

On the Impact of Green Credit Policy on the Transformation and Upgrading of Heavy Polluting Enterprises in China

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Abstract

It is of great significance for China to understand how to use financial policies to promote the achievement of the dual carbon goal. This project will be carried out under the background of double carbon. The goal is to explore the impact of China's green credit policy on the transformation and upgrading of heavily polluting enterprises. This study will use the data of China's listed heavily polluting enterprises from 2008 to 2015, and use the "Green Credit Guidelines" issued in 2012 as the target policy, and use the difference-in-differences (DID) method to evaluate the policy effect. Based on the research conclusions, effective policy recommendations are proposed to provide some reference for the revision of China's green credit policy in the future.

Keywords

GCP; Transformation; Upgrading; DID.

1. Introduction

With the rapid development of economy and urbanization, the ecological environment is also deteriorating rapidly. Environmental problems have gradually become an important factor affecting enterprise investment and resident consumption. To date, environmental pollution has posed great harm to human health due to the complexity of changing environmental challenges (X u et al., 2022; Omokanmi et al., 2022). With the development of the society, enterprises have become the main body of the market economy. The increased energy consumption of heavy polluting enterprises, especially the use of fossil fuels, has led to excessive emissions of greenhouse gases such as carbon dioxide and sulfur dioxide, having a significant impact on the whole world (Duan et al., 2022).

In the context of global warming, how to achieve the goal of "carbon neutrality" has become an urgent problem for all countries. As an important undertaking subject of green investment, green enterprises have an important impact on the current economic transformation and ecological civilization construction. Therefore, an important step in achieving carbon neutrality is to promote the transformation and upgrading of heavily polluting enterprises. Sampene et al.(2022) pointed out that environmental pollution can be alized through the development of green finance. In recent decades, many countries have implemented a series of green policies and laws and regulations on the basis of the Paris Agreement. Among them, green credit policy (GCP), as one of the important green financial policies, refers to the banking financial institutions to regulate the flow of credit funds on the basis of following the corresponding industrial policies to realize the "green allocation" of funds. It plays an important role in promoting green economic development and facilitating the transformation and upgrading of heavily polluting enterprises. In 2003,10 major banks in seven countries jointly announced the implementation of the Equator Principles, adopting the guidelines and guidelines of the World Bank and the International Finance Corporation. As a pioneer of green finance policy, it guides

financial institutions to have a positive impact on the environment and society when investing in large projects. Currently, at least 116 financial institutions from 37 countries have officially adopted GCP for debt financing activities.

Since China surpassed the United States as the world's first greenhouse gas emitter in 2006, it has been the world's largest carbon producer. In 2012, China's carbon emissions reached 9.21 billion tons, accounting for about 30% of global carbon emissions (Zhang and Da, 2015). The complex air pollution problem has caused a considerable adverse impact on China's environment, human health and economy (Yin et al., 2022). Studies have shown that GCP can reduce the industrial carbon emission intensity of heavy polluting enterprises through two ways: resource allocation effect and green innovation effect (Zhang et al., 2022; Shen et al., 2020), which is significant to achieving the "carbon neutral" goal (Francesco et al., 2021). After the implementation of GCP, due to the rising financing costs, the severely polluting enterprises gradually withdrew from the market (Zhang et al., 2019). In order to achieve the "two-carbon goal", China has been committed to green and sustainable development in recent years, and has closely linked environmental protection with green financial policies. On February 24, 2012, the former China Banking Regulatory Commission issued the Green Credit Guidelines (GCG2012). This is China's first standard document for green credit, aiming to promote the green transformation of heavily polluting companies through credit guidance. In the third quarter of 2017, the People's Bank of China announced that it would include green financing in the implementation of credit policies through the macroprudential Assessment (MPA) system. By linking the system to structured monetary policy tools, the People's Bank of China will only provide supplementary liquidity to commercial banks that have successfully achieved their green finance goals (Kong et al., 2022). By 2020, China's 21 major banks have reported outstanding green credit of 11.6 trillion yuan, saving more than 320 million tons of standard coal and reducing more than 730 million tons of carbon dioxide equivalent every year. China's contribution to global environmental protection is obvious to all.

In China, companies with high pollution, high energy consumption and overcapacity (two high production capacity and one high production surplus) account for a large proportion. According to statistics, in 2012, air pollutants in these enterprises accounted for more than 80% of industrial emissions. Therefore, it is particularly important to study how to promote the transformation and upgrading of heavy polluting enterprises. For these heavily polluting companies, bank credit is their most extensive external financing approach, especially in developing countries with underdeveloped capital markets (Chiu and Lee, 2020). GCP achieves the policy objectives by guiding commercial banks to issue loans to green enterprises and reviewing the loan requests of dyeing enterprises. At present, China's commercial banks basically implement the "one-vote veto system" for environmental protection: the enterprises that do not meet the requirements of environmental protection will resolutely refuse their loan requirements, immediately withdraw the projects that have been involved, and tilt the bank credit resources to the green industry. This will prompt heavily polluting companies to make changes to obtain green loans from commercial banks.

China's green finance started late, and the current GCP issued is not perfect. When faced with the credit financing constraints brought about by GCP, the heavy polluting enterprises mainly show the stress response of reducing capital investment, and the strategic response in adjusting the efficiency of capital allocation is insufficient (Ding, 2019). Enterprise innovation can enhance its market share and value, and promote enterprises to seize the development opportunities in a dynamic environment. Innovation, as the core driving force of enterprise upgrading, plays the most direct and powerful role in promoting the development of enterprises. The original intention of GCP is to promote the green innovation and transformation and upgrading of heavily polluting enterprises, rather than just to limit the bank credit of heavily polluting enterprises. However, due to the short practice time of GCP in China,

there are some obstacles to its implementation. The lack of technical policies such as performance evaluation standards and industrial environmental performance evaluation guidelines are the most fundamental obstacle to the implementation of green credit, while the lack of supervision and supervision mechanism of the government is the most important obstacle factor (Zuo et al., 2017). Therefore, it is of great significance to study the influence mechanism of GCP on the transformation and upgrading of heavily polluting enterprises, which will be conducive to dredging the blockage of the current transmission mechanism of green credit policy and further improve the effectiveness of the policy.

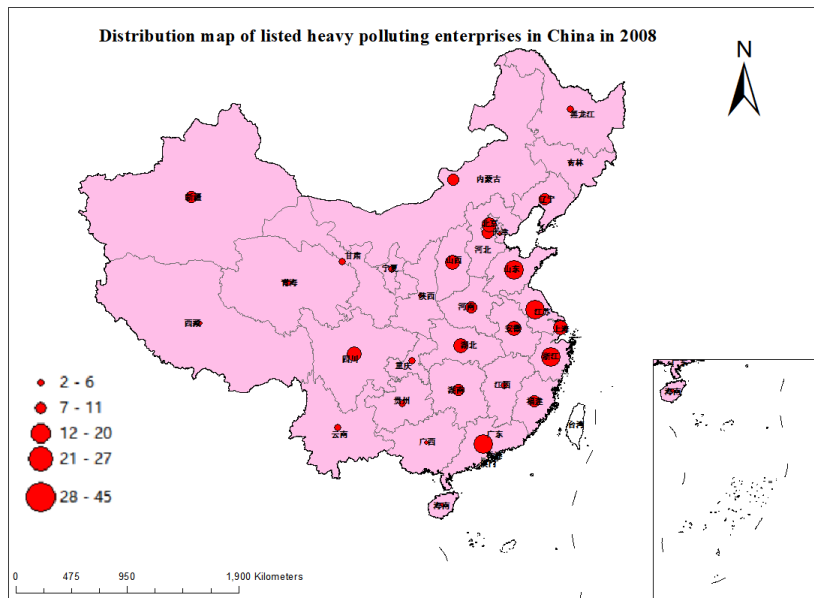


Figure 1. Distribution map of listed heavy polluting enterprises in China in 2008

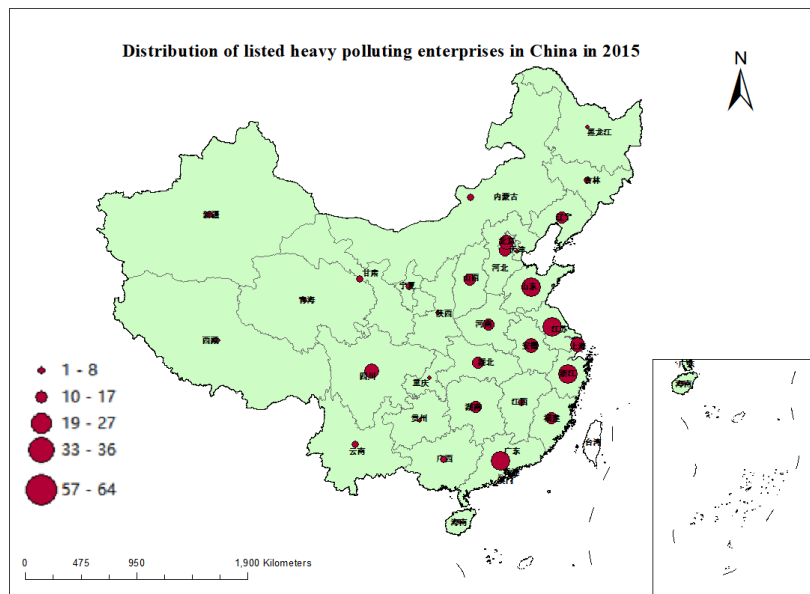


Figure 2. Distribution map of listed heavy polluting enterprises in China in 2015

2. Literature Review and Hypotheses

2.1. Transformation and Upgrading of GCP and Heavy Polluting Enterprises

At present, most studies believe that GCP has effectively promoted the transformation and upgrading of heavily polluting enterprises through direct or indirect effects (Du et al., 2019;

Zhang et al., 2019; Jiang et al., 2020; Xiao et al., 2022). Investment is an important point for enterprises to become bigger and stronger. GCP will affect the investment decisions of enterprises. Enterprises need to take into account the risks, returns and investment period of the project when investing. Abundant cash flow and the high growth concept of blindly becoming bigger and stronger will stimulate corporate management to engage in more overinvestment behavior. GCP has a significant inhibitory effect on the overinvestment of heavily polluting enterprises (Ning et al., 2021). The type and degree of diversification of heavy polluting enterprises were verified by logistic regression and Poisson regression. Heavy polluting enterprises tend to diversify into non-heavy polluting industries through business diversification, which is not for speculative purposes, but for a deep strategic investment. Wang and Li. (2022) pointed out that the investment efficiency of all companies has been significantly improved after the implementation of GCP. Guiding heavy polluting enterprises to make green investment is an important way for their transformation and upgrading, and the improvement of investment efficiency is an important channel to accelerate the transformation of enterprises. Moreover, GCP helps to reduce the total financing of target industries while reducing the investment in energy-intensive industries (Liu et al., 2015). This also makes it have a certain ability to adjust the industrial structure. Innovation activities are the source of improving the efficiency of their existing processes. Tan and Lin (2018) analyzed the factors that affected the decline of energy intensity in China's energy-intensive industries, and found that technological improvement was the most significant factor. The peer effect of heterogeneous enterprises is revealed by studying the interaction of different enterprises in a specific peer group. The green innovation of enterprises can significantly improve the innovation willingness and innovation motivation of other groups in the same industry.

A large number of studies have shown that the GCP will also significantly reduce the energy consumption and pollutant emissions of heavily polluting enterprises (Zhang et al., 2021; Peng et al., 2021; Nabeeh et al., 2021). Su et al.(2022) analyzed the different stages after the implementation of GCP and found that GCP has different environmental effects in its early and maturation stages. In the short term, financial institutions lack the incentive because of the low proportion of green credit. However, in the long run, with the improvement of the green credit system, GCP has a significant role in reducing the emission of pollutants and energy consumption intensity.

To sum up, we can find that GCP will promote the transformation and upgrading of heavy polluting enterprises to a certain extent, and the green transformation of enterprises can reduce the energy consumption intensity and pollutant emission intensity so as to better protect the environment. Based on these conclusions, the first hypothesis:

Hypothesis: GCP promotes the transformation and upgrading of heavily polluting enterprises.

2.2. Research on the Mechanism of GCP on the Transformation and Upgrading of Heavy Polluting Enterprises

At present, many studies believe that GCP has obvious punitive effect and investment inhibition effect on heavily polluting enterprises (Su and Lian., 2018; PhD and PhD., 2022). There are many factors affecting the upgrading and transformation of heavily polluting enterprises. In addition to technology, talent and other factors, the financing environment is an important driving factor. Convenient external financing can effectively promote R & D investment, so as to promote energy conservation, emission reduction, transformation and upgrading of enterprises. And the enterprise research and development activities (R & D) have the characteristics of long term, large investment and high risk. The Company uses the credit line as part of its liquidity management tool to support its R & D investments (Guney et al., 2017).When the enterprise finance is limited, the risk will increase with the increase of R&D intensity. Chiu et al.(2022) Research has found that financing constraints will significantly

improve the sensitivity of enterprises' investment cash flow. Therefore, if heavy polluting enterprises want to innovate, on the one hand, they need to have sufficient internal cash reserves to cope with the high investment in research and development activities; on the other hand, they need to have smooth external financing channels. Since the promulgation of the green credit guidance policy, heavily polluting enterprises have generated high environmental supervision costs, and faced greater public pressure and environmental litigation risks. After labeling heavily polluting companies, they face more financial constraints than green ones (Mannasoo and Merikull, 2020). Heavy polluting enterprises are restricted in both equity financing and debt financing, and their financing capacity has been significantly reduced, which is mainly reflected in the reduction of bank borrowing and the shortening of debt term (Liu et al., 2019). The change of debt maturity structure is manifested by the decline of long-term debt ratio. In addition, GCP will reduce the performance of heavily polluting enterprises by increasing the corporate financing constraints and reducing the investment level (Yao et al., 2021). As corporate performance affects the company's stock price, GCP increases the risk of stock price crash of heavily polluting companies by imposing financial constraints and reducing the quality of information disclosure (Shao et al., 2022). By increasing the cost of capital, narrowing the external constraints of financing channels and increasing the level of corporate environmental social responsibility (Si and Cao et al., 2022). Guo et al.(2020) Heterogeneity analysis further reveals that the negative impact of green policy on market value depends on the characteristics of the company, such as size, ownership structure, profitability, and industry. Some scholars believe that GCP can promote the green innovation and research and development level of heavy polluting enterprises (James et al., 2012; Viviana, 2022; Zhang et al., 2022). Green innovation to improve the research and development level is an important way to transform and upgrade heavy polluting enterprises. Studies have pointed out that companies with high quality of environmental information disclosure will not get more loans, and that only green innovation can promote the access to corporate loans (Xing et al., 2021; Wen et al., 2021). By studying the data of heavily polluting enterprises from 2011 to 2020, it was found that the green credit policy promoted the green innovation of enterprises through the intermediary role of government subsidies and bank loans. By flying the relationship between R&D investment and enterprise transformation performance, it is found that, the energy transformation performance is increased by 0.741 units. The threshold model was used to investigate the relationship between green credit and the company's R&D level. The research results show that there is a positive but non-linear relationship between green credit and the company's R&D level. Due to the imperfect nature of Chinese capital market, the asymmetry of information and agency cost leads to the external financing cost being higher than the internal financing cost. If heavy polluting enterprises do not carry out green innovation to obtain more green credit, they will face high financing costs and exit the market risk.

However, some scholars have put forward different views, believing that the current GCP does not show the Porter effect and has an inhibitory effect on the green innovation of heavy polluting enterprises. Green innovation of enterprises requires a lot of time costs and capital costs. Whether the output brought by innovation can exceed the R&D investment is a question worth thinking about. The long-term return of green projects depends on long-term financial support (Wang et al., 2019). The GCP restricts bank credit for heavily polluting companies, especially in long-term credit. This constraint effect reduces corporate upgrading investment, and companies with no access to bank credit tend to have lower productivity (Cao and Leung, 2020; Lu et al.2021). Through the study of green patent data of Chinese listed companies, it is found that GCP will have a negative impact on the green innovation behavior of listed companies, and the impact is mainly concentrated in enterprises applying for green invention patents, non-state-owned and enterprises with low financial development in their regions. Although GCP is considered a win-win strategy for the central government and banks, its level

of implementation efficiency is far from expectations (Zhang et al., 2011). To this, Ding et al.(2020) proposed that the current net effect of GCP presents a U-shaped trend. In the short term, GCP will have a negative impact, but in the long term, GCP will have a significant positive effect on the economy.

Based on the above analysis, we can find that GCP will increase the financing constraints of heavy polluting enterprises and force them to carry out green transformation. It is still debated whether GCP will promote green innovation in heavily polluting enterprises, but the long-term promotion effect is significantly positive.

2.3. Asymmetry of the Utility of Green Credit Policies

Due to the differences in property rights, regions and other factors of different enterprises, the asymmetry of utility is generated when the policies are conveyed to the enterprise level (Fan and Li, 2022). Enterprises can be divided into state-owned enterprises and non-state-owned enterprises according to the different nature of property rights. Under the same conditions, due to the better credit and solvency of state-owned enterprises, they get more bank credit than non-state-owned enterprises. Industries such as metallurgy, chemical industry and other concentrated a large number of state-owned enterprises, they concentrate a large number of credit resources. However, non-state-owned enterprises are less dependent on bank credit. Bank credit also accounts for a lower proportion of its balance sheet.

In China, due to the different economic development degrees of different regions, the degree of financial marketization is different. The development degree of the eastern region is higher than that of the central and western regions, and the bank credit varies between different regions. The more developed the region, the more developed the financial market, the more bank credit resources. On the other hand, the distribution of natural resources in China is uneven. Coal and other natural resources are mainly concentrated in the western region, while the coastal cities in the eastern region have a high urbanization level, which makes the heavy polluting enterprises more inclined to the central and western regions with small population, leading to the differences in policy effects between different regions.

Literature review and marginal contribution: To sum up, the existing literature has conducted a lot of research on the impact mechanism, green innovation, bank credit and other aspects, which provides a multi-dimensional analysis perspective for this paper. However, there are still some places worthy of further research. On the one hand, most of the literature mainly focuses on the impact on the cash flow of enterprises at the micro level of enterprises, while there is little research on the evaluation of the transformation and upgrading performance of heavily polluting enterprises. On the other hand, the existing studies mainly focus on qualitative analysis, and there are few quantitative studies on policy effects. The marginal contribution of this paper mainly has three aspects. First, this study explores the impact of GCP on the transformation and upgrading of heavily polluting enterprises theoretically and realistically, and provides empirical support for the adoption of green financial policies to promote the green transformation of enterprises.

3. Data and Variables

3.1. Data

In this study, the data of 342 listed companies from 2008 to 2015 were selected. The data were mainly obtained from China Economic and Financial Research Database (CSMAR) and China Innovation Patent Research Database (CIRD). The experimental group was 102 heavy pollution enterprises, and the control group was 240 non-heavy pollution enterprises. Heavy pollution list of identified mainly according to the China Securities Regulatory Commission in 2012 revision of the industry classification guidelines of listed companies, the environmental

protection department in 2008 the environmental verification industry classification management list of listed companies and the environmental information disclosure guidelines of listed companies published the specific list, through the CSMR database, CIRD database matching after the sample data. In order to avoid the experimental results, the experimental data were processed by winsorize.

3.2. Variables

The transformation and upgrading of an enterprise is defined as improving the production efficiency of an enterprise by introducing or improving existing processes (Yoruk, 2019). In this study, the total factor productivity of enterprises was taken as the proxy variable to measure the transformation and upgrading of heavily polluting enterprises, which is defined as the natural logarithm of total factor productivity. The calculation method of total factor productivity refers to the OP method proposed by O lley and Pakes (1996).

In order to test the influence mechanism of GCP on heavily polluting enterprises, in this paper, two intermediary variables are introduced as proxy variables of financing constraint effect and green innovation effect, namely bank credit and patent quality respectively. Bank credit is defined as the ratio of the sum of long-term loans and short-term loans to total assets, and the calculation of patent quality refers to Zhang and Zheng (2018).

The specific measurement method of patent knowledge width is as follows:

$$\text{Patent_q}_{nt,type} = 1 - \sum \alpha^2$$

Where, α represents the proportion of the major categories in the patent classification number. It can be seen that the larger Patent_q, the greater the difference between the patent classification numbers of each large group, that is, the wider the knowledge used by the enterprise to create patents, the higher the patent quality may be. It should be noted that this paper only estimates the quality of enterprise invention patents and utility model patents, but not the quality of appearance design patents. This is because the patent classification number system of the appearance design is completely different from the invention patent and the utility model patent, so the accurate knowledge width of the appearance patent cannot be calculated.

The variable selection situation in this paper is as follows:

Table 1. Variable names and meanings

Variable type	variable name	Variable meaning
Explained variable	TFP	Natural logarithm of total factor productivity
Metavariable	Bank Credit	(Long-term loans + short-term loans) / total assets
	Patent_q	Patent knowledge width
Controlled variable	lnAge	The natural logarithm of the number of years of enterprise existence
	lnSize	Natural logarithm of the number of employees
	Fixed asset	Enterprise fixed assets
	ROA	ROE
	Growth	increase rate of business revenue
	CapIntensity	Net value of enterprise fixed assets / number of employees

4. Experimental Design

4.1. Model Construction

In order to study the impact of GCP on the transformation and upgrading of heavy polluting enterprises, we use the micro-level DID model, which can solve the endogenous problem well. The model is as follows:

$$TFP = \alpha + \alpha_1 \text{Treat}_i \times \text{Time}_t + \alpha_2 \text{Control}_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where, TFP represents the proxy variable of transformation and upgrading. $\text{Treat}_i \times \text{Time}_t$ represents the effect of the policy after its implementation. Treat_i is the individual grouping variable. In the sample, the heavy polluting enterprises are 1, non-heavy polluting enterprises are 0. Time_t is the time dummy variable. It was 0 before 2012, and 1 after 2012. α_1 is the coefficient of our main study, it is used to measure the effectiveness of the policy. When the coefficient is greater than 0, the GCP promotes the transformation and upgrading of heavily polluting enterprises; When the coefficient is less than 0, it means that GCP suppresses the transformation and upgrading of heavy polluting enterprises. Control_{it} represent the control variable. μ_i, λ_t represent individual fixed effect and time fixed effect. ε_{it} is an error term.

4.2. Parallel Trend Test

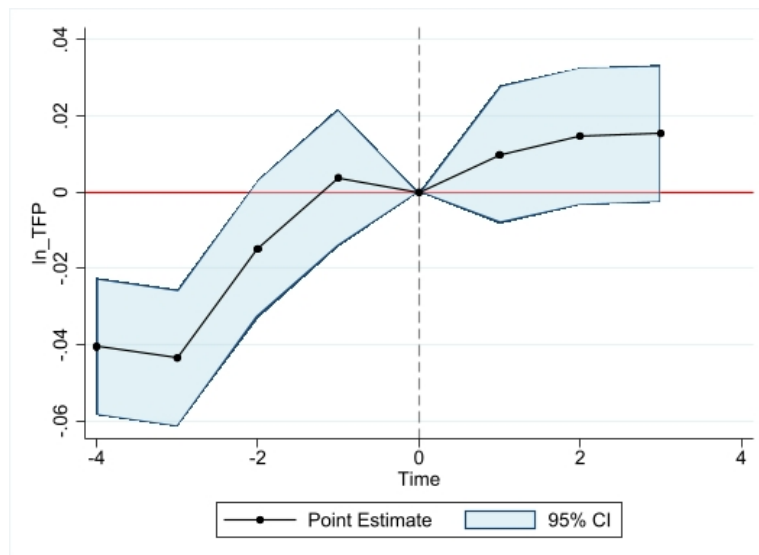


Figure 3. Parallel Trend Test

In order to verify the consistent change of the transformation and upgrading level of heavy polluting enterprises before the implementation of the green credit policy, this paper uses the event research method to conduct the parallel trend test. As shown in the figure above, in the first two years of the policy, the regression coefficient value was around 0, and the confidence interval also included 0, and the regression coefficient was not significant, meeting the parallel trend assumption.

5. Results and Discussion

The regression analysis results are shown in Table 2.

As shown in the above table, the green credit policy has a significant positive effect on the transformation and upgrading of heavily polluting enterprises. Based on the research results of domestic and foreign scholars, the concept of green credit policy, green transformation and heavy pollution enterprises is defined, and the relevant theories such as Porter hypothesis, information asymmetry and sustainable development are introduced into the theoretical research framework for comprehensive analysis and the research assumptions are put forward.

Putting the theory into practice, this paper selects the data of 342 listed companies from 2008 to 2015, and discusses the impact of green credit policy on the green transformation of heavily polluting enterprises through the double difference method. The following conclusion is obtained: the implementation of GCP can effectively promote the green transformation of heavy polluting enterprises. Under the background of "double carbon", as an important part of the market is also one of the heavy pollution sources, consumers are paying more attention to heavy polluting enterprises year by year. GCP requires banks and other financial institutions to base themselves on green credit, optimize the credit evaluation system, guide the flow of funds to green industries, effectively control environmental and social risks, and promote the development of green economy. In order to survive and develop, heavy polluting enterprises should constantly improve their ability to save energy and reduce emissions, improve their development strategies, fulfill their environmental responsibilities, and promote the green transformation of enterprises.

Table 2. Regression Analysis Results

	(1)	(2)
Variables	TFP	TFP
treat_time	0.0344*** (0.00315)	0.0366*** (0.00309)
ln_size		0.0115*** (0.00220)
ROA		0.271*** (0.0240)
CapIntensity		1.62e-08*** (1.07e-09)
Fixed_asset		0 (0)
Growth		0.00105*** (0.000289)
Constant	1.907*** (0.000990)	1.788*** (0.0188)
Observations	2,736	2,733
R-squared	0.047	0.180
Number of id	342	342

Note: Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Based on this conclusion, this study makes the following recommendations: First, strengthen the implementation of the green credit policy. It can be seen from the above conclusion that although the green credit policy has a positive impact on the green transformation of enterprises, the policy effect shows a downward trend three years after the implementation, indicating that the policy effect is likely to gradually weaken with the increase of time. To increase the sustainability of the green credit policy, it needs the joint efforts of the government, banks and enterprises. The government should ensure the implementation of project review and supervision, and improve the green credit feedback mechanism; banks should actively innovate green financial products, increase product diversification, and meet the financing needs of enterprises and individuals in the field of environmental protection; enterprise managers should seriously consider the needs of various stakeholders, actively adjust their business models, take the initiative to assume social responsibilities, and strengthen the awareness of environmental protection.

Second, optimize the credit process and improve the differentiated credit evaluation system. Green credit policy aims to promote efficient, low-carbon and high-quality development of enterprises, rather than implementing a one-size-fits-all approach to eliminate heavily polluting enterprises. Banks, therefore, should optimize the approval process, improve the differentiation credit evaluation system, the high pollution, low capacity, high energy-intensive projects continue to improve credit requirements, reduce its financing scale even refused to give financing support, and for highly polluting enterprises clean environmental protection projects, should give certain incentives, power green transformation and upgrading for the enterprise. Secondly, enterprise managers should strengthen cooperation with social organizations, jointly build an information exchange platform, and promote information. Third, build a multi-dimensional green financial system, increase the support for capital investment, and dynamically adjust the incentive and restraint mechanism of enterprises. In the context of national economic transformation and upgrading, the high-quality development of enterprises is conducive to promoting the process of the whole society. Therefore, the government should further guide enterprises to improve their awareness of environmental protection and increase their financial support for non-state-owned enterprises. Secondly, although the green credit policy helps to accelerate the process of industrial survival, its policy effect has a certain asymmetry. In order to improve the effect of policy implementation and eliminate its limitations, policy makers should consider individual enterprise differences in the process of implementing green credit policies, so as to encourage enterprises to transform and upgrade. Finally, the government should formulate and introduce supporting policies in line with green credit policies and encourage non-state-owned enterprises to actively carry out green transformation. For regions with a low level of green development, the central finance should strengthen the implementation of green policies, such as tax incentives to encourage enterprises to actively participate in energy conservation and emission reduction incentives, while implement a green fiscal incentive system for cities with a good level of green development. This provides an endogenous engine for promoting the optimization and upgrading of China's industrial structure.

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