e+06	8.20e+07	32,235.51	79,949.29	238,071.32
log(CO2 emissions) (firm)	11.43	1.64	10.38	11.26	12.35
Leverage (firm)	-10.20	3,692.06	3.26	5.52	9.83
ROA (firm)	-12.71	1,257.70	2.13	3.75	6.45
Net profit (firm)	759.42	32,639.58	7.00	36.00	164.00
Equity (firm)	10,717.01	410727.18	154.00	569.00	2,323.00
Total assets (firm)	41,127.35	1.13e+06	1,210.00	3,378.00	10,721.00
Revenues (firm)	27,136.51	335920.26	1,247.00	3,498.00	11,302.00
Revenues over tot assets (firm)	1.36	1.05	0.78	1.20	1.73
Observations	986,677				

This table reports the summary statistics for the variables used in Equation (1). The sample consists of 4,556 loan observations between September 2021 to February 2022 from AnaCredit database, matched with borrower and bank financial information from Cerved-Cebil (CC) and supervisory statistics, respectively. The table also shows the variables on firms' environmental profiles computed as described in Appendix A.2.

Panel D

	Mean	SD	Q1	Median	Q3
Loan-level data					
Loan amount (log)	13.92	2.48	12.43	14.00	15.45
Loan amount Covid (log)	1.69	4.52	0.00	0.00	0.00
Loan spread (basis points)	273.01	262.60	104.99	203.80	368.80
Bank-level data					
Treated (bank)	0.81	0.40	1.00	1.00	1.00
Net NPL ratio (bank)	4.34	2.41	3.24	4.44	5.52
Tier1 (bank)	15,475.73	19,353.92	2,088.84	8,620.32	11,055.99
Net interest margin (bank)	5,917.36	7,095.72	977.06	3,405.34	4,253.47
Non-interest income (bank)	3,113.11	3,773.61	516.64	1,907.16	2,242.95
Firm-level data					
Post (month)	0.51	0.50	0.00	1.00	1.00
Brown_Comm (firm)	0.08	0.27	0.00	0.00	0.00
CO2 emission (firm)	2.49e+08	1.17e+09	386826.10	1.70e+06	4.81e+06
log(CO2 emissions) (firm)	14.43	2.48	12.87	14.35	15.39
Leverage (firm)	2,227.57	11,229.42	2.79	4.09	6.30
ROA (firm)	4.53	3.47	2.75	3.92	6.46
Net profit (firm)	70,776.20	425156.93	196.00	980.00	4,304.00
Equity (firm)	1.06e+06	5.94e+06	8,319.00	27,279.00	106043.00
Total assets (firm)	2.20e+06	1.18e+07	36,854.00	116,079.00	411728.00
Revenues (firm)	802,234.42	4.07e+06	22,687.00	40,150.00	156,250.00
Revenues over tot assets (firm)	0.72	0.58	0.18	0.67	1.16
Observations	4,556				

Table 2: Climate policy shock and banks' lending to brown firms

This table reports estimates of the causal relationships of the SSM Guide publication on banks' lending toward the more polluting firms. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

Panel A

	(1)	(2)	(3)	(4)
$Brown_f \times Post_t \times Tre_b$	-0.02161*	-0.0176*	-0.0231**	-0.0209**
	(0.0115)	(0.0101)	(0.0101)	(0.00996)
$Brown_f \times Post_t$	0.00218			
	(0.0101)			
$Brown_f$	0.822***			
	(0.0212)			
$Brown_f \times Tre_b$	0.0730***	0.0375**	0.0565***	0.0607***
	(0.0241)	(0.0182)	(0.0176)	(0.0175)
$Post_t \times Tre_b$		0.0420***		
		(0.00665)		
$Covid_{b,f,t}$	0.00933***	0.0282***	0.0355***	0.0180***
	(0.00130)	(0.000994)	(0.00102)	(0.00101)
$Leverage_f$	0.000000679			
	(0.00000339)			
ROA_f	-0.00135*			
	(0.000810)			
$Net\ profit_f$	-0.00000631***			
	(0.00000122)			
$Equity_f$	0.000000707***			
	(0.000000100)			
$Asset\ Turnover_f$	-0.0234***			
	(0.00555)			
Tre_b		0.0321**		
		(0.0141)		
$NPL\ ratio_b$		0.0252***		
		(0.00200)		
$T1\ ratio_b$		0.000082***		
		(0.00000787)		
$Net\ Int\ Margin_b$		-0.0001860***		
		(0.0000262)		
$Non\ Int\ Income_b$		-0.00003707*		
		(0.0000112)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.089	0.490	0.498	0.585
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the CST announcement on banks' lending toward the more polluting firms. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

Panel B

	(1)	(2)	(3)	(4)
$Brown_f \times Post_t \times Tre_b$	0.0127	0.0134	0.0108	0.00792
	(0.00896)	(0.00845)	(0.00843)	(0.00828)
$Brown_f \times Post_t$	-0.0134*			
	(0.00771)			
$Brown_f$	0.820***			
	(0.0195)			
$Brown_f \times Tre_b$	0.0547**	0.0355**	0.0462***	0.0386**
	(0.0224)	(0.0171)	(0.0168)	(0.0165)
$Post_t \times Tre_b$		-0.0297***		
		(0.00549)		
$Covid_{b,f,t}$	0.0114***	0.0274***	0.0337***	0.0165***
	(0.00116)	(0.000899)	(0.000947)	(0.000932)
$Leverage_f$	-0.00000516			
	(0.00000509)			
ROA_f	-0.00301***			
	(0.00112)			
$Net\ profit_f$	-0.00000735***			
	(0.00000197)			
$Equity_f$	0.000000760***			
	(0.000000155)			
$Asset\ Turnover_f$	-0.0189***			
	(0.00538)			
Tre_b		0.0838***		
		(0.0136)		
$NPL\ ratio_b$		0.0342***		
		(0.00223)		
$T1\ ratio_b$		0.0000752***		
		(0.00000782)		
$Net\ Int\ Margin_b$		-0.000168***		
		(0.0000271)		
$Non\ Int\ Income_b$		-0.0000296**		
		(0.0000116)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.083	0.471	0.477	0.578
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Climate policy shock and banks' credit spread to brown firms

This table reports estimates of the causal relationships of the SSM Guide publication on the banks' credit loan spread charged to the more polluting firms. The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

Panel A

	(1)	(2)	(3)	(4)
$Brown_f \times Post_t \times Tre_b$	-1.610	0.740	1.440	0.441
	(2.606)	(2.852)	(2.762)	(2.556)
$Brown_f \times Post_t$	5.285**			
	(2.356)			
$Brown_f$	-48.21***			
	(3.985)			
$Brown_f \times Tre_b$	-24.08***	-17.25***	-18.37***	-17.15***
	(4.470)	(4.687)	(4.456)	(4.171)
$Post_t \times Tre_b$		-25.61***		
		(2.019)		
$Covid_{b,f,t}$	-5.653***	-9.283***	-8.987***	-3.502***
	(0.199)	(0.223)	(0.226)	(0.208)
$Leverage_f$	-0.0000355			
	(0.000871)			
ROA_f	-0.670***			
	(0.128)			
$Net\ profit_f$	0.000142			
	(0.000122)			
$Equity_f$	-0.0000194**			
	(0.00000958)			
$Asset\ Turnover_f$	-10.63***			
	(0.907)			
Tre_b		-39.23***		
		(3.629)		
$NPL\ ratio_b$		4.760***		
		(0.549)		
$T1\ ratio_b$		-0.0113***		
		(0.00163)		
$Net\ Int\ Margin_b$		0.0142**		
		(0.00564)		
$Non\ Int\ Income_b$		0.0310***		
		(0.00243)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.073	0.306	0.324	0.541
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the CST announcement on the banks' credit loan spread charged to the more polluting firms. The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

Panel B

	(1)	(2)	(3)	(4)
$Brown_f \times Post_t \times Tre_b$	0.361	-1.355	-0.648	0.0162
	(1.765)	(1.926)	(1.898)	(1.748)
$Brown_f \times Post_t$	-1.651			
	(1.507)			
$Brown_f$	-45.17***			
	(2.947)			
$Brown_f \times Tre_b$	-24.13***	-19.01***	-16.08***	-12.17***
	(3.483)	(3.575)	(3.493)	(3.161)
$Post_t \times Tre_b$		24.33***		
		(1.369)		
$Covid_{b,f,t}$	-4.417***	-6.770***	-7.114***	-2.154***
	(0.158)	(0.168)	(0.177)	(0.161)
$Leverage_f$	0.000937			
	(0.000655)			
ROA_f	-0.435***			
	(0.0955)			
$Net\ profit_f$	0.000157			
	(0.000123)			
$Equity_f$	-0.0000204**			
	(0.00000968)			
$Asset\ Turnover_f$	-7.681***			
	(0.796)			
Tre_b		-22.57***		
		(2.910)		
$NPL\ ratio_b$		4.459***		
		(0.421)		
$T1\ ratio_b$		-0.00696***		
		(0.00144)		
$Net\ Int\ Margin_b$		0.00299		
		(0.00500)		
$Non\ Int\ Income_b$		0.0301***		
		(0.00217)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.083	0.471	0.477	0.556
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Climate policy shock and banks' lending: the role of banks' and firms' commitments

This table reports estimates of the causal relationships of the SSM Guide publication on banks' lending toward the more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Bank\ Comm_b$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel A

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b$		-0.0261***
		(0.0101)
$Brown_f \times Post_t \times Tre_b$	-0.0209**	-0.00901
	(0.00996)	(0.0110)
$Brown_f \times Tre_b \times Bank\ Comm_b$		-0.0134
		(0.0178)
$Brown_f \times Tre_b$	0.0607***	0.0671***
	(0.0175)	(0.0194)
$Covid_{b,f,t}$	0.0180***	0.0180***
	(0.00101)	(0.00101)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	652,744	652,744
R^2	0.585	0.584
Number of Banks	38	38
Number of Firms	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the announcement of the climate stress test on banks' lending toward the more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Bank\ Comm_b$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel B

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b$		0.0109
		(0.00913)
$Brown_f \times Post_t \times Tre_b$	0.00792	0.00288
	(0.00828)	(0.00913)
$Brown_f \times Tre_b \times Bank\ Comm_b$		-0.0294*
		(0.0177)
$Brown_f \times Tre_b$	0.0386**	0.0521***
	(0.0165)	(0.0182)
$Covid_{b,f,t}$	0.0165***	0.0165***
	(0.000932)	(0.000932)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	703,796	703,796
R^2	0.578	0.578
Number of Banks	38	38
Number of Firms	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the SSM Guide publication on banks' lending toward the more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Firm\ Comm_f$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel C

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Firm\ Comm_f$		1.288
		(1.169)
$Brown_f \times Post_t \times Tre_b$	1.124	1.125*
	(0.685)	(0.667)
$Brown_f \times Tre_b \times Firm\ Comm_f$		2.792
		(2.155)
$Brown_f \times Tre_b$	0.178	0.188
	(0.321)	(0.320)
$Covid_{b,f,t}$	0.0273**	0.0235***
	(0.0117)	(0.0112)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	3,337	3,337
R^2	0.578	0.569
Number of Banks	23	23
Number of Firms	55	55

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the announcement of the climate stress test on banks' lending toward the more polluting firms, also considering the presence of firms' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Firm\ Comm_f$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel D

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Firm\ Comm_f$		-2.118**
		(0.906)
$Brown_f \times Post_t \times Tre_b$	-0.128	-0.126
	(0.226)	(0.226)
$Brown_f \times Tre_b \times Firm\ Comm_f$		3.785
		(2.469)
$Brown_f \times Tre_b$	1.020*	1.014*
	(0.600)	(0.595)
$Covid_{b,f,t}$	0.0230**	0.0231**
	(0.0103)	(0.0103)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	3,333	3,333
R^2	0.489	0.494
Number of Banks	22	22
Number of Firms	52	52

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Climate policy shock and banks' credit spread: the role of banks' and firms' commitments

This table reports estimates of the causal relationships of the SSM Guide publication on banks' credit spread charged to more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Bank\ Comm_b$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel A

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b$		1.038
		(2.316)
$Brown_f \times Post_t \times Tre_b$	-0.353	0.441
	(2.721)	(2.556)
$Brown_f \times Tre_b \times Bank\ Comm_b$		-17.13***
		(3.895)
$Brown_f \times Tre_b$	-8.893**	-17.15***
	(4.502)	(4.171)
$Covid_{b,f,t}$	-3.495***	-3.502***
	(0.208)	(0.208)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	652,744	652,744
R^2	0.541	0.541
Number of Banks	38	38
Number of Firms	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the announcement of the climate stress test on banks' credit spread charged to more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Bank\ Comm_b$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel B

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b$		1.480
		(1.933)
$Brown_f \times Post_t \times Tre_b$	0.0162	-0.691
	(1.748)	(1.871)
$Brown_f \times Tre_b \times Bank\ Comm_b$		-11.65***
		(3.491)
$Brown_f \times Tre_b$	-12.17**	-6.818***
	(3.161)	(3.400)
$Covid_{b,f,t}$	-2.154***	-2.150***
	(0.161)	(0.161)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	703,796	703,796
R^2	0.556	0.556
Number of Banks	38	38
Number of Firms	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the SSM Guide publication on banks' credit spread toward the more polluting firms, also considering the presence of banks' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Firm\ Comm_f$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel C

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Firm\ Comm_f$		-148.8*
		(79.41)
$Brown_f \times Post_t \times Tre_b$	-136.4**	-136.8**
	(65.28)	(64.98)
$Brown_f \times Tre_b \times Firm\ Comm_f$		19.33
		(102.3)
$Brown_f \times Tre_b$	90.07	90.10
	(68.98)	(68.98)
$Covid_{b,f,t}$	-5.776**	-5.677***
	(1.911)	(1.908)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	3,337	3,337
R^2	0.408	0.408
Number of Banks	23	23
Number of Firms	55	55

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the announcement of the climate stress test on banks' credit spread toward the more polluting firms, also considering the presence of firms' commitments to reducing future emissions. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Brown_f$, $Post_t$, Tre_b and $Firm\ Comm_f$ are defined as in Table 1 Panel B. Treated banks are SIs, while control banks are LSIs.

Panel D

	(1)	(2)
$Brown_f \times Post_t \times Tre_b \times Firm\ Comm_f$		85.37**
		(37.10)
$Brown_f \times Post_t \times Tre_b$	92.52***	92.33***
	(30.65)	(30.62)
$Brown_f \times Tre_b \times Firm\ Comm_f$		-16.36
		(116.5)
$Brown_f \times Tre_b$	-83.74**	-83.71**
	(40.73)	(40.74)
$Covid_{b,f,t}$	-2.970*	-2.968*
	(1.600)	(1.601)
Bank-Time Fixed Effects	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes
Bank and Firm controls	Yes	Yes
Observations	3,333	3,333
R^2	0.432	0.432
Number of Banks	22	22
Number of Firms	52	52

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 6: Climate policy shock and banks' credit lending to brown firms. Additional robustness checks: top emitting and green firms

This table reports estimates of the causal relationships of the SSM Guide publication on banks' lending to the top emitting firms ($Brown\ High_f$) and the greener companies ($Green_f$). The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level. *Panel A*

	(1)	(2)	(3)	(4)
$BrownHigh_f \times Post_t \times Tre_b$	-0.0124	-0.0221**	-0.0221**	-0.0234**
	(0.0125)	(0.0111)	(0.0111)	(0.0109)
$BrownHigh_f \times Post_t$	-0.000617			
	(0.0112)			
$BrownHigh_f$	0.887***			
	(0.0237)			
$BrownHigh_f \times Tre_b$	0.0306	0.0411**	0.0411**	0.0679***
	(0.0267)	(0.0200)	(0.0200)	(0.0192)
$Post_t \times Tre_b$		0.0410***	0.0410***	
		(0.00595)	(0.00595)	
$Covid_{b,f,t}$	0.00920***	0.0283***	0.0283***	0.0180***
	(0.00130)	(0.000994)	(0.000994)	(0.00101)
$Leverage_f$	-0.00000252			
	(0.00000392)			
ROA_f	-0.00101			
	(0.000779)			
$Net\ profit_f$	-0.00000722***			
	(0.00000161)			
$Equity_f$	0.000000762***			
	(0.000000128)			
$Asset\ Turnover_f$	-0.0258***			
	(0.00552)			
Tre_b		0.0362***	0.0362***	
		(0.0132)	(0.0132)	
$NPL\ ratio_b$		0.0252***	0.0252***	
		(0.00222)	(0.00222)	
$T1\ ratio_b$		0.0000828***	0.0000828***	
		(0.00000787)	(0.00000787)	
$Net\ Int\ Margin_b$		-0.000186***	-0.000186***	
		(0.0000273)	(0.0000273)	
$Non\ Int\ Income_b$		-0.0000370***	-0.0000370***	
		(0.0000116)	(0.0000116)	
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.092	0.490	0.490	0.585
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Panel B

	(1)	(2)	(3)	(4)
$Green_f \times Post_t \times Tre_b$	0.00694	-0.00102	0.00160	0.00279
	(0.0130)	(0.0112)	(0.0111)	(0.0110)
$Green_f \times Post_t$	0.0167			
	(0.0111)			
$Green_f$	-0.757***			
	(0.0222)			
$Green_f \times Tre_b$	-0.118***	-0.00584	-0.0195	-0.0180
	(0.0258)	(0.0196)	(0.0192)	(0.0191)
$Post_t \times Tre_b$		0.0333***		
		(0.00598)		
$Covid_{b,f,t}$	0.00703***	0.0352***	0.0356***	0.0171***
	(0.00174)	(0.00162)	(0.00165)	(0.00163)
$Leverage_f$	-0.00000586			
	(0.00000392)			
ROA_f	-0.00159*			
	(0.000818)			
$Net\ profit_f$	-0.00000759***			
	(0.00000180)			
$Equity_f$	0.000000810***			
	(0.000000142)			
$Asset\ Turnover_f$	-0.0217***			
	(0.00551)			
Tre_b		0.0525***		
		(0.0134)		
$NPL\ ratio_b$		0.0253***		
		(0.00222)		
$T1\ ratio_b$		0.0000827***		
		(0.00000787)		
$Net\ Int\ Margin_b$		-0.000186***		
		(0.0000273)		
$Non\ Int\ Income_b$		-0.0000371***		
		(0.0000116)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.064	0.490	0.497	0.585
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the announcement of the climate stress test on banks' credit lending to the top emitting firms ($Brown\ High_f$) and the greener companies ($Green_f$). The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

Panel C

	(1)	(2)	(3)	(4)
$BrownHigh_f \times Post_t \times Tre_b$	-0.00229	-0.00171	-0.00495	-0.0103
	(0.0116)	(0.0111)	(0.0111)	(0.0111)
$BrownHigh_f \times Post_t$	-0.00388			
	(0.0104)			
$BrownHigh_f$	0.957***			
	(0.0266)			
$BrownHigh_f \times Tre_b$	-0.00311	0.0616***	0.0785***	0.0809***
	(0.0299)	(0.0225)	(0.0221)	(0.0216)
$Post_t \times Tre_b$		-0.0224***		
		(0.00455)		
$Covid_{b,f,t}$	0.0116***	0.0274***	0.0337***	0.0165***
	(0.00117)	(0.000898)	(0.000947)	(0.000931)
$Leverage_f$	-0.00000375			
	(0.00000494)			
ROA_f	-0.00263**			
	(0.00111)			
$Net\ profit_f$	-0.00000705***			
	(0.00000181)			
$Equity_f$	0.000000722***			
	(0.000000143)			
$Asset\ Turnover_f$	-0.0191***			
	(0.00519)			
Tre_b		0.0865***		
		(0.0123)		
$NPL\ ratio_b$		0.0342***		
		(0.00223)		
$T1\ ratio_b$		0.0000753***		
		(0.00000782)		
$Net\ Int\ Margin_b$		-0.000169***		
		(0.0000271)		
$Non\ Int\ Income_b$		-0.0000294**		
		(0.0000116)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.084	0.471	0.477	0.578
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Panel D

	(1)	(2)	(3)	(4)
$Green_f \times Post_t \times Tre_b$	-0.0125	-0.00480	-0.00231	-0.00201
	(0.0101)	(0.00913)	(0.00908)	(0.00881)
$Green_f \times Post_t$	0.0135			
	(0.00843)			
$Green_f$	-0.731***			
	(0.0202)			
$Green_f \times Tre_b$	-0.112***	-0.0154	-0.0214	-0.00401
	(0.0239)	(0.0183)	(0.0180)	(0.0177)
$Post_t \times Tre_b$		-0.0217***		
		(0.00505)		
$Covid_{b,f,t}$	0.0102***	0.0274***	0.0338***	0.0166***
	(0.00120)	(0.000899)	(0.000948)	(0.000933)
$Leverage_f$	-0.00000579			
	(0.00000543)			
ROA_f	-0.00359***			
	(0.00120)			
$Net\ profit_f$	-0.00000749***			
	(0.00000207)			
$Equity_f$	0.000000782***			
	(0.000000162)			
$Asset\ Turnover_f$	-0.0172***			
	(0.00508)			
Tre_b		0.106***		
		(0.0131)		
$NPL\ ratio_b$		0.0343***		
		(0.00223)		
$T1\ ratio_b$		0.0000751***		
		(0.00000782)		
$Net\ Int\ Margin_b$		-0.000168***		
		(0.0000271)		
$Non\ Int\ Income_b$		-0.0000297**		
		(0.0000116)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.060	0.471	0.477	0.578
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Climate policy shock and banks' credit spread to brown firms. Additional robustness checks: top emitting and green firms

This table reports estimates of the causal relationships of the SSM Guide publication on banks' credit spread to the top emitting firms ($Brown\ High_f$) and the greener companies ($Green_f$). The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level. *Panel A*

	(1)	(2)	(3)	(4)
$BrownHigh_f \times Post_t \times Tre_b$	-3.706	0.452	0.806	0.333
	(2.682)	(2.949)	(2.851)	(2.642)
$BrownHigh_f \times Post_t$	4.996**			
	(2.457)			
$BrownHigh_f$	-52.98***			
	(4.243)			
$BrownHigh_f \times Tre_b$	-16.22***	-16.28***	-16.40***	-16.38***
	(4.685)	(4.935)	(4.673)	(4.391)
$Post_t \times Tre_b$		-25.37***		
		(1.795)		
$Covid_{b,f,t}$	-5.642***	-9.288***	-8.995***	-3.508***
	(0.199)	(0.223)	(0.226)	(0.208)
$Leverage_f$	-0.000135			
	(0.000873)			
ROA_f	-0.693***			
	(0.130)			
$Net\ profit_f$	0.000129			
	(0.000116)			
$Equity_f$	-0.0000179*			
	(0.00000917)			
$Asset\ Turnover_f$	-10.49***			
	(0.910)			
Tre_b		-42.05***		
		(3.259)		
$NPL\ ratio_b$		4.763***		
		(0.549)		
$T1\ ratio_b$		-0.0113***		
		(0.00163)		
$Net\ Int\ Margin_b$		0.0142**		
		(0.00564)		
$Non\ Int\ Income_b$		0.0310***		
		(0.00243)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.073	0.306	0.324	0.541
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Panel B

	(1)	(2)	(3)	(4)
$Green_f \times Post_t \times Tre_b$	1.892	-0.736	-1.016	-1.208
	(3.091)	(3.361)	(3.231)	(2.971)
$Green_f \times Post_t$	-5.150*			
	(2.711)			
$Green_f$	39.93***			
	(4.544)			
$Green_f \times Tre_b$	31.23***	23.99***	24.70***	22.68***
	(5.241)	(5.469)	(5.223)	(4.841)
$Post_t \times Tre_b$		-25.07***		
		(1.629)		
$Covid_{b,f,t}$	-5.548***	-9.276***	-8.981***	-3.499***
	(0.199)	(0.222)	(0.226)	(0.208)
$Leverage_f$	0.000111			
	(0.000870)			
ROA_f	-0.652***			
	(0.129)			
$Net\ profit_f$	0.000155			
	(0.000129)			
$Equity_f$	-0.0000213**			
	(0.0000102)			
$Asset\ Turnover_f$	-10.78***			
	(0.911)			
Tre_b		-53.66***		
		(3.083)		
$NPL\ ratio_b$		4.766***		
		(0.549)		
$T1\ ratio_b$		-0.0113***		
		(0.00163)		
$Net\ Int\ Margin_b$		0.0142**		
		(0.00564)		
$Non\ Int\ Income_b$		0.0310***		
		(0.00243)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.073	0.306	0.324	0.541
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

This table reports estimates of the causal relationships of the announcement of the climate stress test on banks' credit spread to the top emitting firms ($Brown\ High_{f,t}$) and the greener companies ($Green_{f,t}$). The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level. *Panel C*

	(1)	(2)	(3)	(4)
$Brown\ High_f \times Post_t \times Tre_b$	-0.413	-0.538	-0.250	1.087
	(2.045)	(2.269)	(2.228)	(2.081)
$Brown\ High_f \times Post_t$	-2.014			
	(1.821)			
$Brown\ High_f$	-54.44***			
	(3.590)			
$Brown\ High_f \times Tre_b$	-12.49***	-20.52***	-15.75***	-14.42***
	(4.074)	(4.179)	(4.070)	(3.716)
$Post_t \times Tre_b$		23.77***		
		(1.101)		
$Covid_{b,f,t}$	-4.426***	-6.764***	-7.114***	-2.152***
	(0.159)	(0.168)	(0.177)	(0.161)
$Leverage_f$	0.000831			
	(0.000675)			
ROA_f	-0.450***			
	(0.0948)			
$Net\ profit_f$	0.000137			
	(0.000114)			
$Equity_f$	-0.0000180**			
	(0.00000896)			
$Asset\ Turnover_f$	-7.731***			
	(0.810)			
Tre_b		-27.11***		
		(2.474)		
$NPL\ ratio_b$		4.471***		
		(0.421)		
$T1\ ratio_b$		-0.00701***		
		(0.00144)		
$Net\ Int\ Margin_b$		0.00315		
		(0.00500)		
$Non\ Int\ Income_b$		0.0301***		
		(0.00218)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.055	0.302	0.311	0.556
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Panel D

	(1)	(2)	(3)	(4)
$Green_f \times Post_t \times Tre_b$	1.359	0.879	0.466	0.515
	(2.105)	(2.239)	(2.211)	(2.019)
$Green_f \times Post_t$	0.270			
	(1.728)			
$Green_f$	36.66***			
	(3.313)			
$Green_f \times Tre_b$	29.27***	20.43***	17.75***	11.46***
	(4.069)	(4.159)	(4.066)	(3.640)
$Post_t \times Tre_b$		23.44***		
		(1.108)		
$Covid_{b,f,t}$	-4.329***	-6.775***	-7.118***	-2.158***
	(0.159)	(0.168)	(0.177)	(0.161)
$Leverage_f$	0.000967			
	(0.000699)			
ROA_f	-0.388***			
	(0.0936)			
$Net\ profit_f$	0.000166			
	(0.000130)			
$Equity_f$	-0.0000221**			
	(0.0000102)			
$Asset\ Turnover_f$	-7.857***			
	(0.844)			
Tre_b		-37.28***		
		(2.487)		
$NPL\ ratio_b$		4.450***		
		(0.421)		
$T1\ ratio_b$		-0.00695***		
		(0.00144)		
$Net\ Int\ Margin_b$		0.00293		
		(0.00500)		
$Non\ Int\ Income_b$		0.0302***		
		(0.00217)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	703,796	703,796	703,796	703,796
R^2	0.055	0.302	0.311	0.556
Number of Banks	38	38	38	38
Number of Firms	27,404	27,404	27,404	27,404

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Climate policy shock and banks' credit lending to brown firms. Additional robustness checks: CO2 emission intensities

This table reports estimates of the causal relationships of the SSM Guide publication on banks' credit lending to the brown firms, identified according to the CO2 emission intensities ($CO2int_f$).The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

	(1)	(2)	(3)	(4)
$CO2int_f \times Post_t \times Tre_b$	0.0000279	-0.0000573**	-0.0000668***	-0.0000606***
	(0.000335)	(0.0000238)	(0.0000225)	(0.0000235)
$CO2int_f \times Post_t$	0.000345			
	(0.000235)			
$CO2int_f$	-0.000431*			
	(0.000234)			
$CO2int_f \times Tre_b$	-0.000154	0.0000762***	0.0000792***	0.0000703***
	(0.000345)	(0.0000232)	(0.0000226)	(0.0000236)
$Post_t \times Tre_b$		0.0185***		
		(0.00425)		
$Covid_{b,f,t}$	0.00571***	0.0272***	0.0346***	0.0170***
	(0.00119)	(0.000868)	(0.000882)	(0.000877)
$Leverage_f$	0.00000149			
	(0.00000389)			
ROA_f	-0.00387***			
	(0.000746)			
$Net\ profit_f$	-0.00000755***			
	(0.00000185)			
$Equity_f$	0.000000815***			
	(0.000000146)			
$Asset\ Turnover_f$	-0.0155***			
	(0.00576)			
Tre_b		0.0442***		
		(0.0123)		
$NPL\ ratio_b$		0.0255***		
		(0.00222)		
$T1\ ratio_b$		0.0000817***		
		(0.00000789)		
$Net\ Int\ Margin_b$		-0.000182***		
		(0.0000274)		
$Non\ Int\ Income_b$		-0.0000385***		
		(0.0000116)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.027	0.489	0.496	0.584
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9: Climate policy shock and banks' credit spread to brown firms.

Additional robustness checks: CO2 emission intensities

This table reports estimates of the causal relationships of the SSM Guide publication on banks' credit lending to the brown firms, identified according to the CO2 emission intensities ($CO2int_f$). The dependent variable is the average credit spread (bps) by bank b on loans to firm f in month t. $Post_t$ and Tre_b are defined as in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

	(1)	(2)	(3)	(4)
$CO2int_f \times Post_t \times Tre_b$	-0.000355	0.00487	0.00818	0.00530
	(0.0260)	(0.00575)	(0.00569)	(0.00580)
$CO2int_f \times Post_t$	-0.0310*			
	(0.0186)			
$CO2int_f$	0.0373**			
	(0.0182)			
$CO2int_f \times Tre_b$	0.0189	-0.00129	-0.000664	0.00309
	(0.0258)	(0.00639)	(0.00626)	(0.00624)
$Post_t \times Tre_b$		-25.24***		
		(1.475)		
$Covid_{b,f,t}$	-5.361***	-9.309***	-8.990***	-3.531***
	(0.201)	(0.223)	(0.227)	(0.209)
$Leverage_f$	-0.000417			
	(0.000872)			
ROA_f	-0.660***			
	(0.128)			
$Net\ profit_f$	0.000163			
	(0.000136)			
$Equity_f$	-0.0000225**			
	(0.0000107)			
$Asset\ Turnover_f$	-11.06***			
	(0.948)			
Tre_b		-48.16***		
		(2.826)		
$NPL\ ratio_b$		4.667***		
		(0.550)		
$T1\ ratio_b$		-0.0111***		
		(0.00163)		
$Net\ Int\ Margin_b$		0.0137**		
		(0.00565)		
$Non\ Int\ Income_b$		0.0312***		
		(0.00244)		
Bank-Time Fixed Effects	Yes		Yes	Yes
Firm-Time Fixed Effects		Yes	Yes	Yes
Loan Type-Time Fixed Effects				Yes
Observations	652,744	652,744	652,744	652,744
R^2	0.064	0.306	0.324	0.540
Number of Banks	38	38	38	38
Number of Firms	26,808	26,808	26,808	26,808

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 10: Falsification tests

This table reports the effect of the SSM Guide publication on banks' credit lending to the brown firms but based on a sample that comprises randomly assigned treated banks ($Fake\ Tre_b$) and a placebo period of six different months ($Fake\ Post_t$), i.e. December 2020-May 2021. The dependent variables are the monthly loan credit amount (log) and the average credit spread (bps) by bank b on loans to firm f in month t, respectively. $Brown_f$ is defined in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

	(1) $Log(Loan)_{b,f,t}$	(2) $Spread_{b,f,t}$	(3) $Log(Loan)_{b,f,t}$	(4) $Spread_{b,f,t}$
$Brown_f \times Post_t \times Fake\ Tre_b$	0.003752	0.4032706		
	(0.009748)	(2.465593)		
$Brown_f \times Fake\ Tre_b$	-0.0481316***	-1.322194		
	(0.0180804)	(4.085477)		
$Covid_{b,f,t}$	0.0180861***	-3.530086***		
	(0.0010079)	(0.208439)		
$Brown_f \times Fake\ Post_t \times Tre_b$			0.00399	-0.01425
			(0.00667)	(0.01703)
$Brown_f \times Tre_b$			0.0596***	-0.22294***
			(0.01322)	(0.03160)
$Covid_{b,f,t}$			0.017446***	-0.03446***
			(0.00083)	(0.00176)
Bank-Time Fixed Effects	Yes	Yes	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	652,744	652,744	792,781	792,781
R^2	0.585	0.541	0.576	0.535
Number of Banks	38	38	38	38
Number of Firms	29,766	29,766	30,742	30,742

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 11: Differences in bank-firm relationships.

Additional robustness checks: inclusion of bank-firm fixed-effects

This table reports the effect of the SSM Guide publication on banks' credit lending to brown firms, including bank-firm fixed effects. The dependent variable is the monthly loan credit amount (log) by bank b on loans to firm f in month t, respectively. $Brown_f$ is defined in Table 1 Panel A. Standard errors are clustered at the bank-firm level.

	(1) $Log(Loan)_{b,f,t}$	(2) $Log(Loan)_{b,f,t}$	(3) $Spread_{b,f,t}$	(4) $Spread_{b,f,t}$
$Brown_f \times Post_t \times Tre_b \times Bank\ Comm_b$		-0.0229***		0.267
		(0.00771)		(1.921)
$Brown_f \times Post_t \times Tre_b$	-0.0135*	-0.00265	0.270	0.143
	(0.00720)	(0.00798)	(2.027)	(2.190)
$Covid_{b,f,t}$	0.0127***	0.0127***	0.339*	0.339*
	(0.000838)	(0.000838)	(0.179)	(0.179)
Bank-Time Fixed Effects	Yes	Yes	Yes	Yes
Firm-Time Fixed Effects	Yes	Yes	Yes	Yes
Loan Type-Time Fixed Effects	Yes	Yes	Yes	Yes
Bank-Firm Fixed Effects	Yes	Yes	Yes	Yes
Bank controls	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes
Observations	650,297	650,297	650,297	650,297
R^2	0.763	0.763	0.748	0.748
Number of Banks	38	38	38	38
Number of Firms	29,766	29,766	30,742	30,742

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix

A.1. Computation of credit instrument spreads

Given the granularity of the AnaCredit dataset, I compute the credit spread over the contemporaneous duration-matched risk-free rate at the instrument level and by differentiating for the related type of interest rates (fixed/variable).

For instruments with a variable interest rate, I compute the spread as the difference between the annualized agreed rate and the corresponding risk-free rate with a similar maturity date. I follow a bucketing approach to identify different maturity buckets for each instrument and I take the corresponding risk-free rate from the Interest Rate Swap (IRS) curve for each date[36]. For example, as of 30 September 2020 consider an outstanding loan with a variable interest rate and a 5-year legal final maturity date granted on 15 March 2018 by bank A to firm F. The spread is computed as the difference between the annualized agreed rate and the corresponding node of the risk-free curve (i.e. 5-year Interest Rate Swap, IRS) at the date of observation, i.e. 30 September 2020. For instruments with a fixed interest rate, I follow a similar approach except for the risk-free rates considered, which in this case are updated at the time of the inception date of the contract. For instance, as of 30 September 2020 consider an outstanding loan with a fixed interest rate and a 10-year legal final maturity date granted on 2 May 2008 by bank A to firm F. The spread is computed as the difference between the annualized agreed rate and the corresponding node of the risk-free curve (i.e. 5-year Interest Rate Swap, IRS) at the inception date, i.e. 2 May 2008.

[36]In particular, for instruments with maturities less than 1-year I consider 3 months Euribor; for maturities higher than 1-year I take the following IRS nodes: 1-year IRS, 3-year IRS, 5-year IRS, 7-year IRS, and 10-year IRS for each date of observation.

A.2. Imputation Procedure for CO2 emissions at firm level

Information about CO2 emissions for firms suffers from significant data gaps, especially for small-medium enterprises (SME) and non-listed companies. To overcome this issue, I rely on public data, following a similar approach adopted in Faiella et al. (2022) and Emambakhsh et al. (2023) to downscale the sectoral energy consumption for different fossil fuels to firm level and then convert this quantity into S1-S2 emissions (ton of oil equivalent, toe) through specific carbon emission factors for each fuel for Italy.

In detail, the imputation procedure consists of the following two-step approach.

1. Estimate of the total energy consumed by each firm with the aggregated information about energy consumption sourced from Eurostat Physical energy flow accounts (PEFAs)[37] for different energy sources and sectors.[38] This information is then attributed at the firm level in terms of per-worker consumption by using sectoral total workers. The number of employees for each firm is drawn from the National Social Insurance Agency (INPS), while the sectoral data is taken from the Italian National Statistical Institute (ISTAT):

$$e_{f,t} = \sum_{z=1}^{Z} w_{z,f,t}$$

where z=1,...,Z represents the energy sources and $w_{z,f,t}$ is defined as:

$$w_{z,f,t} = \frac{l_{f,t}}{L_t} \times E_{z,t}$$

where:

- $l_{f,t}$ denotes the number of number of employees for firm f at time t
- L_t denotes the total number of employees enrolled in the same sector as the one of the firm f at time t
- $E_{z,t}$ is the energy consumption (at the sector level of firm f) for energy source z at time t

2. Estimate of S1-S2 CO2 emissions (tonne of CO2) through carbon emission factors for each fuel from the Italian Institute for Environmental Protection and Research (ISPRA) and Ministry of Environment and Energy Security[39].

[37] PEFAs complement the traditional energy statistics, balances and derived indicators, which are the main reference data source for EU energy policies and record the flows of energy within the economy.

[38] I considered sectors according to the Nomenclature of Economic Activities (NACE) of the European statistical classification of economic activities.

[39] In particular, I use the carbon emission and the energy conversion factors for electricity, natural gas (as a proxy of heating fuels), gasoline, and gasoil from official sources, such as ISPRA and Ministry of Environment and Energy Security.

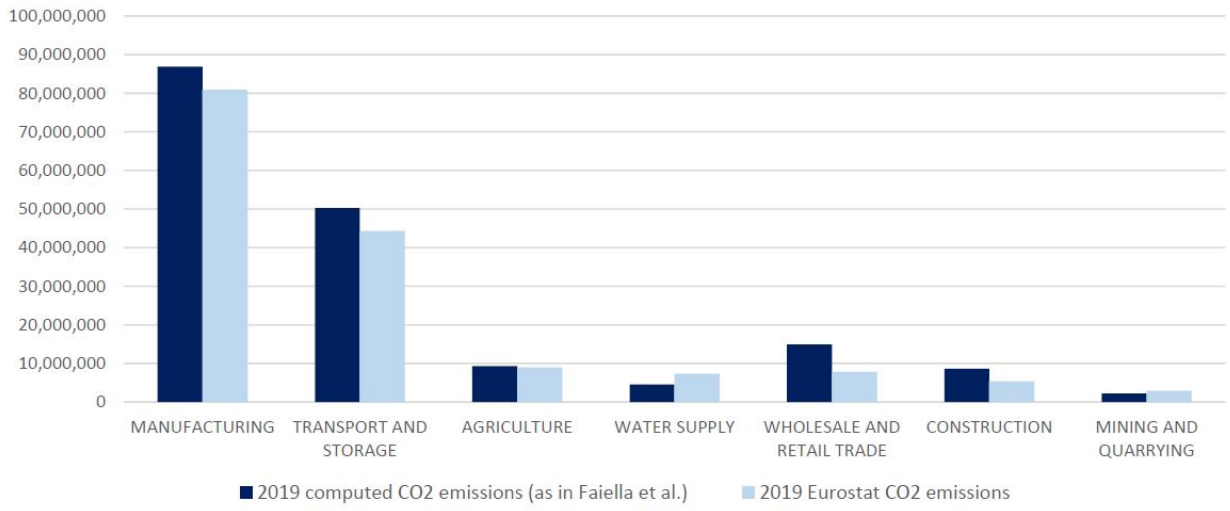
The firm-level emissions are estimated considering data at the end of 2019 when investigating the effects on bank lending after the publication of the 2020 SSM Guide; for the announcement of the CST one year later I consider data at the of 2020.

It is undoubtful that within-sector variability depends only on the number of workers. However, for this research, this approach allows estimating firm-level data coherently with the approach followed by major data providers and banks.

To check whether the imputation gives a reasonable figure about firms' CO2 emissions I aggregate firm-level data at the sector level to compare the computed top emitting sectors with the historical information from Eurostat.

As shown in Figure 4, the ranking is coherent, despite slight differences. First, while Eurostat data only includes scope 1 emissions, the comparison is performed considering a sample of the existing limited liability companies in Italy as of 2020. Second, Eurostat emissions are computed by considering the economic activities of Italian residents. [40]

Figure 4: Top CO2 emitting sectors (tonnes)



[40] I included all NACE1-digit economic sectors but sector D (electricity, gas, steam, and air conditioning supply) since the computed emissions differ from those sourced from Eurostat. In terms of exposures, total credit granted by Italian banks to firms belonging to sector D represents a small portion of banks' portfolios (around 5% of total credit to non-financial firms in the AnaCredit dataset as of the end of December 2020) and, therefore, I excluded it from the scope of this research.

A.3. Description of key variables

Variable	Description	Source
Dependent variables		
Loan Amount	Log of monthly loan credit amount	AnaCredit
Average credit spread	Weighted average spread in basis points over the the contemporaneous duration-matched risk-free rate	AnaCredit, Refinitiv
Explanatory variables		
Treated	Dummy that equals 1 if the bank at the highest level of consolidation is classified as SI, 0 if LSI	Supervisory statistics
Post	Dummy that equals 1 if the loan is outstanding after November 2020,0 otherwise	Supervisory statistics
Covid	Log of monthly loan credit amount backed by Covid-19 guarantees	Supervisory statistics
Brown	Dummy that equals 1 if firm's CO2 emissions (computed as in Appendix B) are above the 50th percentile, 0 otherwise	Eurostat, ISTAT, INPS, Cerved-Cebil (CC)
Brown (Log)	Dummy that equals 1 if firm's CO2 emissions in log terms (computed as in Appendix B) are above the 50th percentile, 0 otherwise	Eurostat, ISTAT, INPS, Cerved-Cebil (CC)
BrownComm	Dummy that equals 1 if the firm is classified as Brown but also with planned carbon reduction targets	Eurostat, ISTAT, INPS, Refinitiv
BankComm	Dummy that equals 1 if the bank has emission reduction targets to be achieved on land, air or water from business operations	Refinitiv, Bank's website, SBTi
CO2 emissions	Firm's CO2 emissions expressed in tonnes	Eurostat, ISTAT, INPS, Cerved-Cebil (CC)
Leverage	Ratio of firm's total debts over total assets	Cerved-Cebil (CC)
ROA	Firm's Returns on total assets (%)	Cerved-Cebil (CC)
Net profit	Firm's net profit, millions of euros	Cerved-Cebil (CC)
Equity	Firm's total equity, millions of euros	Cerved-Cebil (CC)
Total assets	Firms' total assets, millions of euros	Cerved-Cebil (CC)
Revenues	Firms' revenues, millions of euros	Cerved-Cebil (CC)
Net NPL ratio	The ratio between a bank's non-performing loans net of loan loss provisions over gross loans	Supervisory statistics
Tier1	Bank's Basel Tier1 capital, millions of euros	Supervisory statistics
Net interest margin	Bank's net interest margin, millions of euros	Supervisory statistics
Non-interest income	Bank's non-interest income, millions of euros	Supervisory statistics

RECENTLY PUBLISHED "TEMI" (*)

N. 1439 – *Procuring survival*, by Matilde Cappelletti, Leonardo M. Giuffrida and Gabriele Rovigatti. (February 2024).

N. 1440 – *Estimating the returns to occupational licensing: evidence from regression discontinuities at the bar exam*, by Omar Bamieh, Andrea Cintolesi and Mario Pagliero. (February 2024).

N. 1441 – *Household perceived sources of business cycle fluctuations: a tale of supply and demand*, by Clodomiro Ferreira and Stefano Pica. (February 2024).

N. 1442 – *Aggregate uncertainty, HANK, and the ZLB*, by Alessandro Lin and Marcel Peruffo (March 2024).

N. 1443 – *Monetary policy under natural disaster shocks*, by Alessandro Cantelmo, Nikos Fatouros, Giovanni Melina and Chris Papageorgiou (March 2024).

N. 1444 – *Endogenous job destruction risk and aggregate demand shortages*, by Nicolò Gnocato (March 2024).

N. 1445 – *Carbon taxes around the world: cooperation, strategic interactions, and spillovers*, by Alessandro Moro and Valerio Nispi Landi (March 2024).

N. 1446 – *Nowcasting Italian GDP growth: a Factor MIDAS approach*, by Donato Ceci, Orest Prifti and Andrea Silvestrini (March 2024).

N. 1447 – *The green sin: how exchange rate volatility and financial openness affect green premia*, by Alessandro Moro and Andrea Zaghini (March 2024).

N. 1448 – *Oil price shocks in real time*, by Andrea Gazzani, Fabrizio Venditti and Giovanni Veronese (March 2024).

N. 1449 – *Market perceptions, monetary policy, and credibility*, by Vincenzo Cuciniello (March 2024).

N. 1450 – *Energy price shocks, unemployment, and monetary policy*, by Nicolò Gnocato (March 2024).

N. 1451 – *The impact of hydrogeological events on firms: evidence from Italy*, Stefano Clò, Francesco David and Samuele Segoni (April 2024).

N. 1452 – *Measuring households' financial fragilities: an analysis at the intersection of income, financial wealth and debt*, by David Loschiavo, Federico Tullio and Antonietta di Salvatore (April 2024).

N. 1453 – *Unconventionally green*, Andrea Zaghini (April 2024).

N. 1454 – *Mobile internet, collateral and banking*, by Angelo D'Andrea, Patrick Hitayezu, Kangni Kpodar, Nicola Limodio and Andrea F. Presbitero (June 2024).

N. 1455 – *Productivity and entry regulation: evidence from the universe of firms*, by Andrea Cintolesi, Sauro Mocetti and Giacomo Roma (June 2024).

N. 1456 – *Credit supply and green investments*, by Antonio Accetturo, Giorgia Barboni, Michele Cascarano, Emilia Garcia-Appendini and Marco Tomasi (June 2024).

N. 1457 – *The structural Theta method and its predictive performance in the M4-Competition*, by Giacomo Sbrana and Andrea Silvestrini (June 2024).

N. 1458 – *Mom's out: employment after childbirth and firm-level responses*, by Francesca Carta, Alessandra Casarico, Marta De Philippis and Salvatore Lattanzio (July 2024).

N. 1459 – *Mortgage lending and bank involvement in the insurance business: the effects of cross-selling*, by Federico Apicella, Leandro D'Aurizio, Raffaele Gallo and Giovanni Guazzarotti (July 2024).

N. 1460 – *The impact of macroeconomic and monetary policy shocks on the default risk of the euro-area corporate sector*, by Marco Lo Duca, Diego Moccero and Fabio Parlapiano (July 2024).

N. 1461 – *Geographic shareholder dispersion and mutual fund flow risk*, by Javier Gil-Bazo, Alexander Kempf and Raffaele Santioni (July 2024).

(*) Requests for copies should be sent to:
Banca d'Italia – Servizio Studi di struttura economica e finanziaria – Divisione Biblioteca e Archivio storico – Via Nazionale, 91 – 00184 Rome – (fax 0039 06 47922059). They are available on the Internet www.bancaditalia.it.

2022

ANDINI M., M. BOLDRINI, E. CIANI, G. DE BLASIO, A. D'IGNAZIO and A. PALADINI, *Machine learning in the service of policy targeting: the case of public credit guarantees,* Journal of Economic Behavior & Organization, v. 198, pp. 434-475, **WP 1206 (February 2019).**

ANGELICO C., J. MARCUCCI, M. MICCOLI and F. QUARTA, *Can we measure inflation expectations using twitter?,* Journal of Econometrics, v. 228, 2, pp. 259-277, **WP 1318 (February 2021).**

BARTOCCI A., A. NOTARPIETRO and M. PISANI, *Covid-19 shock and fiscal-monetary policy mix in a monetary union,* Economic challenges for Europe after the pandemic, Springer Proceedings in Business and Economics, Berlin-Heidelberg, Springer, **WP 1313 (December 2020).**

BOTTERO M., C. MINOIU, J. PEYDRÒ, A. POLO, A. PRESBITERO and E. SETTE, *Expansionary yet different: credit supply and real effects of negative interest rate policy,* Journal of Financial Economics, v. 146, 2, pp. 754-778, **WP 1269 (March 2020).**

BRONZINI R., A. D'IGNAZIO and D. REVELLI, *Financial structure and bank relationships of Italian multinational firms,* Journal of Multinational Financial Management, v. 66, Article 100762, **WP 1326 (March 2021).**

CANTELMO A., *Rare disasters, the natural interest rate and monetary policy,* Oxford Bulletin of Economics and Statistics, v. 84, 3, pp. 473-496, **WP 1309 (December 2020).**

CARRIERO A., F. CORSELLO and M. MARCELLINO, *The global component of inflation volatility,* Journal of Applied Econometrics, v. 37, 4, pp. 700-721, **WP 1170 (May 2018).**

CIAPANNA E. and G. ROVIGATTI, *The grocery trolley race in times of Covid-19. Evidence from Italy,* Italian Economic Journal / Rivista italiana degli economisti, v. 8, 2, pp. 471-498, **WP 1341 (June 2021).**

CONTI A. M., A. NOBILI and F. M. SIGNORETTI, *Bank capital requirement shocks: a narrative perspective,* European Economic Review, v.151, Article 104254, **WP 1199 (November 2018).**

FAIELLA I. and A. MISTRETTA, *The net zero challenge for firms' competitiveness,* Environmental and Resource Economics, v. 83, pp. 85-113, **WP 1259 (February 2020).**

FERRIANI F. and G. VERONESE, *Hedging and investment trade-offs in the U.S. oil industry,* Energy Economics, v. 106, Article 105736, **WP 1211 (March 2019).**

GUISO L., A. POZZI, A. TSOY, L. GAMBACORTA and P. E. MISTRULLI, *The cost of steering in financial markets: evidence from the mortgage market,* Journal of Financial Economics, v.143, 3, pp. 1209-1226, **WP 1252 (December 2019).**

LAMORGESE A. and D. PELLEGRINO, *Loss aversion in housing appraisal: evidence from Italian homeowners,* Journal of Housing Economics, v. 56, Article 101826, **WP 1248 (November 2019).**

LI F., T. MÄKINEN, A. MERCATANTI and A. SILVESTRINI, *Causal analysis of central bank holdings of corporate bonds under interference,* Economic Modelling, v.113, Article 105873, **WP 1300 (November 2020).**

LOBERTO M, A. LUCIANI and M. PANGALLO, *What do online listings tell us about the housing market?,* International Journal of Central Banking, v. 18, 4, pp. 325-377, **WP 1171 (April 2018).**

MIRENDA L., M. SAURO and L. RIZZICA, *The economic effects of mafia: firm level evidence,* American Economic Review, vol. 112, 8, pp. 2748-2773, **WP 1235 (October 2019).**

MOCETTI S., G. ROMA and E. RUBOLINO, *Knocking on parents' doors: regulation and intergenerational mobility,* Journal of Human Resources, v. 57, 2, pp. 525-554, **WP 1182 (July 2018).**

PERICOLI M. and M. TABOGA, *Nearly exact Bayesian estimation of non-linear no-arbitrage term-structure models,* Journal of Financial Econometrics, v. 20, 5, pp. 807-838, **WP 1189 (September 2018).**

ROSSI P. and D. SCALISE, *Financial development and growth in European regions,* Journal of Regional Science, v. 62, 2, pp. 389-411, **WP 1246 (November 2019).**

SCHIVARDI F., E. SETTE and G. TABELLINI, *Credit misallocation during the European financial crisis,* Economic Journal, v. 132, 641, pp. 391-423, **WP 1139 (September 2017).**

TABOGA M., *Cross-country differences in the size of venture capital financing rounds: a machine learning approach,* Empirical Economics, v. 62, 3, pp. 991-1012, **WP 1243 (November 2019).**

2023

APRIGLIANO V., S. EMILIOZZI, G. GUAITOLI, A. LUCIANI, J. MARCUCCI and L. MONTEFORTE, *The power of text-based indicators in forecasting Italian economic activity,* International Journal of Forecasting, v. 39, 2, pp. 791-808, **WP 1321 (March 2021).**

BALTRUNAITE A., G. BOVINI and S. MOCETTI, *Managerial talent and managerial practices: are they complements?,* Journal of Corporate Finance, v. 79, Article 102348, **WP 1335 (April 2021).**

BARTOCCI A., A. NOTARPIETRO and M. PISANI, *Non-standard monetary policy measures in non-normal times,* International Finance, v. 26, 1, pp. 19-35, **WP 1251 (November 2019).**

CAPPELLETTI G. and P. E. MISTRULLI, *The role of credit lines and multiple lending in financial contagion and systemic events,* Journal of Financial Stability, v. 67, Article 101141, **WP 1123 (June 2017).**

CECI D. and A. SILVESTRINI, *Nowcasting the state of the Italian economy: the role of financial markets,* Journal of Forecasting, v. 42, 7, pp. 1569-1593, **WP 1362 (February 2022).**

CIAPANNA E, S. MOCETTI and A. NOTARPIETRO, *The macroeconomic effects of structural reforms: an empirical and model-based approach,* Economic Policy, v. 38, 114, pp. 243-285, **WP 1303 (November 2020).**

CORNELI F., *Sovereign debt maturity structure and its costs,* International Tax and Public Finance, v. 31, 1, pp. 262-297, **WP 1196 (November 2018).**

DAURICH D, S. DI ADDARIO and R. SAGGIO, *The macroeconomic effects of structural reforms: an empirical and model-based approach,* Review of Economic Studies, v. 90, 6, pp. 2880–2942, **WP 1390 (November 2022).**

DI ADDARIO S., P. KLINE, R. SAGGIO and M. SØLVSTEN, *The effects of partial employment protection reforms: evidence from Italy,* Journal of Econometrics,v. 233, 2, pp. 340-374, **WP 1374 (June 2022).**

FERRARI A. and V. NISPI LANDI, *Toward a green economy: the role of central bank's asset purchases,* International Journal of Central Banking, v. 19, 5, pp. 287-340, **WP 1358 (February 2022).**

FERRIANI F., *Issuing bonds during the Covid-19 pandemic: was there an ESG premium?,* International Review of Financial Analysis, v. 88, Article 102653, **WP 1392 (November 2022).**

GIORDANO C., *Revisiting the real exchange rate misalignment-economic growth nexus via the across-sector misallocation channel,* Review of International Economics, v. 31, 4, pp. 1329-1384, **WP 1385 (October 2022).**

GUGLIELMINETTI E., M. LOBERTO and A. MISTRETTA, *The impact of COVID-19 on the European short-term rental market,* Empirica, v. 50, 3, pp. 585-623, **WP 1379 (July 2022).**

LILLA F., *Volatility bursts: a discrete-time option model with multiple volatility components,* Journal of Financial Econometrics, v. 21, 3, pp. 678-713, **WP 1336 (June 2021).**

LOBERTO M., *Foreclosures and house prices,* Italian Economic Journal / Rivista italiana degli economisti, v. 9, 1, pp. 397-424, **WP 1325 (March 2021).**

LOMBARDI M. J., M. RIGGI and E. VIVIANO, *Worker's bargaining power and the Phillips curve: a micro-macro analysis, and wages,* Journal of the European Economic Association, v. 21, 5, pp. 1905–1943, **WP 1302 (November 2020).**

MODENA F., S. PEREDA-FERNANDEZ and G. M. TANZI, *On the design of grant assignment rules,* Politica economica/Journal of Economic Policy, v. 1/2023, pp. 3-40, **WP 1307 (December 2020).**

NERI S., *Long-term inflation expectations and monetary policy in the Euro Area before the pandemic*, European Economic Review, v. 154, Article 104426, **WP 1357 (December 2021).**

ORAME A., *Bank lending and the European debt crisis: evidence from a new survey*, International Journal of Central Banking, v. 19, 1, pp. 243-300, **WP 1279 (June 2020).**

RIZZICA L., G. ROMA and G. ROVIGATTI, *The effects of shop opening hours deregulation: evidence from Italy,* The Journal of Law and Economics, v. 66, 1, pp. 21-52, **WP 1281 (June 2020).**

TANZI G. M., *Scars of youth non-employment and labour market conditions,* Italian Economic Journal / Rivista italiana degli economisti, v. 9, 2, pp. 475-499, **WP 1312 (December 2020).**

2024

BALTRUNAITE A. and E. KARMAZIENE, *Fast tracks to boardrooms: director supply and board appointments,* Journal of Corporate Finance, v. 88, Article 102642, **WP 1278 (June 2020).**

BENCHIMOL J. and L. PALUMBO, *Sanctions and Russian Online Prices,* Journal of Economic Behavior & Organization, v. 225, pp. 483-521, **WP 1468 (October 2024).**

BRANZOLI N., R. GALLO, A. ILARI and D. PORTIOLI, *Central banks' corporate asset purchase programmes and risk-taking by bond funds in the aftermath of market stress,* Journal of Financial Stability, v. 72, Article 101261, **WP 1404 (March 2023).**

BRANZOLI N., E. RAINONE and I. SUPINO, *The role of banks' technology adoption in credit markets during the pandemic,* Journal of Financial Stability, v. 71, Article 101230, **WP 1406 (March 2023).**

BUONO I, F. CORNELI and E. DI STEFANO, *Capital inflows to emerging countries and their sensitivity to the global financial cycle,* International Finance, v. 27,2, pp. 17-34, **WP 1262 (February 2020).**

DEL PRETE S, G. PAPINI and M. TONELLO, *Gender quotas, board diversity and spillover effects. Evidence from Italian banks,* Journal of Economic Behavior & Organization, v. 221, pp. 148-173, **WP 1395 (December 2022).**

DE MARCHI R. and A. MORO, *Forecasting fiscal crises in emerging markets and low-income countries with machine learning models,* Open Economies Review. v. 35, 1, pp. 189-213, **WP 1405 (March 2023).**

FERRARI A. and V. NISPI LANDI, *Whatever it takes to save the planet? Central banks and unconventional green policy,* Macroeconomic Dynamics, v. 28, 2, pp. 299-324, **WP 1320 (February 2021).**

FLACCADORO M., *Exchange rate pass-through in small, open, commodity-exporting economies: lessons from Canada,* Journal of International Economics, v. 148, Article 103885, **WP 1368 (May 2022).**

GAUTIER E., C. CONFLITTI, R. FABER, B. FABO, L. FADEJEVA, V. JOUVANCEAU, J.-O. MENZ, T. MESSNER, P. PETROULAS, P. ROLDAN-BLANCO, F. RUMLER, S. SANTORO, E. WIELAND and H. ZIMMER, *New facts on consumer price rigidity in the euro area,* American Economic Journal: Macroeconomics, v. 16, 4, pp. 386-431, **WP 1375 (July 2022).**

LATTANZIO S., *Schools and the transmission of Sars-Cov-2: evidence from Italy,* Economics & Human Biology, v. 52, Article 101342, **WP 1453 (February 2023).**

MORO A. and V. NISPI LANDI, *The external financial spillovers of CBDCs,* Journal of Economic Dynamics and Control, v. 159, Article 104801, **WP 1416 (July 2023).**

PORRECA E. and A. ROSOLIA, *Immigration and unemployment. Do natives get it right?,* Journal of Economic Behavior & Organization, v. 225, pp. 522–540, **WP 1273 (April 2020).**

RAINONE E., *Real-time identification and high frequency analysis of deposits outflows,* Journal of Financial Econometrics, v. 22, 4, pp. 868–907, **WP 1319 (December 2017).**

ZAGHINI A., *Unconventional Green,* Journal of Corporate Finance, v. 85, Article 102556, **WP 1453 (April 2024).**

FORTHCOMING

BALTRUNAITE A., M. CANNELLA, S. MOCETTI and G. ROMA, *Board composition and performance of state-owned enterprises: quasi experimental evidence,* The Journal of Law, Economics, and Organization, **WP 1328 (April 2021).**

BENVENUTI M. and S. DEL PRETE, *The evolution of banking competition in italian credit markets using a profit elasticity approach,* Italian Economic Journal / Rivista italiana degli economisti, **WP 1237 (October 2019).**

CIANI E., A. GROMPONE and E. OLIVIERI, *Jobs for the long-term unemployed: place-based policies in depressed areas,* Italian Economic Journal / Rivista italiana degli economisti, **WP 1249 (November 2019).**

CUCINIELLO V. and N. DI IASIO, *Determinants of the credit cycle: a flow analysis of the extensive margin,* Journal of Money, Credit and Banking, **WP 1266 (March 2020).**

CUCINIELLO V., C. MICHELACCI and L. PACIELLO, *subsidizing business entry in competitive credit markets,* Journal of Political Economy, **WP 1424 (October 2023).**

FLACCADORO M., *Exchange rate pass-through in small, open, commodity-exporting economies: lessons from Canada,* Journal of International Economics, **WP 1365 (April 2022).**

LOSCHIAVO D., F. TULLIO and A. DI SALVATORE, *Measuring households' financial fragilities: an analysis at the intersection of income, financial wealth, and debt,* Review of Income and Wealth, **WP 1452 (April 2024).**

MICHELANGELI V. and E. VIVIANO, *Can internet banking affect households' participation in financial markets and financial awarness?,* Journal of Money, Credit and Banking, **WP 1329 (April 2021).**

MISTRETTA A., *Synchronization vs transmission: the effect of the German slowdown on the Italian business cycle,* International Journal of Central Banking, **WP 1346 (October 2021).**

MORO A., *Optimal policies in a small open economy with an environmental externality and shallow foreign exchange markets,* Portuguese Economic Journal, **WP 1348 (October 2021).**

RAINONE E., *Reservation rates in interbank money markets,* Journal of Money, Credit and Banking, **WP 1160 (February 2021).**

ROPELE T., Y. GORODNICHENKO and O. COIBION, *Inflation expectations and misallocation of resources: evidence from Italy,* American Economic Review: Insights, **WP 1437 (December 2023).**

ROSOLIA A., *Do firms act on their inflation expectations? Another look at Italian firms,* Journal of Political Economy Macroeconomics, **WP 1353 (October 2021).**