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The Role of Credit in the Green Transition

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Abstract

The Covid-19 pandemic has shed new light on the costs of climate change to our economies. We decided to analyze its role in reshaping banks' belief towards the need for a green transition by studying how firm-level carbon emissions influence the bank lending channel in a sample of European firms. Using firm-bank data, we show that firms with lower scope-1 emissions could obtain a higher supply of loans during the Covid-19 pandemic. These results are confirmed at the industry level, where green industries seem to attract more investments. They are essentially attributable to the supply of credit, and they survive a battery of robustness tests. Some preliminary evidence seems to support the hypothesis that the increase in bank lending to green firms and industries led to a reduction in emissions. In this context, it comes as no surprise that brown firms started to cut their emissions to become greener and thus obtain more loans.

Keywords: green transition, carbon emissions, bank lending, climate finance, Covid-19, real effects, pandemic

Introduction

Climate change is one of the major challenges of our time and it is at the forefront of social and policy debates. According to the Intergovernmental Panel on Climate Change held in 2021 (IPCC, 2021), CO2 emissions must be reduced by 60%, relative to 2010, by 2030 in order to mitigate the climate problem. This process is often called transition from "brown to green" economy, and it essentially refers to the private sector, which produces most carbon emissions. Given the centrality of the financial sector in allocating resources to non-financial companies (NFGs), banks could play a fundamental role in imposing financing costs to more polluting companies either through price or quantity adjustments.

Empirical evidence suggests that increased environmental awareness (for example after the Paris Agreement 2015) may lead banks and institutional investors to account for climate risk by increasing the cost of capital or reducing the supply of credit to highly polluting firms (Bolton and M. Kacperczyk, 2020; Bolton and M. Kacperczyk, 2021; Reghezza et al., 2021; Mueller and Sfrappini, 2021). If these decisions are relevant for economic activity, companies can decide to cut emissions. So, it appears relevant to analyze the role of banks in facilitating emission reduction through their lending decisions.

In this paper, our goal is to analyze the European banking sector's role in incentivizing the green transition during and after the Covid-19 pandemic. This shock determined an overall rethinking of our society behavior, starting from an increased awareness of the need for a real green revolution. This is due to the strong interconnection between the Covid-19 pandemic and climate change. As highlighted by Carlson et al. (2021), rising temperatures due to climate change push animals to move out of their environment getting closer and closer to human settlements. This raises the possibility of a virus proliferation from animals to humans as well exemplified by the Covid-19 pandemic.

In this context, we assume that banks decide to increase credit to less polluting firms (i.e. green firms) during the pandemic as a result of a change in their belief and the adoption of a lending policy aimed at supporting a green transition. To empirically analyze this hypothesis, we set up a firm-bank panel from the Orbis and BankFocus databases, merged with firm-level data on emissions downloaded from Refinitiv and Bloomberg. With these data, we define a firm as green if its average Scope-1 emission level between 2013-2019 is below the average Scope-1 emission level of the whole sample of companies in the same period. This allows us to estimate a double difference-in-difference model where our main dependent variable is the (natural logarithm) of total firm loans and our main explanatory variables is the interaction term between the time dummy Post, equal 1 if year is 2020 or 2021 and 0 otherwise and Green for firms' greenness as defined above.

Our analysis contributes to two emerging fields of the literature. On the one hand, it provides evidence of climate change and finance; on the other hand, it contributes to the studies on how the pandemic influences the economy. So far, our paper is unique because it constitutes a first important step in the rising literature regarding the green transition during and after Covid-19.

In our first test, we examine at the firm-bank level whether green firms experienced an increased supply of loans during the pandemic (i.e. 2020 and 2021). This is done by including different sets of fixed effects (e.g. firm and industry-time fixed effects) to control of demand isolating supply effects (Khwaja and Mian, 2008), which massively increase the fit of the regression as shown by Oster (2019). The results are consistent with our hypothesis that banks increased the supply of loans towards green firms during the pandemic. These results however are not heterogenous among banks and firms. The biggest banks of our sample lent to the biggest and growing firms highlighting an alteration of the Holmstrom and Tirole (1997) framework due to the firm greenness.

The second step of our analysis involves reproducing our first test at the industry-level to check whether green industries obtained more credit during the Covid-19 pandemic. Industries are defined as green depending on the number of green companies with respect to the brown ones. Again, the results seem to confirm our hypothesis even at industry level.

Our analysis has been checked by a battery of robustness tests typical of difference-in-difference settings. More specifically, green (treated) and brown (non-treated) firms seemed to follow similar trends prior to the pandemic shock (moreover, we change the definition of green firms/industries by using the quartile level of emissions as threshold, instead of the average emission level of the sample). At industry level, we apply the EU green taxonomy based on NACE2 industry classification codes; in this case, the sample of green industries is smaller than the one used in the analysis, but the estimates are still consistent with our hypothesis.

So far, our analysis points clearly to the fact that banks seem to discriminate against brown firms. We then check whether the bank lending decisions may have some real effect in terms of emissions, in the sense that banks can induce an effective adjustment in the firm environmental performance. Our analysis seems to confirm that there is a significant effect of green/total loans in terms of emission reduction. Moreover, we show that firms with ex-ante higher emissions started to reduce their polluting activity during the Covid-19 pandemic.

Chapter 1

Literature Review

Our work relates to two quickly emerging strands of the literature. Firstly, it adds to the flourishing literature on climate change and finance by using firm-level data to estimate the determinants of the credit supply to green firms (green loans) with a special focus on Covid-19. There is rather sparse literature about lending and green transition. This body of research considers both physical and transitional risks[1], and the effects of the Paris Agreement (2015) on the banking sector's decisions. Most of the papers in this strand of the literature have focused on credit allocation to polluting firms through the lens of price and quantities showing that, after 2015, there is a lower allocation to firms with a greater emission production. More specifically, M. T. Kacperczyk and Peydrò (2021) analyze the credit allocation across firms with different levels of carbon emissions and show that more committed banks towards the green issue cut the supply of loans to less clean or green firms. Further results in this vein have been provided by Reghezza et al. (2021) that exploited loan level data matched with firm-level greenhouse gas emissions to study the effects of environmental events, such as the Paris Agreement or Trump's announcement [2] of the USA withdrawal (2017), on the credit reallocation of European banks towards green firms. Finally, Mueller and Sfrappini (2021) use the Paris Agreement as a shock to

[1]Physical risk is defined as the risk associated to future environmental and climatic events; Transitional risk is considered the risk associated to the adaptation of firms and industries to the new "green" paradigm (Bernardini et al. 2021).

[2]The Trump Effect impacted negatively on the Green Transition causing an opposite credit allocation with respect to the one followed up the Paris Agreement of 2015 as highlighted by their paper.

banks' perception of regulatory risks and find that European banks reallocate their credit consistently with the green transition. In terms of pricing climate risk, several papers analyze the syndicated market. Delis, Greiff, and Ongena (2019) show that, after 2015, banks started to price climate policy risk especially for firms with higher fossil fuel reserves. Degryse et al. (2019) show that green firms borrow at a lower spread from lenders and that this is especially true if the lender is considered green as well. Furthermore, Ehlers, Packer, and Greiff (2021) provide evidence that demonstrate the existence of a loan carbon premium across industries for Scope 1 emissions. The request of a carbon premium for firms' stocks with a greater exposure to climate transition risk is documented by Bolton and M. Kacperczyk (2020) and (2021) which find that all the institutional initiatives to push firms' commitment to reduce carbon emissions have been successful, although there is a high resistance from more polluting companies. Choi, Gao, and Jiang (2020) prove that premiums are always required whenever climate risk is perceived to be higher. Finally, Ginglinger and Moreau (2019) and J. H. Nguyen and Phan (2020) show, using firm level data, that a lower financial leverage is linked to a higher exposure to climate risk.

Secondly, our work contributes to the burgeoning literature on the influences of the Covid-19 pandemic on the corporate sector focusing on a possible reshape of banks' belief on climate change. Bekaert, Engstrom, and Xu (2021) provide evidence of an increased uncertainty and risk aversion as a reaction to the fear for the disease incidences and severity. This is relevant for our analysis because it is highly probable that it has affected bank lending behavior after the beginning of the pandemic. Several researchers provide evidence of a positive shock to the demand for US bank loans at the start of 2020 caused by high credit lines drawdowns of firms as in Acharya and Steffen (2020) and confirmed by Li et al. (2020) and Chodorow-Reich et al. (2020), which highlight the presence of a run both on Money Market Funds and across firms, together with a decrease in US total loans in the first quarter of 2020. Furthermore, Greenwald, Krainer, and Paul (2020) show that aggregate US bank lending to companies increased after adverse shocks such as Covid-19 driven by drawdowns by large firms. This evidence shows that the increased loan supply from credit lines drawdowns is not a driver of the growth in total lending in the first quarter of 2020. This is also consistent with our evidence where we observe an increased supply of loans from 2020 since we consider the annual lending growth. Finally, Colak and Öztekin (2021) study the impact of the pandemic on bank lending finding results consistent to Li et al. (2020) and Chodorow-Reich et al. (2020). They show that bank lending is weaker in more affected countries by the pandemic and that this varies depending on bank and country heterogeneity.

As far as we know, our paper is the first study that tries to mix these two fields of research trying to understand the effect of the pandemic on green bank lending. Few papers analyze the relationship of Covid-19 with green sustainable investments. Using data on institutional investors' bond holdings, Fatica and Panzica (2021) discover that green bonds faced lower sales during the pandemic with respect to normal times. On the contrary, Garel and Petit-Romec (2021) provides empirical evidence suggesting that ESG performance is asymmetrically coordinated with the pandemic showing that the shock has boosted investors' attention to environmental issues since climate responsibility is rewarded more. The ESG performance index is indirectly connected with our work because it considers not only the environmental factor (E), but also the social (S) and government (G) components. Moreover, from Amundi Asset Management (2020), it could be noticed that the E-component outperformed returns.

Based on this evidence, our work suggests a pattern aiming to study the role of the pandemic in pushing banks to invest in green loans, showing a positive relation between the shock and green loans. Furthermore, our methodology and findings are consistent with the ones of M. T. Kacperczyk and Peydrò (2021), and Mueller and Sfrappini (2021) which documented a credit reallocation consistent with the green transition after 2015 through a model based on interactions.

Chapter 2

Institutional Framework and Hypothesis Development

2.1 A rising environmental concern

Climate change is one of the major challenges of our time. Between 2015 and 2022, the several initiatives undertaken to deal with it all over the world, and particularly in Europe, point out, on the one hand, the need of increasing sustainable investments to build countries' resilience to climate change; on the other hand, the importance of private investments in reducing and limiting carbon emissions (Hong, Karolyi, and Scheinkman, 2020). Since banks are the main providers of capital to the global economy and have specific expertise in risk management, we might say they are on the front line in fighting climate change.

To tackle the problem of climate change, the first global legally binding agreement is the Paris Agreement settled in 2015 (PA15 hereafter). The framework established a common pattern to reach climate-neutrality by the end of the century. The main long-term goal agreed by governments consisted in keeping the increase in global temperature to well below 2° C above pre-industrial revolution level putting a further limit of 1,5° C [1]. This agreement had a strong impact on the common beliefs, bringing the topic to the core of the expectations of policymakers, banks and investors that

[1] Climate Action, European Commission, Paris Agreements.

started to consider climate risk and its consequences in the design of their strategies and investments. To meet the requirements established by PA15, the European Union (EU) developed an even more ambitious plan that could make its member countries the frontier of a green transition. The Green New Deal, established in 2019, reinforced the PA15 goals by considering the fight to climate change as a principal pillar of the Union. The action foresaw that Greenhouse gas emissions (Appendix A.3), which are identified as the main source of the observed global warming (IPCC (2014)), must be reduced almost to zero before 2050. This is also confirmed in the 2030 Climate Action Plan, whose goal consists of cutting emissions by 55% by 2030 [2]. In 2020, the EU further developed a Taxonomy [3] to facilitate sustainable investments. Although its use is purely voluntary, it helps to identify and define, through scientific criteria, activities that are qualified as sustainable. It could also stimulate the disclosure of Environmental, Sustainable and Governance (ESG) data. The creation of this taxonomy can play a fundamental role for the Green Transition since, today, there does not exist an agreed methodology to determine whether an entity can be defined as sustainable.

These intense efforts highlight a new rising global awareness towards environmental topics that is reshaping people beliefs. More recently, two episodes have contributed to focus the attention on the problems of climate change. Firstly, the return to the green policies stage of the US leadership after the election of Joe Biden as president of the USA (the so called "Biden effect" [4]) , which has reversed the total neglect of the Trump period. This change in the US attitude has had important consequences for its main strategic partners, in particular Europe and the United Kingdom (UK). Secondly, the Covid-19 pandemic has operated as an accelerator of

[2] Available at `https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0562&from=EN`.

[3] Regulation (EU) 2020/852. The Taxonomy still represents a work in progress. European Parliament and Commission are discussing about the role that new nuclear technology could play among sustainable activities. Available at `https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32020R0852&from=EN`.

[4] In the report shown by Amundi Asset Management (2021), there is evidence of an outperformance from the Energy and Emissions sub-pillar of ESG score highlighting the presence of "green momentum" where investors better integrate CO2eq emissions in picking stocks for their portfolios.

the allocation of resources toward the green transition in a period when, to offset the effects of the containment measures, central banks strongly eased monetary policies to face concerns about solvency and liquidity of non-financial corporate firms trying to allocate money to green investments. Moreover, many countries launched extraordinary loan guarantees programs and other financial measures to sustain, essentially, credit to small and medium firms. In addition to this, Covid-19 could have played a role on banks' belief due to its high connection to climate change as highlighted in *paragraph 2.2*.

In April 2020, Europe introduced the *NextGenerationEu* program, a recovery plan to create an ecological, digital, and resilient EU. For the plan, 2.018 billion euros [5] were allocated by the European authorities, of which about 420 for Natural Resources and Environment. Moreover, one third of the investments of the plan should finance the *Green New Deal*, so that the recovery could be sustainable and responsible: *"With this money, we not only want to overcome the consequences of the crisis, but also build a better economy for the future: greener, more digital, more resilient. Fit for the next generation"* (Vor der Leyen, 2020). Although the immediate effects of the pandemic on banks led to a reduction of their returns, the above initiatives from European Governments and the Eurosystem, together with supervisory authorities, led to an increase in the volume of new banking loans and prevented an eventual deterioration in credit quality due to the possibility of households and companies going bankrupt (European Central Bank, 2020a). Figure 2.1 shows the evolution of loans in our sample of quoted firms towards the evolution of the overall banks' balance sheet credit. Both measures are increasing after the dashed line which marks the beginning of the pandemic.

In 2021, Italy held the Presidency of the G20, the multilateral forum of the most important countries of the world (the G20 countries contribute to almost 90% of the world GDP). Thanks also to the turning point in the US policy, the Italian Presi-

[5] This amount is constituted by 806,9 billion belonging to the NextGenerationEu and 1.210,9 billion allocated to the already existent Multiannual Financial Framework 2021-2027. Available at `https://ec.europa.eu/info/strategy/recovery-plan-europe_en`.

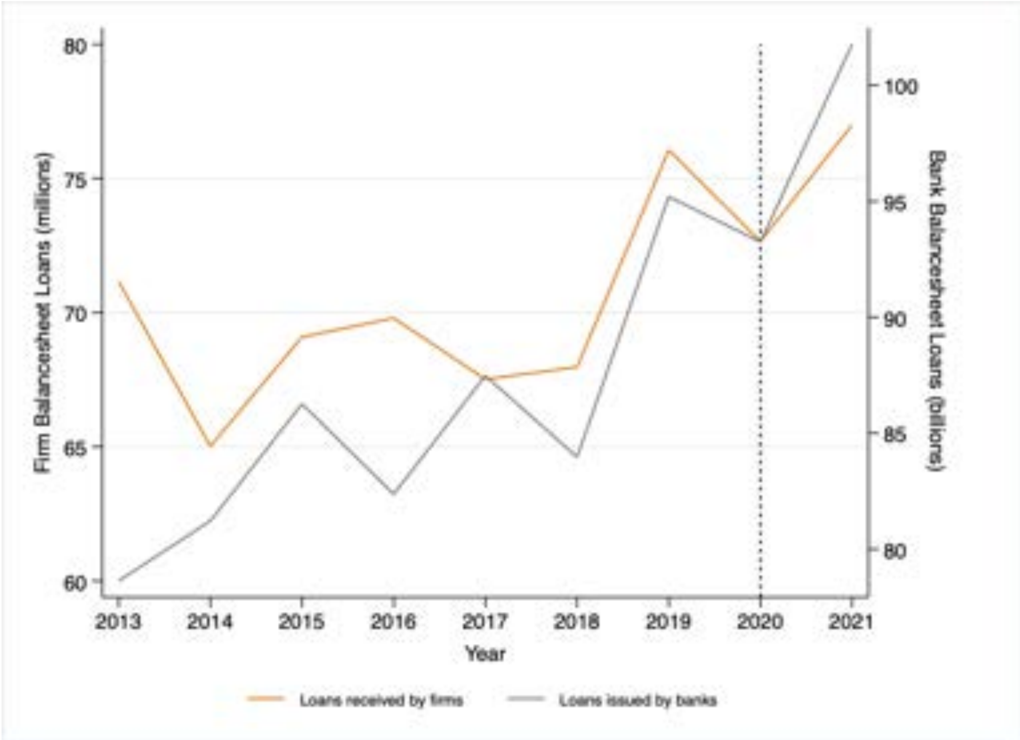

Figure 2.1: Evolution of Banks' Total Credit and Firms' Total Debt

dency could open a new round of global negotiations on environment and sustainable finance and promoted an ambitious green agenda. According to the three keywords of the Italian program: *People, Planet and Prosperity*, the Italian Presidency created a new working group devoted to sustainable finance, under the co-chairs of China and the USA, notwithstanding the political divergences between the two powers in many other fields: *"Sustainable finance is crucial for promoting orderly and just transitions towards green and more sustainable economies and inclusive societies, in line with the 2030 Agenda for Sustainable Development and the Paris Agreement"* (Rome Leaders' Declaration G20 (2021)).

2.2 Covid-19 and climate change

The Covid-19 pandemic played a crucial role in reshaping the beliefs about climate change. Although its origin is strongly debated by scientists, virologists, and politicians, the most accredited and proved hypothesis is related to the virus transmissions from animals to humans Worobey et al. (2022), in the line of many other viruses spreading from animals to humans in the last 20 years, such as Swine flu, Ebola, etc. One of the shared conclusions of these discussions is about the existence of a deep connection between viruses, such as coronavirus, and climate change. This link is documented by an international team of scientists of the Georgetown University of Washington DC (Carlson et al., 2021), according to which, *"changes in climate and land use will lead to opportunities for viral sharing among previously geographically isolated species of wildlife"*. In other terms, the geographic range shifts of animals due to higher temperatures will lead to a higher probability for viruses like the Coronavirus family or Ebola to appear in new areas making the transmission to humans easier. More specifically, because of climate change effects animal habitats will move nearer to human ones, generating new hotspots of spillover risk. This was also argued by Horberg and Brooks (2015), which showed how viruses evolve thanks to climatological variation and ecological permutation caused by the erosion of the environment from human activities.

The perception of the connection between Covid-19 and environment has had an unprecedented impact on our life. Consumers and investors are now more concerned about their health, and they have changed their behavior accordingly. On the consumption side, there is an increasing number of papers documenting a shift towards a higher share of green purchases (see for instance Hassen, El Bilali, and Allahyari (2020) and Sajid et al. (2022)).

Similar evidence has been shown for investment decisions. The excessive volatility generated by the Covid-19 pandemic should prompt governments, banks, and investors to consider the environmental and social components of investment decisions. Refk et al. (2021) show that the increasing anxiety and fear over Covid-19 may have changed the attitudes towards environmentally and socially responsible investing. Garel and Petit-Romec (2021), studying a cross-section of stock returns during the pandemic, show that firms with environmentally responsible strategies are characterized by higher stock returns, supporting the hypothesis of the centrality of environmental issues in investment decisions.

Notwithstanding the still short period since the outbreak of the Covid-19 pandemic, this evidence is already sufficient to justify the assumption that climate change and its effects on land and human life have grown in importance for bank lending decisions, with an increase in loans to firms with low carbon emissions or to sectors that are less exposed to the consequences of climate change.

2.3 The European banking sector and green finance

The Covid-19 pandemic and the related issue of green finance have raised new challenges for banks and the financial sector as a whole, which have to rethink their business model. In this context, along with the sustainability issue, three main factors are at work: low interest rates (LIR), tighter financial regulation and technological innovation. These phenomena are causing, respectively, a reduction in banks' net interest income, an increasing accumulation of capital and liquid assets, and more competition among banks and non-bank entities, which overall may determine a decrease in banks' profitability. The Covid-19 pandemic has been and still is playing a crucial role in exacerbating such trends, by increasing credit risk and lowering growth. If, on the one hand, banks can withstand the increased risk thanks to the more solid capital and liquidity structures built after the Great Financial Crisis (European Central Bank (2020b)), on the other hand, their intermediation activity may be significantly harmed over the medium term by competition and reduced returns. So far, as suggested in Cardillo, Gallo, and Guarino (2021), the only way for banks to "survive" could be to invest in digital innovation and green finance.

The switch to green finance and ESG-related investments could happen through three channels: rebalancing market portfolios by investing in sustainable assets, providing advisory services, and directly financing green companies or projects. All of them are crucial and must be considered by banks to support the green transition and exploit its potential opportunities. The first channel could count on the developments of the market segment related to global sustainable assets. As reported by the Global Sustainable Investment Alliance (2020), there is evidence of an increased importance of global sustainable investment, which has grown by 55% from 2016 to 2020 (15% from 2018 to 2020). The second mechanism, which clearly depends on the banks' competencies in the field (Giovannini and Tamburrini, 2022), is based on the concept that banks could exploit as a source of revenues the provisions of advice and services to investors that want to undertake sustainable investments. Finally, the last channel involves directly lending to green firms (for instance, the World Bank has already cut the provisions of brown loans to the petroleum industry; see World Bank (2017)). This is the focus of our analysis. According to Cardillo, Gallo, and Guarino (2021), financing green firms could increase bank profitability because of the reduced cost of funding (i.e., lower transaction costs) that banks can face via green bonds. Furthermore, Brogi and Lagasio (2019) show that lending strategies based on ESG impact positively on the profitability of commercial banks.

Finally, as shown by M. T. Kacperczyk and Peydrò (2021), banks' decision to lend to green firms could be motivated as a response to an increased business risk related to higher pollution, but also by their own preferences [6]. Although the green revolution is only at the beginning and the green share of investments is relatively small, nevertheless it represents a valid opportunity and a great potential for the entire banking sector, which appears to have begun a slow transition to a more green-based business model.

2.4 Hypothesis development

Given the preceding discussion, it is reasonable to ask whether the change of attitude brought about by sustainability issues might have influenced bank lending decisions. This is important because banks' financing role could facilitate and speed up the green transition in supporting firms' sustainable investment strategies. Our analysis will therefore focus on the risk attitude of banks and test whether they

[6] Banks could also face a regulatory risk, i.e. the risk of a change in regulations and laws able to affect industries and firms (Bernardini et al. (2021)), which bring them to shift their preferences towards green investments.

have increased their loans towards green firms (i.e. those less polluting), in particular during the pandemic. Our hypothesis is that the pandemic shock and the greater environmental awareness are powerful factors behind the banks' decision to increase their loan supply towards green firms. This strategy may be explained by the fact that banks consider brown firms (i.e. those more polluting) riskier over the medium-long term, given public policy decisions or announcements aimed at reducing polluting emissions , such as the EU proposal to eliminate petrol/diesel engines by 2035[7].

[7] Public policy decisions or announcements can have either a direct or an indirect effect on banks. On the one hand, regulators could promote laws that, for example, impose lower capital requirement to green firms; on the other, regulators could decide to limit profit from brown industries or firms by establishing higher taxes.

Chapter 3

Data and Empirical Methodology

3.1 Firm-bank data

Our empirical analysis relies on four data sources. Firm level data are drawn from *Orbis*, a proprietary and confidential Bureau Van Dijk database, which provides financial statement information for listed and unlisted companies all over the world. *Orbis* is not a granular database, but it contains information on the names of the main lenders to a firm for most countries. We selected all listed companies displaying loans over the period 2013-2021, belonging to the UK and the EU [1]. The choice is motivated by two reasons: the Bank of England (and clearly the UK government) is a leading promoter of green finance to contrast climate change [2]; moreover, Britain was in the EU until 2020. We chose only quoted firms because data on emissions are usually only disclosed by them. Our initial sample contains a total of 1,470 firms, with 4,060 firm bank relationships.

Bank level data are obtained from *Moody's BankFocus*. The initial sample of banks has a total of 3,830 commercial, saving, and cooperative banks. These banks' unconsolidated balance sheet information is matched to lenders' names through a fuzzy matching procedure as explained in Appendix A.1.

[1] Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

[2] United Kingdom's approach to reduce emissions and deal with the impact of climate change is based on the 2008 Climate Change Act which established legally binding emission targets for 2050. This act has been promoted well before the introduction of the European Green New Deal in 2019.

Firm level data on emissions are taken from the dataset *Refinitiv* using the ISIN [3] code to match them with the firms in our sample. For more information on emissions, we exploit the *Bloomberg dataset*, which is matched relying on the same procedure used for Refinitiv data. The average level emission over revenues/sales is computed as the annual average between emissions from the two database sources.

After winsorizing the data between the 1st and the 99th percentile of firm's credit, we are left with a strongly balanced panel of 458 firms, 265 banks and 1,289 firm bank relationships, observed over 9 years, from 2013 to 2021. It also contains 213 NACE2 core code [4] used for industry classifications. This industry classification is exploited to carry out the industry level analysis. The NACE2 nomenclature allows us to use the more standardized taxonomy presented by the EU in 2020. Information about the new EU taxonomy is retrieved by the EU website and by Kooroshy, Dai, and Clements (2020). Summary statistics are presented in table B1. This panel has two main limitations. On the one hand, we have no single firm-bank loan exposure. It follows that a firm's debt is divided in to number of equal fractions depending on the number of lenders (e.g. firm-bank relationships). On the other hand, the panel appears to be somehow restricted because of the unavailability of data on emissions for many firms. This is also related to another important issue that is linked to the unavailability of a standardized taxonomy that defines what are "green" activities (Ferrer, 2019). This implies the impossibility of indicating a common compulsory methodology for the disclosure and comparison of financial data related to climate change (NGFS, 2019). Nevertheless, even with these limitations, the panel allows us to perform an analysis on the effects of financial sustainability considerations on the supply of loans from banks after the explosion of the COVID19 pandemic.

[3] The International Securities Identification Number is a 12-digit alphanumeric code that uniquely identifies a specific security.

[4] The Nomenclature statistique des Activites economiques dans la Communaute Europeenne is the standard used by the European Union in classifying industries.

3.1.1 Greenhouse Gas Emissions and Green Firms

Greenhouse gases (GHG) are the major threat related to climate change. They trap heat in the atmosphere making the planet warmer. Human activity is responsible especially for the emission of carbon dioxide related to the combustion of fossil fuels. We focused on emissions because they constitute the simplest and most standardized way to determine whether a firm is clean in comparison to the E component of ESG data that considers environmental factors not directly affecting our society (Harris, 2022). There are direct and indirect GHG emissions, and they are grouped in three main scopes: Scope 1 concerns direct GHG emissions from sources owned and controlled by the company (e.g., emissions from combustion); Scope 2 is referred to indirect GHG emissions generated by the consumption of purchased electricity; finally, Scope 3 includes all remaining indirect GHG emissions which are not included in the previous two categories (World Resource Institute and World Business Council for Sustainable Development, 2004).

In our study we focused on Scope 1 emissions from *Refinitiv* and *Bloomberg. Refinitiv* displays data on emissions relative to revenues, while in *Bloomberg* they are relative to sales. Notwithstanding these differences, the data from the two sources are very similar and complete each other in some cases (Appendix A.3). In this way we can generate a unique variable, called Emissions, for emission levels, which is used to compute our Green Indicator at the firm level. This is obtained by measuring for each firm the average Emissions level from 2013 to 2019, excluding possible biases due to the COVID19 pandemic, and comparing it to the average Emissions for all the sample in the 2013-19 period. In the absence of a common and unique rule, we decided to consider as "green" a firm if its average emission level is lower than the average emission of the whole sample of companies. In this way we get 307 green firms while the remaining 151 firms are considered as "brown". This could raise some concerns about the likelihood of our sample of analysis. A possible explanation for the high number of green firms could be related to the fact that brown companies are less willing to disclose their data fearing of the negative – mostly reputational – consequences. At the industry level, we proceed in a different way by exploiting the previous firm classification. We determine whether an industry is green by checking if there are more green companies than the brown ones within the same industry. In this case, we obtained 116 green industries and 97 brown ones. Green firms and industries display an average emission level which is lower than the respective brown ones.

In the section on robustness checks, by using a more traditional classification derived from the recently approved European taxonomy, which is based on a NACE classification (Kooroshy, Dai, and Clements, 2020), we get a more balanced classification, with 12 green industries and 201 brown ones.

3.2 Empirical Methodology

In order to analyze how loans to green firms (green loans, hereafter) have changed during the pandemic, we exploit both time-series and cross-sectional variations in bank exposure of green firms and industries to COVID19. Since banks' responses to the same public health crisis can vary, we evaluate not only the average effect, but also the heterogeneity across banks, i.e. how size and capital can influence the supply of credit from banks. A very similar analysis is done for firms' heterogeneity too.

3.2.1 Firm-bank level specification

To assess how COVID19 affects bank credit supply with respect to their "polluting" characteristics (i.e. their green or brown activity), we exploit a panel fixed effects regression methodology, where the dependent variable is (the natural logarithm of) total loans provided by banks, which can be considered as a measure of their willingness to supply loans to firms. We have chosen to model firm-bank relationships essentially because we can better identify the effect on the real economy, and deal with credit demand shocks. Our empirical model relied on the following specification:

$$Ln(TotLoans)_{ijt} = \alpha + \beta \cdot Green_{jt-1} \cdot Post_{t-1} + \gamma \cdot Bank_{it-1} + \delta \cdot Bank_{it-1} \cdot Post_{t-1} + \mu \cdot Firm_{jt-1} + \phi_{t-1} + \theta_j + NAICS_{jt-1} + \epsilon_{ijt-1}$$

All control variables are lagged one year to avoid possible biases due to endogeneity. The indicator variable for COVID19, *Post*, is a dummy variable equal to 1 during the pandemic years (2020 and 2021), 0 otherwise. The coefficient β identifies how the shock affects the supply of loans pre- and post- COVID19. Our expectation is that there has been an increase in the supply of loans to green solvent firms, independently from bank's characteristics.

We used both banks' and firms' characteristics as control variables. The former, $Bank_{it-1}$,includes *Equity*, *Size* and *ROA*. They are taken standalone and interacted with the variable Post so that we could better identify the channel of transmission to the real economy. The latter, $Firm_{jt-1}$, includes (the natural logarithm of) *Total Assets*, *Total Liabilities*, *Tangible Assets*, *Total Revenues*, and *ROE* to control mostly for firm characteristics (basically, size, liquidity and profitability).

Firm and Industry fixed effects are used to control for firm- and industry- level time-invariant heterogeneity. In the second case, the hypothesis is that the firms belonging to the same cluster are subject to similar shocks (we have 213 clusters according to the NACE2 Core Code). Finally, year fixed effects are included to account for unobserved common trends.

3.2.2 Heterogeneity Analysis

One of our main research points is to analyze whether the supply of loans is heterogeneous across banks. To do this, we augment the baseline specification by interacting the variables *Green* and *Post* with the bank balance sheet variables *Size* and *Tier1ratio*. The resulting specification is:

$$Ln(TotLoans)_{ijt} = \alpha + \beta_0 Green_{jt-1} \cdot Post_{t-1} + \beta_1 \cdot Green_{jt-1} \cdot Post_{t-1} \cdot Size_{it-1}$$
$$+\beta_2 \cdot Green_{jt-1} \cdot Post_{t-1} \cdot Tier1ratio_{it-1} + \gamma \cdot Bank_{it-1} + \delta Bank_{it-1} \cdot Post_{t-1}$$
$$+\mu \cdot Firm_{jt-1} + \phi_{t-1} + \theta_j + NAICS_{jt-1} + \epsilon_{ijt-1}$$

The coefficients of this regression will show the characteristics of the banks that are lending to green firms. We expect to have a positive coefficient for the triple interactions related to *Size* and *Tier1ratio*. In this case, the banks which are lending to green firms are on average bigger and safer since *Tier1ratio*, defined as the sum of equity and reserves, represents the bank's financial strengths.

A very similar heterogeneity analysis is run for the size, the level of intangible assets, and the turnover ratio of firms. In this case the specification is the following:

$$Ln(TotLoans)_{ijt} = \alpha + \beta_0 \cdot Green_{jt-1} \cdot Post_{t-1} + \beta_1 \cdot Green_{jt-1} \cdot Post_{t-1} \cdot Size_{jt-1}$$
$$+\beta_2 Green_{jt-1} \cdot Post_{t-1} \cdot TurnoverRatio_{jt-1} + \beta_3 Green_{jt-1} \cdot Post_{t-1} \cdot Intan_{jt-1}$$
$$+\gamma \cdot Bank_{it-1} + \delta \cdot Bank_{it-1} \cdot Post_{t-1} + \mu \cdot Firm_{jt-1} + \phi_{t-1} + \theta_j$$
$$+NAICS_{jt-1} + \epsilon_{ijt-1}$$

We expect the estimates of all coefficients to be positive, which means that firms receiving loans are on average the largest ones of our sample with higher revenues and intangibles assets.

So far, we expect to have a match between larger and more capitalized banks lending to larger and profitable firms. This hypothesis is based on the idea that, even though green finance is gaining importance, its costs and risks could be very high that smaller firms could be induced to postpone green projects. Although this hypothesis contrasts with the Holmstrom and Tirole (1997) theoretical analysis, which showed that banks with higher capital usually provide loans to riskier and smaller firms because they have stronger incentives, i.e. higher skin-in-the-game, to monitor borrowers, the empirical evidence provided by Mkhaiber and Werner (2020) on a huge sample of U.S. banks seems to support it: they show that, during the 2008 financial crisis, there was an inverse relationship between bank size and the propensity of banks to lend to small businesses.

3.2.3 Industry level specification

As a second step in our analysis, the previous specification is estimated at a higher aggregation level. We construct an industry panel database where green industries are distinguished from brown ones depending on the number of green firms in the industry sector (see above for the definition of green/brown industry). In this case, we expect that green industries received more bank credit after the pandemic. To assess this effect, we run the following specification:

$$
\begin{aligned}
Log(TotLoans)_{ijt} = \alpha + \beta \cdot Green_{jt-1} \cdot Post_{t-1} + \gamma \cdot Bank_{it-1} \\
+\delta \cdot Bank_{it-1} \cdot Post_{t-1} + \mu \cdot Firm_{jt-1} + \phi_{t-1} + \epsilon_{ijt-1}
\end{aligned}
$$

As for the single firm analysis, an alternative definition of green/brown industry could be obtained at aggregate level using the European Taxonomy; however, results should be broadly similar.

3.2.4 Disentangling demand and supply

Finally, we want to check whether during the pandemic the shock has been demand or supply driven. In other words, we want to understand whether the increase in the bank lending behavior towards green firms can be due only to a bank's decision. This analysis is performed by keeping demand constant through fixed effects. Supply/demand effects are represented in two different ways: a) to capture demand factors we add firm fixed effects to the baseline specification at the firm bank level, in the spirit of Khwaja and Mian (2008); b) following Degryse et al. (2019), we add industry-location-size-time (ILST) fixed effects, given that firms in the same industry, located in the same area and of similar size have a similar credit demand. In both cases, the estimate of the coefficient for the interaction between Green and

Post should be positive, meaning that banks increased the supply of loans towards cleaner firms.

As a third alternative, we follow Li et al. (2020) and add to the main specification a proxy to disentangle demand for borrowing from supply. In order to compute our proxy, we exploit the residuals obtained by regressing the natural logarithm of employment for each industry on a trend from 2013 to 2021. They represent a dynamic measure of the yearly distance of industrial employment from its trend. The residuals are considered as a proxy of the important negative repercussions to businesses and households on the demand-side of the economy. In conclusion, we still expect that the interaction between Green and Post is positive.

Chapter 4

Results

This section is organized as follows: Section 4.1 reports the results of the baseline model; Section 4.2 examines possible heterogeneous effects for banks and firms; Section 4.3 disentangles demand from supply; Section 4.4 reports the results at the industry level; finally, Section 4.5 provides some robustness checks.

4.1 The Baseline Model

Table 4.1 reports the estimates of the coefficients of interest of the baseline specification including the t-statistics obtained from standard errors clustered at the firm-bank level.

We show the results of our baseline specification for several definitions of firm clusters. Column (1) includes firm and time fixed effects to account for possible unobserved heterogeneity at the company level. Column (2) considers industry and time fixed effects. This is a less demanding control for unobserved heterogeneity with respect to the previous one, but it allows us to verify whether our results are still valid considering the industry to which the firm belongs to. Finally, Columns (3) and (4) introduce industry-time and industry-location-time fixed effects to check whether banks increased their supply of loans to firms not only belonging to the same industry in the same year (3), but also localized in the same area (4). In each case, we use bank and firm controls. Across all specifications of Table 4.1, we find that

Ln(Total Loans)	(1)	(2)	(3)	(4)
Green x Post	0.442**	0.457**	0.771***	0.820*
	(0.179)	(0.181)	(0.288)	(0.427)
Time FE	Yes	Yes	No	No
Firm FE	Yes	No	No	No
Industry FE	No	Yes	No	No
Industry-time FE	No	No	Yes	No
Industry-location-time FE	No	No	No	Yes
Bank Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Observations	4,248	4,262	4,020	3,347
R-squared	0.598	0.303	0.455	0.728

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.1: Baseline Model

The table reports the estimates of the model at firm-bank level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

the coefficient estimate relative to the green loan supply is positive and significant. In particular, the estimate changes when we consider different clusters and increases when we add fixed effects relative to the industry. Firm and bank controls are of particular importance. On the one hand, by including *Bank size*, *ROA* and the *Equity ratio*, we are implicitly controlling the bank business model. On the other, firm controls are relevant since our dependent variable, the logarithm of total firm loans, is part of the firm balance sheet so that we should add both balance sheet and income statement firm variables such as *size*, *liability ratio*, *tangible assets*, *total revenues*, and *ROE*. Specification in column (1), which includes the narrowest firm cluster, implies that green firms during the pandemic had a 0.44% increase in credit, almost twice of the average credit growth in our sample in 2019 (0.23%). Overall, based on these estimates and consistent with our hypothesis, the evidence shown in Table 4.1 seems to support the assumption that the burst of the Covid-19 pandemic has contributed to increase the supply of loans towards green firms.

Real effects of increasing the supply to green firms. The main reason why banks are beginning to supply more money to green companies is related to an environmental concern. By augmenting the supply of loans towards cleaner firms, banks are not only investing in more secure projects, but also managing the climate issue that could be detrimental for them. Climate change is a matter of great concern because the consequences impact the ability of all borrowers to repay their loans. This is shown in part of the literature which has been studying the issue of climate finance considering the effects on loans by a sea level rise. Most of the banks increase the spread of the loans to borrowers living near the coast (D. D. Nguyen et al., 2022). This is relevant for us to show that banks care about emissions because of the costs they could incur, and that their supply shift is to reduce real emissions incentivizing higher emission firms to reduce them. In order to partially verify this issue, we carry out a firm-bank level analysis where our dependent variable is represented by the natural logarithm of emissions. Since we want to study the effects of the increased supply of green loans on the emission level during 2020 and 2021, we use as our independent variable of interest the triple interaction among loans, Green and Post. Results shown in table B.2 are robust and show that a rise both in green bank and total loans results in lower emissions. This could be explained by the fact that companies are slowly deciding to decrease their emissions in order to be eligible for new loans. Table B.3 shows that firms with ex ante higher emission growth rate (brown companies) during Covid-19 had a lower emission production growth. This is consistent with the evidence provided by M. T. Kacperczyk and Peydrò (2021) where they seek evidence for brown companies adjusting their operations and technologies after 2015 finding that, on average, firms having a relationship with committed banks reduce emissions. The same results hold true after 2020. By clustering at the firm and industry level, we find that, on average, brown firms are reducing their emission growth.

4.2 Heterogeneity Analysis

Our findings suggest that the greenness characteristic of firms may influence banks' lending decisions and that, consequently, there is a higher supply of loans from banks. Now, it would be important to ascertain whether this effect is homogeneous across banks and firms. Firstly, we investigate bank heterogeneity, i.e. which groups of banks are providing additional loans during the pandemic. To do so, we include a triple interaction with *BankSize*, computed as (the natural logarithm of) bank total assets, and with *Tier1CapitalRatio*, i. e. the ratio between core tier 1 capital [1] and its total risk-weighted assets. It measures banks' financial strength considering their core equity capital against total risk-weighted assets. As discussed above, according to our hypothesis, we expect that the lending banks in our sample are those with larger amount of capital.

Ln(Tot Loans)	(1)	(2)
Green x Post x BankSize	0.0747*	
	(0.0445)	
Green x Post x Tier1ratio		0.944*
		(0.527)
Firm FE	Yes	Yes
Time FE	Yes	Yes
Bank Controls	Yes	Yes
Firm Controls	Yes	Yes
Observations	3,120	3,069
R-squared	0.627	0.639

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.2: Bank Heterogeneity

The table reports the estimates for studying heterogeneity among banks. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. In the triple interactions, BankSize is equal to the natural logarithm of bank total assets, while Tier1ratio is equal to the percentage level of Tier 1 Capital over its total risk-weighted assets. Observations are winsorized around the 1st and 99th percentile of credit. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

[1] The core tier 1 capital corresponds to equity capital plus disclosed reserves

The Column (1) of Table 4.2 seems to suggest that the banks providing loans to green firms are usually the biggest ones of our sample. This is consistent with Colak and Öztekin (2021) that showed that larger and more profitable banks reduce less their loan growth during the pandemic. Furthermore, it is plausible that smaller banks cut their loan growth more because of the higher cost of capital (Baker and Wurgler (2015); Gandhi and Lustig (2015)). Column (2) shows that these banks usually are better capitalized too. This positive effect on bank lending towards green firm could be explained by two reasons. On the one hand, the European regulatory system was important in preparing banks to deal with eventual and unexpected crisis such as the pandemic. So far, European banks have been less severely affected by Covid-19 and could decide more freely in choosing green ones. On the other hand, the effect produced by the regulation could have raised competition among banks, affecting positively the bank lending channel, as shown in Colak and Öztekin (2021) where using a larger sample of banks from all over the world they show that higher capital requirements did not impact negatively on loan supply. In conclusion, our results show that banks may have reacted differently to the COVID19 pandemic depending on their size and capital.

Secondly, we study firms' heterogeneity. We include a triple interaction with *firm's Size*, *Turnover Ratio* (total revenues over total assets), and *Intangibles assets* (see Table 4.3). According to our hypothesis, firm size and turnover ratio coefficient estimates are positive and significant. In Column (2), the coefficient estimate of intangibles is slightly negatively correlated with the supply of loans, but it is not significantly different from zero.

So far, this heterogeneity analysis has provided us with the following evidence: larger and more profitable banks tend to lend more to larger firms that display a higher turnover ratio, i.e. higher revenues. This may be explained by many different factors, among which the difficulty for larger banks to process "soft information" on which the lending relationship is based, as highlighted by Berger and Udell (2002). In this sense, our evidence shows that the firm greenness may modify the traditional framework of Holmstrom and Tirole (1997).

Ln(Total Loans)	(1)	(2)	(3)
Green x Post x FirmSize	0.134**		
	(0.0623)		
Green x Post x FirmIntangibles		-0.00491**	
		(0.00194)	
Green x Post x FirmTurnoverRatio			0.408***
			(0.0619)
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
Observations	4,248	4,248	4,240
R-squared	0.598	0.598	0.600

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.3: Firm Heterogeneity

The table reports the estimates for studying heterogeneity among banks. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. In the triple interactions, FirmSize is equal to the natural logarithm of firm total assets; FirmIntangibles is equal to the natural logarithm of tangible assets; FirmTurnoverRatio is equal to total firm revenues over total firm assets. Observations are winsorized around the 1st and 99th percentile of credit. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

4.3 Disentangling Demand and Supply

In this paragraph, we try to disentangle demand versus supply-side effects on loan provision. Up to now, our analysis has yielded two important results: 1) bank credit supply towards green firms increased during the pandemic; 2) this effect is heterogenous among banks and firms. The inclusion of firm and industry fixed effects already mitigates concerns about mixed credit demand effects. Our estimates suggest that it is the bank lending behavior that leads to a credit rise towards green firms. To better isolate the supply-side component of loan provision, we proceed in two ways.

Firstly, we further exploit industry-size-time and industry-size-location-time fixed effects (from now on ILST) in the logic of Degryse et al. (2019). This methodology is based on the above cited assumption that similar firms in terms of size, location and industry face a similar credit demand. The positive and significant coefficient estimates in column (1) and (2) of Table 4 support the hypothesis that banks supply a greater number of loans during the pandemic to green firms.

Secondly, we employ additional controls for loan demand. Lockdowns and social distancing measures could affect not only banks' decisions to supply loans, but also the demand of loans by firms. Thus, we decide to create a demand proxy able to capture the degree to which companies were hit by government measures enacted to deal with the pandemic. We add this variable to our baseline specification obtaining positive coefficient estimates for our interaction term as displayed in column (3) of Table 4.4. This further demonstrates that the increased loan supply is not cofounded with demand.

Ln(Total Loans)	(1)	(2)	(3)
Green x Post	0.706**	0.876**	0.506**
	(0.331)	(0.440)	(0.218)
Time FE	No	No	Yes
Industry-size-time FE	Yes	No	No
Industry-location-size-time FE	No	Yes	No
Demand Proxy	No	No	Yes
Bank Controls	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
Observations	3,610	3,113	4,139
R-squared	0.505	0.735	0.145

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.4: Disentagle demand and supply

The table reports the estimates of the model at firm-bank level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. The Demand Proxy is represented by the residuals of the natural logarithm of industrial employment from a trend. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

4.4 Industry level specification

The second important step of our analysis is to check if the results obtained at the firm-bank level are still valid at a higher aggregation level such as the industry one obtained by mean collapsing our firms' observations. To carry out this analysis we should define when an industry is green. This is done by considering the number of green firms within the industry: if green firms are the majority, then the industry would result green as well. The specification used is the same as the baseline model with the only difference that we cannot include firm or industry-type fixed effects because we are at a higher level of aggregation and the analysis would not produce any estimates. Year fixed effects are still present otherwise our analysis would be biased. Results are displayed in Table 4.5.

Ln(Total Loans)	(1)	(2)
Green x Post	0.407**	0.488**
	(0.205)	(0.239)
Time FE	Yes	Yes
Bank Controls	No	Yes
Firm Controls	Yes	Yes
Observations	1,400	1,155
R-squared	0.086	0.102

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.5: Industry level Specification

This table reports the regression estimates for analyzing the effects of the pandemic on bank lending towards green firms at a higher aggregation level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if the number of green firms within an industry is higher than the number of brown ones. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. Standard errors are clustered at the industry level *** p<0.01, ** p<0.05, * p<0.1.

The coefficient of the interaction term between Green and Post is still positive and significant. We can notice that in the specification with bank controls, the coefficient slightly increases. Overall, we provide evidence that green industries faced a rise in the credit supply from banks during the pandemic. This is relevant because it means that the evidence provided at the firm level is also confirmed for industries.

4.5 Robustness checks

In this section we provide some test of the robustness of our baseline specification. By looking at Figure C.2, that displays the Parallel Trend Tests usually carried out in this type of analysis, we can immediately see that our treated and control groups have a similar trend in terms of bank loans before the pandemic shock. Successively, although green loans decrease a bit, they remain quite stable in comparison to the sharply decline in brown loans. This is perfectly consistent with our results because it shows that any divergence in trend after Covid-19 cannot be attribute to pre-existing differential trends. Thus, this figure is very important for us since it provides support for our identification strategy and allow us to investigate our hypothesis through a double difference-in-difference model.

First, given that we used as dependent variable the natural logarithm of total loans, we re-estimate our main specification with a new dependent variable, the logarithm of bank total loans. This variable allows us to better identify the bank-lending channel among firms and banks because it only refers to the number of loans that firms received from banks. The estimates do not change the coefficient estimates of the interactions between *Green* and *Post*, which are always positive and significant in column (1) and (2) of Table 4.6, while in column (3) the coefficient estimate, though not significant, remains positive and very similar to the one of column (2). Then we consider a stricter version of green firms by defining as green only those firms whose *Average Level Emission* is below *Emission Threshold Q*, which is the lower quartile of firms' *Average Level Emission* from 2013 to 2019. The coefficient estimates of the interactions between *Green Q* and *Post* remain positive and significant in column (4) and (5), while column (6) of Table 4.6 is still positive and similar to the others, but insignificant.

Ln(Bank Total Loans)	(1)	(2)	(3)	(4)	(5)	(6)
Green x Post	0.690***	0.590***	0.585			
	(0.213)	(0.223)	(0.370)			
GreenQ x Post				0.486**	0.492*	0.505
				(0.246)	(0.256)	(0.365)
Time FE	Yes	Yes	No	Yes	Yes	No
Firm FE	Yes	No	No	Yes	No	No
Industry FE	No	Yes	No	No	Yes	No
Industry-time FE	No	No	Yes	No	No	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,489	2,501	2,259	2,489	2,501	2,259
R-squared	0.606	0.427	0.602	0.605	0.426	0.602

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.6: Robustness check with lags

The table reports the estimates of the model at firm-bank level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. GreenQ is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the emission quartile. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.1.2. Bank controls are included as standalone and interacted with the Post dummy variable. All the control variables are lagged as in the baseline model. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

Secondly, we estimate our baseline specification (without lagged variables) only on the latter part of our sample, from 2018 to 2021. Again, we consider the two previous alternative definitions of green firms. The estimates in Table 4.7 confirm our findings: the interaction is positive with all cluster controls.

When we cluster for industry-time fixed effects, the significance level of each regression estimate increases no matter what cluster we use. This could be related to the fact that we focus on a shorter period where the concept of green investment has become more widespread.

Similar tests are also run for the industry level specification. The aim is always to check whether the coefficient of the interaction term *Green* x *Post* is positive. We run two different robustness checks. Firstly, we define in a different way whether an industry is green. In the main analysis, we consider an industry green if the number

Ln(Bank Total Loans)	(1)	(2)	(3)	(4)	(5)	(6)
Green x Post	0.357**	0.356**	0.551**			
	(0.156)	(0.170)	(0.251)			
GreenQ x Post				0.487***	0.540***	0.668***
				(0.180)	(0.186)	(0.232)
Time FE	Yes	Yes	No	Yes	Yes	No
Firm FE	Yes	No	No	Yes	No	No
Industry FE	No	Yes	No	No	Yes	No
Industry-time FE	No	No	Yes	No	No	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,314	1,322	1,217	1,314	1,322	1,217
R-squared	0.904	0.707	0.763	0.905	0.710	0.765

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.7: Robustness check without lags

The table reports the estimates of the model at firm-bank level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. GreenQ is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the emission quartile. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. Control variables are not lagged. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

of green firms within the industry was greater than the number of brown firms. Now, we exploit the same methodology used at the firm level to define whether a firm was green. This is done by taking *Average Level Emission Ind* and comparing it to *Emission Threshold* Ind (see Appendix A.2 for variables definition). Moreover, we use as a dependent variable the natural logarithm of bank total loans. This model is estimated both with and without lags in the control variables. Column (1) and (2) of Table 4.8 display the results: the interaction coefficients are always positive and significant. Finally, in column (3) of Table 4.8, we try to exploit a more standard classification of green industries, by exploiting the European Taxonomy and the NACE2 industry classification (Kooroshy, Dai, and Clements (2020)). The number of green industries is much lower (12) than the brown ones (201). By taking the baseline specification without lags and the natural logarithm of total loans as a dependent variable, the coefficient estimates are positive and significant, in line with our previous results.

	Model with Lag	Model without Lag	Model with Taxonomy
	Bank Loans	Bank Loans	Total Loans
	(1)	(2)	(3)
Green x Post	1.101***	0.772**	0.468*
	(0.363)	(0.336)	(0.271)
Time FE	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes
Observations	865	994	1,332
R-squared	0.171	0.320	0.322

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4.8: Industry robustness Checks

The table reports the estimates of the model at the industry level. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if industry's average emissions from 2013 to 2019 are below the industry sample mean emission. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. In columns (1) and (2), control variables are both with and without lags. In column (3), Green is defined based on the European Taxonomy and control variables are taken without lags. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

Conclusion

One of the most debated questions in the current discussion on climate policies is whether the financial sector may play a fundamental role in the green transition leading to a substantial reduction in emissions. We study this issue in the context of the European banking sector over the 2013-2021 period. Using firm-bank data, we find strong and robust evidence that, during the Covid-19 pandemic, banks provided more loans to green firms. This is even more true for the relationship between the biggest banks and the biggest and fastest growing firms of our sample. Indeed a companys' greenness seems to alter the traditional framework of Holmstrom and Tirole (1997), where big banks prefer to lend to smaller and riskier firms. Our evidence is also confirmed at industry level.

Furthermore, using several set of fixed effects, it appears that these results may be attributed to the supply side instead of being driven by demand. This is also confirmed by the analysis carried out adding a demand proxy that takes into account the severity of the pandemic shock.

We also show that green loans provided during the pandemic were followed by a reduction in emissions. Ex-ante more polluting firms start to cut their emissions in order to be eligible for new (green) loans. In conclusion, our results suggest that the benefits of an action to limit climate change are not only resulting from the reallocation of credit supply towards green firms, but also from the fact that brown firms are trying to reduce their emissions. In any case, even though the overall economic effects appear to be very small (maybe because it is still too early to study them), they nonetheless represent a good starting point for future research.

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Appendix A

Data

Our empirical analysis exploits four different data sources. Firm level data for listed companies are downloaded from Bureau Van Dijk's *Orbis*, while bank's unconsolidated balance sheet data from *Moody's BankFocus*. Firms and banks were selected from European countries and the United Kingdom and were matched trough a fuzzy merge technique.

A.1 Fuzzy Matching Techinique

The match between firms from *Orbis* and banks from BankFocus is possible because of the availability in *Orbis* of the name of firm's main lenders. However, it just provides main lenders' names without any identification code through which an exact matching with the banks' name from *BankFocus* could have been done. This is the reason why we are forced to use fuzzy matching based on bank's names. After cleaning bank's names from any non-alphabetic characters and typing them in lower case, the function *reclink* is used to generate a score based on the similarity of the matched strings (bank's names). Figure A.1 reports the distribution of the matching score, which is quite satisfactory, given that almost 51% of the observations found an exact match and the observations that have a matching score below 0.9 are fewer than 16% of our initial sample. We decided to drop this 16% of observation so that the probability of making a mistake in the matching is reduced.

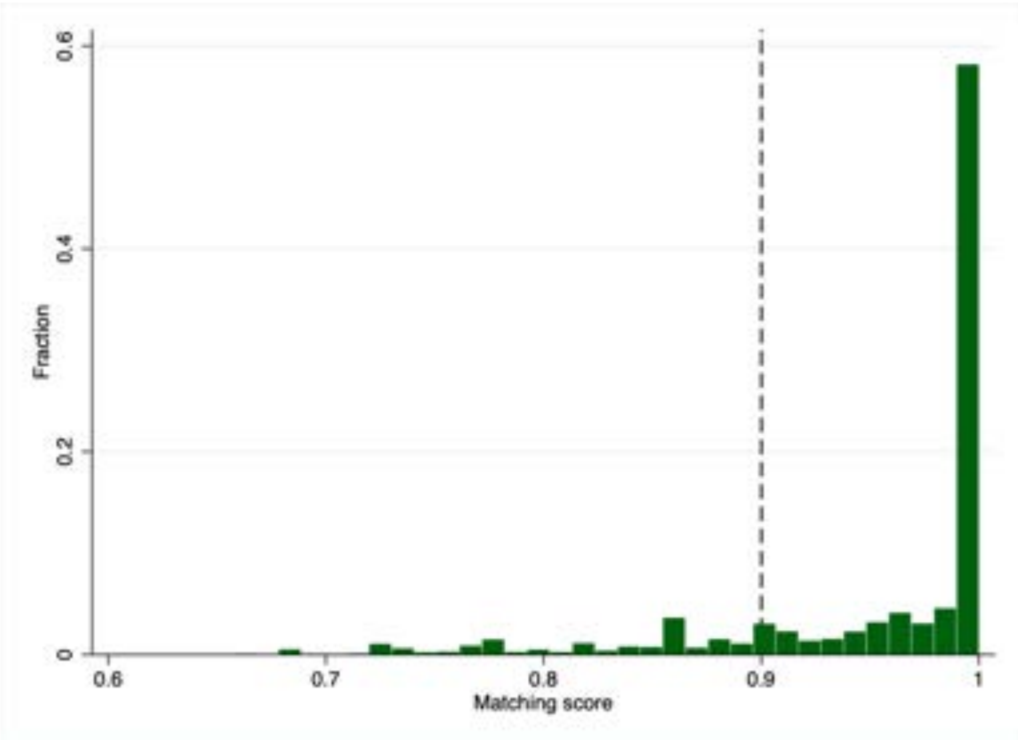

Figure A.1: Matching Performance

This figure represents the distribution of the matching score generated by the fuzzy matching procedure. The dashed line is the threshold below which we drop the observations.

A.3 Greenhouse Gas Emissions

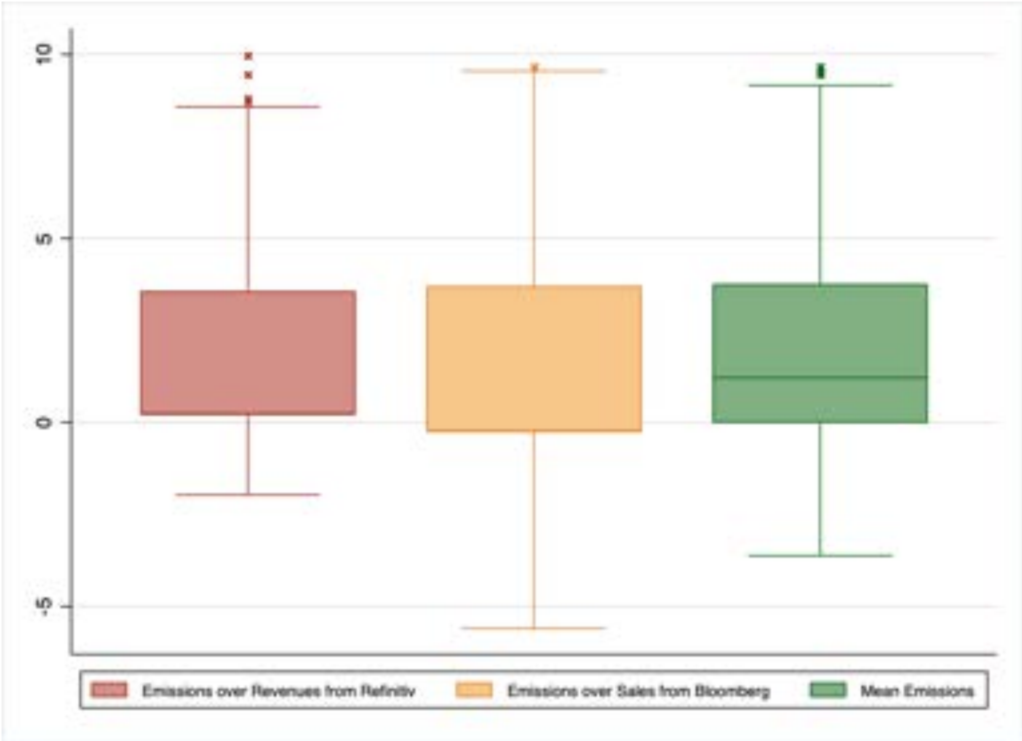

Figure A.2: Emission Distribution

This figure represents the distribution of emission data dowloaded from Refinitiv and Bloomberg. The green boxplot considers the average emission between these two sources.

A.2 Variable Definition

Variables	**Definition and source**
Main variables	
Ln(Total Loans)	Natural logarithm of the ratio between total loans and total assets (Source: Orbis)
Ln(Bank Loans)	Natural logarithm of the ratio between total bank loans and total assets (Source: Orbis)
Post	A binary indicator that equals 1 during 2020 and 2021, and 0 otherwise
Green	A binary indicator that equals 1 if the average firm level of emission from 2013 to 2019 is lower than the average of total emissions produced by all firms from 2013 to 2019, and 0 otherwise
GreenQ	A binary indicator that equals 1 if the average firm level of emission from 2013 to 2019 is lower than the lower quartile of the distribution of total emissions produced by all firms from 2013 to 2019, and 0 otherwise
Firm Controls	
Ln(Total Assets)	Natural logarithm of firm total asset (Source: Orbis)
Ln(Tangible Assets)	Natural logarithm of the ratio between firm tangible asset and total asset. It holds for Intangibles too (Source: Orbis)
Ln(Liabilities)	Natural logarithm of the ratio between total liabilities (computed as the sum of non current and current liabilities) and total assets, i.e. debt-to-asset ratio (Source: Orbis)
Ln(Revenues)	Natural logarithm of the ratio between total revenues and total assets, i.e. turnover ratio (Source: Orbis)
Ln(ROE)	Natural logarithm of the return on equity (Source: Orbis)
Bank Controls	
Equity ratio	Natural logarithm of the ratio of bank equity to total asset, i.e. equity-to-asset ratio (Source: Orbis BankFocus)
Size	As a bank control, it is a dummy variable equal 1 for top 10% banks, 0 otherwise; while, in the triple interaction for heterogeneity, we used the natural logarithm of bank total assets (Source: Orbis BankFocus).
ROA	Bank's return on assets (Source: Orbis Bank Focus)
Tier1CapitalRatio	Natural logarithm of Tier1 Capital Ratio (Source: Orbis BankFocus)
Firm Emission Level	
Mean Emissions	Average level of emissions between data retrieved by Refinitiv and Bloomberg for each year (Source: Refinitiv and Bloomberg)
Mean Emissions Ind	Average level of firm *Mean Emissions* by industry (*NACE2*)
Average Level Emission	Average level of *Mean Emissions* for each firm in each year from 2013 to 2019
Average Level Emission Ind	Average level of *Mean Emissions Ind* for each industry in each year from 2013 to 2019
Emission Threshold	Mean of Firm *Average Level Emission* from 2013 to 2019
Emission Threshold Ind	Mean of *Average Level Emission Ind* from 2013 to 2019
Emission Threshold Q	Lower quartile of *Average Level Emission* from 2013 to 2019
Industry Classification Codes	
NACE2	2-digit NACE2 core industry classification (Source: Orbis)

Table A.1: Variable Definition

Appendix B

Additional tables

PANEL A: Firm Level						
Total Firms' Variables	N	Mean	StD Dev	p25	p50	p75
Total Loans	10,548	70.70	3.77	0.139	2.882	21.38
Bank Loans	6,813	197.4	4.49	0	15.01	72
Total Assets	10,548	6,842	5.18	42.17	42.17	42.17
Total Liabilities	10,548	5,328	4.90	14.23	14.23	1,124
ROE	10,331	20.68	2.81	5.601	13.46	25.07
Tangible Assets	10,548	1.801	3.56	6.479	129.5	706.5
Total Revenues	9,591	3,145	5.86	28.63	28.63	28.63
Emission to Revenues	7,927	103.8	4.82	1.250	1.250	35.47
Emission to Sales	7,285	113.5	4.84	0.783	0.783	40.65
Mean Emission	8,556	125.8	4.60	1.017	3.474	45.39
Brown Firms' Variables	N	Mean	StD Dev	p25	p50	p75
Total Loans	2,880	57.94	3.21	0.359	3.974	32.21
Bank Loans	1,841	246.6	3.73	0.0975	12.98	153.8
Total Assets	2,880	4,434	3.16	42.17	42.17	42.17
Total Liabilities	2,880	3,599	2.82	14.23	14.23	2,204
ROE	2,843	19.30	2.48	5.469	12.37	21.51
Tangible Assets	2,880	2,335	2.36	11.33	186.1	1,516
Total Revenues	2,538	1,980	3.88	28.63	28.63	28.63
Emission to Revenues	1,926	322.8	1.76	1.250	1.250	515.4
Emission to Sales	1,819	388.0	2.71	0.783	0.783	566.8
Mean Emission	2,113	419.4	2.49	1.017	12.52	573.3
Green Firms' Variables	N	Mean	StD Dev	p25	p50	p75
Total Loans	7,668	75.49	3.85	0.0915	2.529	18.96
Total Assets	7,668	7,747	4.87	42.17	42.17	42.17
Bank Loans	4,972	179.2	5.25	0	15.58	63.44

Total Liabilities	7,668	5,978	5.01	14.23	14.23	761.8
ROE	7,488	21.20	2.90	5.723	14.03	26.35
Tangible Assets	7,668	1,601	4.19	4.175	116.8	571.4
Total Revenues	7,053	3,565	5.88	28.63	28.63	28.63
Emission to Revenues	6,001	33.50	13.60	1.250	1.250	25.17
Emission to Sales	5,466	22.14	1.91	0.783	0.783	24.31
Mean Emission	6,443	29.49	7.55	1.017	3.363	28.63

PANEL B: Bank Level						
Bank Variables	N	Mean	StD Dev	p25	p50	p75
Total Bank Loans	10,548	87,793	1.91	0	3,897	143,598
Total Assets	10,548	144,070	2.05	0	2,839	130,640
Total Equity	10,548	9,787	2.10	0	44.92	8,939
Tier 1 Capital Ratio	6,248	2.688	0.084	2.535	2.679	2.856
ROA	10,548	1.282	0.83	0.0672	2.183	2.183

Table B.1: Summary Statistics

All summary statistics refer to the time window 2013 - 2021. Panel A refers to firm level variables. Each variable is winsorized between 1st and 99th percentile of firm's credit. Panel B refers to bank level variables. Observations are winsorized between the 1st and 99th percentile of bank's gross loans.

Table B.2: Real effects of a greater supply of green loans on emissions

ΔLn(Mean Emission)	(1)	(2)	(3)	(4)
Green x Post x $\Delta ln(TotLoans)$	-0.175***		-0.214***	
	(0.0422)		(0.0393)	
Green x Post x $\Delta ln(BankLoans)$		-0.0448		-0.170***
		(0.0429)		(0.0567)
Time FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	No	No
Industry FE	No	No	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Observations	2,326	1,262	2,346	1,277
R-squared	0.218	0.305	0.127	0.198

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table reports the estimates of the following model:

$$\Delta ln(MeanEmissions)_t = \alpha + \beta_0 \times Green_{t-1} \times Post_{t-1} \times Loans + \beta_1 \times \Delta Bank_{it-1}$$
$$+\beta_2 \times \Delta Bank_{it-1} \times Post_{t-1} + \beta_3 \times \Delta Firm_{t-1} + \phi_{t-1} + \theta_j + NAICS_{jt-1} + \epsilon_{ijt-1}$$

The dependent variable is the growth of the natural logarithm of Mean Emissions. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Green is a dummy variable equal 1 if firm's average emissions from 2013 to 2019 are below the sample mean emission. Observations are winsorized around the 1st and 99th percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. Control variables are taken as lagged growth rates. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

Table B.3: Real effects of a firm emissions

ΔLn(Emissions)	(1)	(2)
Brown x Post	-0.680**	-0.462*
	(0.281)	(0.254)
Time FE	Yes	Yes
Firm FE	Yes	No
Industry FE	No	Yes
Bank Controls	Yes	Yes
Firm Controls	Yes	Yes
Observations	2,326	2,346
R-squared	0.214	0.121

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The table reports the estimates of the following model:

$$\Delta ln(MeanEmissions)_t = \alpha + \beta_0 \times Brown_{t-1} \times Post_{t-1} + \beta_1 \times \Delta Bank_{it-1}$$
$$+\beta_2 \times \Delta Bank_{it-1} \times Post_{t-1} + \beta_3 \times \Delta Firm_{t-1} + \phi_{t-1} + \theta_j + NAICS_{jt-1} + \epsilon_{ijt-1}$$

The dependent variable is the growth of the natural logarithm of Mean Emissions. Post is a dummy variable equal 1 if year is equal 2020 or 2021, 0 otherwise. Brown is a dummy variable equal 1 if the average firm level of emissions from 2013 to 2019 is lower than the average fo total emissions produced by all firms from 2013 to 2019, and 0 otherwise. Observations are winsorized around the 1st and 99^{th} percentile of credit. Bank and firm controls are those specified in Section A.2. Bank controls are included as standalone and interacted with the Post dummy variable. Control variables are taken as lagged growth rates. Standard errors are clustered at the firm-bank level *** p<0.01, ** p<0.05, * p<0.1.

Appendix C

Additional figures

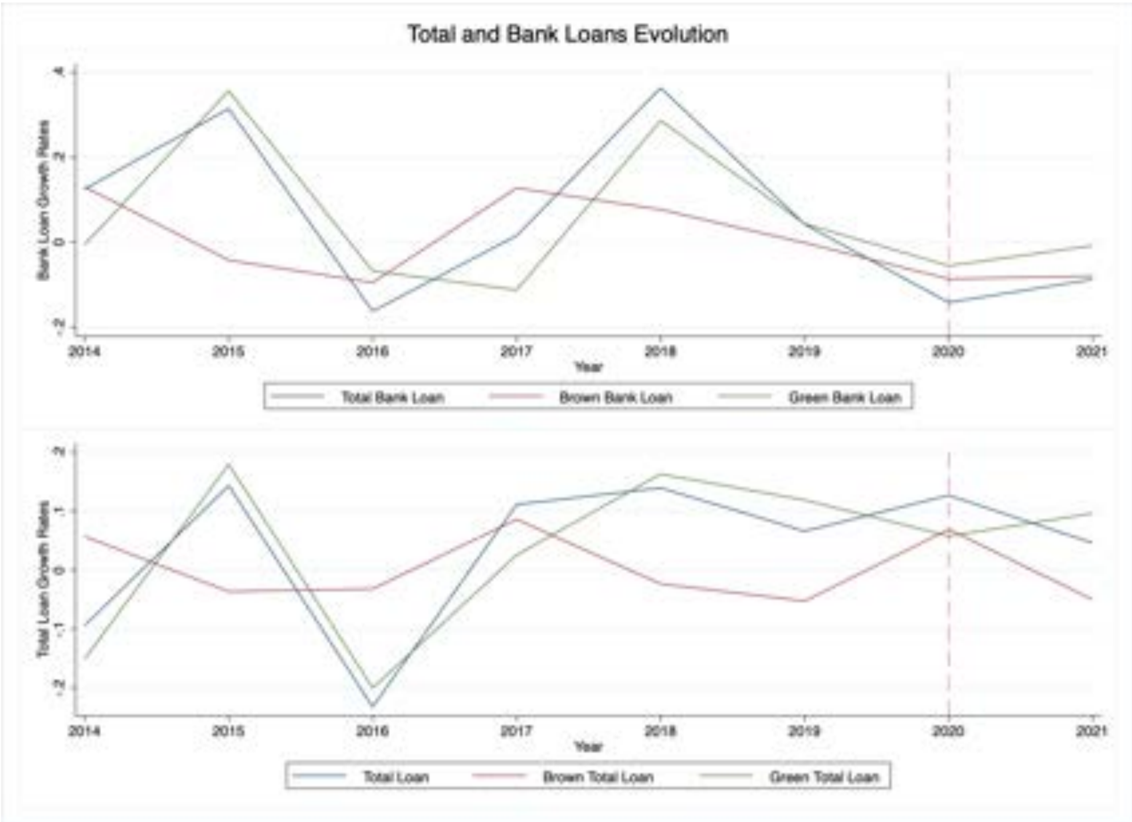

Figure C.1: Evolution of Bank and Total loans by Green and Brown firms

In this figure, we can see the evolution of total, green and brown loans. In the upper plot, we represent firm bank loans, while in the lower part we consider all firm loans. In 2020, we can observe a decrease of total brown loans and an increase of green total loans. A similar pattern is shown for green and brown bank loans too. In this case, while green loans begin to increase, brown loans seem to remain stable.

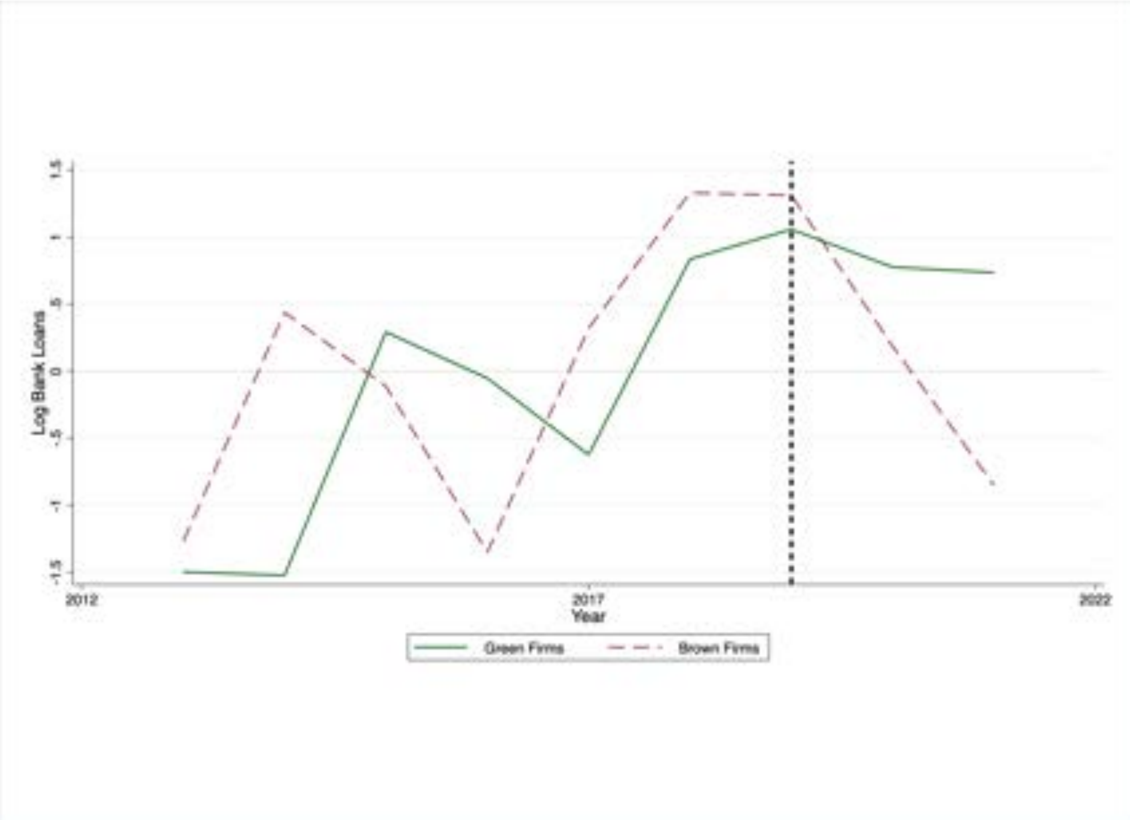

Figure C.2: Bank Lending: Parallel Trends

This figure illustrates the bank lending channel by comparing lending to green and brown firms. For each year we aggregate all the loans to these firms and plot the time series for this aggregate lending. To ease comparability, we normalize the y-axis. As we can see from the graph, green and brown loans have a similar trends up to a point where brown ones start to sharply decrease, while green loans decline less remaining quite stable.

Bibliography

Acharya, V. V. and S. Steffen (2020). "The risk of being a fallen angel and the corporate dash for cash in the midst of COVID". In: *Review of Corporate Finance Studies* 9, pp. 430–471.

Amundi Asset Management (2020). "The Coronavirus and ESG Investing, the emergence of the Social pillar". In: *Responsible investing performance Report*.

Amundi Asset Management (2021). "The Recent Performance of ESG Investing, the Covid-19 Catalyst and the Biden Effect". In: *Responsible investing performance Report*.

Baker, M. and J. Wurgler (2015). "Do Strict Capital Requirements Raise the Cost of Capital? Bank Regulation, Capital Structure and the Low Risk Anomaly". In: *American Economic Review* 105(5), pp. 315–320.

Bekaert, G., E. C. Engstrom, and N. R. Xu (2021). "The time variation in risk appetite and uncertainty". In: *Columbia Business School Research Paper*(17-108).

Berger, A. N. and G. F. Udell (2002). "Small Business Credit Availability and Relationship Lending: The Importance of Bank Organisational Structure". In: *The Economic Journal* 112(477), F32–F33.

Bernardini, E. et al. (2021). "Banche centrali, rischi climatici e finanza sostenibile". In: *Bank of Italy Occasional Paper*(608).

Bolton, P. and M. Kacperczyk (2020). "Global pricing of carbon transition risk". In: *NBER Working Paper*(28510).

Bolton, P. and M. Kacperczyk (2021). "Do investors care about carbon risk?" In: *Journal of Financial Economics* 142(2), pp. 517–549.

Brogi, M. and V. Lagasio (2019). "Environmental, social, and governance and company profitability: Are financial intermediaries different?" In: *Corporate Social Responsibility and Environmental Management* 26(3), pp. 576–587.

Cardillo, S., R. Gallo, and F. Guarino (2021). "Main challenges and prospects for the European banking sector: a critical review of the ongoing debate". In: *Bank of Italy Occasional Papers*(634).

Carlson, J. C. et al. (2021). "Climate change increases cross-species viral transmission risk." In: *Nature Reviews*(607), pp. 555–562.

Chodorow-Reich, G. et al. (2020). "Bank liquidity provision across the firm size distribution". In: *Journal of Financial Economics* 144(3), pp. 908–932.

Choi, D., Z. Gao, and W. Jiang (2020). "Attention to global warming". In: *The Review of Financial Studies* 33(3), pp. 1112–1145.

Colak, G. and Ö. Öztekin (2021). "The Impact of COVID-19 Bank Lending Around the World". In: *Journal of Banking Finance* 133(106207), pp. 1112–1145.

Degryse, H. et al. (2019). "Identifying credit supply shocks with bank-firm data: Methods and applications". In: *Journal of Financial Intermediation* 40(C).

Delis, M. D., K. de Greiff, and S. Ongena (2019). "Being Stranded with Fossil Fuel Reserves? Climate Policy Risk and the Pricing of Bank Loans". In: *Swiss Finance Institute Research Paper*(18-10).

Ehlers, T., F. Packer, and K. de Greiff (2021). "The pricing of carbon risk in syndicated loans: which risks". In: *Bank of International Settlement Working Paper*(946).

European Central Bank (2020a). "Financial Stability Review". In(: November).

European Central Bank (2020b). "Financial Stability Review". In(: May).

Fatica, S. and R. Panzica (2021). "The pricing of carbon risk in syndicated loans: which risks". In: *JRC Working Papers in Economics and Finance (European Commission).*

Ferrer, R. (2019). "Climate change, the green transition and the financial sector". In: *Caixa Bank Research Paper.*

G20 (2021). "Rome Leaders' Declaration Finance Track Sections". In: *Ministry of Economics and Finance Working Paper.*

Gandhi, P. and H. Lustig (2015). "Size Anomalies in U.S. Bank Stock Returns". In: *The Journal of Finance* 70(2), pp. 733–768.

Garel, A. and A. Petit-Romec (2021). "Investor Rewards to Environmental Responsibility in the COVID-19 Crisis". In: *Journal of Corporate Finance.*

Ginglinger, E. and Q. Moreau (2019). "Climate risk and capital structure". In: *Université Paris-Dauphine Research Paper.*

Giovannini, A. and F. Tamburrini (2022). "Sustainable Finance: Three Questions in Search of an Answer". In: *European Economy: banks, regulation, and the real sector.*

Global Sustainable Investment Alliance (2020). “Global Sustainable Investment Report”. In.

Greenwald, D. L., J. Krainer, and P. Paul (2020). “The credit line channel”. In: *Federal Reserve Bank of San Francisco Working Paper* 26.

Harris, M. (2022). “ESG should be boiled down to one simple measure: emissions. Three letters that won’t save the planet.” In: *The Economist*.

Hassen, B. T., H. El Bilali, and M. S. Allahyari (2020). “Impact of COVID-19 on food behavior and consumption in Qatar”. In: *Sustainability* 12(17).

Holmstrom, B. and J. Tirole (1997). “Financial intermediation, loanable funds, and the real sector”. In: *The Quarterly Journal of Economics* 112(3), pp. 663–691.

Hong, H., A. G. Karolyi, and J. A. Scheinkman (2020). “Climate Finance”. In: *The Review of Financial Studies* 33(3), pp. 1011–1023.

Horberg, E. P. and D. R. Brooks (2015). “Evolution in action: climate change, biodiversity dynamics and emerging infectious disease”. In: *The Royal Society Journal* 370(1665).

IPCC (2014). *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.*

IPCC (2021). *Climate Change 2021: The physical science basis. Summary for policymakers.*

Kacperczyk, M. T. and J.L. Peydrò (2021). “Carbon Emissions and the Bank-Lending Channel”. In: *Preliminary Draft* 370(1665).

Khwaja, A. I. and A. Mian (2008). “Tracing the impact of bank liquidity shocks: Evidence from an emerging market”. In: *American Economic Review* 98(4), pp. 1413–42.

Kooroshy, J., L. Dai, and L. Clements (2020). “Sizing the green economy: Green Revenues and the EU taxonomy”. In: *FTSE Russell Sustainable Investment Report*.

Li, L. et al. (2020). “Runs and interventions in the time of COVID-19: Evidence from Money Funds”. In: *Division of Research Statistics of the Federal Reserve System, Research Paper*.

Mkhaiber, A. and R. Werner (2020). “The relationship between bank size and the propensity to lend to small firms: New empirical evidence from a large sample”. In: *Journal of International Money and Finance* 110.

Mueller, I. and E. Sfrappini (2021). “Climate change-related regulatory risks and bank lending”. In: *IWH-Halle Working paper*.

NGFS (2019). "A call for action Climate change as a source of financial risk." In: *Network of Central Banks and Supervisors for Greening the Financial System Comprehensive report* 1.

Nguyen, D. D. et al. (2022). "Climate Change Risk and the Cost of Mortgage Credit". In: *Review of Finance*.

Nguyen, J. H. and H. V. Phan (2020). "Carbon risk and corporate capital structure". In: *Journal of Corporate Finance* 64(C).

Oster, E. (2019). "Unobservable selection and coefficient stability: Theory and evidence." In: *Journal of Business Economic Statistics* 37(2), pp. 187–204.

Refk, S. et al. (2021). "Is COVID-19 Related Anxiety an Accelerator for Responsible and Sustainable Investing? A Sentiment Analysis". In: *Applied Economics* 53(13), pp. 1528–1539.

Reghezza, A. et al. (2021). "Do banks fuel climate change?" In: *ECB Working Paper*.

Sajid, K.S. et al. (2022). "The Effect of Fear of COVID-19 on Green Purchase Behavior in Pakistan: A Multi-Group Analysis Between Infected and Non-infected". In: *Frontiers in Psychology Working Paper* 13(826870).

Vor der Leyen, U. (2020). "Speech at the SME United General Assembly on Next Generation EU". In: *European Commission Speech* December.

World Bank (2017). "Speech at the SME United General Assembly on Next Generation EU". In: *World Bank Group Announcements at One Planet Summit Press release* December.

World Resource Institute and World Business Council for Sustainable Development (2004). "The Greenhouse Gas Protocol". In: *Chapter 4*.

Worobey, M. et al. (2022). "The Huanan Seafood Wholesale Market in Wuhan was the early epicenter of the COVID-19 pandemic". In: *Science*.

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