Energy Economics 101 (2021) 105415

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Green credit policy and firm performance: What we learn from China

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ARTICLE INFO

Keywords:
Green credit policy
Firm performance
Financial constraints
Investment
China

ABSTRACT

We explore the effect of green credit policy on firm performance of listed firms in China. We find that green credit policy reduces firm performance in heavily polluting industries. This effect is more prominent in state-owned enterprises, firms with large size, high institutional ownership, high analyst coverage and during high economic policy uncertainty period. Moreover, we observe that green credit policy decreases heavily polluting firms' performance by increasing firm financing constraints and decreasing investment level. Our results help to restrain heavily polluting enterprises and promote industrial transformation in developing markets.

1. Introduction

Resource depletion and environmental pollution are becoming increasingly serious, and environmental regulation develops into a widely used means to realize the coordinated development of economy and environment. As a key part of environmental regulation, green credit attracts wide attention from academia and industry. Green credit means that the bank takes the information related to the project and its operating company as the inspection standard in the process of lending, and then makes a loan decision (Thompson and Cowton, 2004). Green credit expects to rationally allocate credit funds through differentiated credit services, which will eventually lead to coordinated progress between finance and environmental protection (Nandy and Lodh, 2012; He et al., 2019). Prior Studies have found that green credit helps banks avoid environmental risks, firms' green transformation and sustainable economic development (Zhang et al., 2011; Nandy and Lodh, 2012; Cui et al., 2018). Besides, green credit can also improve firms' information transparency and strengthen the linkage between the financial sector and the environmental protection sector (Wang et al., 2015; Eiler et al., 2015). However, few researchers explored the influence of green credit on firm performance from the perspective of firms. Therefore, different from previous literature, this paper aims to investigate whether green credit has a "penalty effect" on firms with poor environmental performance from the view of firm performance, and then provide suggestions for understanding the role of green credit and promoting industrial transformation.

Firm performance is an important standard to evaluate the profitability, asset operation level and solvency of firms, which directly reflects firms' subsequent development ability (Liu et al., 2019a, 2019b). The existing research explores the factors that influence firm performance and finds that firm performance is influenced by factors such as political connections, financial characteristics, manager characteristics and competitive experience (Berk et al., 2010; Banker et al., 2013; Zailani et al., 2015; Galbreath, 2019; Li et al., 2019). However, only limited research examined the influence of green credit on firm performance from the perspective of environmental protection. Some studies pointed out that green credit helps to effectively curb the investment level and long-term borrowing level of energy-intensive industries and highly polluting firms (Liu et al., 2017; Sun et al., 2019). For firms with heavy pollution or polluting projects, banks have to limit the issuance of loans after the implement of green credit. Bank loan is an indispensable source of firms' financing activities. The limited financing may lead to the reduction of investment and production scale, and then affect firm performance. Therefore, we expect that green credit may have a "penalty effect" on heavily polluting firms and reduce their performance.

The Chinese market is an appropriate setting for the following two reasons. First, how to face up to the relationship between credit policy and business operation has become an issue affecting China's social stability and economic security. The rapid development of economy has

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https://doi.org/10.1016/j.eneco.2021.105415
Received 9 February 2021; Received in revised form 5 June 2021; Accepted 21 June 2021
Available online 29 June 2021

brought increasingly serious resource shortage and environmental pollution. Environmental violations of construction projects and enterprises in some areas are more prominent. The closure of polluting firms further aggravates the credit and environmental risk of lending institution, resulting in increased social instability. Thus, Chinese firms should take the initiative to participate in environmental protection for their long-term development, while financial institutions should strictly control lending standards in order to reduce their own risks. Both of them should take active responsibility for China's social stability and sustainable economic development. Therefore, China's stock market provides a convenient setting to probe into the influence of credit policy on firms' business operation.

In addition, the immature market environment and especial institutional background provide a good foundation for us to comprehend the function of green credit. In China, enterprises, as profit-making organizations, have always lacked the motivation to actively carry out environmental protection, and environmental protection problems depend on the active guidance of the government and financial institutions (Zhang et al., 2021). However, in China, the policy implementation is weak and the system needs to be improved (Allen et al., 2005; Kong et al., 2020). Commercial banks generally have low utilization rate of environmental information released by the state, which makes it impossible to comprehensively assess firms' environmental risks (Zhang et al., 2011). These weak institutional environments provide an ideal platform for us to observe the role of green credit. More importantly, to guide firms to change their business behavior and give financial institutions credit policies to follow, the China Banking Regulatory Commission (hereafter, CBRC) issued *Guidelines for Green Credit* (hereafter, *Guidelines*). The implementation of *Guidelines* provides an exogenous event for studying whether green credit affects firm performance.

Based on *Guidelines* issued by the CBRC in 2012, we construct a difference-in-differences (DID) test to explore the influence of green credit on the heavily polluting firms' performance. First, the baseline regression results indicate that green credit has a "penalty effect" on heavily polluting firms, which reduces their performance. To further eliminate the influence of potential endogeneities, we conduct some robustness tests, such as parallel trends analysis, PSM-DID, alternative measures of key variables, dosage effects, placebo test and multiple fixed effect models. Second, we examine the conditional relationship of firm characteristics and external supervision mechanisms. The results indicate that the green credit policy effect is more pronounced for state-owned-enterprises (hereafter, SOEs), firms with large size, high institution ownership, high analyst coverage and during high economic policy uncertainty period. Finally, the channel tests indicate that increased financial constraints and decreases investment level act the crucial linkage role between green credit policy and firm performance.

Our study aims to have the following contributions to the literature. First, this paper expands the research literature of green credit. Specifically, this paper provides evidence for the penalty effect of green credit. Existing literature has mixed opinions on the influence of green credit. Some researchers believe that green credit policy not only inhibits heavily polluting firms' long-term borrowing level and total factor productivity (Sun et al., 2019; Wen et al., 2021), but increase firms' information transparency, and produce environmental protection effects (Eiler et al., 2015; Wang et al., 2015). However, some scholars also suggest that green credit is not ideal. For example, Biswas (2011) finds that banks do not have enough motivation to implement green credit, which causes insufficient green credit execution. We find that green credit may change highly polluting firms' business behavior and reduce their performance, which supports the view that green credit has a "penalty effect".

Secondly, our research provides evidence support for understanding the function and transmission mechanism of green credit. Green credit's function needs to be transmitted through micro-subjects, and the effect of the policy depends on firms' response to the policy. By investigating the impact of green credit on firm performance, the regression results indicates that the effect of green credit policy will be affected by the nature of enterprise property rights, scale, and supervision level, and it also needs to play its role through financing and investment. Our findings provide theoretical support for understanding the differential impact of environmental regulation, the micro transmission mechanism of green credit and enriching corporate governance means. This helps to encourage firms to enhance their awareness of environmental responsibility and restrain their own environmental pollution behaviors, thus helping to protect the ecological environment.

Finally, starting from the background of green finance and the social environment that firms need to face, this paper enriches the related research of firm performance. The studies mainly examined the influence of firm characteristics on firm performance. For instance, some researchers find that firm performance is positively correlated with corporate innovation ability and competitive experience (Banker et al., 2013; Zailani et al., 2015), the leverage ratio and executive characteristics will also affect the strategic decision-making and firm performance (Berk et al., 2010; Galbreath, 2019). Some studies explore the impact of government-implemented policies (such as strengthening tax enforcement) on firm performance (Mironov, 2013). However, few of them examine in detail the possible role of green credit in firms' performance from the perspective of environmental protection. We examine the influence of green credit on firm performance and therefore expands the research literature of firm performance.

The main policy recommendations are as follows: First, the government, banks and firms should strengthen the improvement and implementation of green credit policies; Second, the government needs to take into consideration the differences of all firms' governance pressures and eliminate the asymmetry of policy effects; Third, the government and financial institutions should fully consider the role of financing and investment, and innovate and optimize green financial products.

The remaining part of the paper is structured as follows: Section 2 introduces the institutional and theoretical background. Section 3 summarizes the existing literature and proposes the research hypothesis. Section 4 introduces the design of empirical research; Section 5 shows the results of baseline regression and analyzes the conditional relationship on firm characteristics, external monitoring and economic policy uncertainty; Section 6 reports the results of channel analysis; Section 7 conducts the robustness checks; and Section 8 summarizes the main conclusions and puts forward policy suggestions.

2. Institutional and theoretical backgrounds

2.1. Institutional background

As a modern financial phenomenon, green credit has gradually become a reform direction in many countries. America is one of the first countries to implement green credit. *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. If the project has caused environmental pollution after obtaining credit funds, commercial banks should bear joint and several liabilities. Since then, Britain, Australia, Japan and other countries have incorporated green credit standards into environmental protection bills (Taghizadeh-Hesary and Yoshino, 2019). And they encourage financial institutions to actively implement green credit and firms to reduce their own environmental risks by providing loan concessions and subsidies, taking tax return for green energy projects, establishing recognition systems, innovating environmental risk rating schemes and setting up environmental finance departments (Yoshino et al., 2019).

Since then, in 2007, China introduced a green credit policy required banks to consider lending firms' environmental protection. In 2012, the CBRC issued *Guidelines*. *Guidelines* is considered as the first normative document for green credit in China and the programmatic document for

all banking financial institutions in Chinese mainland to develop green credit. Its introduction further strengthened environmental regulation and prompted financial institutions to be deeply concerned firms' environmental and social risks. Specifically, green credit policy requires financial institutions to assess the environmental and social risks of customers before approving loan projects, and to implement a differentiated and dynamic credit policy. Customers who do not comply with environmental and social performance should not be granted credit. Environmental and social risk assessment checkpoints should be set up for projects that have been granted credit. In case of major risks, the disbursement of credit funds could be suspended or even terminated.

With the development of the system and the improvement of residents' awareness of environmental protection, the vitality and environmental benefits of green credit policy have gradually emerged. Statistics from China Banking and Insurance Regulatory Commission show that in 2020, the green credit balance of 21 major banks in China exceeded 11 trillion yuan. The NPR ratio of green credit assets is far lower than the overall non-performing level of various loans in the same period. According to the proportion of credit funds to the total investment of green projects, 21 major banks implement green credit, which can support reducing carbon dioxide equivalent by more than 600 million tons every year.

2.2. Theoretical background

Stakeholder theory shows that environmental regulation may help firms ease the conflict between them and stakeholders, and achieve more healthy and sustainable development (Kitsikopoulos et al., 2018). In 1960s, the Stanford Research Institute (SRI) first proposed the concept of "stakeholders". Since then, stakeholder theory has emerged as the times require, and has become a widespread concern of corporate managers and academic researchers. Stakeholder theory means that firms need to attach importance to the role of stakeholders and consider the interests of other stakeholders in their daily operations (Donaldson and Preston, 1995). Among them, stakeholders include any individuals and groups that can influence the realization of corporate goals, such as trading partners (shareholders, creditors, consumers, employees, suppliers, etc.), external pressure groups (government, community, media, public welfare organizations, etc.), and topics affected by corporate business activities (natural environment, development of future generations, etc.). Corporate development depends on its stakeholders, and there is a close relationship between them (Casciaro and Piskorski, 2005; Flammer and Kacperczyk, 2016), therefore, the stakeholder theory is put forward to remind firms to undertake wider charitable and ethical responsibilities while realizing their own interests.

The negative influence of environmental pollution on economic and social development gradually appears, and the public pays more attention to firms' environmental protection behavior, which promotes the deepening of the conflict of interests between them (Zhang et al., 2021). In order to alleviate this conflict, the government and firms have formulated a series of rules and regulations and adopted positive environmental protection measures. Green credit is one of the means by which the government cooperates with financial institutions to urge enterprises to attach importance to energy conservation, environmental protection and green development through credit channels (Zhang et al., 2011). Referring to stakeholder theory, green credit's implementation helps to alleviating the contradiction between firms and stakeholders. On the basis of fully considering the interests of stakeholders, firms consciously accept the constraints of green credit, and timely adjust their non-standard business behavior, which can help them achieve more healthy and steady development (He et al., 2019; Wen et al., 2021).

In addition, the signaling theory shows that environmental regulation may encourage firms to standardize their own behaviors, so as to transmit favorable signals to the public (Yu et al., 2016). In the financial market, due to the objective existence of information asymmetry, firms must send high-quality signals to the market to improve competitiveness, and the actions taken usually need to have certain costs, which makes it difficult for others to follow suit easily (Spence, 1973). Therefore, signaling theory means that in order to show its development potential, financial status and social responsibility, firms can improve their reputation by publishing sound financial status, publishing environmental information reports and undertaking social responsibility, and transmit favorable signals to the market (Hu et al., 2021). Banks and other financial institutions can't fully grasp firms' business situation and social responsibility. To reduce risks and safeguard interests, they will make full use of green credit policies to select lending targets and lending standards. Therefore, under the pressure of implementing green credit, firms may take the initiative to reduce pollution projects and irregular behaviors in order to obtain financial support, and send a "green" signal to banks and the public.

3. Literature review and hypothesis development

Environmental regulation is a significant means to promote the coordinated development of economy and environment. Formulating reasonable environmental regulations helps to stimulate firms' internal emission reduction power, realize active emission reduction, and promote long-term economic growth (Porter and Linde, 1995; Petitjean, 2019; Liu et al., 2021). In October 2002, "Equator Principle" was promulgated, which requires financial institutions to take the fulfillment of firms' environmental and social responsibilities into account when deciding to lend to firms. Based on this standard, green credit has gradually become an essential part of government environmental regulation.

Green credit means that the bank takes the information related to the project and its operating company as the inspection standard in the process of lending, and then makes a loan decision (Thompson and Cowton, 2004). Bank loan is an indispensable source of firms' financing activities. As creditors, banks supervise borrowers and restrain their behaviors through debt contracts and their execution.

Green credit policy is helpful for banks to avoid risks, green transformation of firms and sustainable development of economy. First, with the increase of public attention to the environment and the improvement of environmental regulation level, financial institutions are active in lending support to green projects (Aintablian et al., 2007). There are certain environmental risks when banks lend to firms, including direct risks, indirect default risks and reputation risks caused by environmental problems (Aintablian et al., 2007). Therefore, green credit policy helps to adjust banks' credit structure and reducing the risk of bank loans and social environment (King and Levine, 1993; Cui et al., 2018). Second, green credit policy requires that bank loans tend to green projects and restrict high pollution projects (Zhang et al., 2011), thus exerting environmental pressure on firms. Once the firm obtains green credit, the firm can transmit the signal of its green management to the market. This signal helps to improve the market expectation of firms, increase investors' investment, and get more tax benefits (Gao and Mei, 2013; Bajo et al., 2016). Finally, providing differentiated credit services to different firms helps banks to adjust the flow of funds, control the promotion of environmental pollution projects, and realize the upgrading of industrial structure and sustainable economic development (Nandy and Lodh, 2012; He et al., 2019).

In addition, most researchers have explored the impact of green credit on firms' investment level and financing ability (Liu et al., 2017; He et al., 2019; Xu and Li, 2020). Few studies explored the "penalty effect" of green credit on firm performance. For heavily polluting enterprises, financial institutions have the right to restrict or refuse to issue loans. This behavior has a "penalty effect" on polluting firms. Limited financing sources may lead to heavy polluting firms having to reduce production investment and production scale, thus affecting their performance. Judge in view of the above, we posit the following hypotheses.

H1. Green credit policy reduces heavily polluting firms' performance.

Credit policies have different impacts on firms with various characteristics (Aghion et al., 2012). Financial institutions have obvious preferences when making credit decisions, and there is widespread "financial discrimination" against private enterprises. The actual control rights of many listed firms are owned by the state in China. Under the specific property right structure, these firms have more complex principal-agent relationship. Compared with non-SOEs, SOEs enjoy government guarantee and financing convenience, and they also undertake more social responsibilities. Although non-SOEs have stronger profitability, they are generally considered to have poor credit (Brandt and Li, 2003). Due to the credit discrimination, the credit funds obtained by non-SOEs through financial institutions are obviously lower than those of SOEs (Cheng et al., 2020; Yao et al., 2020). Similarly, compared with small-scale firms, large-scale firms have more advantages in obtaining bank loans (Petersen and Rajan, 2017). Large-scale firms usually have higher reputation and commercial credit, and also have more mortgage assets. These characteristics promote their strong repayment ability and low financing constraints (Petersen and Rajan, 2017), so that they can get more loans from financial institutions. Therefore, after implementing green credit, the penalty effect of financial institutions on heavily polluting firms should mainly affect SOEs and large firms. For firms that do not have access to adequate credit in the first place, the punitive effect may not be significant. Accordingly, this hypothesis is proposed.

H2. The role of green credit policy in reducing firm performance is more significant in SOEs and large firms.

In addition, firms' external monitoring level is also a vital reason affecting the policy to play its role. High level of external supervision is usually accompanied by higher institutional shareholding and higher analyst following. Institutional investors supervise management behavior by exercising voting rights, proposing bills and publishing ratings through the media, which is helpful to alleviate information asymmetry and improve corporate governance (Cornett et al., 2007). As one of the information intermediaries, the number of analysts' followers represents the market's attention to firms and is also the indicator of firm information environment (Lang et al., 2003). The participation of analysts helps to dig more deep information and increase the cognition of other external investors to firms (Chang et al., 2006; Ball and Shivakumar, 2008). As an external supervisory force with higher information superiority and information processing ability, institutional investors and analysts are more likely to see the long-term value brought by environmental protection actions. Therefore, firms with higher institutional shareholding and higher analysts' attention may be more likely to accept the advocacy of green credit policy and reduce their own pollution project activities. Based on this, the hypothesis is proposed.

H3. The effect of green credit policy on firm performance is more prominent in firms with stronger external supervision.

Recently, governments have adjusted the economic and trade policies more frequently. The extent of economic intervention has been significantly enhanced and the economic policy uncertainty (hereafter, EPU) has been increasing. Studies have shown that the greater the EPU, the greater the operational risks of firms (Bloom et al., 2007). When the EPU rises, firms tend to retain some assets in case of emergency (Li, 2019; Cui et al., 2021), while reducing investment and financing behavior (Wang et al., 2014). Therefore, in the period of high EPU, green credit policy may generate stronger credit constraints and have a greater influence on firm performance. Accordingly, we propose the fourth hypothesis.

H4. EPU enhances the restraining effect of green credit policy.

Financing constraints and investment level are crucial factors that affect firms' economic transformation and upgrading. Liu et al. (2019a, 2019b) find that green credit help improve the level of credit allocation and have a sustained influence on corporate financing. Specifically, Fazzari et al. (1988) point out that financing constraint refers to the difficulties for firms to achieve the best performance because of high external financing cost under the condition of incomplete market. Previous studies suggest that green credit policies raise heavily polluting firms' debt financing costs and affects firms' business activities (Xu and Li, 2020).

Meanwhile, firms' investment decisions are made with partial knowledge of external information (Knyazeva et al., 2009). The introduction of green credit may affect firms' investment behaviors. Limited credit granted by banks to heavily polluting firms may lead to insufficient internal funds. Considering this situation, firms may give up some projects with positive NPV, resulting in insufficient investment (Fazzari et al., 1988). Moreover, green credit may reflect governent's supervision direction. Thus, firms may adjust their investment behavior and minimize the investment in projects that the government does not advocate, which will lead to a decline in their investment level (Liu et al., 2017).

Overall, financing constraint is closely related to firm performance and is the key to hinder firm development, and the results of investment decisions will eventually reflect in firm performance. Some studies find that financing constraints may affect firm performance by inhibiting corporate growth (David et al., 2018); insufficient investment may be also negatively related to firms' financial performance (Titman et al., 2004). We put forward the last hypothesis.

H5. Green credit policy reduces firm performance by increasing corporate financing constraints and reducing firms' investment level.

4. Research design

4.1. Sample selection

The data is from the CSMAR database. The sample companies include Chinese A-share listed firms covering from 2008 to 2015. To meet the research needs, we process the sample by: (1) excluding financial and ST firms[1]; (2) removing the firms with missing research variables; (3) all continuous variables are winsorized at 1% and 99% to exclude the outlier effect.

4.2. Measurement of firm performance

Following Gordon et al. (2009), Lee et al. (2016) and He et al. (2020), ROA, ROE and Tobin's Q are used to represent firm performance. ROA and ROE are financial return indicators of enterprises. Tobin's Q reflects firms' current financial performance and expected future income.

4.3. Identification strategy

The implementation of *Guidelines* in 2012 linked bank credit with corporate sewage discharge, which became an exogenous event that changed firms' business behaviors. The publication of *Guidelines* also provides a natural experiment for us to learn the influence of green credit on firm performance. To refine the causal relationship between green credit and enterprise performance accurately, we conduct a DID approach and determine the core independent variable.

Guidelines requires financial institutions to shorten the debt period of heavily polluting firms and increase their credit difficulty accordingly. Therefore, heavily polluting firms are facing more regulatory pressure. The promulgation of this regulation has a stronger deterrent effect on heavily polluting firms. Therefore, following Zhang et al. (2019), we

[1] ST refers to the stocks of domestic listed firms that have suffered losses for two consecutive years and have been specially treated.

identify the treated firms and the control firms according to industry differences. Specifically, according to *Guidelines for Environmental Information Disclosure of Listed Firms (Draft for Soliciting Opinions)* published by China Environmental Protection Administration in 2010 (hereafter, *Draft*), we select 16 industries as heavy polluting industries, such as electrolytic aluminum, petrochemical, tanning, etc. If the firm belongs to these 16 heavily polluting industries, we include them in the treated group and $Treat_i$ equals to 1; otherwise, we include them in the control group and $Treat_i$ equals to 0.

Then, we take the implementation of *Guidelines* in 2012 as the exogenous impact point, and the time dummy variable $Post_t$ equals 1 in 2012 and beyond; $Post_t$ equals 0 before 2012. The coefficient of $Post_t{*}Treat_i$ directly reflects the effect of green credit.

4.4. Model specification

To examine the impact of green credit on firm performance, this paper constructs Eq. (1):

$$Performance_{i,t} = \beta_0 + \beta_1 Post_t{*}Treat_i + \beta_2 Post_t + \beta_3 Treat_i + \sum_k \gamma_k Control_{k,i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (1)$$

where $Performance_{i,t}$ represents the proxies of firm performance, which are measured by ROA, ROE and Tobin's Q respectively. $Post_t$ is the time dummy variable, $Treat_i$ is the grouping variable. $Control_{k,i,t}$ represents several control variables that has been proved as potential factors affecting firm performance by prior studies (Surroca et al., 2010; Dong et al., 2016; Weng and Chen, 2017; Li and Jin, 2021). These variables include firm size ($Size_{i,t}$), leverage ratio ($LEV_{i,t}$), intangible asset ratio ($IA_{i,t}$), capital intensity ($CI_{i,t}$), senior executives' shareholding ($MH_{i,t}$), firm age ($Age_{i,t}$), fixed assets ratio ($FA_{i,t}$) and Senior management team size ($Msize_{i,t}$). $\Sigma Industry$ and $\Sigma Year$ are included the industry and year fixed effects. The Appendix reports the definition of the main variables.

5. The influence of green credit on firm performance

5.1. Descriptive statistics

As shown in Panel A of Table 1, the mean values of $ROA_{i,t}$ and $ROE_{i,t}$ are 0.052 and 0.090, respectively. $TobinQ_{i,t}$ has a mean of 2.361 and the std. dev. of 1.939, indicating that there is a large difference in $TobinQ_{i,t}$ among sample firms, which indicates that Chinese firms' performance is uneven. The mean of $Treat_i$ is 0.352, indicating that the samples in the treated group account for 35.2% of the total samples.

Panel B reports the Spearman and Pearson correlation coefficients. The correlation coefficients for that between $ROA_{i,t}$ and $Post_t{*}Treat_i$ are −0.032 and − 0.025. Analogously, the coefficient for that between $ROE_{i,t}$ and $Post_t{*}Treat_i$ are −0.083 and − 0.079, while the coefficient for that between $Tobin_{i,t}$ and $Post_t{*}Treat_i$ are −0.060 and − 0.058. These coefficients are all significant. The results indicate that green credit decreases firm performance, preliminarily supporting our *H1*.

In order to test whether there is multicollinearity between variables, we conduct a VIF test and report the results in Panel C. The values of VIFs are all between 1 and 4, which indicates there is no issues of multicollinearity among our variables.

Table 2 shows the univariate analysis results on firm performance. As we can see from this table, before the implementation of *Guidelines* in 2014, the treated firms had higher ROA than control firms. Meanwhile, there is no obvious difference in ROE and Tobin's Q between the two groups. However, after the implementation of the policy, the difference of ROA between them became insignificant, while ROE and Tobin's Q of the treated firms are significantly lower than those of the control firms. The above results indicate that the policy results in lower firm performance in treated firms relative to control firms. That is, the green credit policy decreases firm performance in heavily polluting industries, which supports *Hypothesis 1*.

5.2. Regression results

In Table 3, columns (1), (3) and (5) show the results of fixed effects regressions without controls. The coefficients of $Post_t{*}Treat_i$ are −0.005, −0.013 and − 0.278 and are statistically significant. Other Columns report fixed effects regressions with controls and the coefficients of the key independent variable remains negative and significant, which indicate that green credit has a "penalty effect" on polluting firms, that is, green credit may lead to limited financing sources and reduced production scale of heavily polluting firms, and ultimately affect their performance, which supports our *Hypothesis 1*. Table 3 also reports the impact of other control variables on firm performance. For instance, leverage ratio and capital intensity are negatively correlated with firm performance (Weng and Chen, 2017; Li and Jin, 2021).

5.3. Additional analysis

To further clarify the restraint effect of green credit policy, this section examines if the negative association between green credit and firm performance will be influenced by firm characteristics, external monitoring and economic policy uncertainty.

5.3.1. Firm characteristics

To explore if the relationship between green credit policy and heavily polluting firms' performance will be influenced by property right and firm size, we divide the sample into SOE and non-SOE subsamples and large-cap and small-cap subsamples. Firms ultimately controlled by the state are included in the SOE, otherwise they are included in the non-SOEs. Following Cui et al. (2021), if the market value of a firm is higher than the median of sample firms, we categorize it as a large-cap firm, otherwise it is a small-cap firm. Then, we re-execute the regression results.

Table 4 reports the conditional impact of green credit on property right and firm size. The coefficients of $Post_t{*}Treat_i$ are significantly negative for SOEs and large-cap firms, while the coefficients of $Post_t{*}Treat_i$ are insignificant in the counterparties. The results suggest that compared with non-SOEs and small-cap firms, it is easier for SOEs and large-cap firms to obtain credit funds through financial institutions by virtue of their commercial credit and reputation. Therefore, the "penalty effect" of the green credit policy mainly affects SOEs and firms with larger-cap, which supports *Hypothesis 2*.

5.3.2. Monitoring mechanisms

To study if the relationship between green credit policy and heavily polluting firms' performance will be influenced by monitoring mechanisms, we divide the sample into high institutional ownership and low institutional ownership subsamples and high analyst coverage and low analyst coverage subsamples. If the average institutional shareholding (the average number of analysts following) of a firm is higher than the median of sample firms, we categorize it as a high institutional ownership (high analyst coverage) firm, otherwise it is a low institutional ownership (low analyst coverage) firm. Then, we re-execute the

Table 1
Descriptive statistics and correlation analysis.

Panel A: Descriptive statistics.

Variables	N	Mean	Std. dev.	25th	Median	75th
$ROA_{i,t}$	7138	0.052	0.048	0.021	0.046	0.076
$ROE_{i,t}$	7138	0.090	0.084	0.045	0.085	0.131
$TobinQ_{i,t}$	7138	2.361	1.939	1.071	1.812	3.027
$Post_t$	7138	0.646	0.478	0.000	1.000	1.000
$Treat_i$	7138	0.352	0.478	0.000	0.000	1.000
$Size_{i,t}$	7138	21.95	1.276	21.050	21.710	22.560
$LEV_{i,t}$	7138	0.367	0.201	0.203	0.353	0.513
$IA_{i,t}$	7138	0.047	0.048	0.018	0.035	0.059
$CI_{i,t}$	7138	12.46	1.071	11.82	12.43	13.10
$MH_{i,t}$	7138	0.163	0.216	0.000	0.019	0.325
$Age_{i,t}$	7138	1.684	0.601	1.099	1.609	2.197
$FA_{i,t}$	7138	0.235	0.161	0.111	0.202	0.329
$Msize_{i,t}$	7138	1.848	0.351	1.609	1.792	2.079

Panel B: Spearman (above diagonal) and Pearson (below diagonal) correlation coefficients.

Variables		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	$ROA_{i,t}$		0.792***	0.422***	−0.032***	−0.039***	−0.009	−0.122***	−0.408***	−0.018	−0.222***	0.155***	−0.168***	−0.176***	−0.009
2.	$ROE_{i,t}$	0.796***		0.249***	−0.083***	−0.146***	−0.014	0.118***	−0.039***	−0.066***	−0.193***	0.026**	−0.020*	−0.192***	0.086***
3.	$TobinQ_{i,t}$	0.368***	0.236***		−0.060***	0.068***	−0.088***	−0.536***	−0.526***	0.044***	−0.302***	0.358***	−0.238***	−0.231***	−0.162***
4.	$Post_t$*$Treat_i$	−0.025**	−0.079***	−0.058***		0.390***	0.714***	0.110***	−0.006	0.116***	0.225***	0.010	0.122***	0.208***	0.007
5.	$Post_t$	−0.048***	−0.138***	0.076***	0.390***		−0.045***	0.091***	−0.033***	0.079***	0.021*	0.221***	0.091***	−0.101***	0.023*
6.	$Treat_i$	0.012	−0.010	−0.081***	0.714***	−0.045***		0.113***	0.036***	0.108***	0.269***	−0.122***	0.115***	0.337***	0.009
7.	$Size_{i,t}$	−0.080***	0.094***	−0.425***	0.096***	0.068***	0.105***		0.509***	−0.037***	0.302***	−0.383***	0.445***	0.097***	0.306***
8.	$LEV_{i,t}$	−0.388***	−0.077***	−0.432***	−0.005	−0.028**	0.033***	0.489***		−0.037***	0.201***	−0.299***	0.367***	0.157***	0.211***
9.	$IA_{i,t}$	−0.025**	−0.027**	−0.029**	0.052***	0.035***	0.040***	0.050***	0.008		0.075***	−0.001	0.037***	0.194***	0.002
10.	$CI_{i,t}$	−0.184***	−0.157***	−0.267***	0.212***	0.007	0.256***	0.356***	0.209***	0.074***		−0.241***	0.205***	0.635***	0.043***
11.	$MH_{i,t}$	0.094***	−0.000	0.273***	0.010	0.167***	−0.093***	−0.369***	−0.303***	−0.065***	−0.231***		−0.459***	−0.269***	−0.080***
12.	$Age_{i,t}$	−0.117***	−0.012	−0.155***	0.125***	0.106***	0.113***	0.392***	0.367***	0.102***	0.229***	−0.460***		0.177***	0.084***
13.	$FA_{i,t}$	−0.176***	−0.187***	−0.240***	0.182***	−0.107***	0.311***	0.182***	0.169***	0.046***	0.666***	−0.246***	0.197***		−0.016
14.	$Msize_{i,t}$	0.010	0.095***	−0.136***	0.000	0.019	−0.000	0.305***	0.209***	0.012	0.053***	−0.085***	0.082***	0.004	

Panel C: VIF tests

		VIF	1/VIF
1.	$Post_t$*$Treat_i$	3.226	0.310
2.	$Post_t$	1.672	0.598
3.	$Treat_i$	2.841	0.352
4.	$Size_{i,t}$	1.686	0.593
5.	$LEV_{i,t}$	1.412	0.708
6.	$IA_{i,t}$	1.016	0.984
7.	$CI_{i,t}$	2.037	0.491
8.	$MH_{i,t}$	1.464	0.683
9.	$Age_{i,t}$	1.486	0.673
10.	$FA_{i,t}$	1.969	0.508
11.	$Msize_{i,t}$	1.117	0.895
15.	Mean	1.812	

Panel A reports the descriptive statistics of the variables. Panel B reports the time-series averages of the cross-sectional Spearman (above diagonal) and Pearson (below diagonal) correlation coefficients. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively. Panel C reports the variance inflation factor (VIF) test.

Table 2
Univariate analysis.

	Treated firms (1)	Control firms (2)	Differences (1)–(2)	*t*-Test (1)–(2)
$ROA_{i,t}$				
2008–2011 (a)	0.057	0.052	0.005	2.107**
2012–2015 (b)	0.049	0.049	0.001	0.306
Diff (a) - (b)	0.009	0.003	0.006	1.980**
t - Test (a) - (b)	3.486***	1.742*		
$ROE_{i,t}$				
2008–2011 (a)	0.108	0.105	0.003	0.810
2012–2015 (b)	0.077	0.084	−0.006	−2.481**
Diff (a) - (b)	0.030	0.021	0.009	2.130**
t - Test (a) - (b)	8.021***	8.632***		
$TobinQ_{i,t}$				
2008–2011 (a)	2.146	2.175	−0.029	0.400
2012–2015 (b)	2.148	2.633	−0.484	−7.711***
Diff (a) - (b)	−0.002	−0.458	0.456	4.600***
t - Test (a) - (b)	−0.033	−7.373***		

This table reports the univariate analysis on the mean differences of the three firm performance measures ROA, ROE and Tobin's Q. *, **, and *** denote 10%, 5%, and 1% confidence levels. All variables are defined in the Appendix.

Table 3
The Influence of green credit on firm performance.

Dependent variable =	$ROA_{i,t}$		$ROE_{i,t}$		$TobinQ_{i,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.005**	−0.004**	−0.013***	−0.009***	−0.278***	−0.340***
	(−1.97)	(−1.98)	(−3.61)	(−2.72)	(−4.63)	(−5.83)
$Post_t$	−0.009***	−0.012***	−0.022***	−0.039***	1.701***	2.388***
	(−3.62)	(−4.08)	(−5.67)	(−8.56)	(25.58)	(29.20)
$Treat_i$	0.005*	0.010***	0.007	0.012***	−0.181*	0.161*
	(1.72)	(3.79)	(1.54)	(2.71)	(−1.85)	(1.92)
$Size_{i,t}$		0.009***		0.018***		−0.605***
		(10.11)		(12.18)		(−21.50)
$LEV_{i,t}$		−0.103***		−0.060***		−1.171***
		(−24.24)		(−8.99)		(−9.85)
$IA_{i,t}$		−0.054***		−0.071***		−0.662
		(−3.31)		(−2.75)		(−1.42)
$CI_{i,t}$		−0.005***		−0.009***		−0.080***
		(−5.22)		(−5.71)		(−2.71)
$MH_{i,t}$		0.013***		0.026***		0.543***
		(2.78)		(3.69)		(3.93)
$Age_{i,t}$		−0.001		0.002		0.127***
		(−0.18)		(0.79)		(2.62)
$FA_{i,t}$		−0.038***		−0.087***		−0.849***
		(−5.57)		(−8.09)		(−4.32)
$Msize_{i,t}$		0.008***		0.012***		−0.049
		(3.78)		(3.61)		(−0.80)
Constant	0.023***	−0.069***	0.050***	−0.186***	1.685***	1.584***
	(2.74)	(−3.32)	(3.98)	(−5.61)	(5.76)	(4.69)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7138	7138	7138	7138	7138	7138
Adjusted R^2	0.030	0.098	0.063	0.105	0.329	0.359

This table reports the influence of green credit policy on firm performance. Columns (1), (3) and (5) report the regression results without controls, while Columns (2), (4) and (6) report the regressions results with controls. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firms' performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

regression results.

Table 5 reports the subsample analysis on firms' institutional ownership and analyst covergae. The coefficients of green credit are significantly negative high institutional ownership and high analyst following subsamples, while the coefficients of $Post_t$*$Treat_i$ are insignificant in the counterparties. Consequently, it is probably easier for firms with higher external supervision to discover the long-term value brought by environmental protection actions, so they are more willing to accept the advocacy of green credit policy and reduce their own pollution project activities. The impact of green credit on firm performance is more obvious for firms with higher external supervision. *Hypothesis 3 is verified.*

5.3.3. Economic policy uncertainty

We also explore the influence of the EPU on the green credit policy effect in this section. Previous studies mostly used the EPU index compiled by Baker et al. (2016), which was constructed by tracking the contents published in *South China Morning Post*. Furthermore, Huang and Luk (2020) have further improved this index according to the situation in China. They tracked 10 major newspapers including *Beijing Youth Daily* to

Table 4
The conditional relationship of firm characteristics.

Panel A: Impact of state ownership

	SOEs			Non-SOES		
Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.019***	−0.033***	−0.341***	0.005	0.007	−1.124
	(−6.94)	(−5.65)	(−5.29)	(1.58)	(1.53)	(−1.50)
$Post_t$	−0.007*	−0.039***	1.405***	−0.019***	−0.048***	2.541*
	(−1.78)	(−4.78)	(14.40)	(−4.70)	(−8.22)	(1.92)
$Treat_i$	0.009**	0.011	0.093	0.007**	0.005	0.871
	(2.20)	(1.27)	(0.80)	(2.07)	(0.94)	(1.43)
$Size_{i,t}$	0.005***	0.012***	−0.402***	0.011***	0.024***	−1.135***
	(4.08)	(5.08)	(−12.47)	(8.49)	(11.64)	(−8.56)
$LEV_{i,t}$	−0.099***	−0.073***	−1.173***	−0.103***	−0.051***	−0.957
	(−17.85)	(−6.24)	(−8.48)	(−18.98)	(−6.29)	(−1.50)
$IA_{i,t}$	−0.033*	−0.042	−0.167	−0.054***	−0.128***	−2.940
	(−1.67)	(−1.01)	(−0.33)	(−2.61)	(−3.79)	(−1.14)
$CI_{i,t}$	−0.001	−0.007**	−0.067*	−0.007***	−0.009***	−0.204
	(−0.41)	(−2.14)	(−1.66)	(−5.82)	(−5.08)	(−1.61)
$MH_{i,t}$	0.074**	0.182**	1.996**	0.011**	0.027***	0.000
	(2.01)	(2.39)	(2.06)	(2.25)	(3.65)	(0.00)
$Age_{i,t}$	−0.004*	−0.002	−0.173***	0.001	0.004	1.255***
	(−1.68)	(−0.34)	(−2.58)	(0.55)	(1.29)	(4.90)
$FA_{i,t}$	−0.037***	−0.091***	−0.636***	−0.026***	−0.076***	−1.462
	(−4.14)	(−4.80)	(−2.81)	(−2.93)	(−5.60)	(−1.54)
$Msize_{i,t}$	0.007**	0.017**	−0.080	0.008***	0.011***	−0.266
	(2.30)	(2.56)	(−1.02)	(3.07)	(2.78)	(−0.91)
Constant	−0.041	−0.140**	11.726***	−0.077***	−0.303***	2.546***
	(−1.44)	(−2.43)	(15.51)	(−2.74)	(−6.54)	(8.28)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2493	2493	2493	4645	4645	4645
Adjusted R^2	0.167	0.140	0.335	0.086	0.101	0.285

Panel B: Impact of firm size.

	Large -cap			Small-cap		
Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.008***	−0.016***	−0.289***	0.001	0.001	−0.657
	(−3.16)	(−3.10)	(−5.16)	(0.49)	(0.19)	(−0.76)
$Post_t$	−0.010***	−0.049***	1.281***	−0.010**	−0.023***	3.510**
	(−2.97)	(−7.14)	(15.71)	(−2.45)	(−3.49)	(2.39)
$Treat_i$	0.006*	0.005	0.182*	0.010***	0.013**	0.524
	(1.70)	(0.75)	(1.91)	(2.94)	(2.52)	(0.77)
$Size_{i,t}$	0.006***	0.015***	−0.439***	0.008***	0.023***	−2.271***
	(5.01)	(6.44)	(−14.66)	(4.05)	(7.39)	(−8.66)
$LEV_{i,t}$	−0.102***	−0.062***	−0.897***	−0.081***	−0.055***	−0.402
	(−20.62)	(−6.22)	(−7.76)	(−14.84)	(−6.15)	(−0.51)
$IA_{i,t}$	−0.050**	−0.074*	−0.277	−0.035*	−0.088***	−3.140
	(−2.53)	(−1.91)	(−0.59)	(−1.71)	(−2.60)	(−1.04)
$CI_{i,t}$	−0.004***	−0.011***	−0.126***	−0.006***	−0.009***	−0.221
	(−3.40)	(−4.19)	(−4.07)	(−4.64)	(−4.23)	(−1.33)
$MH_{i,t}$	0.009	0.024*	0.433**	0.017***	0.032***	−0.099
	(1.24)	(1.70)	(2.31)	(3.43)	(4.18)	(−0.20)
$Age_{i,t}$	0.001	0.004	−0.090*	−0.004**	−0.004	1.625***
	(0.50)	(1.06)	(−1.75)	(−2.04)	(−1.32)	(5.10)
$FA_{i,t}$	−0.040***	−0.103***	−0.574***	−0.020**	−0.053***	−2.024*
	(−4.88)	(−6.24)	(−2.89)	(−2.22)	(−3.67)	(−1.66)
$Msize_{i,t}$	0.009***	0.019***	−0.043	0.001	0.002	−0.599
	(3.40)	(3.74)	(−0.71)	(0.43)	(0.35)	(−1.50)
Constant	0.001	−0.101*	13.679***	−0.024	−0.294***	0.481***
	(0.02)	(−1.84)	(9.13)	(−0.61)	(−4.59)	(8.71)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3574	3574	3574	3564	3564	3564
Adjusted R^2	0.132	0.128	0.337	0.105	0.089	0.360

This table reports the conditional effect of green credit policy on firm characteristics. Panel A reports the subsample analysis on firms' state ultimate controller. Panel B reports the subsample analysis on market capitalization. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 5
The conditional relationship of monitoring mechanisms.

Panel A: Impact of institutional ownership.

	High institutional ownership			Low institutional ownership		
Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.011***	−0.020***	−0.372***	0.005	0.007	−0.418
	(−4.62)	(−4.20)	(−5.53)	(1.53)	(1.44)	(−0.50)
$Post_t$	−0.012***	−0.048***	1.754***	−0.008***	−0.025***	3.796***
	(−3.31)	(−7.23)	(17.03)	(−3.54)	(−3.93)	(2.61)
$Treat_i$	0.012***	0.014**	0.192	0.003	0.001	0.279
	(3.15)	(2.08)	(1.61)	(0.78)	(0.16)	(0.41)
$Size_{i,t}$	0.005***	0.014***	−0.560***	0.008***	0.020***	−1.162***
	(4.55)	(6.66)	(−16.00)	(5.35)	(9.18)	(−7.49)
$LEV_{i,t}$	−0.099***	−0.060***	−1.021***	−0.083***	−0.058***	0.129
	(−18.95)	(−6.02)	(−6.82)	(−12.25)	(−6.62)	(0.18)
$IA_{i,t}$	−0.060***	−0.085**	−1.178**	−0.004	−0.041	−1.517
	(−2.99)	(−2.26)	(−2.00)	(−0.17)	(−1.19)	(−0.53)
$CI_{i,t}$	−0.004***	−0.012***	−0.050	−0.006***	−0.007***	−0.196
	(−3.23)	(−4.74)	(−1.26)	(−3.86)	(−3.47)	(−1.28)
$MH_{i,t}$	0.057***	0.107***	2.453***	0.016***	0.041***	0.069
	(5.43)	(5.50)	(7.53)	(3.17)	(5.20)	(0.13)
$Age_{i,t}$	0.001	0.006	0.080	−0.005**	−0.004	1.764***
	(0.50)	(1.54)	(1.20)	(−2.51)	(−1.14)	(5.66)
$FA_{i,t}$	−0.038***	−0.085***	−0.774***	−0.018*	−0.084***	−1.113
	(−4.45)	(−5.36)	(−3.12)	(−1.86)	(−5.85)	(−0.97)
$Msize_{i,t}$	0.008***	0.020***	0.079	0.006**	0.005	−0.572
	(2.98)	(3.91)	(1.02)	(2.02)	(1.22)	(−1.60)
Constant	0.026	−0.045	14.610***	−0.030	−0.300***	23.446***
	(0.97)	(−0.94)	(17.79)	(−0.93)	(−6.22)	(6.63)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3573	3573	3573	3565	3565	3565
Adjusted R^2	0.126	0.122	0.329	0.114	0.104	0.243

Panel B: Impact of analyst coverage.

	High analyst coverage			Low analyst coverage		
Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.008**	−0.008**	−0.291***	−0.001	−0.007	−0.535
	(−2.54)	(−1.97)	(−3.63)	(−0.25)	(−1.03)	(−0.67)
$Post_t$	−0.004*	−0.024***	1.709***	0.003	−0.002	2.877**
	(−1.93)	(−8.72)	(14.23)	(0.88)	(−0.29)	(2.21)
$Treat_i$	0.015***	0.008	0.287**	0.006**	0.010	0.187
	(4.07)	(1.51)	(2.25)	(2.03)	(1.60)	(0.31)
$Size_{i,t}$	0.003***	0.004**	−0.568***	0.005***	0.012***	−1.186***
	(2.63)	(2.29)	(−13.73)	(4.21)	(4.27)	(−7.77)
$LEV_{i,t}$	−0.116***	−0.045***	−0.838***	−0.074***	−0.056***	0.359
	(−17.74)	(−5.62)	(−4.72)	(−16.54)	(−4.50)	(0.51)
$IA_{i,t}$	−0.046**	−0.028	−0.637	−0.033*	−0.057	−3.062
	(−2.02)	(−0.98)	(−1.00)	(−1.79)	(−1.50)	(−1.14)
$CI_{i,t}$	−0.005***	−0.008***	−0.039	−0.005***	−0.005**	−0.249
	(−2.93)	(−4.27)	(−0.89)	(−4.29)	(−2.53)	(−1.61)
$MH_{i,t}$	−0.007	−0.001	0.574***	0.012***	0.020***	−0.386
	(−0.93)	(−0.13)	(2.66)	(2.63)	(2.63)	(−0.72)
$Age_{i,t}$	0.001	0.001	0.169**	−0.006***	−0.008***	1.079***
	(0.48)	(0.36)	(2.23)	(−3.76)	(−2.82)	(4.06)
$FA_{i,t}$	−0.039***	−0.071***	−1.476***	−0.019**	−0.068***	−0.844
	(−3.84)	(−5.54)	(−5.01)	(−2.57)	(−4.43)	(−0.79)
$Msize_{i,t}$	0.007**	0.011***	−0.089	0.007***	0.011**	−0.826**
	(2.06)	(3.05)	(−1.03)	(3.01)	(2.13)	(−2.32)
Constant	0.086***	0.113***	15.250***	−0.002	−0.147**	26.697***
	(3.14)	(2.92)	(15.85)	(−0.08)	(−2.42)	(7.97)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3607	3607	3607	3531	3531	3531
Adjusted R^2	0.080	0.098	0.313	0.124	0.103	0.269

This table reports the conditional effect of green credit on monitoring mechanisms. Panel A reports the subsample analysis on firms' institutional ownership. Panel B reports the subsample analysis on analyst following. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 6
Conditional relationship on EPU.

Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)
$Post_t$*$Treat_i$*EPU_t	−0.025**	−0.037**	−0.658**
	(−2.30)	(−2.21)	(−2.25)
EPU_t	−0.020***	−0.038***	−2.193***
	(−2.70)	(−3.27)	(−8.33)
$Post_t$*$Treat_i$	−0.033**	−0.049**	−0.853**
	(−2.07)	(−2.00)	(−2.01)
$Post_t$	−0.012***	−0.041***	−0.346***
	(−3.80)	(−8.07)	(−7.00)
$Treat_i$	0.011***	0.012***	−0.038
	(3.85)	(2.74)	(−0.38)
$Size_{i,t}$	0.009***	0.018***	−0.425***
	(10.07)	(12.14)	(−12.96)
$LEV_{i,t}$	−0.104***	−0.060***	−1.597***
	(−24.29)	(−9.01)	(−11.52)
$IA_{i,t}$	−0.054***	−0.070***	−0.602
	(−3.27)	(−2.73)	(−1.10)
$CI_{i,t}$	−0.005***	−0.009***	−0.012
	(−5.20)	(−5.71)	(−0.33)
$MH_{i,t}$	0.013***	0.026***	1.242***
	(2.78)	(3.70)	(7.69)
$Age_{i,t}$	−0.000	0.002	0.977***
	(−0.21)	(0.78)	(9.20)
$FA_{i,t}$	−0.038***	−0.087***	−1.338***
	(−5.49)	(−8.04)	(−5.83)
$Msize_{i,t}$	0.008***	0.012***	−0.231***
	(3.78)	(3.62)	(−3.25)
Constant	−0.036	−0.125***	1.451***
	(−1.53)	(−3.38)	(9.15)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	7138	7138	7138
Adjusted R^2	0.303	0.324	0.283

This table reports the conditional effect of green credit policy on EPU. The EPU index (EPU_t) compiled by Huang and Luk (2020) as the measurement of EPU. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

build an index of China's EPU. Following He et al. (2021), we introduce the EPU index (EPU_t) compiled by Huang and Luk and add EPU_t, $Post_t$*$Treat_i$*EPU_t into our regression model.[2] The results are reported in Table 6. $Post_t$*$Treat_i$ are still negative retated with firm performance and the coefficients of $Post_t$*$Treat_i$*EPU_t are significantly negative, which indicate that the when the EPU is high, the restraining effect of green credit is more prominent. The results support *Hypothesis 4*.

6. Economic channel analysis

6.1. Financing constraints

Financing constraint is the key to hinder firms' development. While the implementation of green credit increases heavily polluting firms' debt financing cost (Xu and Li, 2020), improves corporate financing constraints. Therefore, to test whether financing constraints is the channel through which green credit affects heavily polluting firms' performance, we introduce the SA index to measure financing constraints.

Following Hadlock and Pierce (2010), we calculate listed firms' financial constraints based on the formula below:

$$SA_{i,t} = -0.737*Size_{i,t} + 0.043*Size_{i,t}^{2} - 0.04*Age_{i,t} \quad (2)$$

Larger value of $SA_{i,t}$, greater firms' financing constraints.

We then test the role of financing constraints. The models are specified as below:

$$SA_{i,t} = \alpha_0 + \alpha_1 Post_t*Treat_i + \alpha_2 Post_t + \alpha_3 Treat_i + \sum_k \gamma_k Control_{k,i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (3)$$

$$Performance_{i,t} = \beta_0 + \beta_1 SA_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (4)$$

Table 7 reports the results. Panel A and Panel B report the regression results of financing constraints on $Post_t$*$Treat_i$ and the regression results of firm performance on financing constraints. In the first stage, the coefficient of $Post_t$*$Treat_i$ is 0.005 and is significantly positive. The result indicates that green credit increases heavily polluting firms' financing constraints. In the second stage, $SA_{i,t}$ are significantly negative related to firm performance. The result indicates that financing constraints decreases firm performance. The above results indicate that the perfection and implementation of green credit may help improve the level of credit allocation and have a sustained influence on corporate financing. Under the constraint of financing ability, firms' internal funds are insufficient and the business development is limited. Therefore, increasing corporate financing constraints is one of the channels for green credit policies to reduce the performance of heavily polluting firms.

6.2. Internal control

Green credit urges heavily polluting firms to adjust investment behavior and reduce polluting investment, which leads to the decline of their investment level (Liu et al., 2017). While inadequate investment has a negative influence on their financial performance (Titman et al., 2004). Thereby, to examine whether corporate investment is the channel through which green credit policy affects heavily-polluting firms' performance, with reference to Xie (2015), we introduce the $INV_{i,t}$ to measure firms' investment.

$$INV_{i,t} = Cash\_LA_{i,t} / Assets_{i,t} \quad (5)$$

where $Cash\_LA_{i,t}$ represents the cash payment for long-term assets in the current year, $Assets_{i,t}$ represents the initial total assets. The larger the $INV_{i,t}$ index is, the higher firms' investment level.

We then test the role of corporate investment. The models are specified as below:

$$INV_{i,t} = \alpha_0 + \alpha_1 Post_t*Treat_i + \alpha_2 Post_t + \alpha_3 Treat_i + \sum_k \gamma_k Control_{k,i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (6)$$

$$Performance_{i,t} = \beta_0 + \beta_1 INV_{i,t} + \sum_k \gamma_k Control_{k,i,t} + \sum Industry + \sum Year + \varepsilon_{i,t} \quad (7)$$

Table 8 reports the two-stage channel analysis of corporate investment. Panel A and Panel B report the regression results of corporate

[2] Different from the cross-section analysis on firm characteristics and monitoring mechanisms mentioned above, the difference of the EPU index in cross-section is small because all sample firms face a same EPU in a given year, which may induce multicollinearity among the *Post* variable and the year fixed effect. Therefore, we use interaction term analysis here to explore the impact of EPU.

Table 7
Channel test: the effect of financing constraints.

Panel A: regression of financing constraints on $Post_t$*$Treat_i$		Panel B: regression of firm performance on financing constraints			
Variables	$SA_{i,t}$	Variables	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
$Post_t$*$Treat_i$	0.005**	$SA_{i,t}$	−0.034***	−0.062***	−1.042***
	(1.98)		(−3.35)	(−3.14)	(−4.57)
$Post_t$	0.122***	$Size_{i,t}$	0.007***	0.017***	−0.601***
	(29.61)		(4.29)	(5.22)	(−21.55)
$Treat_i$	0.024***	$LEV_{i,t}$	−0.081***	−0.051***	−1.157***
	(3.87)		(−18.00)	(−5.83)	(−9.75)
$Size_{i,t}$	0.016***	$IA_{i,t}$	−0.039**	−0.103***	−0.731
	(9.92)		(−2.12)	(−2.88)	(−1.57)
$LEV_{i,t}$	−0.019***	$CI_{i,t}$	−0.005***	−0.010***	−0.092***
	(−3.55)		(−3.89)	(−4.01)	(−3.14)
$IA_{i,t}$	−0.036*	$MH_{i,t}$	0.042***	0.056***	0.473***
	(−1.66)		(4.97)	(3.44)	(3.43)
$CI_{i,t}$	−0.003**	$Age_{i,t}$	−0.003	−0.018***	0.341***
	(−1.96)		(−1.32)	(−3.71)	(5.10)
$MH_{i,t}$	−0.072***	$FA_{i,t}$	−0.032***	−0.081***	−0.966***
	(−8.94)		(−3.91)	(−5.16)	(−4.92)
$Age_{i,t}$	0.140***	$Msize_{i,t}$	0.005**	0.010**	−0.027
	(50.50)		(2.33)	(2.12)	(−0.44)
$FA_{i,t}$	−0.067***				
	(−7.26)				
$Msize_{i,t}$	0.010***				
	(3.61)				
Constant	2.762***	Constant	0.099***	0.098	19.107***
	(71.03)		(2.77)	(1.43)	(20.26)
Industry FE	Yes	Industry	Yes	Yes	Yes
Year FE	Yes	Year	Yes	Yes	Yes
Observations	7138	Observations	7138	7138	7138
Adjusted R^2	0.858	Adjusted R^2	0.111	0.069	0.352

This table reports the two-stage channel analysis of firm financing constraints. Panel A and Panel B report the regression results of financing constraints on $Post_t$*$Treat_i$ and the regression results of firm performance on financing constraints. $SA_{i,t}$ measures firms' financing constraints and is calculated by following Hadlock and Pierce (2010). $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 8
Channel test: the effect of corporate investment.

Panel A: regression of corporate investment on $Post_t$*$Treat_i$		Panel B: regression of firm performance on corporate investment			
Variables	$INV_{i,t}$	Variables	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
$Post_t$*$Treat_i$	−0.016***	$INV_{i,t}$	0.047***	0.150***	1.733***
	(−5.04)		(6.91)	(11.77)	(6.17)
$Post_t$	−0.033***	$Size_{i,t}$	0.007***	0.017***	−0.799***
	(−8.00)		(9.14)	(11.78)	(−17.42)
$Treat_i$	0.018***	$LEV_{i,t}$	−0.093***	−0.061***	−0.504***
	(4.74)		(−25.82)	(−9.28)	(−3.16)
$Size_{i,t}$	0.006***	$IA_{i,t}$	−0.049***	−0.101***	−1.510**
	(4.62)		(−3.50)	(−3.97)	(−2.33)
$LEV_{i,t}$	0.008	$CI_{i,t}$	−0.005***	−0.010***	−0.186***
	(1.35)		(−6.03)	(−6.22)	(−4.45)
$IA_{i,t}$	0.197***	$MH_{i,t}$	0.011***	0.025***	0.721***
	(8.73)		(2.77)	(3.56)	(3.14)
$CI_{i,t}$	0.004***	$Age_{i,t}$	0.000	0.006**	0.535***
	(2.72)		(0.12)	(2.41)	(6.81)
$MH_{i,t}$	0.006	$FA_{i,t}$	−0.028***	−0.085***	−0.699**
	(1.04)		(−4.86)	(−8.09)	(−2.53)
$Age_{i,t}$	−0.025***	$Msize_{i,t}$	0.006***	0.012***	−0.178**
	(−11.72)		(3.01)	(3.50)	(−2.17)
$FA_{i,t}$	0.020**				
	(2.16)				
$Msize_{i,t}$	0.004				
	(1.19)				
Constant	−0.039	Constant	−0.032*	−0.179***	20.553***
	(−1.37)		(−1.76)	(−5.51)	(19.05)
Industry FE	Yes	Industry FE	Yes	Yes	Yes
Year FE	Yes	Year FE	Yes	Yes	Yes
Observations	7138	Observations	7138	7138	7138
Adjusted R^2	0.097	Adjusted R^2	0.120	0.119	0.314

This table reports the two-stage channel analysis of corporate investment. Panel A and Panel B report the regression results of corporate investment on $Post_t$*$Treat_i$ and the regression results of firm performance on corporate investment. $INV_{i,t}$ measures the corporate investment level and is calculated as the cash payment of the long-term assets in the current year divided by the initial total assets. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 9
Robustness check: Parallel trends analysis.

Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)
Pre3	−0.000	0.001	0.162
	(−0.11)	(0.08)	(1.50)
Pre2	−0.002	−0.012	−0.088
	(−0.48)	(−1.47)	(−0.86)
Pre1	−0.004	−0.005	0.134
	(−1.04)	(−0.68)	(1.46)
Post1	−0.007*	−0.013*	−0.099**
	(−1.75)	(−1.68)	(−2.14)
Post2	−0.006	−0.012*	−0.166*
	(−1.43)	(−1.66)	(−1.91)
Post3	−0.008**	−0.014*	−0.237***
	(−2.10)	(−1.83)	(−2.71)
Post4	−0.011***	−0.026***	−0.788***
	(−2.72)	(−3.41)	(−9.29)
$Size_{i,t}$	0.008***	0.028***	−0.612***
	(4.70)	(8.93)	(−21.89)
$LEV_{i,t}$	−0.081***	−0.053***	−1.201***
	(−18.01)	(−6.19)	(−10.18)
$IA_{i,t}$	−0.038**	−0.090***	−0.574
	(−2.05)	(−2.58)	(−1.24)
$CI_{i,t}$	−0.005***	−0.010***	−0.077***
	(−3.75)	(−4.18)	(−2.61)
$MH_{i,t}$	0.046***	0.082***	0.545***
	(5.40)	(5.12)	(3.97)
$Age_{i,t}$	−0.001	0.023***	0.125***
	(−0.41)	(4.24)	(2.59)
$FA_{i,t}$	−0.031***	−0.084***	−0.739***
	(−3.84)	(−5.42)	(−3.79)
$Msize_{i,t}$	0.005**	0.011**	−0.042
	(2.22)	(2.56)	(−0.70)
Constant	−0.031	−0.384***	15.939***
	(−0.88)	(−5.89)	(24.92)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	7138	7138	7138
Adjusted R^2	0.125	0.118	0.376

This table reports the regression results of controlling parallel trends analysis. Specifically, we define the following 5 variables: $y(-3)$, $y(-2)$, $y(-1)$, $y(1)$, $y(2)$, $y(3)$ and $y(4)$. If the green credit policy is implemented (1) three years later, (2) two years later, (3) next year, (4) one year ago, (5) two years ago, (6) three years ago, and (7) four years ago, the specific variable is set to 1 and 0 otherwise. Then, we multiply these variables with $Treat_i$ to get *Pre3*, *Pre2*, *Pre1*, *Post1*, *Post2*, *Post3*, and *Post4*, and then observe the parallel trends. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

investment on $Post_t$*$Treat_i$ and the regression results of firm performance on corporate investment. In the first stage, the coefficient of $Post_t$*$Treat_i$ is −0.016, which is significantly negative. The result indicates that green credit decreases heavily polluting firms' investment level. In the second stage, $INV_{i,t}$ are significantly positive related to firm performance. The result suggests that firms' investment level helps to increase firm performance. These results indicates that green credit prompts firms to change investment behavior and reduce the investment level, thus affecting their performance. Therefore, corporate investment is also the channel through which green credit affects firm performance. *H5* holds.

7. Robustness checks

To verify that the preceding regression results are robust, we conduct further robustness tests, including parallel trends analysis, PSM-DID, change indicator, placebo test and multiple fixed effect models.

7.1. Parallel trends analysis

In this paper, the DID analysis is used in model estimation. An important assumption of using this analysis is that the samples of the treated firms and the control firms should have parallel trends before the putting into effect, that is, if there is no treatment effect, the variation trends of the dependent variables in the two groups are similar. If the parallel trend hypothesis cannot be satisfied, the result of DID estimation may be biased. To test the parallel trends hypothesis, following Serfling (2016), we define the following 5 variables: $y(-3)$, $y(-2)$, $y(-1)$, $y(1)$, $y(2)$, $y(3)$ and $y(4)$. If the green credit policy is implemented (1) three years later, (2) two years later, (3) next year, (4) one year ago, (5) two years ago, (6) three years ago, and (7) four years ago, these seven variables are set to 1. Then, we multiply these variables with $Treat_i$ to get *Pre3*, *Pre2*, *Pre1*, *Post1*, *Post2*, *Post3*, and *Post4*, and then conduct the parallel trends test. Table 9 reports the regression results of controlling parallel trends. Before implementing the green credit policy, there is no obvious difference in firm performance between the two groups. These results show that the parallel trend is generally satisfied.

7.2. PSM-did

To eliminate the sample selection bias, following Yang et al. (2020), we conduct the propensity score matching (PSM) method. Specifically, we use k-nearest neighbor matching (k = 1, 4) to match samples, and then conduct the regression in Eq. (1). The results are reported in Table 10. The results shows that green credit is still significantly negative related to firm performance, which indicate that the conclusion is valid.

7.3. Alternative indicator

Due to the heavy polluting industries stipulated in *Draft* cannot completely match the industry classification, Following Hu et al. (2021), we recalculate the pollution emission intensity of each industry, and divide all industries into heavy polluting industries and non-heavy polluting industries according to the median. Further, we form the treated group and the control group. Specifically, we first select four pollution emissions, including sulfur dioxide, industrial soot (dust), industrial solid waste, and industrial waste water. Then, the emission data of various pollutants are linearly standardized and summed up. On this basis, we calculate the pollution emission intensity of industries in 2011. The specific steps are as follows:

First, we calculate the discharge of pollutants per unit output value of industry:

$$UE_{i,j} = E_{i,j}/O_i \tag{8}$$

where E_{ij} is the discharge of major pollutants j of industry i and O_i is the total output value of industry i.

Second, we linearly standardize the discharge of pollutants per unit output value of the industry:

$$SUE_{i,j} = \left[UE_{i,j} - min\left(UE_j\right)\right] / \left[max(UE_i) - min\left(UE_j\right)\right] \tag{9}$$

where $UE_{i,j}$ is the discharge of major pollutants j per unit output value of industry i, max (UE_j) and min (UE_j) are the maximum and minimum values of major pollutants j in all industries, and SUE_{ij} is the standardized value.

Third, we sum up the emissions per unit output value of various pollutants to obtain the industrial pollution emission intensity γ_i:

$$\gamma_i = \sum_{j=1}^{n} SUE_{i,j} \tag{10}$$

Finally, we classify the industrial sectors according to the median. The industries with $\gamma_i > 0.1669$ are heavily polluting industries, and other industries belong to non-heavily pollution industries. The corresponding heavy polluting firms are divided into treated firms and other firms are divided into control firms.

Then, we use the reacquired core independent variable to perform the regression in Eq. (1). The regression results are shown in Table 11.

Table 10
Robustness check: PSM-DID.

	K-nearest neighbor matching (k = 1)			K-nearest neighbor matching (k = 4)		
Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.007**	−0.015**	−0.226***	−0.004**	−0.012**	−0.325***
	(−2.49)	(−2.20)	(−2.65)	(−2.01)	(−2.55)	(−5.35)
$Post_t$	−0.015***	−0.040***	2.102***	−0.015***	−0.047***	2.226***
	(−3.73)	(−4.44)	(17.65)	(−5.29)	(−7.17)	(25.27)
$Treat_i$	0.010***	0.014**	0.137	0.009***	0.014**	0.163*
	(3.21)	(2.01)	(1.34)	(3.53)	(2.44)	(1.88)
$Size_{i,t}$	0.006***	0.016***	−0.585***	0.008***	0.022***	−0.596***
	(5.16)	(6.46)	(−15.81)	(9.05)	(10.94)	(−19.90)
$LEV_{i,t}$	−0.099***	−0.123***	−1.480***	−0.098***	−0.119***	−1.306***
	(−17.81)	(−9.99)	(−8.68)	(−23.54)	(−12.64)	(−10.19)
$IA_{i,t}$	−0.023	−0.074*	−1.399**	−0.017	−0.043	−0.573
	(−1.15)	(−1.66)	(−2.23)	(−1.11)	(−1.20)	(−1.16)
$CI_{i,t}$	−0.005***	−0.009***	−0.035	−0.006***	−0.009***	−0.067**
	(−3.59)	(−3.01)	(−0.79)	(−5.84)	(−3.53)	(−1.96)
$MH_{i,t}$	0.002	0.015	0.562***	0.009*	0.031***	0.554***
	(0.30)	(1.17)	(2.99)	(1.90)	(2.98)	(3.68)
$Age_{i,t}$	0.003*	0.009**	0.176***	0.000	0.003	0.115**
	(1.67)	(1.97)	(2.68)	(0.19)	(0.92)	(2.17)
$FA_{i,t}$	−0.032***	−0.122***	−0.907***	−0.025***	−0.124***	−0.872***
	(−3.94)	(−6.60)	(−3.51)	(−3.86)	(−8.46)	(−4.30)
$Msize_{i,t}$	0.004	0.012**	−0.045	0.003*	0.014***	−0.048
	(1.44)	(1.99)	(−0.52)	(1.65)	(2.99)	(−0.73)
Constant	0.026	−0.168***	15.007***	−0.008	−0.286***	0.156***
	(1.05)	(−2.98)	(17.77)	(−0.41)	(−6.13)	(2.70)
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	3076	3076	3076	5624	5624	5624
Adjusted R^2	0.097	0.099	0.359	0.118	0.116	0.365

This table reports the results of PSM-DID. Columns (1), (2), (3) and (2), (4), (6) show the results of K-nearest neighbor matching (k = 1, 4). $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 11
Robustness check: alternative measure of key indicator.

Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)
$Post_t$*$Treat_i$	−0.005**	−0.009**	−0.256***
	(−1.99)	(−1.96)	(−4.30)
$Post_t$	−0.006***	−0.045***	2.355***
	(−4.06)	(−7.71)	(28.95)
$Treat_i$	0.012***	0.019***	0.265***
	(4.53)	(3.45)	(3.16)
$Size_{i,t}$	0.008***	0.020***	−0.607***
	(9.53)	(11.15)	(−21.56)
$LEV_{i,t}$	−0.102***	−0.094***	−1.156***
	(−24.44)	(−11.08)	(−9.72)
$IA_{i,t}$	−0.041**	−0.090***	−0.700
	(−2.57)	(−2.78)	(−1.50)
$CI_{i,t}$	−0.005***	−0.009***	−0.086***
	(−5.31)	(−4.35)	(−2.92)
$MH_{i,t}$	0.006	0.026***	0.547***
	(1.35)	(2.98)	(3.96)
$Age_{i,t}$	−0.003*	0.005*	0.123**
	(−1.89)	(1.67)	(2.55)
$FA_{i,t}$	−0.030***	−0.133***	−0.895***
	(−4.44)	(−9.76)	(−4.54)
$Msize_{i,t}$	0.010***	0.019***	−0.041
	(4.50)	(4.50)	(−0.67)
Constant	−0.033*	−0.244***	16.001***
	(−1.75)	(−5.75)	(24.87)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	7138	7138	7138
Adjusted R^2	0.089	0.094	0.358

This table reports the results of alternative measures of heavily polluting firms. We form the treated firms and the control firms by constructing the industrial pollution emission intensity index. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 12
Robustness check: Placebo test.

Dependent variable =	$ROA_{i,t}$	$ROE_{i,t}$	$TobinQ_{i,t}$
	(1)	(2)	(3)
$Post_t$*$Treat_i$	−0.003	−0.008	−0.094
	(−1.36)	(−1.44)	(−1.45)
$Post_t$	−0.009***	−0.032***	0.565***
	(−3.79)	(−5.48)	(9.32)
$Treat_i$	0.010***	0.015***	0.155**
	(4.45)	(2.61)	(2.06)
$Size_{i,t}$	0.007***	0.021***	−0.509***
	(8.31)	(9.99)	(−17.56)
$LEV_{i,t}$	−0.109***	−0.105***	−1.202***
	(−28.86)	(−11.16)	(−10.91)
$IA_{i,t}$	−0.046***	−0.079**	−0.774*
	(−3.45)	(−2.38)	(−1.79)
$CI_{i,t}$	−0.003***	−0.005**	−0.015
	(−3.88)	(−2.24)	(−0.53)
$MH_{i,t}$	0.004	0.020	0.285*
	(0.73)	(1.62)	(1.80)
$Age_{i,t}$	−0.002	−0.002	0.021
	(−1.19)	(−0.56)	(0.52)
$FA_{i,t}$	−0.029***	−0.096***	−0.641***
	(−5.25)	(−6.81)	(−3.91)
$Msize_{i,t}$	0.006***	0.014***	0.053
	(3.08)	(2.84)	(0.81)
Constant	−0.031*	−0.288***	13.155***
	(−1.69)	(−5.99)	(22.88)
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	6926	6926	6926
Adjusted R^2	0.100	0.063	0.428

This table reports the results of Placebo tests. We shift the implementation year of the policy forward by 2 year (2010) and redefine $Post_t$. Then, following Chen et al. (2018), we observe the results of placebo tests. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

Table 13
Robustness checks: multiple fixed effects.

Dependent variable =	$ROA_{i,t}$		$ROE_{i,t}$		$TobinQ_{i,t}$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Post_t$*$Treat_i$	−0.004**	−0.004**	−0.008**	−0.010**	−0.264***	−0.139**
	(−2.08)	(−2.01)	(−2.30)	(−2.03)	(−4.46)	(−2.06)
$Size_{i,t}$	0.008***	0.008***	0.029***	0.037***	−0.789***	−0.911***
	(4.56)	(4.77)	(9.40)	(8.91)	(−15.34)	(−18.13)
$LEV_{i,t}$	−0.077***	−0.080***	−0.054***	−0.094***	−0.355**	−0.354***
	(−16.19)	(−16.45)	(−6.29)	(−8.14)	(−2.51)	(−2.58)
$IA_{i,t}$	−0.047**	−0.041**	−0.091***	−0.136***	−0.669	−0.319
	(−2.37)	(−2.04)	(−2.60)	(−2.85)	(−1.15)	(−0.56)
$CI_{i,t}$	−0.006***	−0.006***	−0.010***	−0.009***	−0.131***	−0.086**
	(−4.28)	(−4.15)	(−4.35)	(−2.96)	(−3.38)	(−2.30)
$MH_{i,t}$	0.053***	0.055***	0.081***	0.144***	0.493*	0.827***
	(5.83)	(6.00)	(5.02)	(6.69)	(1.85)	(3.26)
$Age_{i,t}$	0.001	0.001	0.023***	0.033***	0.863***	0.663***
	(0.32)	(0.19)	(4.30)	(4.49)	(9.67)	(7.49)
$FA_{i,t}$	−0.028***	−0.027***	−0.083***	−0.144***	−0.833***	−0.814***
	(−3.20)	(−3.12)	(−5.38)	(−6.89)	(−3.26)	(−3.30)
$Msize_{i,t}$	0.003	0.004	0.011**	0.017***	−0.048	−0.003
	(1.25)	(1.40)	(2.45)	(2.79)	(−0.66)	(−0.05)
Constant	−0.023	−0.051	−0.409***	−0.690***	19.711***	23.646***
	(−0.62)	(−1.31)	(−6.29)	(−7.48)	(18.28)	(21.36)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	No	Yes	No	Yes	No
Industry*Year FE	No	Yes	No	Yes	No	Yes
Province*Year FE	No	Yes	No	Yes	No	Yes
Observations	7138	7138	7138	7138	7138	7138
Adjusted R^2	0.103	0.149	0.112	0.164	0.373	0.485

This table reports the results of multiple fixed effect models. Columns (1), (3) and (5) show the regression results of controlling firm-year fixed effect. Columns (2), (4) and (6) show the regression results of controlling firm fixed effect with industry-year fixed effect and province-year fixed effect. $ROA_{i,t}$, $ROE_{i,t}$ and $TobinQ_{i,t}$ measure firm performance. Other variables are defined in Appendix. *t*-statistics are given in parentheses. *, **, and *** denote 10%, 5%, and 1% confidence levels.

The coefficient of $Post_t$*$Treat_i$ remains significantly negative, which indicate that the basic regression results are robust.

7.4. Placebo test

To overcome the possibility that the decline of heavily polluting firm performance is caused by other factors rather than green credit policy, following Chen et al. (2018) and Cheng et al. (2021), we introduce placebo test. We shift the implementation year of the policy forward by 2 year (2010) and redefine $Post_t$. Then, we explore the relationship between the two. Table 12 shows the results. The coefficients of $Post_t$*$Treat_i$ become insignificant, which implies that the decline of heavily polluting firm performance is indeed from the green credit policy rather than other factors.

7.5. Multiple fixed effect models

In order to further eliminate the influence of potential factors, following Liu (2016), we conduct multiple fixed effect models. Columns (1), (3) and (5) of table 13 show the results of controlling firm-year fixed effect. Columns (2), (4) and (6) show the results of controlling firm fixed effect with industry-year fixed effect and province-year fixed effect. We observe that the relationship between the two is still significant, which indicate that the conclusion is robust.

8. Conclusions and policy implications

To alleviate environmental pollution and strengthen environmental regulation, the CBRC issued *Guidelines* in 2012. Based on *Guidelines* in 2012, we examine the effect of green credit on heavily polluting firms' performance. First, the baseline regression results show that green credit reduces these firms' performance. To further eliminate the potential endogenous influence, we conduct a series of robustness check, such as parallel trends analysis, PSM-DID, change indicator, dosage effects, placebo test and multiple fixed effect models. After the above checks, the main conclusion still holds. Secondly, we examine the influence of different firm characteristics and external monitoring mechanism on the restraint of green credit. We find that the effect of green credit is more obvious for SOEs, large-scale firms, firms with relatively high level of external supervision and high economics policy uncertainty. Finally, the results of mechanism analysis show that green credit policy improves firms' financing constraints and reduces the investment level, thus reducing firm performance.

The policy recommendations of this paper are as follows. First, the government, banks and firms need to improve the green credit policy. We find that green credit helps to regulate the behavior of heavily polluting firms and it helps to promote environmental protection. Consequently, the government should continue to improve the operability of green credit policy and strengthen the examination and supervision of banks' lending behavior. Banks should strengthen the organization and management of green credit policy, enhance managing environmental and social risk in the credit process, and continue to play the guiding role of green credit policy for firms. Firms should augment their awareness of environmental protection, accelerate transformation, improve their own credit financing ability, and realize their own sustainable development while promoting environmental protection.

Second, the government should eliminate the asymmetry of policy effect as soon as possible. The results of additional analysis indicate that green credit only has a binding effect on SOEs, large-scale enterprises, and enterprises with higher external supervision level, but has a weak effect on other firms. Therefore, the government should consider the differences of all corporate governance pressures and formulate specific control measures and assessment indicators for the implementation of non-SOEs, small firms and firms with low external monitoring, so as to promote green credit policy to play a full role in these firms.

Finally, our research finds that financing constraints and corporate investment are the key channels for green credit to play its role. Therefore, when formulating policies and implementing management, the government and financial institutions should give full consideration to the role of financing and investment, and guide and support heavily

polluting firms to focus on green investment and financing to achieve the goal of restraining corporate pollution behavior and guiding firm transformation.

Acknowledgement

We would like to thank the workshop participants of Tianjin University Financial Engineering Research Center for valuable comments and suggestions. We acknowledge financial support from the National Natural Science Foundation of China [Grant number: 72073101]. Ahmet Sensoy gratefully acknowledges support from the Turkish Academy of Sciences - Outstanding Young Scientists Award Program (TUBA-GEBIP).

Appendix A. Variable Definitions

Variables	Definitions
$ROA_{i,t}$	The ratio of net income to total assets.
$ROE_{i,t}$	The net profit divided by the average balance of shareholder equity.
$TobinQ_{i,t}$	Tobin's Q, the ratio of total market value of equity to total book value.
$Post_t$	A binary variable takes the value one after the green credit policy (2012–2015), and zero otherwise (2008–2011).
$Treat_i$	An indicator variable equals one if firm i belongs to the treated group (i.e., the firm belongs to heavily polluting industries), and zero otherwise.
$Size_{i,t}$	Natural logarithm of a firm's total assets.
$LEV_{i,t}$	The book value of total debt divided by the book value of total assets.
$IA_{i,t}$	The book value of intangible assets divided by the book value of total assets.
$CI_{i,t}$	Capital intensive, calculated as the net value of fixed assets divided by the number of staff.
$MH_{i,t}$	The percentage of shares owned by the senior executives.
$Age_{i,t}$	Natural logarithm of firm age since listing.
$FA_{i,t}$	The book value of fixed assets divided by the book value of total assets.
$Msize_{i,t}$	Natural logarithm of senior executives' number.
$SA_{i,t}$	Firm financial constraint, which is calculated following the approach in Hadlock and Pierce (2010), as shown in Eq. (2).
$INV_{i,t}$	Firm investment level, calculated as cash cash payment of the long-term assets in the current year divided by the initial total assets, as shown in Eq. (5).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eneco.2021.105415.

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