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Green Credit: A Catalyst for Industrial Transition?

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Climate change is a pressing global challenge that demands urgent action to decarbonize the economy and in particular high-polluting and energy-intensive industries. This literature review aims to assess the role of green credit policies as a tool for such a transition. Green credit policies are designed to restrict the development of high-pollution and energy-intensive industries while simultaneously supporting the financing needs of low-carbon firms. These policies can manifest as financial penalties, restricted access to bank credit, exclusion from incentives... However, their negative impact on energy-intensive industries' innovation raises concerns as it could hamper their ability to upgrade their processes, hindering the possibility of a more energy-efficient heavy industry.

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KEY-WORDS

Monetary policy | China | Industry | Decarbonization | Green credit policies | Innovation | Green loans

This review of literature addresses the potential role of green credit policies as effective tools to decarbonize the industry. The first section presents an overview of green industrial policies in the EU, why green credit policies are needed, and presents briefly what are green credits and the main market trends. In section 2, I review how such policies impact polluting firms and their capacity to upgrade. The third section assesses if (and how) low-carbon firms are positively affected by the implementation of green credit policies. Finally, section 4 summarizes the review and concludes. Since most of the scientific literature on green credits primarily focuses on China, sections 2 and 3 are mainly based on its data and context.

I. Introduction

France has set the ambitious goal of reducing its CO2 emissions by 50% by 2030, which requires active participation from the industrial sector. This sector is ever more important following the recent events (Covid crisis and the Russian invasion of Ukraine), as the country is seeking to reindustrialize its territory, focusing on key production chains for the transition to a low-carbon economy, such as gigafactories, semiconductors, solar panels, and wind power. To achieve these goals, the government has already implemented initiatives for the decarbonization of the sector, such as subsidies, mandatory greenhouse gas emission reporting (BEGES), and specific financing conditions for green projects in France. These initiatives are expected to be strengthened in the future with the *Industrie Verte* bill, which has been presented to the Council of Ministers in mid-May. According to the Assemblée Nationale and the French Ministry of Finance (2023), it proposes, among others, new tax credits; strengthened BEGES monitoring as 57% of concerned companies do not comply with their obligations; specific guarantees in case of borrower's default for green investment loans; and the creation of "green" and "climate" saving accounts to strengthen banks' capacity to finance green projects.

A. The European Green Industry plan

Global competition has emerged among the world's most influential nations, focusing on the transition to clean energy and the decarbonization of industries. On August 16, 2022, President Joe Biden signed the Inflation Reduction Act, an unparalleled move by Congress and the US government to address climate change. This groundbreaking legislation authorizes a massive $773 billion in federal funding, aiming to bolster climate initiatives, reduce healthcare expenses, and implement corporate tax reforms. Approximately $433 billion will be invested in supporting the renewable energy sector, offering tax cuts for "clean vehicles", and developing strategies to combat climate change through government spending and tax incentives (Larsen et al., 2022). Following the IRA, the EU has adopted ambitious measures to devise its investment plan. Actually, by offering significant economic advantages the IRA has been viewed as a great investment opportunity for European green companies. However, reorienting their spending towards the US instead of Europe would deal a blow to the EU which counts on them to fulfill its climate targets (RePowerEU, Fit For 55…) while fighting an energy crisis (Espinoza et al., 2023). In this context, the EU Commission unveiled last March the new legislative proposals for the Net Zero Industry Act as part of the Green Deal Industrial Plan, seeking to bolster the competitiveness of Europe's green industry. As described by Mang and Caddick (2023), the plan is built upon four key pillars.

Firstly, it aims to establish a regulatory framework that is shows long term visibility for key products and technologies such as batteries, wind energy, heat pumps, solar power, electrolyzers, and carbon capture and storage (CCS) to promote their deployment. Secondly, the plan seeks to facilitate access to public financial resources for renewable energy deployment, industrial decarbonization, and significant projects within the net zero supply chain. Thirdly, due to the need for new skills in the green transition it proposes extensive upskilling and reskilling initiatives for the workforce. Finally, the plan underscores the significance of open trade for resilient supply chains and the danger of unfair competition.

Interestingly, the IRA and the EU's European Green Deal Industrial Plan share similarities in their goals of addressing climate change while promoting investment and sustainable growth. However, the Commission's proposal has faced criticism for potentially disturbing environmental and social regulations. Reports have highlighted how the EU is losing investment opportunities to the IRA. Both the USA and the EU are currently falling short in reducing emissions and require higher targets to meet the Paris Agreement goals. Moreover, the EU's Green Deal Industrial Plan lacks the connection between industrial policy and social policy found in the USA's approach (Mang & Caddick, 2023), raising concerns regarding unequal repartition of the profit among the population. The Commission's proposals currently lack conditions for companies receiving support and fail to propose mechanisms for sharing the value generated by green industrial policy. This situation poses a risk of bolstering corporate profits with public funds, potentially leading to increased wealth concentration and inequality.

B. Can the EU afford a green industrial policy?

The EU's ability to finance a green industrial policy is increasingly under scrutiny. According to recent findings by Mang and Caddick (2023), there is a growing debate on whether the EU can afford the necessary investments with state debt to meet its climate targets. To achieve these targets, governments should be allocating at least 1% to 1.9% of their GDP, which translates to €159 billion to €323 billion annually. To limit global heating by 1.5°C, meaning achieving a reduction of 65% greenhouse gas (GHG) emissions by 2030, it would require increasing these spending up to 2.3-3.9% of the GDP in 2023, depending on the balance between public and private funding.

However, the challenge lies in the fiscal constraints imposed on EU countries. These countries have committed to limit their public debt under 60% of their GDP, with an annual deficit cap of 3%. In fact, the existing fiscal rules have failed to effectively meet these targets as the main economies far exceed this arbitrary threshold[1]. Consequently, the author insists that Europe won't be able to keep up with other global economic players. For instance, China has emerged as a dominant force in this area. The combined efforts of China's public and private sectors have resulted in the country contributing approximately half of the global investments in renewable energy, energy storage, electric vehicles, and related sectors. This participation increases up to 91% concerning investments in manufacturing industries. In 2027, it is projected that the eurozone will borrow not even half the amount (in terms of % of GDP) borrowed by other G20 countries, and less than one-fifth of what China borrows. On the other hand, the United States is expected to consistently exceed the 3% deficit limit throughout 2023-2027, despite having a debt-to-GDP ratio of 144% in 2022[2]. This raises concerns about the necessity and effectiveness of the EU's debt and deficit restrictions. In contrast, the average deficit spending across the EU is anticipated to be slightly above 1% in 2027.

As a consequence, when considering these additional constraints, only four countries (Ireland, Sweden, Latvia, and Denmark), which represent only 10% of the EU's GDP, could undertake the investments required for a climate scenario aligned with the 1.5-degree target, all while staying within the debt and deficit limits. On the other hand, eight countries (France, Spain, the Netherlands, Poland, Belgium, Finland, Romania, and Slovakia) would not be able to meet the minimum investment needs to achieve the EU's climate targets without surpassing the 3% deficit limit or having to make cuts in other areas (public services) or increase taxes. Furthermore, an additional five countries (Italy, Croatia, Portugal, Greece, and Hungary) are categorized by the Commission as having a high risk of debt, which means they would face pressure to reduce their debt levels in the next four to seven years. This indicates that

[1] Cf. according to the OECD Database: *National Accounts at a Glance*, data from 2022 or the latest available by June 2023.
[2] ibid.

countries representing 50% of the EU's GDP would struggle to meet the lower end of the green spending requirements estimated by the Commission to achieve the EU's climate targets.

C. Green Industrial Policy, theoretical background

Before introducing green credit policy as a tool to promote industry decarbonization, it is essential to understand the motives under industrial policies and their limits. In practice, industrial policies have been heavily criticized by economists, considering the difficulty of achieving well-targeted and effective interventions. While these objections deserve to be properly acknowledged, Rodrik (2014) demonstrates why green industrial policies are still necessary and how they can be improved to surpass the usual limits of industrial policies.

There are two primary counterarguments to government intervention in supporting specific firms or industries. The first argument emphasizes that governments lack the necessary information to make informed choices. Critics often assert that the government's inability to "pick winners" results in frequent mistakes and significant resource waste. The second counterargument highlights the potential for rent-seeking and political manipulation when governments engage in supporting particular industries. This involvement tends to shift industrial policy away from economic considerations and towards political motives, as illustrated by numerous examples described in the literature. Actually, mistakes are an inevitable and necessary part of a well-designed industrial policy program; in fact, too few mistakes are a sign of underperformance (Rodrik 2014). What is needed, instead, is a set of mechanisms and safeguards that limit political lockdown, identify errors and revise policies accordingly.

Regarding the reasons why a green industrial policy is needed in practice, they all refer to market imperfections. Actually, in a theoretical world, investments in industry decarbonization and related decisions should be left to enterprises. However, the difficulty to resolve climate change demonstrates that current economic markets aren't suited to face this type of situation and limits arise in practice. Firstly, the development of new technologies leads to positive spillovers that aren't fully internalized by the original investors. These spillovers encompass cross-firm externalities, industry-wide learning, skill development, or agglomeration effects. Given the experimental nature and substantial risks associated with green technologies, they are particularly susceptible to these failures.

Furthermore, public subsidies for green technologies may be necessary due to the significant mispricing of carbon (CO2 and other greenhouse gas). Fossil fuels continue to receive subsidies, while taxes or controls that would internalize the risks of climate change are lacking. As a result, the user cost of carbon falls well below the appropriate level from a long-term societal perspective. This makes enterprises' behavior move away from the optimal long-term social return, as for investment flow.

Another argument, as elucidated by (Zhang, Wang, et al., 2021) is that renewable energy, as an emerging industry, faces significant financing constraints due to demand fluctuations, high costs, and high risks. Consequently, compared to other types of investments, renewable energy requires greater support from national policies. However, Rodrik (2023) points out that this government support which aims to bolster green domestic industries in global competition raises some concerns. While this approach may be reasonable from a national perspective under certain conditions, the global implications tend to be ambiguous or negative. Terms-of-trade or rent-shifting effects are zero-sum on a global scale, and any resources devoted to achieving national gains come at the expense of global losses.

D. Green credit: definition

In this context, green credits (or green loans) could be a valuable tool for industrial policy, particularly in the context of financing the transition towards sustainability. For instance, concerning the EU and its specific challenges in securing funding for this transition, green credits emerge as an appealing alternative. As defined by Wen et al. (2021), green credit policy (GCP) consists of a series of guidelines, institutions, and practices to promote pollution reduction and energy efficiency improvement through credit intervention. Specifically, GCPs influence the behavior of enterprises by applying differential loan products, loan maturity, loan interest rate, and credit quota. These loans are specifically designed to finance projects such as renewable energy, energy efficiency, and sustainable transportation... It is worth noting that there is currently no globally standardized definition or framework that universally regulate green assets. A number of highly certified international conventions, such as the Equator Principles, the UNEP Finance Initiative, and the IFC Framework, require commercial banks to adopt green credit policies.

The history of green finance begins in October 2002, when the "Equator Principles" were promulgated, which require financial institutions to take the fulfillment of firms' environmental and social responsibilities into account when deciding to lend to firms. America is one of the first countries to implement green credits (Yao et al., 2021; Gilchrist et al., 2021). Comprehensive Environmental Response, Compensation and Liability Act clearly stipulates that banks can issue credit funds to projects only on the premise of ensuring that they will not pose harmful threats to the environment. In practice, green lending started as early as 2005. Several major U.S. banks, such as Wells Fargo and the Bank of America, started to dedicate resources towards sustainable entrepreneurship at that time.

Since then, the green credits' use has grown exponentially (X. Zhou et al., 2020) and has been spreading across the world. Due to its increasing utilization by financial institutions, the Loan Market Association (LMA) published in 2018 the Green Loan Principles (GLP) to set a framework of reference for all actors of the green loan market (borrowers, lenders, certifiers, regulators…). These guidelines enable all market participants to clearly understand the characteristics of a green loan, based on the following four core components:

- Use of proceeds (UoP)

The fundamental determinant of a green credit (or green loan) is the utilization of the loan proceeds for green projects (including R&D, and other related and supporting expenditures). The allocation of the resources should be appropriately described in the documents and framework when issuing a green credit. All green projects should provide clear environmental benefits, which must be assessed and, when feasible, quantified by the borrower.

The GLP explicitly recognize broad, non-exhaustive categories of eligible green projects, which contribute to environmental objectives such as: Climate change mitigation, Climate change adaptation, Natural resource conservation, Biodiversity conservation, and Pollution prevention and control. Concerning this document's interest in their impact on energy transition, green credits could finance, for instance, projects related to renewable energies and energy efficiency.

- Process for Project Evaluation and Selection

The GLP oblige the borrower of a green credit to clearly communicate to its lenders the environmental objectives and risks of the green project and the process by which the borrower determines how the project will fit within the aforementioned categories. The GLP also encourage borrowers to communicate a maximum on the context related to the green credit (objectives, policies…), to provide information on related certifications, and to implement a process to identify solutions against known or potential risks.

- Management of proceeds

The proceeds of a green credit should be credited to a dedicated account or otherwise properly tracked by the borrower to maintain transparency and promote the integrity of the product. For the avoidance of doubt, a facility cannot be labeled as green if it includes a green and non-green tranche(s); the green label applies only to the tranche(s) aligned to the four core components of the GLP. The proceeds of green credits can be managed per loan (loan-by-loan approach) or on an aggregated basis for multiple green credits (portfolio approach).

- Reporting

Borrowers are advised to maintain up-to-date and transparent information on the use of proceeds for green credits. The information should be renewed annually and provided to participating institutions only. The report should contain a list of green projects, brief descriptions, amounts allocated, and expected and achieved impacts. In case of confidentiality agreements or competitive considerations, borrowers may present the information in generic terms or on an aggregated portfolio basis. It is recommended to use qualitative and quantitative performance indicators to communicate the anticipated and achieved impacts of the project. Additionally, borrowers who can monitor the achieved impacts should include them in regular reports to participating institutions.

A last but relevant point highlighted in the GLP is the fungible constraint of green credits. For a matter of coherence, green loans should not be considered interchangeable with non-green loans (meaning any loans that are not aligned with the four core components of the GLP).

As it can be observed, the GLP are not an exhaustive and precise definition of a green loan, and the specifications are still vague, in particular concerning the criteria for green projects. This is because the GLP aims to set a basic non-mandatory definition that can be further completed by other definitions and taxonomies. Some governments have developed their own definitions using the GLP as a starting point (Fig 1). Regarding the EU, it has formed a technical expert group (TEG) comprising experts from various sectors to facilitate green investing. The TEG has developed a green taxonomy to identify economic activities that contribute significantly to environmental objectives such as climate change mitigation and adaptation, circular economy transition, pollution prevention, and biodiversity conservation. The taxonomy was published in 2020 and is aimed at providing a standardized framework for assessing and communicating the environmental sustainability of investments across member states.

Due to China's prominent role in the green loan markets and its significant contribution to the scientific literature on the subject, it is interesting to focus on the specific implementation of green credits within the country. The evolution of China's green credit policy can be traced back to 2007, when the Environmental Protection Administration (now the Ministry of Environmental Protection) in collaboration with the China Banking Regulatory Commission (CBRC) and the People's Bank of China issued the *Suggestions on Implementation of Environmental Policies and Regulations and Guard against Credit Risks*. In 2008, the Chinese government blacklisted 38 companies, completely preventing them from loan access. Yet, the blacklist contained a very small share of companies punished by the Ministry of Environmental Protection for their environmental violations (8000 in 2007) (B. Zhang et al., 2011). This marked the introduction of green credits, aimed at encouraging commercial banks to consider the environmental behavior of firms in loan decisions. On one hand, the implementation of these policies faced challenges due to unclear standards and the pressure of economic growth (P. Guo, 2013). On the other hand, the implementation of green credit policies was also driven by the increase in China's energy consumption and environmental concerns associated with energy-intensive industries (Wen et al., 2021; Song et al., 2021). In 2010, the country consumed approximately 3.606

billion tons of standard coal, with a 7.32% increase from the previous year. In 2012, the National Bureau of Statistics revealed that energy-intensive industries were responsible for more than 80% of industrial emissions. By 2017, China's consumption reached 4.485 billion tons of standard coal, representing a 24% increase from 2010 (National Bureau of Statistics, n.d.). Therefore, from 2012 to 2016, the CBRC issued targeted policies such as the *Key Evaluation Indicators for the Implementation of Green Credit* and the *Green Credit Guidelines (2012)*. These policies provided over 100 indicators for

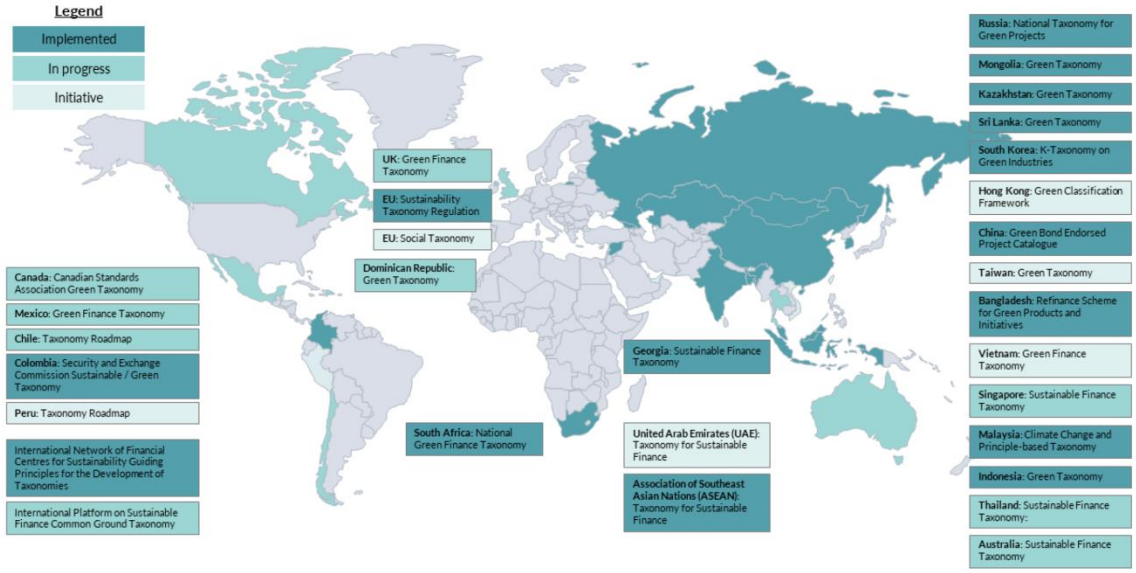

Figure 1: Overview of green taxonomies and their stage of development [8]. However, the implementation of a green taxonomy is not necessarily followed by the implementation of a green loan framework, some countries have developed one only for Green Bonds.

information disclosure, organizational management, and capacity building to regulate the management of green credits in financial institutions (Y. Hu et al., 2020). Finally, in September 2020, China strengthened its commitment to environmental policy and green credits, as demonstrated by its announcement of achieving "carbon peaking" by 2030 and "carbon neutrality" by 2060 (Gu & Tian, 2023).

The absence of comprehensive and universally applicable criteria in green loan markets poses a challenge considering their international scope. A noteworthy example is by comparing the EU and China, as they have distinct definitions for green finance. While there is considerable overlap in the descriptions of green financial products in both regions, certain elements remain controversial. For instance, China considers clean coal as a green product, whereas the EU does not (Gilchrist et al., 2021). This discrepancy can be attributed to differing priorities between developed and developing nations when establishing green finance standards. In fact, the Chinese government's priorities extend beyond carbon emission reduction and encompass a broader spectrum of environmental issues, including air pollution. This lack of appropriate and common definition undermines scholars' efforts to ensure an accurate and meaningful assessment of its efficiency.

E. State of the market

Loans generally have opaque disclosure given they tend to be privately (often bilaterally) arranged. Moreover, most of the regulators do not mandate banks to disclose them. This means it is usually hard to find relevant information about them, including details such as loan amount and term, as well as UoP. Consequently, it can be difficult to get green loan market volumes. This could be a reason explaining the large differences across the sources (Table 1). Another reason for such differences relates to the lack of universal definition: the scope of each source can vary. Hence the table below shouldn't be treated as an indicator of the market size but rather as an indicator of a fast developing market.

Annual green credit issuance depending on sources. (in USDbn)	CLIMATE BOND INITIATIVE	JAPANESE MINISTRY OF ENVIRONMENT	NORDEA BANK	BLOOMBERG	IFC/WORLD BANK GROUP (Gilchrist et al., 2021)
2014	X	X	X	X	165
2015	X	0	30	32	X
2016	0,1	0,2	37	37	X
2017	3,5	5,9	47	46	X
2018	6	17,0	67	55	X
2019	14,2	29,1	92	92-95	X
2020	11,1	19,1	X	87-95	X
2021	19,8	35,7	X	87-95	X
2022	10,4*	51,3	X	X	X
CUMULATIVE (on the relevant period)	65,1 (2016-2022)	158,3 (2015-2022)	273 (2015-2019)	606 (1996-2021)	X

*Table 1: Green loan market volumes between 2014 and 2022, split by source. The "*X*" stands for data not furnished. *Volume tracked as of the 20 January 2023.*

In 2014, the IFC identified approximately USD 165 billion lent in the form of green loans. Nonetheless, only a small fraction (15%) was spent in the clean energy sector. When considering the geographical repartition of green loans, most of them were lent in developed economies (USA, Europe, Japan, China), whereas Turkey claimed the largest share of green credits in its national loan market, surpassing 70 percent.

Concerning the Chinese loan market, the government mandated SOEs and commercial banks to disclose their green credit policy starting in 2007 (Gilchrist et al., 2021). By sticking to the Chinese definition of a green loan and according to the "China Green Finance Development Report (2018)" released by the People's Bank of China, the green credit balance of the 21 major Chinese banks experienced substantial growth increasing from USD 729 billion[3] in 2013 to USD 1.35 trillion[3] in 2018 (Zhang, Li, et al., 2021). It represented more than 90% of the Chinese green credit balance and approximately 10% of its total credit balance (Song et al., 2021). Additionally, data released by the China Banking Association reveals that by the end of 2019, the green credit balance of these major banks had exceeded RMB 10 trillion (USD 1.4 trillion), indicating a significant flow of credit resources toward green industrial enterprises. These figures highlight the substantial progress and increasing importance of green credits in China's financial landscape, making loans one of the main green financing channels for Chinese corporates.

Some scholars believe that due to the reduction of energy demand caused by the recent global economic recession, renewable energy projects have lost the interest of public and private capital participation (Bei & Wang, 2023). Therefore, they believe that green credits will have to play a leading role in the development of clean energy enterprises in the years to come. This document aims at understanding how green credit policies promote industrial transformation and decarbonization. There are two different types of "sustainable investments" which can trigger such an effect; this document assesses each of them separately. The first section presents the effect of green credit policies on high-polluting and high-energy-consuming firms (HPHEC firms). These enterprises must upgrade their infrastructures and processes to increase energy efficiency. Conversely, green credit policies also aim at promoting green industries' development, which we will address in a second section.

[3] In this case, such difference of market volumes compared to precedent sources could be explained by the wider scope of the Chinese definition of a green credit.

II. Limiting High-Polluting-High-Energy-Consuming industries emissions

Even though green credit policies can take many forms, one of their main purposes is to inhibit HPHEC firms' financing. A large number of studies have been conducted on green credits in recent years with mixed findings.

A. Inhibiting polluting firms' financing

Direct inhibiting effect: the penalty effect

The main effect of green credit policies on HPHEC firms is the increase in polluting firms' financial constraints. There are several effects at stake, which can be divided into "direct" and "indirect" effects. The first one is the "penalty effect", a direct inhibiting effect. Green credit policies are often implemented by governments or financial institutions to encourage environmentally sustainable practices and reduce pollution. These policies typically provide incentives, such as favorable loan terms or lower interest rates, to companies that meet certain environmental criteria. Conversely, firms that fail to meet these criteria may face penalties or restrictions which could negatively impact their performance. These penalty effects can vary depending on the policy, jurisdiction, and the way they impact the firm. For instance, a green credit policy could result in:

- Financial Penalties: HPHEC firms may be required to pay fines or additional fees for non-compliance with environmental standards. These penalties can serve as a deterrent and incentivize firms to adopt cleaner practices.
- Restricted Access to Credit: Under a green credit policy, HPHEC firms that do not meet environmental standards may face limitations on their access to credits or loans. Financial institutions may be reluctant to provide financing or may offer less favorable terms, for instance proposing higher transaction costs or interest rates, making it more difficult for these firms to obtain funding for their operations or development.
- Exclusion from Incentives: HPHEC firms that fail to meet the environmental criteria of a green credit policy may be excluded from various incentives, such as tax breaks, subsidies, or grants that are provided to companies promoting sustainable practices. This exclusion can put these firms at a competitive disadvantage compared to their environmentally compliant counterparts.

Regarding China, the *Green Credit Guidelines* (GCG), published in 2012, is considered the first normative document concerning green credits aimed at the industrial sector from a national level. In terms of mechanisms of action, it can be summarized into two different aspects (Chen et al., 2022). First, it relies on a new credit allocation selection, with commercial banks having to take into account firms' environmental performance. If the project is considered too harmful to the environment, the credit can be denied (suspended or withdrawn if already lent). Second, the policy guides financial institutions to issue more credit funds to enterprises with strong green innovation capabilities while limiting credit size or implementing punitive high-interest rates for HPHEC firms. As China is a transition country, with an imperfect capital market, bank credit is the most common external financing channel (Wen et al., 2021). Therefore, Yao et al. (2021) support that, by raising loan rates, the GCG significantly increase the financing constraints of targeted firms, which reduces investment and production scale, consequently affecting their performance. Indeed, financing constraint is closely related to firm performance and is the key to hindering firm development. Some studies find that financing constraints may affect firm performance by inhibiting corporate growth (Lv et al., 2018); insufficient investment may be also negatively related to firms' financial performance (Titman et al., 2004), which can be the case for HPHEC firms because of the policy's penalties.

Although some scholars have criticized it, the reduction of GHG emissions from HPHEC firms due to the penalty effect is probably the least contentious effect regarding green credits' impacts and has been thoroughly demonstrated theoretically and empirically (Liu et al., 2017; Li et al., 2018; Yao et al., 2021; Zhang, Li, et al., 2021). Actually, Amore et al. (2013), note that the constraining effect of green

credits on polluting investments is reflected in the higher threshold restrictions and transaction costs that firms face when accessing credit financing. Furthermore, Sun et al. (2019) support that green credits affect the scale of bank credit for heavily polluting enterprises impacting their financing ability. Moreover, Liu et al. (2017) give a detailed description of the theoretical channel underlying the penalty effect and its potential consequences at the national level. When punitive higher interest rates are imposed, target industries would readjust their financing decisions regarding the ratio between direct financing and indirect financing. Therefore, the policy will increase the financing costs of the target industries. Higher costs produce less profit thereby reducing the investment demands. On the other hand, higher costs will be passed to downstream industries and cause the final product prices to rise. The rising prices in the target industries will also affect their export competitiveness, thereby putting pressure on employment and social stability. Due to repercussion effects on related industries, it is hard to predict accurately all the potential consequences that could have such a policy. By conducting policy experiments on different time scales (short-term where labor is also fixed, medium-term, and long-term), Liu et al. (2017) find that the strongest policy effect arises in the medium-term scenario followed by the short-term, which has less effect but still reduces the output of the industries. In the long-term, they find that it has the weakest policy effect as output and investment decrease in the first place but bounces back after some time. The investments in all the target industries decreased between 0.05% (LT) and 0.3% (MT), whereas all other industries rose. However, it is important to note that some studies have led to opposite conclusions with green credit policy significantly reducing the long-term debts of polluting enterprises (Wang et al., 2019).

Indirect inhibiting effect: reputational effects

But HPHEC firms also suffer from reputational effects. Public awareness and concern for environmental issues are growing, partly induced by significant and highly publicized environmental or health scandals involving companies in heavily polluting and energy-intensive industries. The Deepwater Horizon incident that occurred on 20 April 2010, when an oil rig exploded in the Gulf of Mexico, makes a perfect illustration. BP, which had leased the infrastructure, had to pay USD 13bn in compensation (for over 100 000 claims related to the oil spill). Heflin and Wallace (2017) demonstrated that these legal penalties were not the only consequences. Actually, the entire oil and gas industry witnessed a consistent decline in their stock prices. Nowadays, with the climate crisis getting evermore attention, the polluting industries, and in particular companies related to fossil fuels are suffering from an increasing backlash from other stakeholders under the pressure of the population. On the flip side, certain studies have found that when it comes to individual firm reputations, violations of environmental regulations don't leave a long-lasting impact. For example, Karpoff et al. (2005) revealed that the decrease in stock market value upon the announcement of environmental-related legal actions is almost equivalent to the financial penalties imposed for those violations, indicating that companies violating U.S. environmental regulations do not experience a significant blow to their reputation. This suggests that while reputational effects are notable in the aftermath of a major, highly publicized pollution incident involving such firms, they do not exert a lasting impact when these companies routinely exceed pollution levels. Concerning companies engaged in sustainable and responsible practices, the work of Flammer (2018) and of Gilchrist et al. (2021), have shown that they are more likely to gain trust from governments and local populations, resulting in enhanced profitability. Green credit policy enhances these reputation damage effects. In fact, implementing penalties and restrictions on HPHEC firms' financing increases agents' fear to invest, which consequently reduces investment in such industries (Nandy and Lodh, 2012; Zhang, Li, et al., 2021).

On the other hand, green credits can also serve as a remedy for reputational harm. Through the application of Spence's signaling theory model, Yao et al. (2021) and G. Hu et al. (2021) provided support for this perspective. In the financial market, banks and consumers cannot fully grasp how responsible is a firm (information asymmetry). Therefore, firms must send high-quality signals to the market (banks and consumers) to improve their reputation and consequently their profitability. The

best way is to directly reduce their environmental impact (or fake to do so, leading to *greenwashing* behaviors). By doing so, banks will more likely accept to lend them green loans. Once a firm obtains a green credit, a similar signaling phenomenon occurs: the firm can transmit the signal of its green management to the market. This signal can then help to improve the population's opinion on the firm, increase investment, and increase the allowance of tax benefits (Gao & Mei, 2013; Bajo et al., 2016; Flammer, 2018).

Heterogeneity of green credits inhibiting effects

While studies have shown that, on average, green credit policies tend to inhibit polluting firms' financing, it is crucial to delve deeper into the complexities and nuances of these effects. The significance of the inhibition and the extent to which firms respond to green credit' penalties can be influenced by various factors, such as ownership status and firm size. Understanding these factors and their interaction with green credits is essential for policymakers, financial institutions, and firms themselves to fully comprehend the effectiveness and limitations of green credit policies.

Under usual circumstances, financial institutions tend to show bias in favor of State-Owned Enterprises (SOEs) and discriminate against private enterprises when making credit decisions, this phenomenon is known as private credit discrimination (Brandt & Li, 2003; Cheng et al., 2020). SOEs benefit from government guarantees, easy access to financing, and established relationships with financial institutions. On the other hand, non-SOEs are often considered to have poor credit access, despite having stronger profitability. As a result of this credit discrimination, non-SOEs receive lower credit funds compared to SOEs. With the implementation of green credits, the penalty effect on heavily polluting firms is expected to primarily affect SOEs. For firms that do not have access to adequate credits in the first place, the punitive effect may not be as significant (X. Zhou et al., 2020; Yao et al., 2021).

Similarly, the scale of the enterprise also affects the green credit's inhibition effect. Large-scale firms have greater advantages in obtaining bank loans compared to small-scale firms (or small and medium enterprises – SMEs) (Petersen and Rajan (1997). This is due to factors such as their higher reputation, market shares, and by definition their more important capital which implies a better repayment capacity. These characteristics enable them to secure more loans from financial institutions, lowering their financing constraints. Consequently, with the implementation of green credits, the penalty effect is expected to primarily impact large-scale firms rather than SMEs (Yao et al., 2021).

Finally, Yao et al. (2021) observe that periods with an extensive number of policy interventions (or high economic policy uncertainty – EPU) tend to amplify the green credit's restraining effect. When EPU rises, firms limit loan debt and retain some assets in case of emergency (X. Li, 2019; Cui et al., 2021), hence increasing their financing constraints.

B. Effect of green credits on HPHEC firms' upgrade

In addition to controlling and blocking the funding amounts and channels available to companies with high pollution and energy consumption. The main question which remains is whether this effect compels such enterprises to either phase out of the markets or undergo a transformative process to become greener. To put it in other words, can green credits promote the upgrading of HPHEC firms?

Environmental regulations and innovation: theoretical background

Before delving into the impact of green credits on innovation, it is interesting to first comprehend the influence of environmental regulation on the process of innovation. It has been extensively studied and remains a central and highly debated topic among economists. From a theoretical point of view, the Porter Hypothesis, introduced by economist Michael Porter in the 1990s, sparked significant interest and debate within the field of environmental economics. Traditionally, environmental regulations were viewed as burdensome for businesses, imposing additional costs and hindering their

competitiveness. However, Porter criticizes that this static model does not consider the dynamism of innovation and technological progress, repeating the same mistakes as previous models' predictions of economic disasters and human catastrophes. By taking into account innovation, Porter argues the long-lasting trade-off between environmental goals and industrial competitiveness cease to make sense. He suggests that stringent environmental regulations could actually drive innovation and improve firms' long-term competitiveness (Porter, 1991; Porter & Van Der Linde, 1995).

He supports that regulation might promote innovation due to market imperfections like information asymmetries, undiscovered profitable opportunities… Environmental regulation can play a pivotal role in fostering innovation through various avenues (Porter & Van Der Linde, 1995). Firstly, it serves as a signal to firms, highlighting inefficiencies in resource utilization and enticing them to explore potential improvements. Secondly, regulatory requirements can compel enterprises to gather valuable information, thereby increasing corporate awareness of environmental issues and driving the need for innovation. Additionally, by reducing uncertainty surrounding environmental investments, regulations provide a more favorable environment for increased investment and innovation in sustainable practices. Furthermore, environmental regulations ensure that no free riders can exploit the system by avoiding environmental investments, as all enterprises must comply with the regulations. All these effects set in motion a virtuous cycle, where innovation leads to more competitive firms, creating market pressure that further drives innovation among lagging enterprises.

A last way by which environmental regulation could promote innovation is in case of incomplete offsets. Offsets refer to the potential compensatory mechanisms that can arise as a result of implementing environmental regulations. Porter & Van Der Linde, 1995 classifies them into two types (Fig 2):

- Product offsets: they arise in the form of the added value of the product following the innovation: better-performing, higher-quality, safer… Or also of lower material costs (perhaps from material substitution or less packaging), or higher resale or scrap value (because of ease in recycling or disassembly) ... In case of none of those new characteristics, product offsets still occur as consumers can value the environmentally friendly way it has been produced (eco-labels). Ambec & Barla, (2006) research indicates that products with such green attributes enjoy some market advantage either through higher prices or increased market share.
- Process offsets: they occur when environmental regulation not only leads to reduced pollution, but also results in higher resource productivity such as higher process yields, more efficient monitoring and maintenance, materials savings (due to reuse or recycling of production inputs), better utilization of by-products, lower energy consumption during the production process, reduced material storage and handling costs, conversion of waste into valuable forms, reduced waste disposal costs or safer workplace conditions.

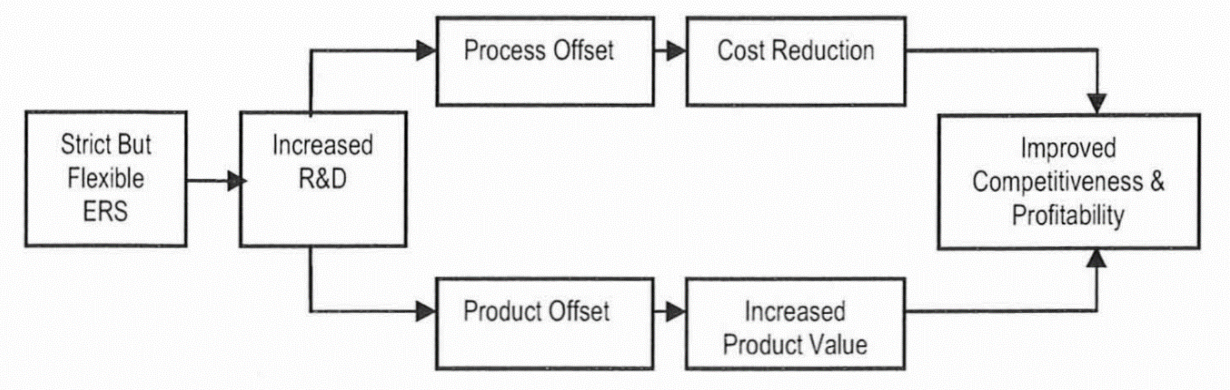

Figure 2: Schematic representation of the Porter Analysis

Yet, this theory has failed to reach a consensus among economists. One criticism is that while innovation offsets are theoretically possible, they are likely to be rare or small in practice (Ambec & Barla, 2006). Second, even if there are systematically profitable business opportunities that are missed, the next question is how could environmental regulations change that reality? Are bureaucrats better informed about business conditions than managers? Although some scholars have set forth formal theoretical models underlining conditions under which profitable projects may systematically be missed and how such regulations could potentially help, these models are still scarce and aren't sufficient to conclude in favor of the Porter hypothesis (Ambec & Barla, 2006). Concerning process offset, a necessary condition for profit to increase is that environmental regulations lead to productivity gains. Most studies report a negative relationship, with an even more important impact for some pollution-intensive industries (Gollop & Roberts, 1983; Berman and Bui, 2001); Alpay et al., 2002). Lastly, another limitation of the Porter Hypothesis is that it isn't compatible with the Pollution Haven Hypothesis, which was first proposed by Walter and Ugelow (1979). They observed that more stringent environmental regulations in developed countries can lead to the relocation of pollution-intensive industries to less regulated or developing countries, often referred to as "pollution havens". Indeed, if the Porter hypothesis was verified, then environmental regulation would actually be opportunities for enterprises, meaning they would have no economic incentives to relocate to such "pollution havens".

Green credits and innovation

It has been widely demonstrated that there is in general a positive correlation between the loan of an enterprise and its innovation (Zhuang, 2013; Nanda & Nicholas, 2014). However, due to the low probability of success and higher capital requirements associated with low-carbon technology innovation compared to general technology innovation, enterprises often prioritize allocating internal resources to end-of-pipe alternatives (Chen et al., 2022). This preference stems from managers adhering to the rational man assumption and seeking solutions that offer greater cost control (Xie et al., 2017). Therefore, the introduction of green credits presents an opportunity for enterprises to actively participate in innovation. Li et al., (2018) proved theoretically that a high successful probability of technique innovation improves an enterprise's intention to innovate, since it implies an increase in the enterprise's expected profit. Chen et al. (2022) argue that green credits can improve the willingness of enterprises to innovate green through: positive incentives (comparative advantage of availability and convenience for firms to obtain credit financing), adverse penalties (HPHEC firms are willing to innovate to counteract the negative effects of tighter financing constraints caused by environmental regulations) and risk management functions (risk of production interruption in case of environmental violation). These results are similar to the findings of Hu et al. (2021) and Song et al. (2021). Their research suggests that despite financial constraints and anticipated higher sunk costs and non-compliance costs, certain firms can effectively motivate themselves to engage in green innovation and successfully undergo a green transformation. Yet, there are many consequences when an enterprise applies for a loan to invest in innovation. First, the enterprise increases its exposition to risk as it previously was exposed to market risks, but now also faces innovation risks. Second, green loan invested in innovation focuses the resources of the enterprise on clean production activities, changing the internal resource allocation and the structure of the firm (Zhang, Li, et al., 2021).

From an empirical point of view, Song et al. (2021) observe that green credits have overall increased the energy utilization efficiency of all Chinese provinces between 2007 and 2017. Yet, all provinces still show a low state of energy efficiency. They find a declining gradient from eastern provinces (which have the highest level of energy utilization efficiency, with an average annual growth rate of 5.40%) to western provinces (which have an energy efficiency level still increasing but at a much slower pace). This gradient results from multiple factors: first, though the implementation of green credit policy, the energy industry undergoes notable changes. It reduces its reliance on traditional energy sources and increases the utilization of renewable energy. As a result, the high-efficiency utilization of energy improves. Furthermore, a high credit scale, indicating a better regional economic level, improves the

government's willingness to invest in technological innovation. Whereas a lower one prompts a preference for investing in heavy industries to stimulate the local economy. Their findings support, with empirical data, the theoretical belief that environmental regulation can increase innovation and energy efficiency level (Brunnermeier & Cohen, 2003; Ambec & Barla, 2006; Hojnik & Ruzzier, 2016; Chen et al., 2022)

Heterogeneity analysis

As previously explained, SOEs have easier access to loans and less negative impact in case of debt but also the advantage of economies of scale and better control of fixed cost (Chen et al., 2022). As innovation requires fixed costs, they are more willing to allocate funds to low-carbon technology. Additionally, all firms seem incentivized by green credits to innovate, regardless of their size, yet not for the same reasons. Zhang, Li, et al. (2021) argue that large-scale firms innovate to compensate for extra costs following green credit policy, while green credits alleviate financial constraint on innovation investments for SMEs.

Limits

Nevertheless, the effect of green credits on HPHEC firms' innovation has long been controversial, both in academia and in practice. Liu et al. (2017) approve that green credit policy effectively curbs investments in energy-intensive industries. However, they find that the policy's effectiveness in adjusting the overall industrial production structure is relatively limited due to the continuous industrialization and urbanization processes in China. These energy-intensive industries still hold an irreplaceable position in the economy and constraint the policy effect.

Xue and Zhu (2021) present a contrasting viewpoint, arguing that the effectiveness of green credit policies in China is still inadequate. According to their analysis, the current green credit policy lacks the necessary market control mechanisms to regulate the flow of funds effectively. This deficiency allows non-compliant enterprises to seek alternative financing options without facing significant obstacles. In alignment with this viewpoint, Wen et al. (2021) assess the impact of the *Green Credit Guidelines* on HPHEC enterprises. They find that the policy significantly reduces bank credit access while increasing their reliance on trade credits. Trade credit serves as a fundamental source of liquidity for inter-firm commerce. This substitution effect holds that trade credits are a form of short-term financing for enterprises when formal credit financing is unavailable (Petersen & Rajan, 1997).

Furthermore, some scholars insist that green credits may inhibit the capacity of HPHEC firms to upgrade due to the tightened long-term debt ability. Consequently, they assert that green credit policy could actually be counterproductive (Wen et al., 2021; G. Zhou, Liu, et al., 2021). They point out that, in practice, banks always lend to firms by sector due to information asymmetries. According to the annual bank reports in China, banks mainly reduced loans to enterprises in energy-intensive industries after the promulgation of green credit policies. It is essential to understand in each highly-polluting and energy-intensive sectors (such as mining, smelting, petrochemical… industries), firms can be more or less efficient in terms of pollution and energy-consumption. Wen et al. (2021) argue that banks do not consider the willingness of the HPHEC enterprises to upgrade and tar all enterprises involved in energy-intensive industries with the same brush. Their statement has crucial implications. To achieve the most effective pollution reduction, the policy should create a situation where only highly-polluting and energy-consuming firms face penalties that seriously restrict their development, possibly leading to their exit from the market, or enticing them to innovate and upgrade their operations. Yet, if bank loan allocation indeed makes it harder for all firms in heavy industry, even those willing to upgrade. Then green credits miss a significant way to reduce pollution. Moreover, it hinders the prospect of achieving a greener heavy industry, indispensable to our economies. Even by considering the trade credit's substitution effect, Wen et al. (2021) maintain this conclusion. Trade credit primarily serves the purpose of facilitating commercial transactions, making it inadequate in providing effective financial support for long-term investments, such as innovation. Thus, it fails to address the negative consequences of credit

intervention for energy-intensive enterprises seeking to upgrade their equipment, technology, and processes.

Wen et al. (2021) provide some data on the green credit allocation within the HPHEC firms. Within the HPHEC firms which received loan financing following the *Green Credit Guidelines* issuance, they show that green credits mainly flowed to less efficient HPHEC enterprises. Meaning that the credit allocation is in average less efficient after the intervention policy. Their study reverts to the classic argument about the effectiveness of industrial policy, which has long been controversial in academia and in practice (Rodrik 2014; T. Chen, 2016; Wen and Zhao, 2020). It states that industrial policy and credit intervention reduce resource allocation efficiency.

Hence, scientific literature hasn't reached a consensus on whether green credits have the potential to promote HPHEC firms' transformation but if it does, it won't be without risks, only further empirical analysis can give us a better understanding of its effectiveness.

III. Promoting Green Industries

After conducting a comprehensive analysis of the impact of green credits on polluting firms, we are now shifting our focus to highlight its equally significant objective: promoting environmentally friendly enterprises. In fact, by establishing access criteria, the policy aimed to redirect credit resources toward green enterprises. This deliberate approach aimed to encourage and support businesses that prioritize environmental sustainability.

A. Promoting green firms' investment

It has now reached a consensus that green credit policies can effectively promote green enterprises, mainly by alleviating financing constraints and more specifically loan access. G. Zhou, Liu, et al. (2021) found by conducting empirical tests, that green credit policy allows green enterprises to obtain more credit resources, with cheaper financing costs than polluting enterprises. The CBRC conducted a study in 2016 that focused on the primary loans for green credits within the Shanghai jurisdiction. The research findings revealed that in recent years, green credits have mostly been allocated to renewable energy and water conservation projects in the region and have played a significant role in their promotion (Y. Hu et al., 2020). Regarding renewables in China, although their development has made some progress, the industry still faces certain challenges. The core technologies in the renewable energy sector are not yet fully mature (except PV cells), resulting in high production costs, technical risks, policy risks, and market risks for renewable energy enterprises. These factors have created significant financing constraints for such companies, as banks have had no incentives to support them prior to the issuance of green credit policies. However, Zhang, Wang, et al. (2021) found the implementation of green credit policies has led to a significant increase in the lending practices of banks toward green firms. Despite this progress, commercial banks still perceive lending to renewable energy enterprises as carrying a high degree of uncertainty. Therefore, the variation of long-term loans, incurring a higher risk of default, wasn't significant.

Factors modulating the promotion of green credits

Similarly, with the inhibition effect, the intensity of the promotion effect of green credits can vary depending on several factors. First, enterprises with different ownership structures or scales are often faced with different financing constraints and exhibit different sensitivities to credit policies. As explained previously with the private credit discrimination phenomenon, banks tend to favor SOEs and large-scale firms when lending. Therefore, if the policy intervention indeed promotes access to green enterprises, then its impact should be more significant on enterprises with difficult access to loans in the first place. Thus, some scholars support that green credit policies have stronger promotion effects on non-SOEs (G. Zhou, Liu, et al., 2021) and SMEs (Zhang, Li, et al., 2021). Second, regional economic development also influenced the promotion effect of green credits. However, its impact remains controversial. On one hand, some findings suggest that green credits have a stronger promotion effect on loan access in developing regions compared to their counterparts in developed regions, where enterprises already had better loan access before the policy implementation (Xu & Li, 2020; G. Zhou, Liu, et al., 2021). On the other hand, Zhang, Li, et al. (2021) conducted a study measuring PM2.5 levels as an indicator of environmental quality before and after policy implementation in China. They found that the implementation of green credits in financially developed regions was more effective compared to less developed ones. Green credit policy can be thought of as a signal from the government to enterprises. As it is transmitted through the market and financial institutions, financially developed areas will enable a smoother transmission mechanism. Another plausible argument is that financially developed regions often exert pressure on polluting enterprises to either shut down or relocate. As a result, these regions tend to have a higher proportion of environmentally friendly enterprises and are more likely to present a tertiary economy, meaning a larger number of enterprises can benefit from the implementation of green credit policies. (G. Zhou, Sun, et al., 2021). Lastly, according to observations made by Yao et al. (2021), companies that are subjected to stronger external supervision are more likely to see long-term benefits from environmental investments. Consequently, these

companies are more inclined to make better use of green credits, employing it more effectively and frequently.

B. Effect on Green industry innovation

The implementation of a green credit policy has alleviated the financing challenges faced by clean energy enterprises, enabling them to secure adequate funds for additional research and development (R&D) activities. Previously, these enterprises encountered a more stringent financing environment and criteria, which posed difficulties in accessing sufficient funds to innovate due to factors such as information asymmetry, R&D uncertainty, and bank restrictions on fund utilization (Gu & Tian, 2023). Consequently, the financing constraints imposed on enterprises without access to bank credits significantly hindered their R&D investments, affecting their innovation capacity.

However, the implementation of green credit policies has transformed this situation. Gu & Tian (2023) discovered that by enjoying lower credit costs through the policy, enterprises can now invest surplus funds in R&D. This finding aligns with previous studies conducted by Yang et al. (2012), which highlight that green credits incentivize enterprises to enhance R&D investments and fosters innovation while supporting emission reductions. Sun and Shi (2019) argue that green enterprises meeting banks' environmental judging criteria can stimulate technological innovation by obtaining green credits, thus positioning them favorably compared to conventional bank credit recipients. More recently, Chen et al. (2022) also observed a significantly positive relationship, indicating that the green credit policy has a notable impact on promoting low-carbon technology innovation, particularly among firms with ESG certification.

Heterogeneity analysis

Technological innovation is usually a way to enhance firms' competitiveness. As SOEs are protected by the government and pressure of the market, they aren't very sensitive to competitiveness, it often isn't their first objective. Therefore, they are less motivated by green credits to innovate than private enterprises (Gu & Tian, 2023), which on the opposite are profit-oriented and aim to gain market share through technological innovation. Furthermore, Gu & Tian, 2023 conducted a study revealing that green credit policies exhibit a more pronounced influence on the technological innovation of clean energy enterprises in developed regions as compared to less-developed regions. This discrepancy can be attributed to the fact that environmental issues are regarded as a more important obstacle to further economic advancement in highly developed areas, unlike underdeveloped ones. In addition, a higher level of scientific and technological innovation and a concentrated high-tech industry have formed advantages, which can better drive the upgrading of green industries in developed regions. Conversely, underdeveloped areas lack these technical factors, leading to an economy predominantly reliant on traditional and heavy industries.

Across the reviewed literature, only one study confronts the promotion effect of green credits on green enterprise innovation. He et al. (2019) found that the development of green finance (meaning green credits and other green assets) inhibited bank credits to renewable energy firms, which as a consequence, negatively affected their development and innovation.

C. Impact of green credits on industrial structure

While there is a general belief that green credits optimize the industrial structure, existing studies have yet to reach a consensus on whether it effectively advances the upgrading of industrial structure in China. Many scholars argue that by restricting loan access to HPHEC firms – consequently inhibiting their development – and relieving financing constraints for cleaner enterprises, green credits can

optimize resource allocation, leading to a Pareto improvement (G. Zhou, Liu, et al., 2021). It can guide capital to flow towards high-tech and service industries (Shao et al., 2019). This results in shifting the leading industry from primary to secondary to tertiary (Y. Hu et al., 2020), and can promote the green transformation of its economy (Y. Chen, 2008; Y. Guo et al., 2018; Liu et al., 2019; Zhang, Li, et al., 2021). Through theoretical and empirical analyses, Y. Hu et al. (2020) have identified several key mechanisms by which green credits influence the industrial structure in China.

- The other main mechanism by which green credits upgrade the industrial structure is the fund or capital orientation mechanism, as highlighted by Zhang, Li, et al. (2021). By utilizing interest rate mechanisms, banking institutions can incentivize investment in green industries through the reduction of financing costs, while simultaneously discouraging funding for industries characterized by high pollution. This strategy aims to optimize the industrial structure by encouraging more enterprises to proactively engage in the green industry, while exerting pressure on polluting sectors to undergo reorganization and transition or to exit the market. Y. Hu et al. (2020) empirically find that this process facilitates the development and expansion of secondary/tertiary industries over primary/secondary industries, ultimately leading to the reduction of pollution and high energy consumption. Additionally, certain environmental protection industries may face challenges in generating short-term profits. To address this, it becomes necessary for the government to support these industries by providing loans in the form of policy-based green loans.

- The feedback and credit-generating mechanisms describe the positive feedback cycle between the development of secondary and tertiary industries and credit funds from banks. Industries shift from the primary sector to the secondary and tertiary sectors, thus, the dependence on credit funds increases. Conversely, green credits facilitate this positive feedback cycle by supporting the development of secondary and tertiary industries.

- The industrial integration mechanism highlights the impact of the financial system on the governance structure of enterprises. The financial system allows, by directing the flow of resources in green industries, to increase firms' scale in such industries. This impacts their governance structure; hence enterprises break the original development mode and integrate completely the market.

However, Y. Hu et al. (2020) note that green credits' effect on industrial structure is significantly stronger in developed areas (eastern and central regions rather than western regions). They hypothesize that tertiary economies (i.e., eastern in the case of China) are more effective when integrating traditional industries. Interestingly, Zhang, Li, et al. (2021) found that green credits could reduce pollution more effectively by its effect on industrial structure than by promoting enterprise innovation. This may be because industrial structure directly determines energy consumption and pollution emissions, meaning it has a clearer and more direct impact on the environment. Whereas for the enterprise innovation channeling, innovation must be successful, then commercially deployed, before impacting enterprise energetic performance and pollution.

Inhibitive effect of foreign direct investment – FDI

Based on the case of China, several studies have noticed the impact of foreign investment when implementing a green credit policy. As reported by Chang (2012), a higher degree of openness could theoretically promote innovation spreading and be a catalyzer of industry decarbonization. Yet, in practice, foreign investors keep their technology confidential, don't introduce their most advanced technology, and often delocalize secondary industries, meaning firms that on average are more polluting and energy-intensive compared to tertiary industries (Y. Hu et al., 2020). This results in a

negative effect of FDI on industrial structure improvement following green credit policy implementation (Chang, 2012; Y. Hu et al., 2020; Zhang, Li, et al., 2021)

Limits

As briefly mentioned earlier, the positive impact of green credits on the industrial structure is widely accepted among economists. Yet, some researchers such as Zhan (2015), have raised concerns regarding information asymmetry and low penalty costs for environmental violations, that may limit the effectiveness of green credits in promoting industrial change.

IV. Summary and conclusion

Climate change is a pressing global challenge that demands urgent action to mitigate its impacts and reduce greenhouse gas (GHG) emissions. There is a growing awareness of the need to decarbonize industries and transition to a sustainable, low-carbon economy. This transition requires significant investments in renewable energy, clean and energy-saving technologies, and environmentally friendly practices across various sectors. Green finance, encompassing various financial assets such as green credits, is indispensable to mobilize the necessary resources and investments to finance the transition and promotion of a green economy. More specifically, the UE faces challenges in securing financial resources for this transition due to alarming debt situations. In such a context, green credit emerges as a promising alternative to finance the necessary changes. With not even 20 years of development, green credits have now become a hundred billion USD worth market. However, this surprising performance was not accompanied by the adoption of a universal exhaustive framework and definition, which makes it hard to gather precise data on its use. Thus, hindering economists' efforts to assess its impact. This lack of universally applicable criteria has permitted the proliferation of national frameworks, sometimes causing controversies as for the EU and China. This review of literature identifies the major impacts of green credit policy on enterprises, mainly based on theoretical analyses and observations in China.

- In its capacity as a financial tool, it has been well established that green credits can hamper the expansion of polluting and energy-intensive corporates. By restricting loan access for such enterprises, green loans have decreased the flow of financial resources into polluting enterprises, mainly SOEs and large-scale firms, through several direct (penalties and restrictions) and indirect (reputational damage) effects.

- The second and as-well-established effect of green credits is the promotion of clean industries. By redirecting investment flows towards such enterprises, green credits alleviate their financing constraints, hence promoting their development. As non-SOEs and SMEs are usually the enterprises with the tightest access to bank loans, green credits better promote their development.

- Finally, concerning innovation, the effect of green credits is ambiguous. It is rather clear that it enables green enterprises to invest more in R&D than prior to the policy implementation. However, its effect on polluting and energy-intensive corporates is still controversial. This debate echoes a wider conflict on the impact of environmental regulation and industrial policy on polluting enterprises. One point of view suggests that green credits incentivize such firms to upgrade to counteract the negative effects of tighter financing constraints caused by environmental regulations. Other scholars argue that, due to ineffective bank allocation, green credits impose additional constraints on all firms from heavy industries, even punishing the most effective ones and making it more difficult for them to upgrade their practices.

Overall, we can conclude that green credit policies as they currently stand, are a financial tool that will have to play a role in the transition financing. It is worth reminding that compared to green bonds (the main financing alternative to green loans globally), green credits are more reliable for investors (as the loan agreement is bilateral and can include penalties for violations of use of proceeds), and more suited to SMEs financing (as such enterprises do not usually issue bonds) (Joywin, 2018). Additionally, it seems to be an effective way to reduce pollution without severe consequences on economic growth compared to other environmental regulations such as differential electricity prices, or a production tax increase for polluting enterprises (Liu et al., 2017).

Yet, the key obstacle is to reconcile the various definitions associated with green credit (i.e., green loan, green enterprise, green industry…) to create an enabling environment that facilitates effective communication and coordination for the deployment of green credits. Furthermore, many scholars suggest increasing and reforming information gathering concerning corporates' environmental behavior. B. Zhang et al., (2011) propose that environmental information should be provided by public entities. Gilchrist et al. (2021) argue that information is either not available or is not timely provided. Hence, investors and financial institutions end up having only access to the ESG scores of enterprises. An elusive concept merging completely different, even sometimes opposite, aspects. Therefore, banks lack the necessary knowledge and cooperation with the public entities needs to be crucially improved (He et al., 2019; Gilchrist et al., 2021). If the environmental protection agencies do not cooperate, green credit policies cannot be properly enforced. In addition, governments must better entice banks to follow green credit policies (B. Zhang et al., 2011; Z. Chen et al., 2022; Gu & Tian, 2023). As they are the main intermediaries of such policies, their commitment is essential. Actually, green credit policy implementation in China and in India remains weak due to this lack very of motivation (Biswa, 2011; Yao et al., 2021).

Finally, green credit policies must be integrated into a broader set of economic tools to promote investment in the transition. In fact, green credits such association can emphasize the effect described in this review. Li et al. (2018) proposes to introduce government subsidies that would be allocated to firms who were recently granted green loans. They find that it reinforces the innovation effect of green credits. All while ensuring cost control for the government: with the possibility to adjust the subsidy intensity according to the balance between environmental policy and fiscal policy. Another example of combination with other tools would be the support they can provide to carbon price policies (carbon tax, ETS…) (Campiglio, 2015). In fact, carbon pricing is a well-known and effective way to encourage green investments. However, under certain circumstances such as a depressed macroeconomic environment combined with the unattractive risk/return profile of low carbon technologies (the risks, either real or perceived, associated with them have always been large), banks prefer not to fund low carbon projects, even with attractive prices induced by the carbon price measures. This misallocation of credit hinders the promotion of such projects. The 2008 crisis is a perfect example of such circumstances. Therefore, green credit policies have the potential to mitigate such market failures. Rozenberg et al (2013), for instance, argue for the introduction of differentiated reserve ratio requirements directed in favor of green sectors. Reserve ratio requirements, which specify the proportion of reserves banks must maintain, serve as a liquidity safeguard and indicate a bank's ability to withstand sudden fund withdrawals. In the context of green differentiated reserve requirements, banks would need to meet a lower reserve ratio for loans allocated to low-carbon sectors, aiming to encourage banks to increase lending to green initiatives to maximize their profits, given that a reduced reserve ratio expands their lending capacity. Additionally, such green differentiated reserves ratio requirements could be though as "dynamic" meaning that they could depend on the sector in which the bank operates, the bank's size… In Rozenberg et al. (2013), the mechanism would work as follows: a company pursuing low-carbon projects, collaborates with an independent monitoring unit to quantify emissions reductions and obtain certificates. These certificates serve as collateral when seeking a loan, and when approved, they are given to the bank which can keep store in its reserve requirement at the central bank.

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