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Ongena, Steven

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Which banks for green growth? A review and a tentative research agenda

Steven Ongena*,[1]

University of Zurich, the Swiss Finance Institute, KU Leuven, NTNU Business School, CEPR, Switzerland

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ABSTRACT

Which commercial banks are best for green growth? This note aims to review the literature and to provide some potential elements for a research agenda in this space. Commercial bank size (business model, too-big-to-fail status, political or media connections), ownership (captivity, common), depositors, nationality, and orientation are discussed as salient dimensions.

A key question in economics is whether, under what conditions and how finance fosters local entrepreneurship and economic growth.[2] Unsurprisingly, therefore, scholars have begun exploring whether, under what conditions and how finance, in particular banking, can help foster *green* entrepreneurship and/or firm transition / adaptation,[3] and thus *green* economic growth. As the financial system plays a key role in allocating resources in the economy, it is salient to observe that the transition to a climate neutral economy will require a large amount of financing.

Indeed, between now and 2050, 100 to 300 trillion USD, or one to three times world GDP, may be needed in investment, hence understanding why and how green financing matters, and could be falling short, during the transitioning to a carbon-neutral economy has become a first-order question. Xu and Kim (2021) for example provide evidence that financial constraints increase firms' toxic emissions (as firms actively trade off abatement costs against potential legal liabilities), and in Bartram, Hou, and Kim (2022) constrained firms (unintended by regulation) even increased their total emissions after the California cap-and-trade rule by shifting production to other states where they have similar plants that were underutilized.[4]

Thus, understanding the allocation process and the underlying transactional and informational frictions in the financial system is key.[5] This short literature review (including a research agenda) aims to talk to this nascent literature.

In the so-called "functional approach" to finance (e.g., Méndez and Ongena (2020)), which is well summarized in for example Levine (1997) and Levine (2005), there are five functions a financial system needs to fulfill: "1) produce information ex ante about possible investments and allocate capital; 2) monitor investments and exert corporate governance after providing finance; 3) facilitate the trading, diversification, and management of risk; 4) mobilize and pool saving; and 5) ease the exchange of goods and services" (Levine (2005), p. 869). Hence, when

* Correspondence to: Universität Zürich, Institut für Banking und Finance, Plattenstrasse 14, CH-8032 Zürich, Switzerland.
E-mail address: steven.ongena@bf.uzh.ch.

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[2] Starting with Schumpeter and until more recently, entrepreneurship has been considered an important component of economic growth (Schumpeter, 1934; Aghion and Howitt, 1992; Akcigit and Kerr, 2018). It is therefore no surprise that its determinants have attracted scholarly attention (e.g., Dunne, Roberts, and Samuelson (1988); Glaeser and Kerr (2009); Kerr and Nanda (2010)).

[3] Green entrepreneurship can be defined as referring "to a special subset of entrepreneurship that aims at creating and implementing solutions to environmental problems and to promote social change so that the environment is not harmed" (Saari and Joensuu-Salo (2019), op. cit. p. 1). "Green Growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies" (OECD (2024)).

[4] There are other constraints, than financial, that may affect different types of investment. De Haas, Martin, Muûls, and Schweiger (2024) for example show that holding back corporate investment in green technologies embodied in new machinery, equipment, and vehicles may be binding credit constraints, investment in measures to explicitly reduce emissions and other pollution may be held back more by management quality. See also Liu and Xu (2024) for the combined impact with regulatory constraints.

[5] Environmental regulation can in fact aggravate financial frictions and limit the ability of firms to undertake investments in sustainable technologies (Hoffmann, Inderst, and Moslener, 2017; Biais and Landier, 2022). The lower than required investment can even affect the exposure of firms to transition and physical risk negatively (Döttling and Rola-Janicka (2023)).

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financial development occurs financial instruments, financial markets, and intermediaries mitigate the potentially deleterious effects of transaction costs, information asymmetry,[6] and/or difficulties in enforcing contracts, and in providing the five financial functions. Each one of these functions improves savings and investment decisions and consequently economic growth.

In contrast to the so-called "money" approach (e.g., Gurley and Shaw (1955); Tobin (1965) and McKinnon (1973)), the functional approach highlights the value added by the financial sector to economic growth. "The financial system is a 'real' sector: it researches firms and managers, exerts corporate control, and facilitates risk management, exchange, and resource mobilization" (Levine (1997), p. 689). In the functional approach, financial markets and institutions arise, and continue to adapt, to solve the problems created by transaction and information frictions. However, the primary function of any financial system is to "facilitate the allocation of resources, across space and time, in an uncertain environment" (Merton and Bodie (1995), p. 12), mainly through capital accumulation and technological innovation (Levine (1997)).[7]

Within the vast literature on the finance-growth nexus, we want to highlight two discussions. The first discussion addresses the potential differential impact on economic growth of *market-* versus *bank-based* finance (e.g., Beck, Demirgüç-Kunt, Levine, and Maksimovic, 2001; Levine, 2005). Second, there is a recent discussion on whether bank-based finance is *always* equally helpful in fostering (stable) economic growth. *Bank size* and/or *business models* may differ in terms of generalists versus specialists (e.g., Paravisini, Rappoport, and Schnabl, 2023), and/or transactional versus relationship or captive models (e.g., Bolton, Freixas, Gambacorta, and Mistrulli, 2016),[8] *bank nationality* may differ in terms of home versus foreign banks (e.g., Beck, Ioannidou, and Schäfer, 2018), and *bank orientation* may differ in terms of conventional versus religiously or culturally inspired banks (e.g., Abedifar, Molyneux, and Tarazi, 2013; Beck, Demirgüç-Kunt, and Merrouche, 2013).

In this regard we aim to complement recent reviews by de Bandt et al. (2023), De Haas (2023) and Mamonov, Ongena, and Pestova (2024) by focusing on the types and characteristics of financiers, in particular banks, and their impact on long-run, green economic growth, rather than on the impact of climate (and other disaster) risks on their balance sheets, which for banks, and similarly to investors in financial markets can be categorized as physical and transition risks (e.g., Krueger, Sautner, and Starks, 2020). In terms of physical risk, a rapidly expanding global literature investigates how banks may for example price the risk of sea level rise ex ante in their mortgages to households (e.g., Nguyen, Ongena, Qi, and Sila, 2022 for the US) and/or adjust the volume of their lending to the risk of high temperatures, droughts, floods, and/or hurricanes (e.g., Li and Wu, 2023 for China). Banks also recognize technological transition risks in their lending and may for example lend less when legacy assets are jeopardized in their collateral value (e.g., Degryse, Roukny, and Tielens, 2024).

The rest of the paper proceeds as follows. Section I briefly introduces the market versus bank argumentation. Section II provides the main discussion on bank characteristics and green growth. Section III concludes.

1. Markets versus banks

As discussed, one of the main economic functions of the financial sector is to efficiently allocate capital. There is substantial empirical evidence that financial development, either market- or bank-based, fosters economic growth (e.g., King and Levine, 1993; Rajan and Zingales, 1998; Beck and Levine, 2002; Bruno and Hauswald, 2014).

Whether market and bank lending to firms both equally stimulate "sustainable" growth is less clear. For example, a recent insightful published paper by De Haas and Popov (2023) indicates that equity financing may be superior to debt financing when it comes to decarbonizing the economy. In the face of climate transition, financiers may facilitate or hinder the channeling of funds in different ways towards activities that contribute to the green transition.

Ample literature shows that climate transition is a risk for the financial system because of the risk of stranded assets (Batten, Sowerbutts, and Tanaka, 2016; Dicou, de Vries-van Ewijk, Kakes, Regelink, and Schotten, 2016; Caldecott, Harnett, Cojoianu, Kok, and Pfeiffer, 2016; Gros et al., 2016; Furukawa, Ichiue, and Shiraki, 2020). So far, however, only a few studies have explored how bank lending patterns change along with increasing transition risks.

Delis, de Greiff, Iosifidi, and Ongena (2023) for example shows for the period 2007–2016 that fossil fuel firms that are more exposed to climate policy risk are on average not charged higher loan spreads than otherwise similar non-fossil fuel firms or comparable fossil fuel firms. Only after Paris COP21 in 2015 was pricing action taken. Building on this work, Beyene, De Greiff, Delis, and Ongena (2023a) aims to add to the literatures on efficient bank credit allocation (e.g., Diamond and Rajan, 2009; Langfield and Pagano, 2016) as well as on the substitutability between public-market bond debts and private bank loans (e.g., Becker and Ivashina, 2014; Ruggiero, 2018). They investigate how fossil fuel firms substitute from bonds to loans along their transition risk. This substitution may constitute a misallocation of bank credit, in the sense that banks "over-engage" and "under-price" transition risk compared to bond market.

More specifically, they investigate whether fossil fuel firms' composition of bank relative to bond financing changes along with their risk of having stranded assets. On the one hand, fossil fuel resource extraction is capital-intensive and firms in the energy industry traditionally run highly leveraged balance sheets. On the other hand, the transition to a low-carbon economy creates credit risks for the financial sector because it limits the extraction and use of fossil fuel resources by companies to which banks and bondholders may have credit exposures. As governments move to control carbon emissions, bondholders and banks are expected to first respond by demanding a higher interest rate – to compensate for the increased risk of stranded assets – and eventually to exclude the riskiest fossil fuel sector borrowers. While it is generally acknowledged that the finance sector improves the efficiency of capital allocation in the economy, there is no clear-cut picture of the relative performance of corporate bond-based versus bank-based finance in withdrawing funds from declining industries. They therefore compare the relative extent to which bondholders and banks are a source of misallocation during the climate transition by being less likely to decrease the funding of climate-change inducing activities (i.e., of fossil fuel firms).

They present evidence that bond markets price the risk that reserves held by fossil fuel firms strand, while banks in the syndicated loan market do not. Consequently, fossil fuel firms increasingly rely less on

[6] Financial intermediaries, with loan and deposit contracts, arise in Diamond (1984), the ordering with market credit in Diamond (1991), and relationships between financial intermediaries and (corporate) borrowers emanate in Sharpe (1990), Fischer (1990), and von Thadden (2004).

[7] As regards capital accumulation, one class of growth models uses either capital externalities or capital goods. These are produced using constant returns of scale (but without nonreproducible factors) to generate steady-state per capita growth (Romer, 1986; Lucas, 1988; Rebelo, 1991). In these models, the functions performed by the financial system affect steady-state growth by influencing the rate of capital formation. The financial system affects capital accumulation either by altering the savings rate or by reallocating savings among different capital producing technologies. As regards technological innovation, a second class of growth models focuses on the invention of new production processes and goods (Romer, 1990; Grossman and Helpman, 1991; Aghion and Howitt, 1992). In these models, the functions performed by the financial system affect steady-state growth by altering the rate of technological innovation (Levine (1997), p. 691).

[8] See Boot and Thakor (2000) for a model capturing the bank`s choice of business model and industry specialization.

bonds and more on loans.[9] They interpret the within-firm bond-to-loan substitution in stranding risk as a contraction in the supply of bond credit versus bank credit. I discuss these issues more in the next sections.

2. Commercial banks

In Europe, banks are among the most important financial intermediaries.[10] Size and ownership of banks are known to be among their defining characteristics, and may correspond for example not only to observed business and funding models, and political connections, elements discussed below, but also to managerial compensation, contribution to systemic risk, regulatory requirements, supervisory oversight, among other elements, that will not be discussed in much detail.

The absolute and relative size of banks around the world has been increasing uninterruptedly during the last century (Schularick, 2023), possibly due to globalization, financialization, managerial empire building, barriers to entry and policy making during financial crises. A number of global banks are now considered not only too-big-to-fail, but also too-big-to-save.[11]

Ownership has also shifted from public to private (e.g., La Porta, Lopez-de-Silanes, and Shleifer, 2002), and recently also become more common, and concentrated. As important corollaries of growth in size and changes in ownership, banking market concentration has been increasing and bank branches have been both closing (e.g., Bonfim, Nogueira, and Ongena, 2021; Keil and Ongena, 2023) and clustering geographically (e.g., Qi, De Haas, Ongena, Straetmans, and Vadasz, 2023).

Mostly missing from the academic literature so far is a rigorous scientific investigation how the increasing size and changes in ownership of banks, and corresponding market concentration and debranching, may provide both challenges and opportunities for climate transition and biodiversity conservation.

2.1. Bank size

2.1.1. Bank economies of scale and business model

Large banks are observed to lend to large, distant firms employing predominantly "hard" information (e.g., accounting numbers, financial ratio's) in their loan decisions (Cole, Goldberg, and White, 2004; Berger, Miller, Petersen, Rajan, and Stein, 2005; Uchida, Udell, and Watanabe, 2006; Strahan, 2008),[12] while small banks lend to small, opaque, and/or close firms (Petersen and Rajan, 2002; Saunders and Allen, 2002),[13] using mainly "soft" information (e.g., a character assessment of the entrepreneur, the degree of trust; de Blasio (2009)) because small firms may lack any (audited) records for example (e.g., Brown, Ongena, and Yeşin, 2011).

To screen successfully, loan officers may need to interact with the borrower, establish trust, and be present in the local community. This is soft information and is difficult to convey to others within the organization.

Stein (2002) models this observed correspondence based on the organizational impact of the ease and speed at which different types of information can "travel" within an organization. Hard information can be passed on easily within the organization while soft information is much harder to relay. Hence, if the organization employs mostly soft information, a simple, flat, decentralized structure, and local decision making may be optimal.[14]

In practice large banks are often centralized, rely on hard information, and conduct a transactional business model, while small banks resemble a decentralized organization, employ more soft information, and aim to establish long-lasting relationships with their clients.

Bank size is almost by definition increasing through bank mergers and acquisitions (M&As). A natural question is then how small borrowers will be affected by bank M&As where a large acquirer bank takes over a small target bank. Given the potential change in business model experienced for the (small) firms serviced by the target bank, i.e., from relationship to transactional, it is natural to conjecture that these firms will suffer. That is indeed what the literature finds (Sapienza, 2002; Karceski, Ongena, and Smith, 2005; Bonaccorsi di Patti and Gobbi, 2007).[15] And as noted before, in general, as banks grow, they tend to focus more on financing larger firms (also Peek and Rosengren, 1998), and relatively speaking maintain fewer branches (DeLong, 2001; Keil and Ongena, 2023).

The pass through of bank M&As to biodiversity and nature conservation may run through the size of the firms. Take farms for example. Large banks may prefer to lend to large agrobusinesses, ignoring small plot holders. Large agrobusinesses may pursue more intensive monocultural farming thereby relying more on hired labor, machinery and on pesticides, which may require more financing.

Consequently, larger agricultural firms may cause substantial environmental degradation (Tittonell et al., 2020). For instance, the literature has looked at the negative ecological impacts of large-scale agrofuel monoculture production systems (e.g., Altieri, 2009a, 2009b). Similarly, the potential benefits of mixed-species production forest over monocultures have been widely analysed. These benefits include improved habitats for biodiversity (e.g., Lindenmayer and Hobbs, 2004; Carnus et al., 2006; Brockerhoff, Jactel, Parrotta, Quine, and Sayer, 2008; Felton, Lindbladh, Brunet, and Fritz, 2010), improved soil conditions (e.g., Brandtberg, Lundkvist, and Bengtsson, 2000) and even lower risk of diseases (e.g., Jactel and Brockerhoff, 2007).

Hence, whether bank mergers and corresponding bank size lead to more lending to larger agricultural firms and, thus, more nature loss, is a salient empirical question.[16] In this context, environmental regulation

[9] Possible because banks are considered too big to fail and/or politically connected and able to push stranding into the future. See later discussions on both elements.

[10] Total assets of banks in the European Union (Switzerland) for example amount to almost 30 (3) trillion EUR now, around 1.5 (3) times GDP in 2022. While total assets of nonbanks in the European Union (Switzerland) are over 40 (1) trillion EUR now, for corporate credit, household finance, and the functioning of the financial system banks remain vital (Source: *European Commission*; *Federal Statistical Office*). Nonbanks may include (depending on country and time) investment banks, mortgage lenders, money market funds, insurance companies, hedge funds, private equity funds, and peer-to-peer platform lenders.

[11] For example, the total assets of UBS Group AG in 2023Q1 amounted to 1600 billion USD, almost double the GDP of Switzerland in 2023 which is expected to amount to 906 billion USD (source: *worldeconomics.com*).

[12] See, e.g., Liberti and Petersen (2018) on the differences between hard versus soft information and Degryse, Kim, and Ongena (2009) for a general treatise on empirical implications.

[13] However, the firm size–bank size matching may be not equally strong in all size classes and may be dependent on actual loan officer authority (Benvenuti, Casolaro, Del Prete, and Mistrulli, 2009) and bank ownership (Delgado, Salas, and Saurina, 2007).

[14] Recent empirical evidence by Liberti (2004) and Ogura (2006), for example, indeed suggests bank centralization and the intensity of usage of hard information go hand in hand.

[15] When banks merge and local markets become more concentrated, local access to credit may deteriorate, and even local crime may soar (Garmaise and Moskowitz, 2005).

[16] A well-recognized issue in (bank) M&A analysis is the choice of the relevant time frame over which to assess its impact, which can not only range from the observation of substantial talks between parties, the public announcement of the deal, to the actual M&A consummation date (e.g., Becher, 2000), but may even include regulatory events (Becher, 2009; Carletti, Ongena, Siedlarek, and Spagnolo, 2021). In addition, M&As may be considered as staggered events and the new applied econometric developments with respect to repeated staggered events (e.g., de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2021) may have to be mobilized. One should also account for the way in which M&As may not be fully exogenous either to some of the outcome variables of interest (e.g., Huang and Östberg, 2023).

can reduce the negative impact of companies on nature and, thus, the damages from nature loss, but it might exacerbate the financial constraints on the side of firms. This exacerbation effect may be stronger for smaller agricultural firms, which have a lower impact on nature loss but are penalized by the larger size of banks due to mergers. The organizational structure of the banking system thus might undermine the effectiveness of environmental regulation (which small farms would more easily fulfill).

Furthermore, one should also account for the hedge value of nature, meaning that the quality of nature plays a role in the ability of the economy to cope with shocks (e.g., Rizzi, 2023). In particular, one needs to look at how the quality of nature interplay with financial constraints when a nature-related shock hits the economy (e.g., Koetter, Noth, and Rehbein, 2020; Rehbein and Ongena, 2020). For instance, the soil quality might affect the severity of droughts, which then has a negative financial impact on the firm. Not accounting for the feedback effects between banks' organizational structure and environmental policies might undermine the effectiveness of environmental policies. Should bank size be found to hinder transition and conservation, this will constitute a major and novel contribution to the academic and policy literatures providing further impetus to worry about the seemingly never-ending consolidation of banks around the world.

2.1.2. Banks that are deemed too-big-to-fail

Big banks — it is widely reported — continue to finance big fossil fuel firms` exploration and extraction of coal, oil, and gas (e.g., Beyene, Delis, and Ongena, 2022). Beyene et al. (2023a) show that within the banking sector it is the big banks that provide cheaper, and more financing to fossil fuel firms, possibly giving rise to a novel "too-big-to-strand" concern for banking regulators.

There are two complementary ways of viewing these findings. One the one hand, big banks do this possibly simply because of their too-big-to-fail (TBTF) status (Beyene et al., 2023a). This is a fairly "passive" interpretation because banks only need to load up on fossil fuel loans, while the financial stability regulator (which wants to keep these banks afloat irrespective) gets into conflict with the environmental regulator (which works in the direction of stranding the reserves of the fossil fuel firms thereby potentially jeopardizing their repayment to the banks). Beyene et al. (2023a) provide associative evidence that the banks` willingness to provide credit is indeed associated with the sovereign support to the bank,[17] tentative evidence that certain bank – fossil fuel firm combinations may be increasingly deemed too "too-big-to-strand".

But there is also a more active interpretation whereby big banks become the "big buddies" for the large fossil fuel firms — and this is ripe for further investigation and discussed below — because the banks` political and media connections, bolstered through common ownership with fossil fuel connected financiers, provides them (both) with some (temporary) environmental regulatory cover which delay the stranding of the reserves held by fossil fuel firms. Or finance and fossil fuel delaying transition.

2.1.3. Banks and political connections

Banks are often described as historical political creations (Calomiris and Haber, 2014), and understanding their granting and allocation of credit may require incorporating knowledge of the specific political context (e.g., Delis, Hasan, and Ongena, 2020; Kempf, Luo, Schäfer, and Tsoutsoura, 2023).

With respect to the climate transition, Beyene et al. (2022) findings that big banks continue to finance big fossil fuel firms` exploration and extraction of coal, oil, and gas (while the main bond market investors are no longer financing fossil fuel firms), could be due to TBTF issues but it could also be consistent with a complementary, more "active", explanation is that banks can provide fossil fuel firms with some sort of "political assistance". Banks are known to be politically very well connected in many countries. For example, banks lend more to large enterprises and to the government if the legal system is unsound (Haselmann and Wachtel, 2007). And privately owned banks may lend more prior to an election to curry favor, in countries like Russia or India (e.g., Fungáčová, Schoors, Solanko, and Weill, 2023; Ghosh, 2023).[18]

But also, in the US, banks are politically well connected, the extent to which may affect the likelihood of receiving a governmental bailout under the Troubled Asset Relief Program for example (e.g., Duchin and Sosyura, 2012; Blau, Brough, and Thomas, 2013; Vukovic, 2021). US banks are known to be active lobbyists (Philippon, 2019). So far banks have been known to lobby to delay or soften financial regulations that limit their actions. But banks possibly may start lobbying more on behalf of fossil fuel firms, in energy related committees in Congress for example, especially after the Paris Agreement which was adopted by 196 parties at the UN Climate Change Conference (COP21) in Paris on 12 December 2015. This event is increasingly being recognized and employed as a shock to climate awareness and expectation of increasing future climate policy stringency. If banks would start contributing and lobbying more on behalf of the fossil fuel industry would therefore be even more surprising. One approach could be to analyze bank lobbying efforts *à la* Leippold, Sautner, and Yu (2024) to assess whether their energy / fossil fuel firm interests have increased, and whether there is ties (credit, location, …) between the banks and the firms reinforcing this increased vigor.

2.1.4. Banks and media

When discussing the behavior of banks in general, but surely also with respect to climate transition and nature conservation, the traditional media (television, printed press, …), the so-called "Fourth Estate", are often overlooked.[19] Yet, nascent work for example documents how banks are covered in the traditional media (e.g., Arnold, 2021), why it may matter (e.g., Culpepper et al., 2024 on consequences for financial regulation), and what banks may be doing about it (e.g., Durante et al., 2022 on banks trying to capture media).

Yet, the competition on the local market for information collection and dissemination, media ownership, and their broadcasts and writings may play a crucial channeling role for the way in which the political class, and with it the banks, can shape the political discourse and sentiment towards climate transition and nature conservation. The media can be an important vehicle to diffuse narratives of aspiration, ambition, and change in society, or do the opposite and create a climate that lacks ambition and innovation (see, e.g., Mishra, Fu, and Ongena, 2023).

The advent of social media has not necessarily diminished the role of traditional media but has generated more competition and conceptual critiques by a multitude of stakeholders. Traditional print (and visual) media seems to have consequently embarked on a path of "catching eyeballs" (or "shrill calls for attention"), which may have resulted in the proliferation and commoditization of negativity, fear, and emotion. While this may provide an additional layer of suasion or dissuasion of positive action on climate transition and nature conservation, traditional media market competition, ownership, and

[17] Since the Global Financial Crisis, the main credit rating agencies provide banks` *all-in* credit ratings and the two subcomponents which are: (1) the *standalone* ratings, and (2) the *sovereign* (or *parent bank*) *support* (e.g., King, Ongena, and Tarashev, 2020).

[18] Maybe less surprising is that state-owned banks (even if presumably somewhat independent) lend more during a downturn (e.g., Duprey, 2015) or in favor of the ruling coalition (e.g., Koetter and Popov, 2020). Private bank failures may also be politically managed (e.g., Fungáčová, Karas, Solanko, and Weill, 2023).

[19] Nascent work documents how banks are covered in the media (e.g., Arnold, 2021), why it matters (e.g., Culpepper, Jung, and Lee, 2024), and what banks may do about it (e.g., Durante, Fabiani, Laeven, and Peydró, 2022).

reporting on banks matters for their dealings with climate transition and nature conservation. Media ownership and social media developments may change this impact. Analyzing both ownership and deploying textual analysis tools to summarize traditional and social media coverings is from a research perspective very doable today.

2.2. Bank ownership

2.2.1. Captive banks

Over the past decade, sustainable consumption has attracted growing attention. Initiatives to facilitate more environmentally and socially preferable household provisioning have emphasized the importance of low emission vehicles. This debate often neglects that the availability of bank consumer credit drives consumption patterns.

Particularly automotive captive banks (these are banks that are wholly- or majority-owned by automotive producers) may boost the sales of car manufacturers by providing attractive financing solutions to car buyers.

Beyene, Falagiarda, Ongena, and Scopelliti (2023b) investigate these captive banks` actions more closely. They start from the observation that the transition to a green economy strongly depends on the existence of appropriate economic incentives for agents. They argue that the loan market for car purchases is a paradigmatic example in this respect, as lenders may set credit conditions which may discourage or support the purchase of high-emission vehicles.

Using car loan-level data they study whether banks adjust their lending terms and conditions in response to different shocks to the perceived environmental quality of diesel vehicles. Focusing on the impact of the diesel emissions scandal in the automobile sector in 2015 and on local policy changes regarding circulation restrictions due to air pollution, they find that bank lending particularly by captive banks may further reinforce the market and regulatory failures that led to extensive levels of pollution by the automobile sector.

2.2.2. Common ownership

In the last few decades, many studies have investigated partial common and cross ownership from an industrial economics point of view (e.g., Bresnahan and Salop, 1986; Flath, 1991; Malueg, 1992). Recent work has turned towards studying the influence of common ownership on the corporate governance structure of companies (Azar, Schmalz, and Tecu, 2018; Coates, 2023) and on product market competition (He and Huang, 2017). O'Brien and Salop, 2000 for example already estimated the impact of common ownership in various airline routes on airline ticket prices, López and Vives (2019) find that common ownership can improve welfare and consumer surplus (R&D), provided that technological spillovers are sufficiently large, while Antón, Ederer, Giné, and Schmal. (2023) tests the mechanism based on managerial incentives, i.e., whether higher prices under common ownership result from higher costs or from higher markups.

There are reasons to believe that common ownership of publicly listed (large) banks and fossil fuel firms may be increasing. For example, if higher climate scrutiny makes fossil companies and fossil banks riskier, this would lower their price. And this can attract a particular set of investors, creating a higher common ownership between the fossil companies and banks. Also, the direction of the flow of ownership is very interesting: Do banks' owners start to collect the shares of the fossil companies, or is it the other way around? The first suggests that owners want to protect their banks' loan portfolio (this could be solved by a government guarantee). The latter suggests that fossil companies experience difficulties in finding funds, and their owners are planning to exploit the banks; maybe, at the expense of the depositors? Common ownership is then a way to ensure access to bank credit for fossil fuel firms that have lost easy, cheap access to bond market financing (Beyene et al., 2023a).

Duranovic, Carletti, Monasterolo, and Ongena (2024) for example using traditional measures of common ownership establish a noteworthy growth in common ownership of fossil fuel firms by owners that were traditionally also vested in banks.

2.3. Bank depositors

Retail bank depositors are considered a stable and cheap source of funding for banks. Yet, during the Global Financial Crisis depositors started to switch banks, and such switching may be quite consequential (e.g., Cao, Garcia-Appendini, and Huylebroek, 2024). Natural disasters, and even long periods of high temperatures, could lead to depositors to move robbing banks from this relevant funding source besides having many other expected and unexpected consequences too (e.g., Eckel, El-Gamal, and Wilson, 2009; Gallagher and Hartley, 2017; Deryugina, Kawano, and Levitt, 2018).

But depositors need not to physically move to alter their depositing behavior. For example, depositors can react to news about their banks. Using the Dakota Access Pipeline scandal, Homanen (2022) finds that deposits decreased in bank branches that financed the pipeline. Similarly, Chen, Hung, and Wang (2023) report that disclosures of banks' negative social performance reduce depositors' trust in the banks leading to deposit withdrawals.

In a recent paper, i.e., Dursun-de Neef and Ongena (2023) we aim to answer two questions: (1) do "hot days" affect people's beliefs and perceptions about climate change,[20] and then (2) do "hot days" affect their choices of banks to deposit money, i.e., do people continue to deposit at banks that lend to fossil fuel firms?

Hence, while depositors are affected by abnormal temperatures, hence an emanation of a physical risk, the choice of the bank from which to withdraw is based on a possible emanation of stranding of fossil fuel firm assets, a potential regulatory and technological transition risk.

An active literature discusses the first question.[21] Dursun-de Neef and Ongena (2023) contribute to this literature by showing that people update their beliefs about climate change upward when they experience abnormally warm weather. It is one thing to update beliefs, but another one to act on these updated beliefs.[22] Dursun-de Neef and Ongena (2023) contribute to this literature by showing that when they experience abnormally warm weather people start shifting their deposits away from banks that lend to fossil-fuel firms.[23]

In sum, we find a positive answer to both questions. On the first question, we find that a 1∘F increase in the abnormal temperatures is

[20] The UN's World Meteorological Organization and European Copernicus Climate Change Service announced that the June to August of 2023 period was the warmest such period since records began in 1940 (Financial Times, 2023). It was the hottest August on record, estimated to be around 1.5∘C warmer than the pre-industrial average for 1850–1900, and the year 2023 is the second warmest on record behind 2016 (World Meteorological Organization, 2023).

[21] Using survey data from the U.S., Akerlof, Maibach, Fitzgerald, Cedeno, and Neuman (2013), Myers, Maibach, Roser-Renouf, Akerlof, and Leiserowitz (2013), and Zaval, Keenan, Johnson, and Weber (2014) for example show that personal experience with global warming increases people's perception of climate risk (see also, Joireman, Barnes Truelove, and Duell, 2010; Borick and Rabe, 2014; Broomell, Budescu, and Por, 2015; Howe, Mildenberger, Marlon, and Leiserowitz, 2015; Konisky, Hughes, and Kaylor, 2016) and/or become more sensitized to the topic of climate change (Kahn and Kotchen, 2011; Li, Johnson, and Zaval, 2011; Cavanagh, Lang, Li, Miao, and Ryder, 2014; Herrnstadt and Muehlegger, 2014; Lineman, Do, Kim, and Joo, 2015; Choi, Gao, and Jiang, 2020; and Duan and Li, 2024).

[22] A recent literature does show that experiencing abnormal temperatures not only changes beliefs about climate change but also leads to actions on environmental issues or changes in financial preferences (Li et al., 2011; Herrnstadt and Muehlegger, 2014; Choi et al., 2020; Islam and Singh, 2022; Duan and Li, 2024).

[23] In this respect, they also aim to contribute to literature that documents that by withdrawing their deposits depositors can discipline banks (see, e.g., Martinez Peria and Schmukler, 2001; Iyer and Puri, 2012; Maechler and McDill, 2006) and that depositors respond to the disclosure of financial and non-financial information and news about their banks (Saunders and Wilson, 1996; Schumacher, 2000; Goldberg and Hudgins, 2002; Schnabel, 2009; Hasan, Jackowicz, Kowalewski, and Kozłowski, 2013).

associated with a 0.2% increase in the climate change beliefs in that county. This is equivalent to about 30% of the mean growth in climate change beliefs in our sample. We also find that the positive relationship between abnormal temperatures and climate change beliefs is valid mainly for counties with a higher percentage of Republican voters where climate denial is more prevalent.

We next examine whether experiencing warmer-than-usual temperatures motivates households to move their deposits away from banks active in fossil fuel financing, which is the second question we wanted to answer. We find that fossil-fuel-financing banks experience a significant reduction in their deposits relative to other banks in counties with higher abnormal temperatures. According to our results, a 1∘F increase in the abnormal temperature is associated with a 1.6% point (pp) relative reduction in the deposit growth rate of fossil-fuel-financing banks. This is equivalent to about 20% of the mean deposit growth rate in our sample. In addition, we find that deposits in other banks increase with higher abnormal temperatures.

Overall, our results so far suggest that people revise their beliefs about climate change upward when they experience temperatures warmer than usual. This shift in their beliefs motivates them to move their deposits away from fossil-fuel-financing banks to other banks. We find this to be more pronounced in counties with more climate change deniers, i.e., with higher percentages of Republican voters. The results imply that when households become more aware of climate change, they become motivated to change their fossil-fuel-financing banks to fight climate change.

There are many possibilities to expand this analysis. For example, one important missing piece in the analysis is to document that when days are hotter people search more for which banks are climate friendly? We also want to investigate how the intensity of reporting in the local media on the fossil fuel banks affects the deposit shifting. Finally, there is an interesting expansion in the direction of demographics. Old people hold more deposits and local banks in places with a lot of older people may end up lending more riskily as they lack local knowledge where they lend (Doerr, Kabas, and Ongena, 2023). If this is the case the shift out of fossil fuel banks (that have larger geographical footprints) may benefit local banks that end up lending more riskily elsewhere, creating unexpected financial stability issues?

2.4. Bank nationality

Not all countries have the same climate ambition, that is both well-known and observable in the various country environmental stringency indices. This heterogeneity in the stringency of their climate policy may affect both firms' competitiveness in seeking financing and the funding choices of banks and the financial sector in general. Laeven and Popov (2023) for example find that the introduction of a carbon tax is associated with an increase in domestic banks' lending to coal, oil, and gas companies in foreign countries, reminiscent of the cross-state border activities of polluting firms in Bartram et al. (2022).[24]

In Benincasa, Kabas, and Ongena (2023) we aim to extend these settings by identifying the impact of changes in more comprehensive countries' climate policy measures and cross-border bank lending in the syndicated loan market.[25] We answer the following questions: Is the stringency of countries' climate policy a key driver of cross-border lending activities? Do banks increase their cross-border credit exposure to foreign borrowers to deal with the fact that domestic firms have to internalize the cost of new climate rules?

Suppose that a local government decides to introduce a new rule limiting the carbon emissions load of domestic firms. Such a limitation has a direct impact on firms' investment decisions potentially triggering economic, social, and technological transformation as well as changing financiers' willingness to provide funds. Particularly banks may exploit differences between countries' climate policies to increase their cross-border lending activity by means of syndicated loans if lending "at home" becomes riskier or less profitable. Indeed, loan syndications help lenders overcome balance sheet constraints and reduce the concentration of risks by limiting exposures to individual borrowers and by diversifying this risk across countries (Cerutti, Hale, and Minoiu, 2015)). If climate policy implementation varies strongly across countries, the degree of their stringency might directly affect the risk tolerance and lending capacity of domestic banks. Therefore, banks may increase their share of foreign loans to make up for the higher risk perceived in the domestic market.

We document that banks react to domestic climate policy stringency by increasing cross-border lending. We use loan fixed effects to control for loan demand (hence a within-loan estimator that relies on the variation in loan shares) and an instrumental variable strategy employing different instruments such as green party share and time since economic liftoff to establish causality. Consistent with a race to the bottom, the positive effect increases as the borrower country becomes less stringent and is absent if the borrower country is more stringent. Furthermore, climate policy stringency decreases loan supply to domestic borrowers with high carbon risk while increasing loan supply to high-risk borrowers abroad. Our results suggest that cross-border lending enables lenders to exploit the lack of global coordination in climate policies.

We posit that developing a better understanding of the link between stringency of countries' climate policies and cross-border lending is important because the transition to a low-carbon economy requires investing billions of dollars. Insights into how banks consider the stringency of countries' climate policies for their foreign lending decisions should also help policymakers to better identify the recipients of their climate rules in an environment where lacking policy harmonization might threaten the "dream" of a carbon-free society.

Hence in Benincasa et al. (2023) we contribute to the ongoing debate on the relationship between finance and climate change and adds to two main streams in the literature. First, we contribute to the emerging literature on the effect of climate change on institutional investors financing decisions. A survey by Krueger et al. (2020) on climate risk perceptions found that, as of 2018, 55% of institutional investors believed that the regulatory risk stemming from climate change was already materializing while another 36% believed that it will materialize within the next few years. Recent studies show that investors have started pricing the "stranded assets risk" stemming from fossil fuel reserves (Atanasova and Schwartz, 2020; Delis et al., 2023)). Indeed, oil producers are heavily exposed to the risk of being unable to burn all their reserves when climate policy becomes more ambitious. Moreover, to the extent that innovation is a key driver in the transition to a low-carbon economy, many studies suggest that banks are relatively ineffective in combatting climate change both because they are technologically conservative (Minetti (2010)) and because financing innovation involves assets that are usually intangible and hard to collateralize. Therefore, financing these projects to tackle climate risks can be uncertain and less profitable than expected. Benincasa et al. (2023) adds to this literature by studying whether a country's climate policy is a key driver of the cross-border lending activity of banks exposed to higher domestic climate policy risks.

We also contribute to the literature on how incentives drive cross-border lending. Previous studies have argued that banks are less willing to lend to "physically and culturally distant firms" as screening and monitoring activities are costly (e.g., Mian, 2006). Due to the monitoring effort required to alleviate the typical agency problems between borrower and lender in a lending relationship (Holmstrom and Tirole, 1997), banks may engage less in foreign lending. As a result, syndicates tend to be relatively concentrated and composed of domestic banks that are geographically close to the borrowing firms.

[24] Banks can seek to cross-border arbitrage and/or obfuscate their exposures to brown firms (e.g., Giannetti, Jasova, Loumioti, and Mendicino, 2024).

[25] Our identification strategy relies on a combination of advanced saturation with loan fixed effects and instrumentation with a variety of instruments, both non-weak and plausible.

2.5. Bank orientation

Climate change has been shown to have negatively impacted economic activities, ranging from agricultural productivity to industrial output and regional economic growth. Climate risk has also been affecting financial markets in many ways. Regarding households, recent papers have studied how climate change affects households' balance sheets (Engle, Giglio, Kelly, Lee, and Stroebel, 2020; Giglio, Maggiori, Rao, Stroebel, and Weber, 2020). Regarding firms, De Haas et al. (2024) used data from the Banking Environment and Performance Survey (BEPS) to study how financial and managerial constraints may limit green investments. Regarding lending, climate risk has been shown to affect bank loan prices (e.g., Delis et al. (2023)), investor strategies (e.g., Krueger et al., 2020), as well as loan officers' mortgage lending decisions (e.g., Duan and Li, 2020).

While the last set of papers provides evidence that lending institutions take into account climate risk in their decisions, it is still unclear how different banks are adjusting their loan portfolio to the growing environmental awareness that was strengthened by the Paris Agreement and, more recently, by the environmental movement led, among others, by the Swedish environmental activist Greta Thunberg (e.g., Ramelli, Ossola, and Rancan, 2021).

For instance, do increased preferences for environmental sustainability, including those that are culturally or religiously motivated, lead banks to lend to a larger extent to greener firms? Also, which banks are more likely to adjust towards increased environmental consciousness? Do we then observe a difference between the terms of the loans that banks grant to green versus non-green firms? Finally, do firms react by becoming even greener?

3. Conclusion

This paper aims to provide a preliminary answer to the question, "Which banks are best for green growth?", by reviewing the literature and by providing some potential elements for a research agenda in this space. Commercial bank size (business model, too-big-to-fail status, political or media connections), ownership (captivity, common), depositors, nationality, and orientation are discussed as salient dimensions.

CRediT authorship contribution statement

Steven Ongena: Writing – original draft.

Declaration of Competing Interest

No authors have any conflict of interest to declare and all authors in their capacity contributed equally to the manuscript.

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