Journal of Environmental Management 336 (2023) 117648

Contents lists available at ScienceDirect

Journal of Environmental Management

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

Research article

Green credit guideline and enterprise export green-sophistication

Chaobo Zhou [a,b], Zhengxin Sun [c], Shaozhou Qi [d], Yuankun Li [e,*], Heyu Gao [f]

[a] College of International Economics and Trade, Ningbo University of Finance and Economics, Ningbo, 315175, China
[b] Ningbo Philosophy and Social Science Key Research Base "regional Open Cooperation and Free Trade Zone Research Base", Ningbo, 315175, China
[c] School of Government, Peking University, Beijing, 100871, China
[d] Climate Change and Energy Economics Study Center, Economics and Management School of Wuhan University, Wuhan, 430072, China
[e] PBC School of Finance, Tsinghua University, Beijing, 100083, China
[f] School of Software, Northwest Polytechnical University, Xian, 710072, China

ARTICLE INFO

Keywords:
Green credit guideline
Export green-sophistication
Difference in difference
Research and development investment

ABSTRACT

Green credit is a major policy innovation to guide enterprises to participate in environmental governance actively. This study uses the data of Chinese A-share listed companies from 2007 to 2016, takes the green credit guideline (GCG) issued in 2012 as a quasi-natural experiment, and uses a difference in difference (DID) model to test the effect of GCG on the enterprises' export green-sophistication (EGS) and its internal and external mechanisms. The study finds that GCG improves enterprises' EGS and research and development (R&D) investment is the intermediation channel for GCG to affect EGS. Results of heterogeneity analysis show that the role of GCG in promoting EGS is significantly reflected in enterprises that the government does not subsidize, enterprises in areas with a low degree of financial marketization development, state-owned enterprises, and enterprises with a high degree of equity incentive.

1. Introduction

Environmental changes affect the welfare level of hundreds of millions of residents. Since the late 1970s, China's scale-driven economic growth has brought about excessive energy consumption and pollution emissions. In 2021, the amount of energy consumption will become four times that of 1990, and the cumulative sulfur dioxide emissions will exceed 300 million tons. The contradiction between economic development and environmental protection has become increasingly prominent (Li et al., 2022; Zhou and Qi, 2022). As an important policy tool of modern environmental governance, green finance has the characteristics of market-based ER and the financial sector's resource allocation function. Promoting the development of green finance can reduce the credit rationing of highly polluting industries, affect the development strategies of local governments and enterprises, improve the industrial structure, and accelerate the transformation of production mode to cleaner production (Dong et al., 2020). Under the modern environmental governance system, the behavior choice of financial institutions and enterprises can ultimately determine the implementation effect of ER. From the perspective of environmental governance, financial institutions and enterprises play an essential role in improving environmental quality. On the one hand, bank loans are the main source of enterprise financing, whereas basic industries such as chemical and petrochemical industry have significant advantages in the availability of bank credit for a long time (Carolyn, 2017; Su et al., 2022). Thus, the restrictions of GCG on polluting enterprises are more prominent. On the other hand, environmental governance's goal is to change enterprises' behavior choices. More enterprises are willing to assume environmental and social responsibilities for the entire industry to realize green production finally. To guide enterprises to reduce the production behavior of environmental pollution and promote the transformation and upgrading of the polluting industry, China issued the GCG in 2012, which clarified the basic principles of green credit for commercial banks and formally emphasized the importance of green finance development. The GCG requires commercial banks to provide differentiated green financial services to different enterprises, forcing industrial structure reform through differential treatment of enterprise credit financing to realize the development mode of the green economy. By the end of 2019,

Abbreviations: GCG, Green Credit Guideline; DID, Difference in Difference; EGS, Export Green-sophistication; R&D, Research and Development; ER, Environmental Regulation; CCD, China Customs Database; CSMAR, China Stock Market & Accounting Research; TFP, Total Factor Productivity; CV, Control variables; EPLPRC, Environmental Protection Law of the People's Republic of China; PSM, Propensity Score Matching.

* Corresponding author.
E-mail address: 178540317@qq.com (Y. Li).

https://doi.org/10.1016/j.jenvman.2023.117648
Received 25 November 2022; Received in revised form 9 February 2023; Accepted 28 February 2023
Available online 3 March 2023
0301-4797/

the balance of green financial credit in China's banking industry had reached 8 trillion yuan, an increase of 16% over 2018, accounting for 14% of the total corporate loans and showing a growing trend year by year, which has become an important way for corporate financing.

As China's export products are mainly processed trade products, the textile industry, household appliances industry, agriculture, and other products are vulnerable to the impact of green trade barriers. China's exports over the years have also caused a lot of environmental pollution. To enhance export competitiveness and overcome the negative impact of green barriers, enterprises need to transform and upgrade, improve the EGS, and reduce the possible negative environmental effects (Qi et al., 2020). At the same time, under the background of green transformation, enterprises have to choose between technology upgrading and export behavior. How to improve environmental performance and economic efficiency and promote enterprises to overcome the high capital cost of export has become an urgent problem to be solved. Based on the perspective of export sophistication, Li and Lu (2018) proposed the concept of EGS in combination with the urgent need for the green transformation of export trade. The EGS refers to the green technology elements included in the export products of enterprises. The higher EGS, the more green technology elements are included in the export commodities, and the higher the product's added value. The EGS can reflect the technology content of products and the green degree in the production process of products. For a country or a region, the EGS in export can reflect whether the export trade consumes a lot of resources while gaining a comparative advantage, which negatively impacts the ecological environment. Therefore, the EGS is also the ability of a country to gain incremental trade competitiveness under a green, low-carbon economy and is an extension of traditional trade competitiveness. China's ER means mainly include two control zones, total emission control and other administrative restraint means, as well as economic means such as the collection of emission charges and emission trading. However, these ERs increase the marginal cost of enterprise production, bring greater financial pressure to enterprises, and cannot achieve the unity of enterprise economic and environmental benefits. How to promote the integration of enterprise environmental performance and economic performance through market-oriented means and then improve the EGS has received increasing attention from the academic community (Li and Lu, 2018; Ge et al., 2020; Zhou et al., 2022). GCG provides new opportunities for enterprises to balance environmental performance and export quality. Studying the relationship between GCG and EGS is conducive to an in-depth understanding of the resource allocation effect of GCG and its logic and provides policy references for optimizing China's trade structure and obtaining a competitive trade advantage.

The main marginal contributions include the following: First, the existing literature has studied the effect of ER on enterprises' export behavior and the quality of export products, while few studies have linked green credit with enterprises' export behavior. Based on the perspective of green development, we study the effect of GCG on the EGS and the micro mechanism, which enriches the research related to financial development and trade growth, ER, and international trade. This study provides a new dimension for exploring the new strengths of China's export trade. Second, we empirically study the intermediary effect of GCG on enterprises' EGS. Third, we discuss the heterogeneous effect of GCG from four different perspectives of government, market, industry, and enterprise, helping the government to improve enterprises' EGS by optimizing GCG.

2. Literature review and research hypothesis

2.1. Literature review

According to the research questions, four types of literature are closely related to this study. The first kind of literature studied the microeconomic and environmental effects of GCG from different aspects. The implementation of GCG first affects the cost efficiency of commercial banks. As the most closely related intermediary to green finance, reasonable development of green credit businesses can effectively reduce operating costs and improve credit risk management capabilities (Xing et al., 2020). The existing literature has analyzed and tested the effect of GCG on enterprises' investment and financing behavior and found that GCG has financing constraints and investment punishment effects on heavily polluting enterprises. GCG can simultaneously increase the financing cost of heavily polluting enterprises and reduce investment. (He et al., 2019; Liu et al., 2019; Yang and Zhang, 2022). In addition, GCG can also significantly promote innovation and significantly affect the pollution emissions of enterprises (Wang et al., 2022; Chen et al., 2022; Zhang et al., 2022; Guo et al., 2022). Drawing on the perspective of bank credit allocation efficiency, GCG weakens bank credit allocation efficiency by reducing the R&D intensity and total factor productivity of energy-intensive enterprises (Wen et al., 2021). Furthermore, based on energy efficiency, existing studies have shown that GCG can promote efficient energy utilization by increasing investment in clean energy (Ma et al., 2021; Song et al., 2021). GCG significantly reduces corporate performance in high-pollution industries analyzed from the perspective of corporate performance (Yao et al., 2021).

The second kind of literature studied influencing factors of export sophistication. Scholars have studied the important factors that affect the improvement of China's export sophistication from various angles. Some studies believe that the improvement of China's export sophistication is mainly caused by external factors, such as processing trade, import trade, foreign direct investment, and bilateral trade costs (Amiti and Freund, 2008; Xu and Lu, 2009; Zheng and Zheng, 2020). However, some literature claims that some internal factors will affect China's export sophistication, such as infrastructure construction, financial development, foreign direct investment of Chinese enterprises, division of labor embedded in the global value chain, the development degree of the technology market, and institutional environment (Mao and Liu, 2018; Shen and Huang, 2019). Subsequently, trade liberalization and trade barriers have become the research focus of China's export sophistication. Sheng and Mao (2017) found that trade barriers will negatively impact the export sophistication of Chinese industries and products. Considering the background of green development, the impact of ER on EGS has also been a concern of scholars. Ge et al. (2020) independently built the ER index and empirically analyzed the impact of ER on the EGS. The results show that ER will have a significant positive effect on the EGS. Zhou et al. (2022) found that China's pilot carbon market can significantly improve the EGS of enterprises.

The third kind of literature studied the relationship between financial development and export trade. Many studies show that financial development can significantly affect international trade. Most of the early studies focused on the macro level emphasized that the financial development of a country can effectively alleviate the financing constraints faced by the industry and improve the export scale of the industry. Countries with comparative advantages in financial development could better promote the export of highly financing-dependent industries (Beck, 2002), thus forming the development differences in export trade scale among countries. Later, with the creation and development of new-new trade theory, some scholars began to explore the theoretical basis for developing foreign trade from the micro level of enterprises (Melitz, 2003). One critical aspect is that financial development can reduce the financing constraints faced by enterprises, thus playing a positive role in enterprise exports. Manova et al. (2015) found that financing constraints inhibited enterprises' export, whereas foreign investment participation provided additional financing channels for enterprises' export. Paravisini et al. (2015) analyzed Peruvian enterprises and found a similar conclusion. When the scale of credit supply decreases by 10%, the total scale of exports will decrease by 2.3%. Crino and Ogliari (2017) found that insufficient financial market development will lead to financial frictions, affecting the quality of enterprises' export products and export scale and prices. Chen et al. (2020) found that urban commercial banks can alleviate the financing constraint dilemma caused by the inefficiency of the local financial market, thus effectively promoting the export of enterprises. The previous literature mainly focused on the effect of traditional credit on trade development in financial development and did not involve green credit, an essential financial credit method. Research on green finance and China's export development remains lacking.

The fourth kind of literature is about the effect of ER on trade, but it has not yet been unified. Many scholars pay attention to the economic effects of ER. Classical theory shows that regions with loose ER easily attract foreign capital, which is essential in foreign investment, foreign trade development, and enterprise location selection. Therefore, the famous "pollution paradise hypothesis" has emerged in the academic circle (Taylor, 2005). Suppose a country needs to raise foreign capital to boost its export development after implementing strong ER. Thus, it may turn away highly polluting enterprises with cutting-edge technology from developed countries, which is not conducive to developing a country's foreign trade. This theory initially points out that ER, foreign trade, foreign investment and development are closely related. Subsequent scholars have paid more attention to the trade effect of ER and examined its impact on the development of international trade. Hering and Poncet (2014) studied the impact of ER on China's export based on the policy of acid rain and sulfur dioxide pollution control zone and found that the export of enterprises located in the control zone decreased. Liu and Xie (2020) found that China's ER can improve its competitive export advantage, but the competitive advantage brought about by ER has a non-linear U-shaped effect, and the effect is different in industries. Du and Li (2020) analyzed the marginal change in export trade brought about by ER. They found that ER was not conducive to the growth of enterprises' export expansion and would reduce the sustainability of enterprises' exports. Qi and Cheng (2022) found that China's emission trading significantly improved the quality of enterprises' export products.

To sum up, many studies have studied the economic and environmental performance of GCG. From the perspective of environmental benefits, the existing literature focused on the pollution reduction effect of GCG on high-pollution enterprises. From the perspective of economic performance, the existing literature analyzes the impact of GCG on enterprise investment and production efficiency and mostly conducts mechanism tests from financing constraint channels and R&D innovation channels. The existing research focuses on the influencing factors of China's export sophistication but ignores the EGS. It pays insufficient attention to how to improve China's EGS and lacks the corresponding mechanism analysis. In addition, the previous literature focused on exploring the trade results of ER, which did not form a unified conclusion on trade effect and ignored the vital role of green finance in improving the quality of the environment and promoting trade. This study analyzes the impact of GCG on the EGS of enterprises and provides a new solution for China to optimize the trade structure and improve export quality.

2.2. Research hypothesis

As an important part of green finance, GCG refers to policies and institutional arrangements to promote energy conservation and emission reduction of enterprises using credit. The GCG includes three core connotations: First is the adoption of credit policies, and means, including loan varieties, loan terms, loan interest rates, and loan lines, to support energy conservation and environmental protection projects of enterprises. Second is that the enterprises that violate the laws and regulations related to energy conservation and environmental protection, as well as enterprises with excessive pollution emissions, should be punished by raising loan interest, stopping, delaying, or even recovering loans. Third is banks that should strengthen cooperation with environmental protection departments, use credit means to promote enterprises to prevent environmental risks, fulfill social responsibilities, and reduce credit risks.

The impact of GCG on the EGS of enterprises may be produced through external and internal channels. The external effect of GCG on EGS is mainly divided into the financial level and the survival of the fittest level. From the financial perspective, GCG provides low-interest rate credit and financing support for environment-friendly enterprises while easing the financial constraints on R&D investment, helping them improve the level of green technology (Wang et al., 2022). For highly polluting enterprises, GCG provides the environmental performance standard for polluting enterprises to apply for bank credit. To obtain bank credit, enterprises may carry out research and development activities to improve production technology, which positively impacts the quality of enterprises' export products (Yang et al., 2022). The implementation of GCG brings environmental protection signals to enterprises and reduces the uncertainty of enterprises' investment in technology upgrading. Under the sign of cleaner production released by the GCG, polluting enterprises choose to improve their cleaner production capacity to maintain their market position and obtain more market shares. Under the influence of the Porter effect of the GCG, enterprises' R&D investment increases and production efficiency improves, ultimately increasing EGS.

At the survival of the fittest level, under the same technological level, the improvement of resource allocation efficiency brought by the flow of production factors also means improving production efficiency (Zhou and Qi, 2022). Improving production efficiency can save more energy, reduce pollution emissions, and improve the EGS. Therefore, by guiding the flow of production factors, the GCG enables enterprises in the clean industry to upgrade, optimize, and improve their production efficiency continuously. In contrast, polluting enterprises will exit the market due to low efficiency. The entire industry will also be promoted in the entry and exit of enterprises, thus realizing the transformation and upgrading of the whole industry. The transformation and upgrading of the industry mean that the enterprises' EGS in the industry will be improved.

The internal impact of GCG on EGS is mainly divided into the product production level. GCG can make highly polluting enterprises to adjust production and export decisions at the product production level through punishment mechanisms and credit supply restriction measures. In the face of the cost constraints brought by GCG, to pursue cost minimization and profit maximization, heavily polluting enterprises are likely to reallocate production resources and adjust their product production portfolio, actively increasing the input of production factors in the clean production sector and reducing the input of production factors in the polluting production sector (Ge et al., 2020; Qi and Cheng, 2022). The reason is that, with the implementation of GCG, for the sake of avoiding the impact of environmental pollution costs, enterprises will give up the production of polluting products, turn to clean products with low energy consumption, and expand the export category of clean products. The withdrawal of contaminated products and the entry of clean products will improve the overall enterprises' EGS.

Therefore, we put forward the hypothesis: GCG is conducive to improving the enterprises' EGS.

3. Model and data

3.1. DID model

We analyze the effect of GCG on exports' EGS through the DID model. The basic idea of the DID model is to identify the average treatment effect using the intensity difference between the treatment and control groups affected by GCG. With the introduction of GCG as the background, we constructed the treatment and control group required by quasi-natural experiments. Highly polluting enterprises are selected as the treatment group and the rest as the control group (Wang et al., 2022). Given that the enterprise has not disclosed the pollution emission data at present, the pollution degree of the enterprise cannot be directly obtained. According to Liu et al. (2019) and Wang et al. (2022), enterprises in the six industries of thermal power, iron and steel, petrochemical, cement, non-ferrous metals, and chemical industries in the key control areas of the *Announcement on the Implementation of Special Emission Limits for Air Pollutants* issued by the Ministry of Environmental Protection in 2013 are selected as heavy polluters.

$$EGS_{it} = \alpha_0 + \alpha_1 Pollute_i \times Time_t + \alpha_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (1)$$

where subscripts i represents the enterprise and t represents the year. *Pollute* is the pollution degree of enterprise. We assign 1 as the high-pollution enterprise and 0 as the rest. We define the indicator variable of policy impact time as *Time*, take the implementation time of GCG as the time point of policy occurrence, assign the value of each year after the implementation of GCG as 1, and assign the value of each year before the implementation of GCG as 0. X is the control variable. μ and γ represent the fixed effect of enterprise and time, respectively. The coefficient of *Pollute* × *Time* measures the changes in enterprises' EGS before and after the introduction of GCG.

3.2. Mediation effect model

To determine whether GCG will guide enterprises to research actively, develop, and increase R&D investment to improve the EGS, we test whether GCG can improve EGS through RD through the mediation effect model.

$$\mathrm{RD}_{it} = \alpha_0 + \beta_1 Pollute_i \times Time_t + \beta_2 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (2)$$

$$\mathrm{EGS}_{it} = \alpha_0 + \lambda_1 Pollute_i \times Time_t + \lambda_2 \mathrm{RD}_{it} + \lambda_3 X_{it} + \mu_i + \gamma_t + \varepsilon_{it} \quad (3)$$

Variable *RD* refers to an enterprise's R&D investment in Equations (2) and (3). Through the significance of β_1, λ_1, and λ_2, we can test the mediating effects of RD.

3.3. Parallel trend test model

The parallel trend is where no systematic difference exists in the EGS trend before GCG implementation between pilot and nonpilot enterprises. We employ the following model to test the parallel trend.

$$EGS_{it} = \beta_0 + \sum_{t=2009}^{2016} \beta_t Pollute_i \times Time_t + \beta_1 X_{it} + \mu_i + \gamma_t + \varepsilon_{it}, \quad (4)$$

where post is the dummy variable of the year. If the year is 2012, then post $_{2012} = 1$, and the rest are 0. The condition of the parallel trend test, that is, from β_{2009} to β_{2011}, is insignificant, whereas that from β_{2012} to β_{2016} is significant.

3.4. Data and variable definition

3.4.1. Sample selection

The latest export volume data of enterprises published in the Chinese customs database were from 2016. Given data access restrictions, this study selects China's A-share listed companies from 2007 to 2016 as the research sample. The export volume and financial data of enterprises is used to calculate the EGS indicators at the enterprise level. The export volume data of enterprises are sourced from the CCD. At present, the export volume data of the CCD at the enterprise level is only available in 2016 and not in the latest year. The export volume data of enterprises are the key data for measuring the explained variables in this study. Given the limitation of data access, the research time of this study can only end in 2016. According to the research of Qi and Cheng (2022), the export volume data and relevant financial data are obtained after matching the CCD with the CSMAR Database. Next, the sample in non-industrial industries is deleted; the sample observations with serious missing variable data are removed; listed companies in the financial and insurance industry and ST and ST* listed companies are eliminated. The enterprises suffering from serious losses during the sample period are excluded. We winsorize main continuous variables at the 1% level to avoid extreme values' interference.

3.4.2. Variable definition

EGS: Based on the export sophistication, Li and Lu (2018) gave a green connotation to export sophistication, thus proposing EGS, which can reflect the green technology content of products. For a country or region, EGS can reflect whether its comparative advantage in export trade depends on resource consumption or green technology addition. According to the measurement of an enterprise's EGS from Li and Lu (2018) and Zhou et al. (2022), the EGS mainly consists of three parts: the enterprise's export dominant comparative advantage, the enterprise's technology level, and the enterprise's green degree.

$$EGS_i = \frac{EX_{ijk} \Big/ \sum_k EX_{ijk}}{EX_{jk} \Big/ \sum_k EX_{jk}} \times TFP_i \times GC_K \quad (5)$$

In the above formula, EGS refers to the export green-sophistication of enterprise, *EX* refers to the export volume, which is the key variable reflecting the enterprises' export dominant comparative advantage. Subscript i refers to the enterprise, subscript j refers to the industry to which the enterprise belongs, and subscript k refers to the region where the enterprise is located. *TFP* is the TFP of the enterprise. The measurement method of TFP is based on the research of Head and Ries (2003).

$$TFP_i = ln\frac{Q_i}{L_i} - s \times ln\frac{K_i}{L_i} \quad (6)$$

In Equation (6), Q is the main business income of enterprise; K is the capital stock; L is the number of employees, and S is capital contribution, with $S = 1/3$ according to Li and Lu (2018).

GC is the green coefficient of the region where the enterprise is located, which reflects the pollution level of the region. According to the research method of Zhou et al. (2022), we calculate the regional pollutant emissions per unit output value of the three types of pollutants (industrial wastewater, sulfur dioxide, and industrial dust) and then carried out linear standardized treatment on the pollutant emissions per unit output value of the region. The standardized pollutant emission scores were added and averaged to obtain the green degree of the region.

$$GC_k = \sum_{\theta=1}^{n} \rho_{k\theta}/n \quad (7)$$

In Equation (7), *GC* is the green degree of region where the enterprise is located. ρ is the pollutant emission value of per unit output value, which is standardized by the range method. N represents the types of pollutants.

Therefore, the EGS of an enterprise is equal to the product of an enterprise's export dominant comparative advantage, total factor productivity, and green degree.

RD: The mediation variable is the R&D investment of an enterprise, which is the proportion of R&D expenditure in the operating income of enterprises.

CV: We select the following variables that may affect the EGS as control variables. Export volume (Export): According to the research of Li and Lu (2018), enterprises can learn while exporting to accumulate experience and improve green technology. Therefore, we select the natural logarithm of export volume as the control variable.

Enterprise size (Size): We use the logarithm of the total assets of the enterprise to represent its size.

Age of enterprise (Age): The older the enterprise is, the more mature it is, and the more stable it tends to be. The lack of incentives for uncertain innovation may lead to lower motivation for independent R&D,

thus affecting the EGS. We use the logarithm of the number of years of listing to express the Age.

Tobin Q value (Tobinq): Tobinq can represent the market value of an enterprise, and also reflects the market competitiveness of an enterprise. The stronger the enterprise's competitiveness, the stronger its ability to export green technology. Tobinq is the ratio of the market value to the replacement cost of capital.

Asset liability ratio (Lev): Lev can measure the operation of an enterprise, and Lev is the ratio of the enterprise's total assets to total liabilities.

The profit rate of total assets (Roa): Roa reflects the profitability of an enterprise. The stronger the profitability of an enterprise, the easier it is to improve the EGS. Roa is the ratio of the total profit to the total assets.

Lending capacity (Lend): The stronger the borrowing capacity of an enterprise, the better it will be for the enterprise to expand its production scale. The ratio of the net value of fixed assets to the total assets is used to express the Lend. The variables' descriptive statistics are shown in Table 1.

4. Empirical results

4.1. DID results

We estimate the effect of GCG on EGS through Model 1. Columns 1 to 3 in Table 2 were the results of adding control variables and fixed effects. The coefficients of *Pollute* × *Time* have slightly changed and are always significantly positive, indicating that GCG has significantly improved enterprises' EGS.

4.2. Robustness test

4.2.1. Parallel trend and placebo test

Columns 1 to 2 in Table 3 were the results of Equation (4). Before the GCG implementation in 2012, the coefficients of *Pollute* × *Time* were insignificant. After GCG implementation, the coefficients of *Pollute* × *Time* have become significantly positive. That is, the parallel trend test is passed. From the result of the dynamic effect, the driving effect of GCG on EGS was significant after the policy began and had a long-term stable effect. We find that there is no significant difference pre-trend between the high-pollution and low-pollution, which indictor our identification model meet the requirement of DID model. Subsequently, we take a placebo test. We assume that the establishment periods of GCG were in 2009, 2010, and 2011. Then, we remove the samples in 2012 and later conducted regression according to Model (1). The coefficients of *Pollute* × *Time* from the third to fifth columns of Table 3 are insignificant, which means that the placebo test is passed.

4.2.2. Excluding the effect of ER

During the implementation of GCG, China implemented the EPLPRC in 2015, helped the market to form a reasonable expectation of environmental protection, urged enterprises to form a stable expectation for the rigorousness and long-term nature of environmental governance, and sped up the green transformation of enterprises. In this regard, we control the interaction between the pollution industry affected by the EPLPRC and the implementation time of EPLPRC. The pollution industries are classified according to the pollution indicators of each

Table 1
Descriptive statistics.

	Obs	Mean	Std. Dev.	Min	Max
EGS	8725	0.624	3.782	−18.581	21.522
RD	8725	0.031	0.021	0	0.085
Export	8725	16.021	2.602	1.099	23.174
Age	8725	1.782	0 .8279	0	3.219
Size	8725	21.956	1.139	17.879	29.653
Roa	8725	0 .041	0.097	−0.994	0.707
Tobinq	8725	1.573	1.327	0.749	8.505
Lev	8725	0.414	0.222	0.075	0.763
Lend	8725	0.254	0.153	0.004	0.849

Table 2
Impact of GCG on EGS.

	(1)	(2)	(3)
	EGS	EGS	EGS
Pollute × Time	0.441***	0.406***	0.319***
	(0.114)	(0.113)	(0.114)
Export		0.108**	0.11**
		(0.044)	(0.044)
Age		0.954***	0.955***
		(0.083)	(0.086)
Size		0.0138	0.007
		(0.074)	(0.073)
Roa		0.022	0.021
		(0.019)	(0.02)
Tobinq		0.026	0.0224
		(0.025)	(0.024)
Lev		−0.036	−0.041
		(0.255)	(0.254)
Lend		0.301	0.335
		(0.309)	(0.309)
Firm FE	No	No	Yes
Year FE	No	No	Yes
Observations	8725	8725	8725
R-squared	0.696	0.707	0.708

Note: Cluster-Robust standard errors are in parentheses, all regressions are robustly clustered to firms. *, **, *** respectively represent 10%, 5%, and 1% significance levels. The same as in the following table.

Table 3
Parallel trend and placebo test.

	(1)	(2)	(3)	(4)	(5)
	EGS	EGS	EGS	EGS	EGS
Pollute × Time			0.242	0.144	0.056
			(0.362)	(0.165)	(0.201)
Pollute × Post 2009	0.177	0.256			
	(0.218)	(0.204)			
Pollute × Post 2010	0.189	0.177			
	(0.186)	(0.164)			
Pollute × Post 2011	0.242	0.211			
	(0.193)	(0.197)			
Pollute × Post 2012	0.431***	0.422***			
	(0.164)	(0.163)			
Pollute × Post 2013	0.431***	0.421***			
	(0.166)	(0.164)			
Pollute × Post 2014	0.352***	0.347***			
	(0.101)	(0.096)			
Pollute × Post 2015	0.397***	0.363***			
	(0.084)	(0.087)			
Pollute × Post 2016	0.401***	0.382**			
	(0.104)	(0.111)			
Export		0.112**	−0.031	−0.03	−0.03
		(0.045)	(0.065)	(0.065)	(0.064)
Age		0.945***	1.324***	1.316***	1.31***
		(0.087)	(0.168)	(0.169)	(0.169)
Size		0.009	−0.088	−0.091	−0.091
		(0.079)	(0.149)	(0.149)	(0.15)
Roa		−0.005	−0.008	−0.007	−0.007
		(0.016)	(0.014)	(0.014)	(0.014)
Tobinq		0.025	−0.049	−0.047	−0.046
		(0.022)	(0.055)	(0.055)	(0.055)
Lev		0.123	0.252	0.258	0.25
		(0.25)	(0.448)	(0.449)	(0.449)
Lend		0.431	−0.019	−0.021	−0.014
		(0.312)	(0.496)	(0.496)	(0.495)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	8725	8725	8725	8725	8725
R-squared	0.699	0.704	0.713	0.713	0.712

industry in 2014. The top 1/3 of the industries are identified as pollution industries. This indicator is measured by the ratio of the total emissions of three major pollutants in each industry in 2014 to the total output of each industry. The coefficients of *Pollute* × *Time* in Columns 1 and 2 of Table 4 were significantly positive, which proves that this conclusion is still valid after the interference of the EPLPRC is eliminated. Since 2013, China has set up pilot carbon emission trading markets in seven provinces, including Beijing, Shanghai, and Guangdong. Implementing the pilot carbon market may affect the export behavior of heavily polluting enterprises. This study removes the impact of this policy by deleting the sample of provinces that set up pilot carbon markets. The coefficients of *Pollute* × *Time* in Columns 3 and 4 were significantly positive. Industry and macro factors may also lead to changes in the level of EGS of enterprises. Some studies control these effects by adding industry and macro variables, but the disadvantage of this approach is that it cannot exhaust all the influencing factors. We control all industry trends and macro factors by introducing the interactive fixed effect of industry and time and the interactive fixed effect of provinces and time. The coefficients of *Pollute* × *Time* in Column 5 were not much different from the benchmark regression results. The results remain stable after excluding the interference of macroeconomic and industrial factors on the production behavior of enterprises.

4.2.3. Replace pollution industry standard and sample interval

In classifying heavy pollution enterprises, we took the proportion of sulfur dioxide emissions in 1995 as the basis for classifying high-polluting industries, according to Deschenes et al. (2017). Suppose an industry's proportion of SO2 emissions exceeds 5% of the total national emissions. In that case, the industry is considered a high-polluting industry, and the rest are low-polluting enterprises. Then we make regression estimation according to Model 1. The coefficient of *Pollute* × *Time* in Column 1 of Table 5 was positive. DID approach actually does not need long period analysis, on the contrary, a short observation period will be helpful to observe the net policy effect. We limit the sample interval to 2009–2014 and make regression according to model 1. The coefficient of *Pollute* × *Time* in Column 2 of Table 5 was positive.

4.2.4. PSM–DID estimation

The sample we used is listed enterprises, with 8275 sample observations. There are also differences in the enterprise samples' size, financial status, and geographical location. Therefore, this study cannot guarantee that the selected samples have the same individual characteristics. Moreover, for mitigate the systematic differences between the treatment group and control group, we combine PSM method with DID model to test the effect of GCG on the EGS on the basis of Zhang and Duan (2020). The PSM method commonly used in academia mainly includes kernel, nearest neighbor, and caliper matching. Therefore, the present study uses these three matching methods together with DID method to conduct regression. The coefficients of *Pollute* × *Time* from the first to third columns in Table 6 are significant at 1%.

Table 4
Excluding the impact of other policies.

	(1)	(2)	(3)	(4)	(5)
	EGS	EGS	EGS	EGS	EGS
Pollute × Time	0.301***	0.327***	0.311***	0.302***	0.265***
	(0.098)	(0.091)	(0.085)	(0.074)	(0.081)
Export		0.113**		0.092*	0.105***
		(0.045)		(0.054)	(0.014)
Age		0.964***		0.904***	0.931***
		(0.086)		(0.107)	(0.069)
Size		0.007		−0.013	0.015
		(0.074)		(0.101)	(0.059)
Roa		0.022		0.0172	−0.005
		(0.02)		(0.015)	(0.019)
Tobinq		0.022		0.07***	0.028
		(0.024)		(0.024)	(0.021)
Lev		−0.049		−0.159	0.117
		(0.254)		(0.325)	(0.216)
Lend		0.362		0.743**	0.384
		(0.31)		(0.376)	(0.262)
Firm FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Observations	8725	8725	4631	4631	8725
R-squared	0.695	0.701	0.693	0.604	0.533

Table 5
Replace pollution industry standard and sample interval.

	(1)	(2)
	EGS	EGS
Pollute × Time	0.235***	0.412***
	(0.093)	(0.084)
Export	0.107**	0.124**
	(0.045)	(0.059)
Age	0.927***	1.434***
	(0.088)	(0.105)
Size	0.0153	−0.016
	(0.079)	(0.111)
Roa	−0.004	0.0233
	(0.015)	(0.022)
Tobinq	0.029	0.0234
	(0.023)	(0.028)
Lev	0.126	−0.103
	(0.25)	(0.334)
Lend	0.372	0.547
	(0.31)	(0.369)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	8725	5424
R-squared	0.702	0.881

4.3. Impact mechanism test

We analyze the mediating effect of RD according to Models (2) and (3). The coefficients of *Pollute* × *Time* and RD coefficients in Columns 1 to 2 of Table 7 are significant at 10%, indicating that RD is the mediating variable for GCG to improve EGS. GCG is a powerful signal that China has released to enterprises regarding implementing long-term and rigorous environmental governance. According to the Porter effect, it helps to promote enterprises to increase RD and reduce their long-term production costs. Specifically, GCG can enhance the R&D investment of enterprises through capital guidance. Given that the R&D investment of enterprises is essentially an investment behavior, a certain scale of

Table 6
PSM–DID estimation.

	(1)	(2)	(3)
	EGS	EGS	EGS
Pollute × Time	0.211***	0.253***	0.194***
	(0.052)	(0.066)	(0.053)
Export	0.172***	0.123**	0.136***
	(0.046)	(0.048)	(0.036)
Age	0.974***	0.941***	1.121***
	(0.095)	(0.096)	(0.085)
Size	0.032	0.061	0.054
	(0.088)	(0.086)	(0.091)
Roa	−0.018	−0.004	−0.003
	(0.013)	(0.018)	(0.024)
Tobinq	0.025	0.039*	0.031
	(0.024)	(0.023)	(0.054)
Lev	0.315	−0.07	−0.193
	(0.267)	(0.271)	(0.432)
Lend	−0.028	0.227	0.322
	(0.33)	(0.331)	(0.386)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	6977	5586	6083
R-squared	0.584	0.641	0.602

Table 7
Mediating effects of RD.

	(1)	(2)
	RD	EGS
Pollute × Time	0.033*	0.237***
	(0.018)	(0.001)
RD		3.884*
		(2.168)
Export	0.011	0.102**
	(0.014)	(0.045)
Age	5.212***	−0.706***
	(0.079)	(0.114)
Size	0.302***	−0.0804
	(0.082)	(0.081)
Roa	0.018	−0.01
	(0.038)	(0.017)
Tobinq	−0.005	0.03
	(0.03)	(0.022)
Lev	0.485**	0.269
	(0.225)	(0.241)
Lend	1.15***	0.745**
	(0.285)	(0.3)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Observations	8725	8725
R-squared	0.387	0.783

capital investment is required. From the perspective of financing, the proportion of internal financing of Chinese listed enterprises is low, and external financing accounts for more than 80% of enterprise financing models (Wen et al., 2021). Therefore, acquiring external financing is the key factor for enterprises' R&D investment, and convenient external financing can effectively promote enterprises' R&D investment. Bank credit is the most important external financing source for Chinese enterprises. As a kind of credit fund, green credit provides credit and financing support for environment-friendly enterprises and alleviates financial constraints on R&D investment of environment-friendly enterprises. The GCG will also increase the credit cost of highly polluting enterprises, force heavily polluting enterprises to transform and upgrade, and promote enterprises to increase R&D investment in green projects. After the implementation of GCG, the enterprise's production cost may rise in the short term owing to the upgrade and transformation of equipment during green production. However, enhancing R&D investment can enable enterprises to improve production processes and efficiency and reduce long-term production costs (Porter, 1991). When the production cost of an enterprise decreases continuously in the long term, it will help the enterprise to gain a competitive advantage. Therefore, GCG can promote polluting enterprises to increase the scale of R&D investment, improving production efficiency and ultimately enhancing EGS.

4.4. Heterogeneity analysis

We analyze the heterogeneous effect of GCG on EGS from three aspects: government, market, and enterprise.

4.4.1. Heterogeneity of government subsidies

We regress the enterprises that have not received government subsidies and the enterprises that the government has subsidized according to Model 1. Columns 1 and 2 of Table 8 respectively show the different effects of GCG on enterprises that do not have government subsidies and enterprises that have government subsidies. The coefficient of *Pollute* × *Time* in the first column was significantly greater than the second column, which indicates that GCG has a significant effect on improving EGS for enterprises without government subsidies but has no significant effect on enterprises with government subsidies. The main reason is that government subsidies make up for the high production costs of enterprises owing to the GCG; thus, GCG will not impose financing constraints on them. The motivation of enterprises receiving government subsidies to invest in environmental protection facilities to obtain credit is also weaker than that of enterprises not receiving government subsidies. Government subsidies distort the credit costs imposed by GCG for heavily polluting enterprises to a certain extent. Therefore, the promotion effect of GCG on EGS is mainly reflected in enterprises that the government does not subsidize.

Table 8
Heterogeneity of external enterprise environment.

	(1)	(2)	(3)	(4)
	EGS	EGS	EGS	EGS
Pollute × Time	1.045***	0.599	0.346	0.622***
	(0.186)	(0.601)	(0.316)	(0.129)
Export	0.257***	0.225***	0.396***	0.226***
	(0.058)	(0.068)	(0.055)	(0.066)
Age	1.024***	0.927***	0.948***	1.137***
	(0.104)	(0.172)	(0.126)	(0.126)
Size	0.0804	0.0159	0.07	0.051
	(0.105)	(0.123)	(0.134)	(0.1)
Roa	−0.004	−0.009	−0.034	−0.001
	(0.026)	(0.015)	(0.097)	(0.014)
Tobinq	0.034	0.048	0.058	0.01
	(0.027)	(0.044)	(0.04)	(0.024)
Lev	−0.165	−0.21	−0.064	−0.251
	(0.293)	(0.469)	(0.355)	(0.344)
Lend	0.109	0.796	−0.16	0.75*
	(0.38)	(0.515)	(0.456)	(0.389)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3123	5602	6216	2513
R-squared	0.723	0.699	0.704	0.705

4.4.2. Heterogeneity of marketization degree

We use the market development score of each region in the marketization index report of Wang et al. (2019) to measure the marketization degree of each region. We define the top ten regions in terms of market development in 2012 as the market-developed regions. Suppose the enterprises belong to the market-developed regions. In that case, they are the sample of the developed regions, and the rest are the sample of underdeveloped regions. The coefficients of *Pollute* × *Time* in Column 4 are significantly greater than in Column 3 of Table 8, indicating that GCG has a relatively large role in promoting the EGS in underdeveloped regions. The main reason is the higher allocation efficiency of financial resources in regions with high financial marketization and many opportunities for enterprises to obtain financial resources. Therefore, bank credit has relatively weak financial constraints on polluting enterprises. For regions with weak financial marketization, banks are the main way enterprises obtain financial resources. Therefore, GCG brings higher credit costs to enterprises in such regions, and enterprises will be more motivated to green upgrade to receive bank credit. Therefore, the promotion effect of GCG on EGS is mainly reflected in enterprises in underdeveloped areas with financial marketization.

4.4.3. Heterogeneity of enterprise property rights

The coefficients of *Pollute* × *Time* in Columns 1 and 2 of Table 9 indicate that GCG plays a stronger role in improving the EGS of state-owned enterprises. Given the closer relationship between state-owned enterprises and local governments, state-owned enterprises can get more financial support from local governments and have more resource advantages. Their internal business activities are more likely to be controlled by environmental regulations issued by local governments. While state-owned enterprises enjoy more financial support and administrative convenience, they also face greater pressure on ER and must bear more social responsibilities. They need to consider the impact on the environment during production and operation. After implementing the GCG, to assume more social responsibilities, state-owned enterprises will reduce their investment in pollution projects and

Table 9
Heterogeneity of internal enterprise environment.

	(1)	(2)	(3)	(4)
	EGS	EGS	EGS	EGS
Pollute × Time	0.351***	0.245	0.533***	0.416
	(0.103)	(0.155)	(0.143)	(0.423)
Export	0.045	0.304***	0.133*	0.094
	(0.0679)	(0.049)	(0.07)	(0.057)
Age	0.449**	1.532***	0.888***	0.965***
	(0.175)	(0.11)	(0.161)	(0.104)
Size	0.118	−0.018	0.034	0.029
	(0.124)	(0.095)	(0.155)	(0.092)
Roa	−0.003	−0.01	0.028	−0.017
	(0.027)	(0.023)	(0.034)	(0.017)
Tobinq	0.041	0.024	0.023	0.033
	(0.049)	(0.029)	(0.045)	(0.036)
Lev	−0.34	−0.091	−0.434	0.340
	(0.402)	(0.328)	(0.466)	(0.296)
Lend	0.795*	0.016	0.744	0.25
	(0.452)	(0.428)	(0.635)	(0.356)
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	3335	5390	4362	4363
R-squared	0.646	0.748	0.626	0.688

increase their RD investment in green projects. They are willing to invest more production factors in environmental governance to obtain bank loans. Given their relatively large scale and strong competitiveness, enterprises can also use their resource advantages and administrative convenience to strengthen resource integration and actively carry out green technology innovation to enhance the EGS.

4.4.4. Heterogeneity of enterprise equity incentive

We take the ratio between the number of senior executive shareholding and the total number of enterprise shares as the proxy indicator of senior executives' equity incentive. We divide the sample into a high equity incentive sample and a low equity incentive sample according to the median of equity incentive. The coefficients of *Pollute* × *Time* in Columns 3 and 4 of Table 9 show that the GCG plays a stronger effect on the EGS of high equity incentive enterprises. According to Porter's hypothesis, in response to the EGS, enterprises may have an impact on their market competitiveness given the increase of production costs in a short time. However, the GCG can encourage enterprises to accelerate green technology innovation, improve productivity, and eliminate highly polluting products in the long run. The environment-friendly products they produce can be favored by consumers, quickly seize the market, and bring innovation compensation effect, improving competitiveness and enterprise value of enterprises. The equity incentive will reduce the short-sighted behavior of senior executives. The interests of senior executives and enterprises are bound together. Thus, senior executives will speed up green technology innovation to increase their long-term earnings, take the initiative to eliminate the production of polluting products, and produce clean products, improving the content of green technology in the export of enterprises. Therefore, compared with enterprises with low equity incentives, GCG can effectively enhance the EGS of enterprises with high equity incentives.

5. Conclusions, and policy recommendations, and limitations

5.1. Conclusions

Taking the promulgation of GCG in 2012 as an exogenous impact, we construct a quasi-natural experiment to explore the effect of GCG on the EGS. The conclusions are as follows: The GCG improves the enterprises' EGS. R&D investment is the intermediary channel for GCG to affect the EGS. The role of GCG in promoting EGS is significantly reflected in enterprises that the government does not subsidize, enterprises in labor-intensive industries, enterprises in areas with a low degree of financial marketization development, state-owned enterprises, and enterprises with a high degree of equity incentive.

5.2. Policy recommendations

The above research conclusions have important policy implications for further improving the positive effects of GCG.

First, policymakers of GCG should pay attention to the development of R&D innovation incentive mechanism, provide more financing preferential policies for enterprises' cleaner production investment, and use clean technology R&D subsidies, loan discounts, and other means to encourage enterprises to transform and upgrade.

Second, the effect of GCG on non-state-owned enterprises is insignificant, indicating that GCG has not yet solved the problem of "credit discrimination." Financial institutions should strictly establish and improve the loan approval system to prevent the distortion of GCG due to government endorsement or bank enterprise relationships. On the one hand, local governments should pay attention to the simultaneous implementation of supporting policies. Moreover, the local government should provide greater financial support for enterprise technology upgrading through financial discounts, tax relief, investment subsidies, and other ways to promote the green transformation and production efficiency of enterprises. On the other hand, financial institutions should strengthen cooperation and communication with local governments, strictly supervise the environmental performance of enterprises, prevent government subsidies from flowing into backward production capacity enterprises, and reduce the problem of blind flow of monetary funds to low production capacity and high pollution enterprises caused by local championships.

Third, from the results of heterogeneity analysis, GCG plays an obvious role in enterprises in underdeveloped areas with financial marketization, which indicates that GCG has seen uneven regional development in the early stage of development. China's government should further expand the support of green finance for trade, promote the radiation scope of GCG, and achieve balanced regional development.

Fourth, financial regulators should further promote the environmental information disclosure of enterprises. The core function of GCG is to decide whether to approve loans by sharing information between banks and environmental protection departments and evaluating the environmental performance of enterprises. However, Chinese enterprises, especially non-listed companies, still lack environmental information disclosure. Thus, banks must implement differentiated loan interest rates according to different enterprises in environmental information disclosure.

Fifth, banks should continue to adhere to the concept of green development to guide credit operations, strictly control the credit threshold, and expand the scope and coverage of green financial services. Continuously optimize the working mechanism and process of green credit, improve the business level, and ensure the sustainability and stability of the implementation of GCG. Banks must also establish a green credit reward and punishment mechanism to make GCG more targeted. Increase financing support for enterprises in transformation and upgrading. In terms of incentive mechanisms, banks should strengthen the encouragement of technological innovation of enterprises.

5.3. Limitations

After the implementation of the GCG, banks in different regions may have differences in the time of implementing the GCG. Enterprises in different regions may be affected by GCG for different times, so it may be more accurate to use staggered DID to assess the impact of GCG. However, due to the lack of data on the implementation of GCG by different banks, we can only study the impact of GCG on EGS through DID. In the future, we will collect corresponding data at the bank level and study the impact of GCG on EGS through staggered DID.

Credit author statement

Chaobo Zhou: Conceptualization; Writing-Original draft preparation; Methodology; Writing - Review & Editing. Zhengxin Sun: Writing - Review & Editing. Shaozhou Qi: Funding acquisition; Supervision. Yuankun Li: Data curation; Formal analysis; Methodology; Writing Original draft preparation; Writing - Review & Editing. Heyu Gao: Writing - Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Acknowledgements

Thanks to the partial support of Ningbo philosophy and Social Sciences Key Research Base "regional open cooperation and free trade zone research base".

References

Amiti, M., Freund, C., 2008. The anatomy of China's export growth. Policy Research Working Paper Series 1, 4628.
Beck, T., 2002. Financial development and international trade: is there a link? J. Int. Econ. 57, 107–131.
Carolyn, F., 2017. Environmental protection for sale: strategic green industrial policy and climate finance. Environ. Resour. Econ. 66 (3), 553–575.
Chen, Z., Poncet, S., Xiong, R., 2020. Local financial development and constraints on domestic private-firm exports: evidence from city commercial banks in China. J. Comp. Econ. 48, 56–75.
Chen, Z.G., Zhang, Y.Q., Wang, H.S., 2022. Can green credit policy promote low-carbon technology innovation? J. Clean. Prod. 359, 132061.
Crino, R., Ogliari, L., 2017. Financial imperfections, product quality, and international trade. J. Int. Econ. 104, 63–84.
Dong, Q.M., Wen, S.Y., Liu, X.L., 2020. Credit allocation, pollution, and sustainable growth: theory and evidence from China. Emerg. Mark. Finance Trade 56, 2793–2811.
Du, W.J., Li, M., 2020. Influence of environmental regulation on promoting the low-carbon transformation of China's foreign trade: based on the dual margin of export enterprise. J. Clean. Prod. 244, 118687.
Ge, T., Li, J., Sha, R., 2020. Environmental regulations, financial constraints and export green-sophistication: evidence from China's enterprises. J. Clean. Prod. 251, 119671, 2020.
Guo, L., Tan, W., Xu, Y., 2022. Impact of green credit on green economy efficiency in China. Environ. Sci. Pollut. Control Ser. 29, 35124–35137.
He, L.Y., Zhang, L.H., Zhong, Z.Q., 2019. Green credit, renewable energy investment and green economy development: empirical analysis based on 150 listed companies of China. J. Clean. Prod. 208, 363–372.
Head, K., Ries, J., 2003. Heterogeneity and the FDI versus export decision of Japanese manufacturers. J. Jpn. Int. Econ. 17, 448–467.
Hering, L., Poncet, S., 2014. Environmental policy and exports: evidence from Chinese cities. J. Environ. Econ. Manag. 68, 296–318.
Li, C., Lu, J., 2018. R&D, financing constraints and export green-sophistication in China. China Econ. Rev. 47, 234–244.
Li, K., Tan, X.J., Yan, Y.X., 2022. Directing energy transition toward decarbonization: the China story. Energy 261, 124934.
Liu, J., Xie, J., 2020. Environmental regulation, technological innovation, and export competitiveness: an empirical study based on China's manufacturing industry. Int. J. Environ. Res. Publ. Health 4, 14–27.
Liu, X., Wang, E., Cai, D., 2019. Green credit policy, property rights and debt financing: quasi-natural experimental evidence from China. Finance Res. Lett. 29, 129–135.
Ma, X., Ma, W., Zhang, L., Shi, Y., Shang, Y., Chen, H., 2021. The impact of green credit policy on energy efficient utilization in China. Environ. Sci. Pollut. Control Ser. 28, 52514–52528.
Manova, K., Wei, S.J., Zhang, Z., 2015. Firm exports and multinational activity under credit constraints. Rev. Econ. Stat. 97, 574–588.
Mao, H.O., Liu, H.H., 2018. How does China's OFDI affect its export technology content embodied in exports? Journal of Quantitative & Technological Economics 7, 97–113.
Melitz, M.J., 2003. The impact of trade on intra-industry reallocations and aggregate industry productivity. Econometrica 71, 1695–1725.
Paravisini, D., Rappoport, V., Schnabl, P., 2015. Dissecting the effect of credit supply on trade: evidence from matched credit-export data. Rev. Econ. Stud. 82, 333–359.
Porter, M.E., 1991. America's green strategy. Sci. Am. 264 (4), 193–246.
Qi, S.Z., Cheng, S.H., 2022. The influence of China's pollution emissions trading system on the listed companies' export products' quality. Environ. Sci. Pollut. Control Ser. 29, 20145–20159.
Qi, S.Z., Zhou, C.B., Li, K., 2020. The impact of a carbon trading pilot policy on the low-carbon international competitiveness of industry in China: an empirical analysis based on a DDD mode. J. Clean. Prod. 281, 125361.
Shen, G.B., Huang, S.J., 2019. How does provincial IPP affect the export technology content of Chinese enterprises within the framework of the industrial production network? The Journal of World Economy 42 (9), 76–100.
Sheng, B., Mao, Q.L., 2017. Does import trade liberalization affect Chinese manufacturing export technological sophistication. The Journal of World Economy 40 (12), 52–75.
Song, M., Xie, Q., Shen, Z., 2021. Impact of green credit on high-efficiency utilization of energy in China considering environmental constraints. Energy Pol. 153, 112267.
Su, C.W., Li, W.H., Muhammad, U., 2022. Can green credit reduce the emissions of pollutants? Econ. Anal. Pol. 74, 205–219.
Taylor, M.S., 2005. Unbundling the pollution haven hypothesis. B E J. Econ. Anal. Pol. 3 (2), 1–28.
Wang, X.L., Fan, G., Hu, L.P., 2019. China's Marketization Index Report by Province (2018). Social Sciences Literature Press, Beijing.
Wang, H.T., Qi, S.Z., Zhou, C.B., 2022. Green credit policy, government behavior and green innovation quality of enterprises. J. Clean. Prod. 331, 129834.
Wen, H., Lee, C.C., Zhou, F., 2021. Green credit policy, credit allocation efficiency and upgrade of energy-intensive enterprises. Energy Econ. 94, 105099.
Xing, C., Zhang, Y.M., Wang, Y., 2020. Do banks value green management in China? The perspective of the green credit policy. Finance Res. Lett. 35, 101601.
Xu, B., Lu, J.Y., 2009. Foreign direct investment, processing trade and the sophistication of China's exports. China Econ. Rev. 30 (3), 425–439.
Yang, G., 2022. Can the green credit policy enhance firm export quality? Evidence from China based on the DID model. Frontiers inEnvironmental Science, 969726.
Yang, Y., Zhang, Y.L., 2022. The impact of the green credit policy on the short-term and long-term debt financing of heavily polluting enterprises: based on PSM-DID method. Int. J. Environ. Res. Publ. Health 18, 1–19.
Yao, S., Pan, Y., Sensoy, A., Uddin, G.S., Cheng, F., 2021. Green credit policy and firm performance: what we learn from China. Energy Econ. 101, 105415.
Zhang, H.J., Duan, M.S., 2020. China's pilot emissions trading schemes and competitiveness: an empirical analysis of the provincial industrial sub-sectors. J. Environ. Manag. 258, 109997.
Zhang, A.X., Deng, R.R., Wu, Y.F., 2022. Does the green credit policy reduce the carbon emission intensity of heavily polluting industries? -Evidence from China's industrial sectors. J. Environ. Manag. 331, 114815.
Zheng, Y., Zheng, J.H., 2020. How does trade cost infulence China's export technological content? Econ. Rev. 4, 111–127.
Zhou, C.B., Qi, S.Z., 2022. Has the pilot carbon trading policy improved China's green total factor energy efficiency? Energy Econ. 114, 106268.
Zhou, C.B., Li, Y.K., Zheng, S.X., 2022. Has the carbon trading pilot market improved enterprises' export green-sophistication in China? Sustainability 14, 10113.