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Bank green lending and credit risk: an empirical analysis of China's Green Credit Policy

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Abstract

This study empirically investigates the relationship between banks' green lending and their credit risk, and how Chinese green finance regulations contribute to the solvency of individual banks and the resilience of the financial system. Analysing a sample of 41 Chinese banks from 2007 to 2018, we find that the association between a bank's (relative) green lending as a proportion of its overall loan portfolio, and its credit risk, depends critically on the size and structure of state ownership. While the implementation of China's Green Credit Policy reduces credit risk for the major state-controlled banks, it increases credit risk for the city and regional commercial banks. This performance difference appears largely due to information and expertise asymmetries, with the city and regional commercial banks having less access to information and expertise necessary to evaluate the credit risk of green lending. Understanding this phenomenon can help policymakers tailor green finance policies according to banks' characteristics. It also suggests that mechanisms and platforms for the city/regional commercial banks to learn from the major state-controlled banks could be beneficial.

KEYWORDS

China's Green Credit Policy, credit risk, environmental policy, green loan

1 | INTRODUCTION

Banks' role in mobilizing financial resources and allocating them to productive investments makes them important contributors to economic growth and development. As such, bank lending to, and investment in, green assets is viewed as a crucial part of efforts to mitigate climate change by transitioning to a net-zero carbon economy. China's Green Credit Policy, implemented as early as 2007, established China as one of the pioneers in sustainable finance by attempting to strengthen banks' management of environmental exposures in areas such as pollution, energy consumption and climate change in their lending processes. This paper addresses the current lack of empirical studies examining China's Green Credit Policy with regard to its contribution to the solvency of individual banks and the resilience of the financial system as a whole.

Specifically, our analysis centres on credit risk and ownership structure at the bank level in China and the interaction of Chinese green finance regulations with these bank level characteristics. We explore the potential linkages between the sustainability of a bank's lending practice and its financial performance, honing in on whether a bank's green lending affects its credit risk. Much of our focus is on whether the implementation of the Green Credit Policy depends on a given bank's ownership structure and size in the context of China's unique banking system and institutional setting.

Chinese green finance policies have served as an important starting motivation for this research. In an effort to reduce pollution

and achieve the goal of a low-carbon economy, the Chinese government has implemented a series of green finance policies. Among the most influential of these, and of most direct relevance to bank lending, is the so-called Green Credit Policy, introduced in 2007. This policy,[1] a joint effort by China's central bank, main financial regulator, and environmental protection agency, directs banks to incorporate environmental due diligence into lending. The policy has evolved from a more theoretical stage to a clear implementation phase when the "Green Credit Guidelines" were introduced in 2012 (Wang, Yang, et al., 2019).

In order to further support and implement national green policies, the China Banking Association, the official umbrella group for the country's lenders, introduced the 'Guidelines on Corporate Social Responsibility for the Chinese Banking Sector' in 2009. These encourage financial institutions to disclose green finance practice in their corporate social responsibility (CSR) reports. Green finance disclosure and reporting have evolved from voluntary to mandatory since the launch of the 'Notice of the General Office of CBRC on the Submission of Green Credit Statistics Form and the Notice on the Submission of Green Credit Statistics Form' in 2013. Under the Notice, the 21 major banks of China, including three policy banks, five state-owned commercial banks, twelve joint-stock commercial banks and one postal savings bank, are required to submit data on their green lending to the CBRC.

There is evidence that the Green Credit Policy plays a crucial role in transitioning to a low-carbon economy (Akomea-Frimpong et al., 2021; Bukhari et al., 2020; Liu et al., 2017; Zhang et al., 2021), due to its role in guiding funds to the green business activities (Ho & Virginia, 2018). Despite the fact that green credit has become institutionalized in the Chinese legal system, the overall economic effects of green lending remain far from certain. What is the credit risk at the bank level associated with the increasing proportion of green lending? How does state ownership interact with green regulations in shaping a given bank's risk performance? How do China's green finance regulations affect financial stability for the lending institutions and for the financial sector as a whole?

Financial stability is 'about the absence of system-wide episodes in which the financial system fails to function, and about the resilience of financial systems to stress' (Čihák, 2007). It is suggested that credit risk at the level of individual banks affects financial and economic stability at a macroeconomic scale (Keeley, 1990). The instability of the financial system as experienced in recent years, that is, the 2007–2009 financial crisis, is often linked to credit risk (Schmitt et al. 2014). And the financial system is safer if banks carry less of the overall credit risk (Chan-Lau & Gravelle, 2005). The Chinese economy is reliant on bank lending, which represents the main source of financing, whereas capital markets play a limited role. And bank balance sheets are ballooning: according to the Institute for International Finance, China's gross debt surged from 171% to 299% of GDP from 2008 to 2018, with this rapid credit growth raising concerns about financial stability. In light of these vulnerabilities, and the significance of China to the global economy, it is particularly important to address this research gap and better understand these issues in China. Our research not only provides empirical evidence addressing these questions but also looks at the implications for supervisors and policymakers.

Using a sample of 41 Chinese banks from 2007 to 2018, we examine how Chinese banks' green lending actually affects credit risk, as measured by the rate of impaired loans, in the wake of the introduction of the Green Credit Policy in 2007. We use a Granger-style reverse causality minimization procedure following (Godfrey et al., 2020), with robust standard errors clustered at the bank level. We find that, in general, the lagged 1-year effect of the green loan rate on credit risk is insignificant during the sample period for all sample banks. Drawing on the instrumental stakeholder theory (IST) and relationship banking theory, we then further investigate whether the impact of China's Green Credit Policy interacts with bank size and ownership structure. We classify the banks into two groups by the type of ownership structure and the level of green loan investment management: (1) state-controlled major banks and (2) city/regional commercial banks. The state-controlled banks are well informed and more experienced in green loan management, whereas the city/regional commercial banks often lack industry expertise and knowledge in the green sector. The results for the two groups vary greatly. The finding for the former shows that the proportion of green loans has a significant negative association with credit risk, indicating that the implementation of China's Green Credit Policy reduces credit risk for the state-controlled major banks. Meanwhile, the latter group generates a totally opposite result: The increase in the proportion of green loans in the previous year leads to higher credit risk in the current year, suggesting that the Green Credit Policy poses higher credit risk to the city/regional commercial banks. The state-controlled banks outperform the city/regional commercial banks in implementing the Green Credit Policies. And this outperformance is particularly significant after the introduction of mandatory disclosure of green lending in 2013.

Our paper contributes to the understanding of the IST by providing evidence that green lending practice—a form of stakeholder relationship—could lead to improved financial performance when a sustainable competitive advantage is achieved. This study also contributes to the literature on relationship banking (Sharpe, 1990; von Thadden, 2004) that banks that are 'informationally captured' can extract rents in lending to borrowers. We provide empirical evidence to support that state-controlled banks with sufficient information and experience in green lending outperform smaller city/regional commercial banks with insufficient information on green loan investment. Our findings complement Stomper (2006), who shows that industry expertise is essential for lending to borrowers in an industry with uncertain business condition. Moreover, by tackling the question of how bank credit risk relates to increases in green lending, we aim to contribute to the literature by shedding light on the implementation of the Green Credit Policy in China. The finding that the effect of green lending on credit risk for a given bank varies greatly depending on the state ownership structure and size could help policymakers to tailor green finance policies according to banks' characteristics. It also suggests that mechanisms and platforms for the city/regional commercial banks

to learn from state-controlled banks on risk management in green lending could be beneficial. In addition, this study contributes to understanding the financial stability of the lending institutions and the Chinese banking sector as a whole by addressing whether sustainability integration in the form of green lending mitigates environmental and financial risk exposures.

The remainder of the paper is organized as follows: Section 2 provides a review of the related literature. Section 3 presents a brief overview of the banking industry in China and describes our sample, data, and empirical models. Sections 4 and 5 report the empirical results and robustness tests, followed with the discussion in Section 6. Section 7 offers the conclusions and some implications of our findings.

2 | HYPOTHESES DEVELOPMENT

The purpose of this paper is to empirically examine how a Chinese bank's green lending affects its credit risk and whether this effect depends on the bank's ownership structure and size, following the introduction of the Green Credit Policy in 2007. We know that banks are as vulnerable as other companies to environmental risks (Thompson & Cowton, 2004) and that their performance is based on the financial health of their borrowers—in this case, the profitability of companies, as we focus on corporate loans. In light of this, we formulate our empirical hypotheses by first reviewing existing studies on the relationship between corporate environmental performance and financial performance.

According to the legitimacy theory, organizations need to consider the institutional environment in which they operate and the environmental pressures they face, and adjust their policies and performance accordingly. This serves not only for them to be perceived as legitimate to operate within social bonds and norms but also to gain access to operational resources (de Villiers & van Staden, 2006; Dowling & Pfeffer, 1975). The performance consequences for a firm that considers its environmental and social issues in business strategies are theoretically explained in the IST (Jones, 1995). Central to the IST is that developing stakeholder relationships characterized by a high level of trust, cooperation, and information sharing will lead to improved financial performance when firms achieve sustainable competitive advantage[2] from this communal sharing relationship with stakeholders (Jones et al., 2018). Sustainable competitive advantage indicates a firm's ability to generate sustainable economic value than the marginal competitor in the market (Peteraf & Barney, 2003). Green lending could be viewed as a business strategy of interacting ethically with main stakeholders, including borrowing firms, government agencies and local communities. It can address market externalities and mitigate policy risks by incorporating climate change factors in the business model, generating more economic value.

Overview of empirical research on the firm's environmental performance effect indicates a generally positive relationship between corporate environmental performance and corporate financial performance (Ambec & Lanoie, 2008; Dixon-Fowler et al., 2013; Orlitzky & Benjamin, 2001), as surviving firms with better environmental performance tend to have higher innovation (Chen et al., 2019; D'Orazio & Valente, 2019; Hao et al., 2020; Huang et al., 2019; Lv et al., 2021) and operational efficiency (He et al., 2019; Liu et al., 2019; Qi, 2021) as well as strong risk management capabilities (Cullen, 2018; D'Orazio & Popoyan, 2019). Improved innovation, efficiency and organizational management may lead to competitive advantage and increase shareholder value. However, some other theoretical and empirical studies support a negative relationship (Climent & Soriano, 2011; Friedman, 1970; White, 1996) or suggest no significant relationship between the variables (Schaltegger & Figge, 2000), as it is costly to improve environmental performance, and these costs may exceed the financial gain derived from environmental activities. Recent studies find a U-shaped relationship between carbon emission performance and financial performance (Riillo, 2017; Trumpp & Guenther, 2015). More precisely, a higher level of environmental performance is associated with better financial performance, whereas a lower level of environmental performance is related to poor financial performance. Among green firms, better environmental performance tends to be associated with higher financial performance once a critical level of environmental performance is achieved. Other scholars study the financial performance effect of environmental performance from a risk perspective. Bansal and Clelland (2004) find that firms with legitimate environmental policies and practices incur less idiosyncratic risk than firms without such policies. More recently, Jo et al. (2014) suggests that good environmental, social and governance (ESG) corporate practices decrease the volatility of negative returns, as ESG efforts decrease the probability of negative events occurring (Krüger, 2015).

Fewer studies, however, focus on corporate social and environmental performance in China specifically. Drawing on institutional theory, Xun (2013) shows that government-aimed corporate social performance (CSR) is positively related to firms' financial performance in China and argues that CSR is often used as a legitimization tool and a discretionary means for engaging in the political process to interact with key legitimacy actors, that is, the Chinese government, as a way to enhance firm performance. Mengze and Wei (2015) conduct a comparative analysis of environmental credit risk management (ECRM) among banks in the Asia-Pacific region and find that integration of standardized environmental risk assessment procedures into the credit rating process moderately reduces the environmental risks of banks in China. Weber (2017) investigates the link between the sustainability performance of Chinese banks and their financial performance and finds a bidirectional causality between them.

From the portfolio diversification perspective, an increase in the share of green loans helps to reduce the climate-related risks associated with brown loans, thus helping to minimize credit risk and improve the stability of a financial system (Goodhart, 2005; Oluwaseun, 2020). Therefore, we argue that a bank's financial risk is likely to be reduced by greater exposure to firms with higher environmental standards, controlling for the probability of expected financial misconduct. Given all of the above discussion, we posit:

H1. Bank green lending is negatively associated with its credit risk performance.

The IST provides a valuable account of how firms' environmental performance will contribute to improved financial performance. However, the variance in performance exists depending on whether a sustainable competitive advantage from IST-based stakeholder treatment is achieved (Jones et al., 2018).

After the introduction of China's Green Credit Policy in 2007, the state-controlled larger banks have developed internal systems and bank level guidelines including a database, measures and procedures to promote the development of green finance business (Bai et al., 2013). Meanwhile, they gain information and knowledge advantages from establishing reliable relationships with leading corporations that are pioneering in renewable technologies. By interacting with the stakeholders such as corporations, NGOs and relevant government agencies consistently, major banks trained their staff who are qualified to assess newly developed business opportunities in low-carbon industries. For example, in order to strengthen the management of environmental risk, the Industrial and Commercial Bank of China (ICBC) established a database of clients' environmental risks in 2008 and determined the required actions and focal points in each step of green credit from due diligence, loan approval to fund distribution and post-loan management.[3] It has also developed the ICBC ESG Green Index (2017) and issued the management measures for the classification of green credit to identify environmental impacts of its borrowers. As a result, green lending can add value for these banks by investing in projects with lower environmental and technological risks.

In contrast to the leading state-controlled banks that have established thorough internal green loan policies, guidelines, procedures and due diligence requirements in the loan process, smaller commercial banks in cities and regions often lack comprehensive systems for environmental risk management or for transparency in green credit disclosure (Bai et al., 2013). Moreover, we also notice that training on environmental risk assessment for bank staff involved is inadequate. During manual data collection, we hardly find bank-level green lending guidance or management information in the annual reports and CSR reports for the city/regional commercial banks. Indeed, a green lending strategy based on a mutual trust relationship with stakeholders takes time to mature. Without a thorough understanding of the dynamics of renewable energy technology and the appropriate internal and external monitoring mechanisms, the green lending implementation may fail to identify environmental and technology risks and result in economic loss.

We also draw on the theory of relationship banking under asymmetric information: Informed lenders can extract rents from lending to borrowers that are 'informationally captured' because other lenders have insufficient information about them (Hauswald & Marquez, 2006; Sharpe, 1990; von Thadden, 2004). In addition, Stomper (2006) uses a theoretical approach to analyse the relationship between industry expertise and bank credit risk and suggests that banks benefit from industry expertise when lending to borrowers in young industries with uncertain business conditions. Empirical evidence in China also suggests that, in the long and dynamic process, the success ratio of loans by commercial banks is based on the investment experience in the previous period (Li et al., 2012) and lenders gain from industry knowledge in their banking decisions (Kroszner & Strahan, 2001). Thus, the major banks are more likely to gain experience and knowledge in assessing green investment opportunities than smaller regional banks. In addition, Zhang et al. (2021) evaluate the effect of China's Green Credit Policy on corporate investment behaviour in the energy sector. They find that the policy has a greater impact on large-scale and state-owned enterprises and the impacts vary by size and region in China. The above literature discussed leads to our second set of hypotheses:

H2a. For state-controlled major banks, green lending is negatively related to credit risk.

H2b. For smaller city/regional banks, green lending is positively related to credit risk.

H2c. The state-controlled major banks outperform the city/regional banks in green loan investment.

TABLE 1 Summary of banks in the sample

Bank type	State-controlled major banks	No. banks
City commercial bank	No	18
Joint-stock commercial bank	Yes	11
State-owned commercial bank	Yes	5
Rural commercial bank	No	3
Policy bank	Yes	3
Postal saving	Yes	1
Total		41

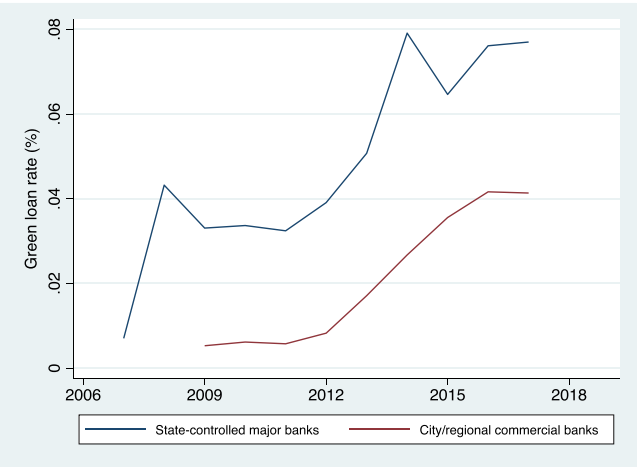

FIGURE 1 The changes in green lending for Chinese banks 2007–2018

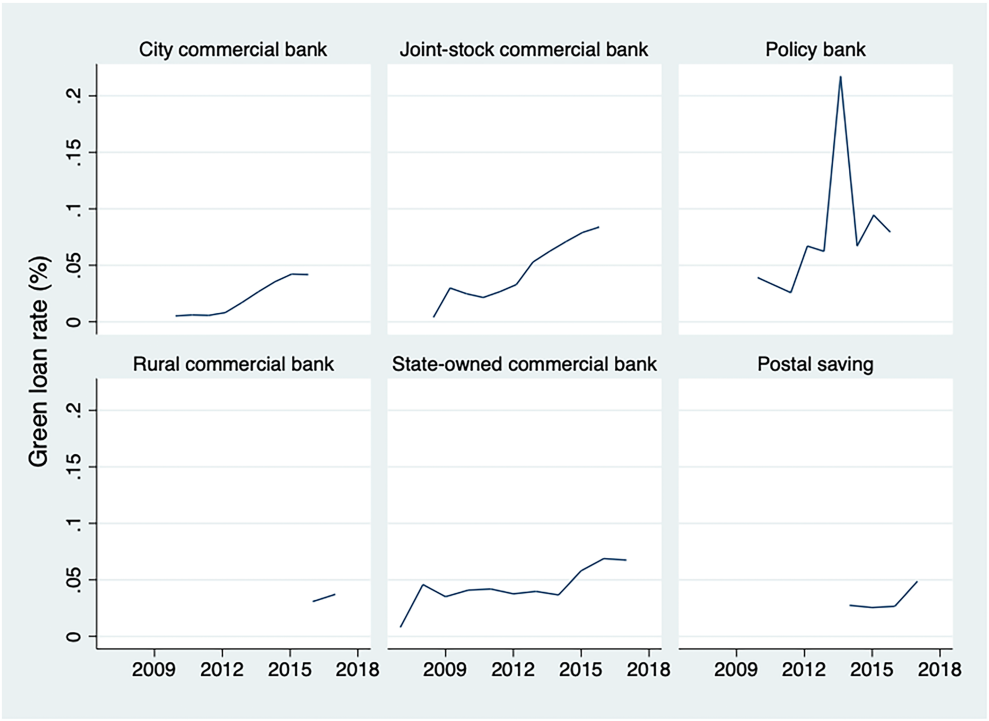

FIGURE 2 The changes in green lending by different types of banks 2007–2018

3 | DATA AND METHODOLOGY

Green investments often have a long time to maturity, high capital intensity and relate to new goods for which a market might not yet exist (Criscuolo & Menon, 2015; Elton & Gruber, 1982). These characteristics also mean it should be easier to investigate the long-term relation between banks' green investments—focusing on green lending, in our analysis—and bank-level financial performance. We run OLS regressions to estimate whether banks with a higher level of green loans are less risky than those with a lower level of green loans. Year dummies are included to account for shocks in the market in a given year. The standard errors are clustered at the bank level.

3.1 | Sample selection

The Chinese banking system comprises four basic bodies: the central bank, the supervisory authority, policy banks and commercial banks. The Chinese government is the sole owner of the policy banks and has controlling stakes in the state-owned commercial banks and national joint-stock commercial banks. In addition, the Chinese banking sector also includes more than 100 city commercial banks and thousands of small credit cooperatives and rural financial institutions. While the major commercial banks account for more than half of total assets in the Chinese banking sector, city and regional commercial banks do hold nearly a third—31.2% of total assets, to be precise.[4]

After the introduction of China's Green Credit Policy in 2007, the major commercial banks started to voluntarily disclose green finance in their annual reports and CSR reports. A few city/regional commercial banks have started to report their green finance information since 2009 under the 'Guidelines on Corporate Social Responsibility for the Chinese Banking Sector'. In 2013, mandatory green credit reporting was enacted.[5] Accordingly, banking institutions are required to categorize their green credit portfolios into two categories: (i) lending to the production and manufacturing of three 'strategic emerging sectors' and (ii) lending to projects and services that save energy and contribute to environmental protection. The size of Chinese banks' green credit portfolios has grown steadily. The most prominent sectors for green lending have been green transportation, renewable and clean energy, industrial energy efficiency, water

TABLE 2 Variable definitions and sources

Variable	Definitions	Source
Credit risk (%)	Impaired loans/gross loans	BankFocus
Green loan (%)	Green loans/total loans	Annual reports
Efficiency (%)	Earning assets/total assets	BankFocus
Leverage (%)	Total equities/total assets	BankFocus
Loan-loss provision (%)	Loan-loss provisions/total loans	BankFocus
Funding cost (%)	(Interest expense + non-interest expense)/total assets	BankFocus
Tier 1 capital ratio (%)	Tier 1 capital/total loans	BankFocus
Loan rate (%)	Total loans/total assets	BankFocus
Log (asset)	Log of total assets	BankFocus
GDP per capita	Gross domestic product (GDP)/population in a country	World Bank

TABLE 3 Summary statistics of firm-level variables

	State-controlled major banks						City/regional banks						*T* test
	Mean (1)	SD (2)	Median (3)	Min (4)	Max (5)	Obs (6)	Mean (7)	SD (8)	Median (9)	Min (10)	Max (11)	Obs (12)	Diff (13)
Credit risk (%)	0.01	0.01	0.01	0.00	0.04	127	0.01	0.00	0.01	0.00	0.02	74	0.001
Green loan (%)	0.06	0.09	0.04	0.00	0.58	127	0.03	0.03	0.03	0.00	0.15	74	0.023
Efficiency	0.85	0.04	0.85	0.76	0.98	127	0.86	0.04	0.86	0.77	1.12	74	−0.017*
Leverage	0.06	0.01	0.06	0.03	0.08	127	0.06	0.01	0.06	0.05	0.11	74	−0.003*
Loan-loss provision	0.01	0.01	0.01	0.00	0.03	127	0.01	0.01	0.01	0.00	0.04	74	−0.002*
Funding cost	0.03	0.01	0.03	0.02	0.05	127	0.03	0.00	0.03	0.02	0.04	74	0.0003
Tier 1 capital rate	0.12	0.02	0.12	0.07	0.18	127	0.17	0.04	0.17	0.09	0.26	74	−0.049***
Loan rate (%)	0.52	0.12	0.5	0.29	0.94	127	0.38	0.06	0.38	0.26	0.53	74	0.140***
Log (asset)	13.56	0.91	13.64	11.44	15.20	127	11.32	0.72	11.28	9.76	12.79	74	2.233***

Note: Columns (1) to (12) report the mean, standard deviation, median, minimum and maximum values for state-controlled major banks and city/regional smaller banks, respectively. Column (13) illustrates the difference between the mean of the two groups, and its significance level. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively. All samples in this study are Chinese banks, and we do not present GDP per capita.

TABLE 4 Variable correlation

	Green loan (%)	Efficiency	Leverage	Loan-loss provision	Funding cost	Tier 1 capital rate	Loan/total assets	Log (asset)
Green loan (%)	1							
Efficiency	0.196	1						
Leverage	0.073	0.144	1					
Loan-loss provision	0.173	0.221	−0.066	1				
Funding cost	−0.070	0.113	−0.106	−0.060	1			
Tier 1 capital rate	0.091	0.186	0.359	0.397	0.005	1		
Loan rate	0.005	0.055	0.302	−0.424	−0.099	−0.697	1	
Log (asset)	0.204	−0.237	0.077	−0.265	−0.244	−0.508	0.577	1

conservation and environmental protection projects, both in terms of volume of loans and in terms of growth of lending.

We manually collect green loan information from individual banks' annual reports and ESG reports from a total of 41 Chinese banks for the period 2007–2018. We classify our sample into two groups depending on size and ownership structure: (1) state-controlled major banks and (2) city/regional commercial banks. The former group includes policy banks, state-owned commercial banks, national joint-stock commercial banks and the postal saving bank, all of which are either solely owned or largely controlled by the central government. The latter group consists of the city or rural commercial banks, scattered throughout the country and owned by local governments and urban firms. Table 1 reports the number of banks by state ownership. Our sample includes 18 city commercial banks, 11 joint-stock commercial banks, 5 state-owned commercial banks, 3 rural commercial banks, 3 policy banks, and 1 postal saving bank. Our panel data are unbalanced as many city commercial banks and rural commercial banks are not required to fill and submit the green credit statistics forms (GCSF) to the CBRC. Appendix A reports bank names in our sample list.

3.2 | Variable measurements

3.2.1 | Variable of interest

Our variable of interest in this study is the proportion of green lending at the bank level. Specifically, we measure it as the ratio of the amount of green loan on a bank's balance sheet to the amount of total loan at that bank, for a given bank *i* at a given time *t*.

$$Green\ Loan_{i,t} = \frac{Green\ loan_{i,t}}{Total\ loan_{i,t}}$$

Figure 1 shows the changes in green lending, for the state-owned major banks group and city/regional commercial banks group, from

TABLE 5 The baseline results of bank green lending effect on credit risk

Variables	Credit risk		
	All sample (1)	State-controlled major banks (2)	City/regional banks (3)
GreenLoan_UCR	0.0001 (0.20)	−0.010** (−2.07)	0.032** (2.55)
Efficiency	−0.036* (−1.94)	−0.040** (−2.45)	−0.077** (−2.37)
Leverage	0.057 (0.64)	−0.069 (−0.42)	0.201 (1.50)
Loan-loss provision	0.205** (2.66)	0.440** (2.71)	−0.018 (−0.26)
Funding cost	0.049 (0.51)	0.150 (1.09)	−0.220 (−1.44)
Tier 1 capital rate	−0.015 (−0.78)	0.083 (1.56)	−0.071 (−1.44)
Loan rate	−0.002 (−1.41)	0.017 (0.99)	−0.021 (−0.88)
Log (total assets)	0.001 (1.14)	0.001 (0.91)	0.001 (1.08)
GDP per capita	−0.007** (−2.61)	−0.010*** (−3.45)	0.009 (1.67)
Constant	0.106*** (3.76)	0.101*** (3.57)	−0.0001 (−0.01)
Year FE	Yes	Yes	Yes
SE cluster	Firm	Firm	Firm
R square	0.562	0.693	0.574
Obs	165	111	54

Note: This table reports the baseline results of the three-step Granger-style reverse causality minimization procedure specified in Equation 5. The independent variable is *GreenLoan_UCR* (green loan unrelated to credit risk). The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate and GDP per capita. The dependent variable is bank credit risk measured by impaired loans. Columns (1), (2) and (3) show the estimates for all sample banks, the group of state-owned major banks and the group of city/regional smaller banks, respectively. All regression control for year fixed effects to account for unknown factors in the market. Standard errors are adjusted for firm-level clustering. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

2007 to 2018. In general, the proportion of green lending in the two types of banks has increased in parallel during the sample period. For the major banks, green lending grown from 5% of total lending in 2007 to almost 10% in 2018, with two sharp rises occurring around 2008 and 2014, a year after two major green credit regulations were issued. For city/regional banks, which are not required to submit green loan information but nonetheless started, in some cases, to report green credit information from 2009, the upward trend in the proportion of green lending does not exhibit any apparent policy effect. Figure 2 illustrates developments in green lending by the different types of banks. This figure suggests that the policy banks' green lending is most heavily affected by regulations and policies. Green loans for joint-stock commercial banks and state-owned commercial banks have grown smoothly and steadily, without any sharp movements. It is also worth noting that rural commercial banks only started to disclose green loan information around 2016, so there is little data available about that category of banks.

3.2.2 | Dependent variable

The dependent variable is bank level credit risk, which is the risk of an economic loss from the failure of borrowers to fulfil their contractual obligations (Jorion, 2003). Among factors used to identify bank risk, the impaired loan or non-performing loan (NPL) has been the focus of most studies of credit risk in the banking sector after the 1997 Asian Financial Crisis (Ahmad & Ariff, 2007; Shehzad et al., 2010; Zhang et al. 2016). In accordance with Ahmad and Ariff (2007), credit risk is measured by the ratio of the amount of impaired loan to the total gross amount of loans, for a given bank *i* at a given time *t*.

$$CreditRisk_{i,t} = \frac{Impaired\ loan_{i,t}}{Gross\ loan_{i,t}}$$

3.2.3 | Control variables

In an attempt to address a potential omitted variables issue, the regression analysis contains a broad set of control variables, including efficiency, leverage, loan-loss provision, funding cost, regulatory Tier 1 Capital, loan rate, total assets and GDP per capita. The definitions of each variable for hypothesis testing are shown in Table 2.

First, the log of total assets is used to measure bank size. Fischer et al. (2001) and find that bank size is significantly, negatively related to the credit risk of US banks. Fischer et al. (2001) also suggest that leverage is significantly and positively related to bank credit risk in Canada and Mexico. We define leverage as the ratio of total equity to total assets. We also control for loan rate which is the rate of total loans to total assets following previous research (e.g., Beltratti &

TABLE 6 The green lending effect on credit risk for the state-controlled major banks

	Credit risk		
Variables	**(1)**	**(2)**	**(3)**
GreenLoan_UCR × *StateBank*	−0.038*** (−2.75)	−0.028** (−2.60)	−0.028** (−2.07)
State bank	0.002 (1.29)	0.001 (1.27)	0.001 (0.88)
GreenLoan_UCR	0.033** (2.44)	0.026** (2.52)	0.026* (1.97)
Efficiency	−0.009 (−0.82)	−0.046*** (−4.68)	−0.046*** (−2.97)
Leverage	0.196** (2.29)	−0.026 (−0.33)	−0.026 (−0.21)
Loan-loss provision	0.319*** (3.31)	0.199*** (2.92)	0.199** (2.28)
Funding cost	0.047 (0.73)	0.055 (0.62)	0.055 (0.58)
Tier 1 capital rate	−0.039 (−1.26)	0.015 (0.60)	0.015 (0.41)
Loan rate	−0.026** (−2.32)	0.007 (0.79)	0.007 (0.50)
Log (total assets)	0.001** (2.11)	0.001 (1.15)	0.001 (0.71)
GDP per capita	−0.003 (−1.40)	−0.007*** (−2.73)	−0.007** (−2.53)
Constant	0.036** (2.04)	0.104*** (4.12)	0.104*** (3.78)
Year FE	No	Yes	Yes
SE cluster	Robust	Robust	Firm
R square	0.335	0.575	0.575
Obs	165	165	165

Note: This table reports the results of the three-step Granger-style reverse causality minimization procedure specified in Equation 6. The independent variable is the interaction term *GreenLoan_UCR*× *StateBank*. *GreenLoan_UCR* is green loan unrelated to credit risk. *StateBank* is the dummy variable and equals to 1 if it is a state-controlled major banks and 0 otherwise. The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate and GDP per capita. The dependent variable is bank credit risk measured by impaired loans. Columns (1) and (2) report the estimates for the regression without and with year fixed effect, and robust standard errors. Column (3) shows the estimates for the regression with year fixed effect and standard errors clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Stulz, 2012; Bonin et al., 2005; Heffernan & Xiaoqing, 2010; Lin & Zhang, 2009). Regulatory capital is the ratio of Tier 1 capital to total loans. Efficiency is measured as the ratio of earning assets to total assets. Loan-loss provision is calculated as loan-loss provisions divided by total loans. Funding cost is the sum of interest expense and non-interest expense divided by total assets. All above financial information is obtained from the BankScope database. GDP per capita is also included to control for macroeconomic factor in the analysis.

3.3 | Research design

We run the regression to test the effect of green lending on credit risk, over the sample period of 2007–2018. Following the previous theoretical literature, notably Sharpe's (1963) capital-asset pricing model (CAPM) and Hamada's (1972) contribution on bank risk and leverage, the baseline model is specified in Equation 1:

$$CreditRisk_{i,t} = \beta_0 + \beta_1 Greenloan_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 Efficiency_{i,t-1} + \beta_4 Leverage_{i,t-1} + \beta_5 LoanLoss_{i,t-1} + \beta_6 FundingCost_{i,t-1} + \beta_7 Capital_{i,t-1} + \beta_9 Loan/assets_{i,t-1} + YearFE + \varepsilon_{i,t} \quad (1)$$

Here, $CreditRisk_{i,t}$ is the impaired loan rate observed for bank *i* in year *t*. *Greenloan* is the actual proportion of green loans for bank *i* in year $t-1$. The above-mentioned control variables are all included in the regression. *YearFE* is included to account for common shocks in the market in a given year. $\varepsilon_{i,t}$ is the error term.

However, previous literature suggests that the relationship between environmental performance and financial performance may be exposed to reverse causality issue (Bruna & Lahouel, 2021; Nekhili et al., 2021; Yoo & Managi, 2021). Regression specification (1) may not address the reverse causality from bank's credit risk performance onto the green loan rate. Following (Godfrey et al., 2020), we employ a Granger-style reverse causality minimization technique.

First, we regress green loan rate on lagged bank credit risk measure as shown in Equation 2 below:

$$Greenloan_{i,t} = \beta_0 + \beta_1 CreditRisk_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

This regression allows us to separate green loan into two components, the one explained by credit risk (*GreenLoan_CR*) and the other unrelated to credit risk (*Greenloan_UCR*). The former, *GreenLoan_CR*, represents the product of lagged credit risk and its coefficient, while the latter, *Greenloan_UCR*, is the sum of the intercept and disturbance

TABLE 7 The GLS estimate of the green lending effect on credit risk

Variables	Credit risk			
	All sample (1)	State-controlled major banks (2)	City/regional banks (3)	All sample (4)
GreenLoan_UCR × *StateBank*				−0.028** (−2.15)
State bank				0.001 (1.23)
GreenLoan_UCR	0.000 (0.02)	−0.010*** (−2.66)	0.032*** (2.69)	0.026** (2.07)
Efficiency	−0.048*** (−5.13)	−0.040*** (−3.39)	−0.077*** (−4.03)	−0.046*** (−4.94)
Leverage	−0.021 (−0.34)	−0.069 (−1.00)	0.201 (1.36)	−0.026 (−0.41)
Loan-loss provision	0.214*** (3.91)	0.440*** (5.55)	−0.018 (−0.28)	0.199*** (3.61)
Funding cost	0.059 (0.80)	0.150 (1.50)	−0.220* (−1.77)	0.055 (0.67)
Tier 1 capital rate	0.013 (0.50)	0.083*** (2.78)	−0.071 (−1.22)	0.015 (0.63)
Loan rate	0.008 (0.83)	0.017* (1.77)	−0.021 (−0.78)	0.007 (0.75)
Log (total assets)	0.001** (2.11)	0.001** (2.27)	0.001 (1.57)	0.001 (1.46)
GDP per capita	−0.007*** (−4.34)	−0.010*** (−6.18)	0.009* (1.86)	−0.007*** (−4.36)
Constant	0.106*** (6.59)	0.101*** (5.51)	−0.002 (−0.05)	0.104*** (6.55)
Year FE	Yes	Yes	Yes	Yes
Obs	165	111	54	165

Note: This table reports the results of the three-step Granger-style reverse causality minimization procedure using the generalized least squares (GLS). The independent variable is *GreenLoan_UCR* (green loan unrelated to credit risk) in columns (1) to (3), and *GreenLoan_UCR*× StateBank in column (4). The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate and GDP per capita. The dependent variable is bank credit risk measured by impaired loans. All regression control for year fixed effects to account for unknown factors in the market. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

term of the regression. Both components can be written as displayed in Equations 3 and 4, respectively.

$$GreenLoan\_CR_{i,t} = \beta_1 CreditRisk_{i,t-1} \tag{3}$$

$$GreenLoan\_UCR_{i,t} = \beta_0 + \varepsilon_{i,t} \tag{4}$$

Second, we conducted two statistical diagnostic tests of *Greenloan_UCR*: (1) a correlation test confirms that *Greenloan_UCR* is uncorrelated to credit risk; (2) a Granger causality *F* test suggests that the effect of $CreditRisk_{i,t-1}$ on $GreenLoan\_UCR_{i,t}$ is insignificant. These results indicate that the possibility of reverse causality has been minimized from $GreenLoan\_UCR_{i,t}$.

Third, we develop our baseline model. Specifically, we regress bank credit risk on lagged *Greenloan_UCR* in Equation 5. The regression includes firm-level control variables and year fixed effects, with standard errors clustered at the firm level.

$$\begin{aligned} CreditRisk_{i,t} = {} & \beta_0 + \beta_1 GreenLoan\_UCR_{i,t-1} + \beta_2 Size_{i,t-1} + \beta_3 Efficiency_{i,t-1} \\ & + \beta_4 Leverage_{i,t-1} + \beta_5 LoanLoss_{i,t-1} + \beta_6 FundingCost_{i,t-1} \\ & + \beta_7 Capital_{i,t-1} + \beta_9 Loan/assets_{i,t-1} + YearFE + \varepsilon_{i,t} \end{aligned} \tag{5}$$

We then include an interaction term $Greenloan\_UCR_{i,t-1}$ × *StateBank* in Equation 6 to test whether the green loan effect on bank credit risk depends on the size and ownership and whether the state-controlled banks outperform the small city/regional banks. *StateBank* is a dummy variable. It is equal to 1 if it is a state-controlled major bank, and 0 otherwise.

$$\begin{aligned} CreditRisk_{i,t} = {} & \beta_0 + \beta_1 Greenloan\_UCR_{t-1} \times StateBank + \beta_2 Statebank \\ & + \beta_3 Greenloan\_UCR_{i,t-1} + \beta_4 Size_{i,t-1} + \beta_5 Efficiency_{i,t-1} \\ & + \beta_6 Leverage_{i,t-1} + \beta_7 LoanLoss_{i,t-1} + \beta_8 FundingCost_{i,t-1} \\ & + \beta_9 Capital_{i,t-1} + \beta_{11} Loan/assets_{i,t-1} + YearFE + \varepsilon_{i,t} \end{aligned} \tag{6}$$

Since the effect of credit risk on green loans has been removed by definition from the term *Greenloan_UCR*, the model specified in the baseline model (Equation 5) and main model (Equation 6) estimate only the effect of green loans on bank's credit risk.

4 | RESULTS

Descriptive summary statistics for our main variables are presented in Table 3. Columns (1) to (12) report the mean, standard deviation, median, minimum and maximum values for state-controlled major banks and city/regional smaller banks, respectively. Column (13) illustrates the difference between the mean of the two groups. It is apparent that the average major bank is larger in terms of total assets than the average city/regional bank and has a higher loan rate. However, the mean values for Tier 1 capital rate, leverage and loan-loss provision are higher for the smaller bank group

TABLE 8 The green lending effect on credit risk for the state-controlled major banks controlling for firm-level ESG scores

Variables	Credit risk		
	State-controlled major banks		
	(1)	(2)	(3)
GreenLoan_UCR	−0.016*** (−4.99)	−0.016*** (−4.15)	−0.016*** (−4.19)
Efficiency	0.001 (0.06)	0.002 (0.07)	0.003 (0.14)
Leverage	−0.478 (−1.78)	−0.436 (−1.48)	−0.417 (−1.39)
Loan-loss provision	0.538*** (5.99)	0.542*** (6.18)	0.537*** (6.64)
Funding cost	0.272 (1.61)	0.261 (1.45)	0.229 (1.24)
Tier 1 capital rate	0.250** (2.51)	0.228* (2.04)	0.227* (2.01)
Loan rate	0.064 (1.76)	0.059 (1.55)	0.058 (1.52)
Log (total assets)	0.005** (3.01)	0.004** (2.63)	0.004** (2.62)
GDP per capita	−0.016*** (−3.95)	−0.015*** (−3.39)	−0.015*** (−3.52)
Environmental score	−0.000 (−1.15)	−0.000 (−0.77)	−0.000 (−0.60)
Social score		−0.000 (−0.76)	−0.000 (−0.18)
ESG score			−0.000 (−1.57)
Constant	0.046 (1.48)	0.046 (1.40)	0.045 (1.30)
Year FE	Yes	Yes	Yes
SE cluster	Firm	Firm	Firm
R square	0.810	0.812	0.814
Obs	76	76	76

Note: This table reports the baseline results of the three-step Granger-style reverse causality minimization procedure specified in Equation 5. The independent variable is *GreenLoan_UCR* (green loan unrelated to credit risk). The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate, ESG scores and GDP per capita. The dependent variable is bank credit risk measured by impaired loan. Columns (1) and (2) report the estimates controlling for firm-level environmental score and social score, respectively. Column (3) shows the estimates for the regression controlling for both environmental and social scores. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

than for the large banks. It is also worth noting that the state-controlled major banks have a higher proportion of green lending than the city/regional banks, but it is not statistically significant. The summary statistics suggest that the group of state-owned major banks exhibits different characteristics to the group of smaller banks, indicating that we need to test the effect of green lending on credit risk separately for those two groups. The correlations between the independent and dependent variables can be found in Table 4.

Our baseline results are presented in Table 5. Column (1) shows the results for all banks across both groups, and columns (2) and (3) show our results for the group of state-owned major banks and the group of city/regional smaller banks, respectively. The coefficient estimate of the green loan variable is 0.01% for all banks, but it is not statistically significant. This finding would seem to suggest that the implementation of China's Green Credit Policy has had a negligible effect on the financial stability of the financial sector as a whole. We reject Hypothesis 1. However, the results vary greatly when we split banks into two groups by ownership structure. The finding for the group of state-owned major banks shows that a 1% increase in the proportion of green loans reduces bank credit risk by 1% at a 5% significance level, indicating that green lending has a significant negative association with credit risk for these banks. Meanwhile, the smaller city/regional banks generate an opposite result: An increase in green lending in the previous year leads to higher credit risk in the current year. These results support our Hypotheses 2a and 2b, respectively, that the effect of banks' green lending on credit risk varies by ownership structure and size: While the proportion of green lending is negatively associated with credit risk for the state-controlled major banks, it is positively related to credit risk for the city/regional commercial banks.

Table 6 present the effect of green loan on credit risk for the interaction term $Greenloan\_UCR_{i,t-1} \times StateBank$ for the whole sample period 2007–2008. Columns (1) and (2) report the estimates for the regression without and with year fixed effect, and robust standard errors. Column (3) shows the estimates for the regression with year fixed effect and standard errors clustered at the firm level. We find that the coefficient on the interaction term $Greenloan\_UCR_{i,t-1} \times StateBank$ is negative and significant (−0.028, $p < 0.01$) for the whole sample period, supporting Hypothesis 2c that the state-controlled major banks outperform the city/regional banks in green lending. The findings suggest that the implementation of the Green Credit Policy depends on a given bank's ownership structure and size in the context of China's unique banking system and institutional setting. The size

TABLE 9 The simultaneous regression result of green lending effect on credit risk

	Credit risk		
Variables	**(1)**	**(2)**	**(3)**
GreenLoan_UCR × *StateBank*	−0.034** (−1.98)	−0.032*** (−2.84)	−0.032** (−2.04)
State bank	0.001 (0.80)	−0.000 (−0.16)	−0.000 (−0.10)
GreenLoan_UCR	0.025 (1.55)	0.030*** (2.73)	0.030* (1.99)
Efficiency	−0.000 (−0.02)	−0.047*** (−5.59)	−0.047*** (−4.16)
Leverage	0.184*** (3.37)	0.060 (1.16)	0.060 (0.95)
Loan-loss provision	0.424*** (3.90)	0.235*** (3.23)	0.235** (2.35)
Funding cost	−0.110 (−1.29)	0.226*** (2.75)	0.226** (2.12)
Tier 1 capital rate	−0.028 (−1.20)	−0.005 (−0.31)	−0.005 (−0.26)
Loan rate	−0.024*** (−2.88)	0.003 (0.50)	0.003 (0.42)
Log (total assets)	0.001** (2.05)	0.001* (1.82)	0.001 (0.99)
GDP per capita	−0.008*** (−2.95)	−0.008*** (−3.75)	−0.008*** (−3.70)
Constant	0.067*** (3.97)	0.101*** (5.36)	0.101*** (4.82)
Year FE	No	Yes	Yes
SE cluster	Robust	Robust	Firm
R square	0.359	0.631	0.631
Obs	201	201	201

Note: This table reports the results of the three-step Granger-style reverse causality minimization procedure. In this analysis, we employ a simultaneous structure of research design, where the credit risk in year t is hypothesized to be affected by firm characteristics and green lending in the same year. The independent variable is the interaction term *GreenLoan_UCR* × StateBank. The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate and GDP per capita. The dependent variable is bank credit risk measured by impaired loans. Columns (1) and (2) report the estimates for the regression without and with year fixed effect, and robust standard errors. Column (3) shows the estimates for the regression with year fixed effect and standard errors clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

and ownership effect provides additional evidence for the relation between a bank's green lending practice and its financial performance.

5 | ROBUSTNESS TESTS

We performed a series of robustness tests. First, we apply the Granger-style reverse causality minimization procedure in the generalized least squares (GLS) regression due to the concern about heteroscedasticity and reverse causality. Table 7 report the GLS regression results. Columns (1), (2), (3) and (4) show the estimates for the whole sample, the state-controlled major banks, the city/regional banks and the interaction term *Greenloan_UCR* × *StateBank*, respectively. We obtained identical, statistically significant estimates for the state-controlled group and the city/regional banks reported in Table 5. The negative coefficient of the interaction term $Greenloan\_UCR_{i,t-1} \times StateBank$ is also significant, at a 5% significance level. This result remains qualitatively the same as reported in Table 6.

Another concern with the results documented is that a bank's decision to issue green loans could be based on its ESG policies or management values. To avoid omitted variable bias from firm culture variation that we were not explicitly controlling for, we added ASSET4 environmental€, social (S) and governance (G) scores in our model for the state-controlled group.[6] In support of our result, we find a strong negative estimate on the *Greenloan_UCR* term. Our results (Table 8) remain robust when we control for year fixed effect and when the standard errors are clustered at firm level.

Compared to the main findings used lagged green lending ratio, we then conduct a simultaneous regression on credit risk for the whole sample period. The results (Table 9) are consistent with the 1-year lagged tests. The findings enhance our main results by showing the green lending effect on credit risk for the state-controlled major banks during the same year period.

Next, we excluded three policy banks in our test as they are less profit driven. The results are reported in Table 10. We obtained identical, statistically significant estimates to those reported in Table 7.

6 | DISCUSSION

This study analyses the effect of green lending on banks' credit risk after the introduction of the China's Green Credit Policy in 2007. Our findings broadly support the work of other studies in this area linking macro policy, green lending and financial risks. The result that the credit risk performance of green lending varies by size and ownership

TABLE 10 The green lending effect on credit risk for the state-controlled major banks (excluding the policy banks)

	Credit risk		
Variables	**(1)**	**(2)**	**(3)**
GreenLoan_UCR × *StateBank*	−0.036** (−2.54)	−0.027** (−2.35)	−0.027** (−1.81)
State bank	0.001 (1.19)	0.001 (0.94)	0.001 (0.64)
GreenLoan_UCR	0.032** (2.30)	0.026** (2.38)	0.026* (1.82)
Efficiency	−0.004 (−0.27)	−0.039*** (−3.01)	−0.039* (−1.85)
Leverage	0.217** (2.31)	−0.028 (−0.33)	−0.028 (−0.21)
Loan-loss provision	0.313*** (3.21)	0.197*** (2.86)	0.197** (2.18)
Funding cost	0.046 (0.71)	0.061 (0.69)	0.061 (0.65)
Tier 1 capital rate	−0.044 (−1.31)	0.019 (0.63)	0.019 (0.42)
Loan rate	−0.026* (−1.95)	0.011 (0.91)	0.011 (0.59)
Log (total assets)	0.001** (2.17)	0.001 (1.33)	0.001 (0.81)
GDP per capita	−0.003 (−1.33)	−0.007*** (−2.63)	−0.007** (−2.39)
Constant	0.030 (1.45)	0.094*** (3.48)	0.094*** (3.15)
Year FE	No	Yes	Yes
SE cluster	Robust	Robust	Firm
R square	0.320	0.568	0.568
Obs	161	161	161

Note: This table reports the results of the three-step Granger-style reverse causality minimization procedure for the subsample excluding policy banks. The independent variable is the interaction term *GreenLoan_UCR* × *StateBank*. The control variables are bank characteristics including size, management efficiency, leverage, loan-loss provision, funding cost, regulatory capital, loan rate and GDP per capita. The dependent variable is bank credit risk measured by impaired loans. Columns (1) and (2) report the estimates for the regression without and with year fixed effect, and robust standard errors. Column (3) shows the estimates for the regression with year fixed effect and standard errors clustered at the firm level. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

is consistent with D'Orazio and Popoyan (2019). They suggest that macro credit policy can promote green lending under certain conditions by mitigating climate-related financial risks. Similarly, Laeven and Levine (2009) find that the same policy has different impacts on bank risk depending on a given bank's governance structure.

This variance in performance could be explained by the IST. It argues that developing a close relationship with stakeholders can create more economic value from knowledge sharing, improved reciprocal coordination, lower transaction costs. The green lending practice could be viewed as a form of stakeholder management strategy which attempts to incorporate environmental and climate change factors in loan investments, meeting the primary stakeholders' interests. Transitioning to a low-carbon industry requires constant adaptation to competitive, technological and regulatory conditions. The major state-controlled banks with a close relationship with stakeholders such as government agencies and corporations are in a stronger position to create value in this dynamic context (Joshi & Campbell, 2003). They had entered the green lending business as earlier as the China's Green Credit Policy announced and had accumulated low-carbon technology and knowledge by constantly interacting with renewable energy borrowers, relevant government agencies and international peers. Mengze and Wei (2015) make a similar point, suggesting that integration of standardized environmental risk assessment procedures into the credit rating process moderately reduces environmental risks of banks in China.

However, the risk mitigation effect of green lending practice is not always secured as there are conditions under which an environmentally friendly lending practice is likely to be a source of sustainable competitive advantage. The smaller city/regional commercial banks are relatively new to the recently labelled green lending business. For example, 42% (8 out of 19) of the smaller regional banks officially started to disclose green lending information in 2013, 5 years lagged behind the state-controlled banks. They have not been able to form close relationships with stakeholders and benefit from low transition costs, knowledge sharing and staff training. An explanation for the positive effect of green lending on credit risk for city/regional commercial banks is that they failed to gain industry expertise and capacity in green finance (Bai et al., 2013), leading to less efficient lending decisions (Hauswald & Marquez, 2006).

We can also interpret our findings using the relationship banking theory (Hauswald & Marquez, 2006; Sharpe, 1990; von Thadden, 2004). It posits that informed lenders can extract rents from lending to borrowers that are 'informationally captured' because other lenders have insufficient information about them. The strong negative association between green lending and bank credit risk for state-controlled major banks can be attributed to the fact that large banks benefit from industry expertise and knowledge in green loan underwriting, as well as sound internal mechanisms of ECRM (Ho & Virginia, 2018). Empirical evidence also suggests that the success of

bank lending depends on investment experience (Li et al., 2012) and industry knowledge (Kroszner & Strahan, 2001). This finding is consistent with (Mengze & Wei, 2015) that ECRM can significantly reduce environmental risks for banks.

7 | CONCLUSION

Although China's Green Credit Policy established the country as one of the pioneers of sustainable finance by getting banks to introduce and scale up green lending, there have so far been few analyses of its success. This paper addresses the current lack of empirical studies examining the Green Credit Policy with regard to its impact on financial stability for lending institutions and for the banking sector as a whole. The empirical evidence this study provides can help policymakers adjust the implementation of climate-related regulations and offers guidance to industry practitioners who wish to mitigate environmental risks in sustainable investing.

Our results shed light on the Green Credit Policy from many angles. Consistent with Laeven and Levine's (2009) study on bank governance, regulation and risk taking, we do not document a significant association between bank green lending and risk performance across the banking sector as a whole; rather, credit risk varies greatly by bank ownership structure and size. This result implies that the Green Credit Policy's effect on credit risk is not consistent across banks. In other words, a blanket green lending policy may not be very effective but rather may require more tailoring to specific bank characteristics.

This view is reinforced by our most important finding that while an increase in the proportion of green lending reduces credit risk for state-owned major banks, it increases credit risks for smaller city/regional commercial banks. For two different groups of banks that differ by size and ownership structure, the same Green Credit Policy actually has an opposite effect. This result suggests that, compared to their large peers, city/regional level commercial banks have more limited capacity and industry expertise, and less developed risk management systems, all of which may contribute to the economic losses they are experiencing in green lending (Ho & Virginia, 2018). Their ownership by city and regional governments may also make them more constrained by local operation environment (i.e., official promotion system) and less integrated into central policymaking than the (central government-owned) major banks, which have a leading role in China's push to achieve a sustainable economy (Sun et al., 2013).

Thus, our findings serve to highlight the challenges in implementing the Green Credit Policy. The large discrepancy between the two groups of banks makes it all the more important for the government to adjust the implementation standards for green finance policies in accordance with regional economic status and bank structure. Factors including ownership, size and capacity of the lending institution, expertise and knowledge in the newly emerged green finance sector, and regional differences have to be taken into account by policymakers in order to ensure continued financial stability for the lending institutions and for the banking sector as a whole. Guidelines and training on best practices could be implemented to help laggard banks to apply green credit policies appropriately.

Given the Chinese institutional context—a 'government-aimed' CSR stakeholder model (Xun, 2013), it is equally important to set up mechanisms and networks for the large state-controlled banks to communicate and exchange information and expertise with the city/regional commercial banks. This could include sharing on low-carbon expertise or environmental risk management but could also extend to collaboration around innovative banking activities, building (shared) green credit data analysis platforms, or setting up specialized green credit institutions.

After all, a systemic shift to sustainable lending requires industry-wide expertise, capacity and risk management. Without mechanisms to access sufficient knowledge or expertise on green finance, or without the right tools to assess environmental risks and opportunities, smaller regional Chinese banks may suffer further deterioration of their credit risk under coercive institutional pressure to blindly increase the proportion of green lending.

Our research comes with some limitations. First, this study only focuses on the Chinese banks' implementation of green lending and its impact in China. The implications may not apply to other countries where the banking system and green financing regulations differ from China. Second, we control for main bank characteristics and GDP to minimize confounding factors, though there could still be omitted variables that influence bank credit risk. Further analysis is required to investigate the cost of green lending in China. Another potentially fruitful avenue for future research is to study whether the implementation of green lending affects bank profitability/return and how the impact varies across regions.

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ENDNOTES

[1] It was formally known as the 'Opinion on Implementing Environmental Regulations and Managing Credit Risks', jointly published by the State Environmental Protection Administration (SEPA), the People's Bank of China (PBOC), and the China Banking Regulatory Commission (CBRC).

[2] Sustainable competitive advantage indicates a firm's ability to persistently generate more economic value than the marginal competitor in the market (Peteraf & Barney, 2003).

[3] Industrial & Commercial Bank OF China, 2018 Corporate Social Responsibility Report 47–50. http://v.icbc.com.cn/userfiles/Resources/ICBCLTD/download/2019/2018csrCN.pdf

[4] Financial Times, 8 November 2019, 'China's small lenders suffer bank runs as economy slows'.

[5] In 2013, the CBRC, the country's bank supervisor, launched the 'Notice of the General Office of CBRC on the Submission of Green Credit Statistics Form' and the 'Notice on the Submission of Green Credit Statistics Form'. These two documents form the Green Credit Statistics System (GCSS).

[6] We downloaded ASSET4 E, S and G scores for 20 major Chinese banks from 2008 to 2019. We cannot test it for the city/regional banks due to a lack of ESG data access.

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APPENDIX A.

Table A1. Chinese bank sample list

Bank name	Bank type	State-controlled major banks
BANK of BEIJING CO LTD	City commercial bank	No
BANK of CHENGDU CO LTD	City commercial bank	No
BANK of CHONGQING	City commercial bank	No
BANK of GANSU	City commercial bank	No
BANK of GUIYANG CO LTD	City commercial bank	No
BANK of HANGZHOU CO LTD	City commercial bank	No
BANK of JIANGSU CO LTD	City commercial bank	No
BANK of JINZHOU CO LTD	City commercial bank	No
BANK of NANJING	City commercial bank	No
BANK of NINGBO	City commercial bank	No
BANK of QINGDAO CO LTD	City commercial bank	No
BANK of SHANGHAI	City commercial bank	No
BANK of TIANJIN	City commercial bank	No
BANK of ZHENGZHOU CO., LTD.	City commercial bank	No
HARBIN BANK	City commercial bank	No
HUISHANG BANK CO LTD	City commercial bank	No
JIANGXI BANK CO LTD	City commercial bank	No
ZHONGYUAN BANK CO LTD	City commercial bank	No
CHONGQING RURAL COMMERCIAL BANK	Rural commercial bank	No
JIANGSU CHANGSHU RURAL COMMERCIAL BANK CO., LTD	Rural commercial bank	No
WUXI RURAL COMMERCIAL BANK CO. LTD	Rural commercial bank	No
CHINA BOHAI BANK	Joint-stock commercial bank	Yes
CHINA CITIC BANK CORPORATION LIMITED	Joint-stock commercial bank	Yes
CHINA EVERBRIGHT BANK COMPANY LIMITED	Joint-stock commercial bank	Yes
CHINA GUANGFA BANK CO LTD	Joint-stock commercial bank	Yes
CHINA MERCHANTS BANK CO LTD	Joint-stock commercial bank	Yes
CHINA MINSHENG BANKING CORPORATION	Joint-stock commercial bank	Yes
CHINA ZHESHANG BANK CO LTD	Joint-stock commercial bank	Yes
HUA XIA BANK CO., LIMITED	Joint-stock commercial bank	Yes
INDUSTRIAL BANK CO LTD	Joint-stock commercial bank	Yes
PING AN BANK	Joint-stock commercial bank	Yes
SHANGHAI PUDONG DEVELOPMENT BANK	Joint-stock commercial bank	Yes
AGRICULTURAL DEVELOPMENT BANK of CHINA	Policy bank	Yes
CHINA DEVELOPMENT BANK CORPORATION	Policy bank	Yes
EXPORT–IMPORT BANK of CHINA - CHINA EXIMBANK	Policy bank	Yes

(Continues)

Bank name	Bank type	State-controlled major banks
AGRICULTURAL BANK of CHINA LIMITED	State-owned commercial bank	Yes
BANK of CHINA LIMITED	State-owned commercial bank	Yes
BANK of COMMUNICATIONS CO. LTD	State-owned commercial bank	Yes
CHINA CONSTRUCTION BANK CORPORATION JOINT STOCK COMPANY	State-owned commercial bank	Yes
INDUSTRIAL & COMMERCIAL BANK of CHINA (THE) - ICBC	State-owned commercial bank	Yes
POSTAL SAVINGS BANK of CHINA CO LTD	Postal saving	Yes