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Do the Green Credit Guidelines Affect Renewable Energy Investment? Empirical Research from China

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Abstract: How to promote renewable energy investment is central to energy transformation and green development. To take China's "green credit guidelines" policy as a quasi-natural experiment, we investigate the impacts of green credit policy on renewable energy investment. Using the samples of 1021 Chinese listed enterprises during 2007–2017, we find that: Firstly, the introduction of the green credit guidelines has promoted renewable energy investment. Secondly, short-term debts play a mediating role in the impacts of green credit guidelines on renewable energy investment, while long-term debts play a masking role, and financing constraints do not play a significant role. Thirdly, the heterogeneous impacts on renewable energy investment are reflected in different ownerships and enterprise scales, with significant impacts on the state-owned enterprises and small ones.

Keywords: green credit guidelines; renewable energy investment; difference-in-difference model; heterogeneity; the mediation effect

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1. Introduction

Energy is an important material guarantee for economic and social development. However, limited non-renewable energy restricts the sustainability of economic and social development. Meanwhile, the use of traditional fossil energy has led to problems such as global warming and serious environmental pollution. It has become the consensus that renewable energy development can optimize energy structure, reduce emissions, and thus improve the environment [1]. Therefore, there is an urgent demand for global renewable energy development. The transformation and upgrading of the energy industry cannot be separated from the support of renewable energy investment. The United Nations Environment Programme pointed out in the report "the unified of financial system and sustainable development" that before 2030 the world needs to invest USD 1 trillion a year in the green transformation of energy and other industries. According to the green development concept, renewable energy investment can promote energy transformation and realize sustainable economic development. However, renewable energy investment remains a challenge, especially for developing countries [2].

We want to explore the effects of green credit policy on renewable energy investment. The reasons are two-fold; firstly, as an emerging industry, renewable energy is faced with greater financing constraints due to the environmental uncertainty caused by the market demand fluctuation, as well as the characteristics of high cost and high risk. Therefore, compared with other types of investment, renewable energy investment needs more support from national policies. Secondly, research shows that the financial development brought about by positive credit policy has played an important role in green economic growth [3,4]. Green credit is the product of financial innovation, and its application in commercial banks is becoming increasingly advanced internationally [5]. Green credit policy encourages the flow of capital into environment-friendly industries, improves the quality of credit services by optimizing credit resources allocation, provides strong financial support to green enterprise projects, and promotes green development [6]. Thus, green credit policy will have important impacts on renewable energy investment.

Another important issue our paper focuses on is: through what mechanisms do the green credit guidelines affect renewable energy investment? With the characteristics of high cost and high risk, renewable energy enterprises may be constrained by both internal and external financing constraints, resulting in the inhibition of renewable energy investment. Specifically, on the one hand, as an emerging industry, the development of renewable energy requires investment in and upgrading of technology, equipment purchases and maintenance, professional training and other aspects, which means that it has the characteristics of high investment costs. On the other hand, renewable energy development, which pertains to the high-tech field, is often faced with higher uncertainty and is vulnerable to R&D failure, thus leading to higher risks in renewable energy investment. Against this background, the green credit guidelines point out that banking financial institutions should not grant credit to customers whose environmental and social performance is not in line with the regulations, should increase support for the green economy and circular economy, and their credit resources should be inclined towards energy conservation and environmental protection projects and green industries. Therefore, we think that the implementation of this policy broadens the financing channels for renewable energy enterprises. Meanwhile, green credit policy gives preferential loan interest rate to green enterprises, which reduces their financing costs. Renewable energy enterprises can access more loans from financial institutions, thus promoting renewable energy investment. In particular, previous studies have also shown that the investment of Chinese enterprises relies on bank loans to a great extent [7], and for China's renewable energy developers, this dependence is more serious [8]. Therefore, we think that the green credit guidelines may affect renewable energy investment via bank loans and the financing constraints of renewable energy enterprises.

The rest of our paper is structured as follows: The second part is the literature review. The third part regards the methodology, variable selection and data sources. The fourth part is the empirical analysis, which includes an econometric test of the impact of the green credit guidelines on renewable energy investment and its impact mechanism. The fifth part further discusses the heterogeneous impacts of green credit guidelines with different ownership structures and scales. The sixth part is the basic conclusion.

2. Literature Review

Our research is mainly related to two branches of literature, one of which is about the effect of green credit policy implementation. Existing research mainly concentrates on two entities to investigate the effect of green credit policy. On the one hand, they pay attention to the effects on commercial banks. It is a farsighted investment behavior for commercial banks to implement green credit [9]. By establishing a green credit business, a bank can reallocate its loan resources effectively, help the sustainable development of enterprises, and improve its operational performance. Weber [10] believes that the implementation of China's green credit policy can improve banks' sustainable development and stabilize the financial sector. Cui et al. [11] found that China's green credit policy reduced the non-performing loan ratio of commercial banks, and improved the environmental performance and financial performance of banks. In addition, there are also studies stating that commercial banks need to examine the evaluation of enterprise environmental indicators and build an environmental risk management mechanism before granting loans, so as to increase the operating costs of commercial banks. According to the research of Scholtens and Dam [12], when commercial banks develop green credit business, their profits would be reduced and their operating costs increased, but the benefits of signing up may outweigh the increased costs. On the other hand, they also paid attention to the effects on listed enterprises. The study of Li et al. [13] proved that environmental regulation would bring about environmental costs at first, but at a certain level, corporate environmental responsibility would also enhance corporate value. As a kind of environmental regulation, green credit policy would make it more convenient for enterprises to finance green innovation investment, relieve the pressure brought about by the high investment and high risk of technological innovation, and thus promote corporate green innovation. The research of Xin et al. [14] and Nanda and Nicholas [15] confirmed this effect of long-term debts on innovation. In addition, green credit policy can also effectively curb the most heavily polluting enterprises, despite their favorable roles in benefiting green enterprises. Liu et al. [16] also studied China's green credit guidelines policy and concluded that this policy has inhibited the financing of heavily polluting enterprises, as well as increasing their financing costs. Therefore, it will also hinder the investment of heavily polluting enterprises [17].

The other is related to the research of renewable energy investment. With regard to the effects of renewable energy investment, scholars have reached a consensus that the use of renewable energy reduces carbon emissions [18] and mitigates climate change and environmental degradation [19]. That said, how to promote renewable energy investment has always been debatable. These influencing factors can be divided into two categories: financial barriers and non-financial ones (such as regulatory factors). The first category is about the non-financial factors, which mainly consist of regulatory ones. For example, Johnstone et al. [20] examined the regulatory effects of environmental policies on renewable energy R&D investment. Kim Schumacher [21,22] argued that Environmental Impact Assessment laws constituted a considerable barrier to renewable energy investment. The second category consists of financial factors. These scholars argue that corporate investment decisions are largely influenced by financial barriers, such as constraint policies and incentive policies. They believe corporate investment behavior is mainly affected by financing constraints [23]. Chen and Chen [24] and Zhang et al. [25] also concluded that excessive cash flow will bring about overinvestment, while insufficient cash flow will bring about underinvestment. Qin et al. [26] argued that foreign capital inflow can promote renewable investment in developing countries. Some scholars have argued that corporate investment decisions are mainly affected by incentive policies. The renewable energy industry is a capital intensive industry, and policy incentives have great effects on renewable energy [27,28]; for example, loose monetary policy can promote corporate investment by providing more bank loans [29]. In particular, the impacts on technology-intensive enterprises are even greater [30]. However, policy uncertainty will reduce the returns and increase the investment risks [31–33], thus inhibiting corporate investment behavior [34,35]. Liu and Zeng [36] found that policy risk plays a different role in renewable energy investment, with great effects on investment at the early development stage, and with gradually decreased effects at the mature development stage.

So far, although some scholars have begun to focus on investments from the incentive and constraint policies, little attention is paid to the impacts of green credit policy on renewable energy enterprises. To this end, we take China's green credit policy as a quasi-experiment and investigate its effect on renewable energy investment. Different from previous studies, the marginal contribution of our paper is as follows: firstly, the introduction of green credit guidelines promotes renewable energy investment. By constructing a difference-in-difference (hereafter called DID) model, we conclude that the introduction of this policy has a promotional impact on renewable energy investment. Secondly, we mean to examine the mechanism of impact on renewable energy investment. After verifying its positive impact on renewable energy investment, we further explore the transmission channels via which this policy affects energy investment. It is found that bank loans play a mediating role in the impacts of green credit guidelines. Specifically, the implementation of this policy promotes renewable energy investment by increasing short-term debts. Thirdly, we examine the heterogeneous impacts of the green credit guidelines, and further find that there are heterogeneous impacts among enterprises with different ownership structures and scales.

3. Methodology, Variable Selection and Data Sources

3.1. Methodology

3.1.1. Difference-in-Difference Method

To investigate whether green credit policy has impacts on renewable energy investment, we need to compare whether renewable energy investment changes before and after the introduction of this policy. There are many methods that can be used to carry out the policy evaluation, of which the traditional one is to add a dummy variable to the regression model, and then make a regression analysis. However, this method is vulnerable to endogenous problems caused by mutual causation. Due to the exogenous policy, the DID model does well in alleviating endogenous problems to a certain extent. Additionally, in recent years, this model has become the common method for policy evaluation. Therefore, we regard the green credit guidelines issued by the China Banking Regulatory Commission (CBRC) on 24 February 2012 as a quasi-natural experiment. Then, we set up the experimental group (renewable energy enterprises) and the control group (non-renewable energy enterprises), and construct a DID model to evaluate their impacts on renewable energy investment. The model is constructed as follows:

$$INV_{it} = \beta_0 + \beta_1 \text{Post}_i + \beta_2 Treat_t + \beta_3 Treat_t \times Post_i + \beta_4 Controls_{it} + firmdum + yeardum + \varepsilon_{it} \quad (1)$$

In Equation (1), the subscripts i and t indicate enterprise and year, respectively; *INV* is the explained variable, which indicates the renewable energy investment, *Post* is the event dummy variable, whose value is 1 when the year is 2012, and otherwise is 0. *Treat* is the treatment dummy variable, whose value is 1 when the enterprises are affected by this policy, otherwise it is 0. *Controls* are a series of corporate characteristic variables, including enterprise size, Tobin q, ROA, cash holdings and leverage. We are mainly concerned with the coefficient of the interaction term *Post* × *Treat*, which measures the impact degree of the policy. So as to eliminate the problems caused by missing individual characteristic variables and time-invariant variables, we also add variables *firmdum* and *yeardum* to our model.

3.1.2. Mediating Effect Method

We mainly discuss the mediating effect of this policy on renewable energy investment via the two mechanisms of bank loans and financing constraints. The mediating effect model is constructed as follows:

$$M_{it} = \phi_0 + \phi_1 \text{Post}_i + \phi_2 Treat_t + \phi_3 Treat_t \times Post_i + \phi_4 Controls_{it} + firmdum + yeardum + \varepsilon_{it} \quad (2)$$

$$INV_{it} = \vartheta_0 + \vartheta_1 M_{\text{it}} + \vartheta_2 \text{Post}_i + \vartheta_3 Treat_t + \vartheta_4 Treat_t \times Post_i + \vartheta_5 Controls_{it} + firmdum + yeardum + \varepsilon_{it} \quad (3)$$

Equations (1)–(3) are the three steps of the mediating effect model. Among them, M is the intermediary variable, which comprises short-term loan SL, long-term loan LL and financial constraints FC. Other variables are consistent with Equation (1). According to the principle of the mediating effect model, after testing Equation (1), we continue to test Equations (2) and (3). If all the coefficients $\varnothing_3$, ϑ_1 and ϑ_4 are significant, and both the coefficients β_3 and $\varnothing_3 \times \vartheta_1$ are positive or negative, there is a mediating effect. If neither ϑ_1 nor ϑ_4 are significant, there is no mediating effect. If neither ϑ_1 nor ϑ_4 are significant, the stepwise regression is not invalid, and further Sobel tests are needed. If one of β_3 and $\varnothing_3 \times \vartheta_1$ is positive, and the other is negative, there is a masking effect.

3.2. Variable Selection and Data Sources

The explained variable of our paper is renewable energy investment. So far, there has been no unified standard for the definition of renewable energy investment. According to China's low carbon development report in 2015, renewable energy investment refers to the social capital flowing into the renewable energy field, which includes the investment in new projects and the expansion of original projects, rather than the investment in the R&D department and manufacturing industry. At the micro level, one view is from the perspective of investors, which argues that renewable energy investment refers to the investment from renewable energy enterprises, and another is from the perspective of investment funds, which argues that renewable energy investment refers to the capital that flows into the renewable energy field. Many scholars define renewable energy investment from the perspective of investors [37,38]. Combining the data availability, our paper also defines renewable energy investment from the investors' perspective via the capital invested from renewable energy enterprises into fixed assets activities in the process of social production. Therefore, in our paper, renewable energy investment is measured by the cash paid for the fixed assets, intangible assets and other long-term assets purchased by renewable energy enterprises, which is then standardized by the total assets of enterprises.

As for green credit policy, as noted above, the CBRC issued the green credit guidelines, which clearly define the framework of China's green credit policy system. This green financial policy is the most comprehensive and representative. Based on this, we establish a quasi-natural experiment, and set the event dummy variable as 1 when the date is in and after 2012; otherwise, it is 0.

The intermediary variables of our paper are bank loans and financial constraints. Among these, bank loans are categorized into two indicators: short-term debts and long-term ones, which are divided by total assets to achieve standardization. Many methods have been put forward to measure financial constraints, among which the representative ones are KZ index, WW index and SA index. The former two indexes are vulnerable to endogenous problems because of the inclusion of financial variables such as cash flow and leverage [39], so we give priority to the SA index as the measurement indicator of financial constraints.

$$FC_{it} = -0.737 \times SIZE + 0.043 \times SIZE^2 - 0.04 \times Age \quad (4)$$

In Equation (4), FC_{it} indicates the financial constraints, whose value is negative. A larger absolute value in FC_{it} means that the enterprises are faced with more serious financial constraints. *SIZE* indicates the firm size. *Age* indicates the listed years.

To examine the impacts of green credit guidelines, we need to add other control variables to exclude the effects of other factors. According to the existing literature, the control variables included are as follows: (1) firm size (*SIZE*) is indicated by the natural logarithm of total assets; (2) Tobin Q is indicated by the ratio of the market value to the total assets; (3) profitability (ROA) is indicated by the ratio of net profit to total assets; (4) cash holdings (CASH) are indicated by the ratio of monetary capital to total assets; (5) leverage (LEV) is measured by the ratio of the liabilities to the total assets; (6) firm age (AGE) is measured by the listed years in China's A-share market. Table 1 shows the specific measurements for each variable.

Table 1. Variable definition.

Variable	Notation	Measurement Indicators
Renewable energy investment	INV	The cash paid for the fixed assets, intangible assets and other long-term assets/total assets
Short-term debts	SD	Short-term debts/total assets
Long-term debts	LD	Long-term debts/total assets
Financial constraints	FC	SA index
Firm size	SIZE	Ln (total assets)
Tobin Q	Tobin Q	Market value/total assets
Profitability	ROA	ROA
Cash holdings	CASH	Monetary capital/total assets
Leverage	LEV	Liability/total assets
Firm age	Age	The listed years

Our samples are mainly China's A-share listed enterprises from 2007 to 2017. In order to ensure the data's continuity, we exclude the enterprises are listed in the A-share market after 2010. We also exclude the enterprises in the financial industry, ST (special treatment) and PT (particular transfer) enterprises, and the enterprises with much missing data. The reason for excluding financial enterprises, as well as ST and PT enterprises, is their comparability. As for financial enterprises, our data are mainly derived from financial statements, which is based on accounting standards, and the general accounting standards for business enterprises are rather different from the financial accounting standards for financial enterprises. As for ST and PT enterprises, these are faced with great losses, which makes them fairly different from other enterprises in investment. After this data preprocessing approach, we obtain a sample containing 1021 enterprises and 9538 annual observations. Specifically, in our model, the experimental group includes 97 renewable energy enterprises. As existing industry classification standards have not clearly indicated renewable energy enterprises, our paper identifies renewable energy enterprises through two steps. First, we select two closely related industries, such as the power, heat, water production and supply industry, and the ecological protection and environmental governance industry, according to the industry classification. Then, we screen out 97 renewable energy enterprises, including solar energy enterprises, hydropower enterprises, wind energy enterprises, geothermal energy enterprises, biomass energy enterprises, tidal energy enterprises and other renewable energy enterprises. The control group includes 924 non-renewable energy enterprises. All the sample data are selected from the China Stock Market and Accounting Research (CSMAR) database. Finally, all the variables are winsorized up and down by 1% to prevent the influence of outliers. The final descriptive results of the variables are shown in Table 2.

Table 2. The descriptive results of variables.

Variable	N	Mean	Std. Dev.	Min	Max
INV	9538	0.0496	0.0534	−0.0584	0.2567
SIZE	9538	9.5285	0.5876	8.2361	11.3020
Tobin Q	9538	2.9659	2.1279	0.9322	11.3571
CASH	9538	0.1962	1.5001	0.0091	0.7394
LEV	9538	0.4777	0.2276	0.0505	1.2796
ROA	9538	0.0343	0.0579	−0.2450	0.1953
Age	9538	10.3995	6.2537	0	27
SD	9538	0.1097	0.1130	0	0.5084
LD	9538	0.0566	0.0969	0	0.4644
FC	9538	−3.5191	0.2428	−4.0199	−3.0434
INV_{soe}	7032	0.0525	0.0542	−0.0446	0.2587
$INV_{non\text{-}soe}$	2506	0.0405	0.0509	−0.1007	0.2481
INV_{SME}	4769	0.0473	0.0566	−0.1025	0.2610
INV_{Large}	4769	0.0511	0.0512	−0.0142	0.2532

Note: INV_{soe} and $INV_{non\text{-}soe}$ indicate the investment of state-owned enterprises and non-state-owned ones, respectively. INV_{SME} and INV_{Large} indicate the investments of large-scale enterprises and small-scale ones, respectively.

Table 2 reports that China's overall renewable energy investment is not high, with an average value of 0.0496 (minimum −0.0584 and maximum 0.2567). In addition, we find that renewable energy investment may also be heterogeneous in different ownership structures and scales. Specifically, among renewable energy enterprises, state-owned enterprises invest more than non-state-owned enterprises on average, with a value of 0.0525 more than the non-state-owned enterprise value of 0.0405. The renewable energy investment of large-scale enterprises is larger than small-scale enterprises, with a value of 0.0511 more than the corresponding value of 0.0473. As such, we can conclude that, compared with small-scale enterprises, large-scale enterprises undertake larger investments on average.

4. Empirical Analysis

4.1. Unit Root Test and Correlation Coefficient Test

In order to avoid serious consequences, such as pseudo-regression and multicollinearity, a unit root test and correlation coefficient test must be carried out for each variable before regression analysis. Considering that the data of the sample are unbalanced, we adopt the Augmented Dickey–Fuller (ADF)–Fisher and the Phillips–Perron (PP)–Fisher methods to perform a unit root test for each variable, and the test results are shown in Table 3. To avoid multicollinearity, we conduct a correlation coefficient test. The results are shown in Table 4.

Table 3. Panel unit root test.

	Fisher–ADF Chi-Square	*p*	PP–Fisher Chi-Square	*p*
INV	5917.8894	0.0000	7409.0861	0.0000
SIZE	3870.1586	0.0000	4586.7856	0.0000
Tobin Q	3361.4245	0.0000	4037.4922	0.0000
CASH	4177.8611	0.0000	6917.0742	0.0000
LEV	3895.4238	0.0000	4488.5632	0.0000
ROA	5384.8142	0.0000	5865.4446	0.0000
Age	4193.0374	0.0000	4673.6678	0.0000
SD	4143.1468	0.0000	4617.6577	0.0000
LD	4207.3699	0.0000	4264.5740	0.0000
FC	3087.6350	0.0000	3398.1974	0.0000

Table 4. Pearson correlation coefficient matrix.

	INV	SIZE	Tobin Q	CASH	LEV	ROA	Age
INV	1						
SIZE	0.062 ***	1					
Tobin Q	0.028 ***	−0.261 ***	1				
CASH	−0.0658 ***	−0.226 ***	0.207 ***	1			
LEV	−0.096 ***	0.310 ***	−0.319 ***	−0.308 ***	1		
ROA	0.123 ***	0.039 ***	0.071 ***	0.259 ***	−0.256 ***	1	
Age	−0.225 ***	0.241 ***	−0.2913 ***	−0.301 ***	−0.315 ***	−0.171 ***	1

Note: *** denote that the coefficient has passed the significance test of 1%.

According to the results in Table 3, there is no unit root for each variable, indicating that each variable is stable and can be used for regression analysis. It can be seen from Table 4 that INV is significantly correlated with SIZE, Tobin Q, CASH, LEV, ROA and Age, and there are also certain correlations between the main explanatory variables, but the degree of correlation is not high. As such, we believe that there is no serious multicollinearity among the explanatory variables.

4.2. The Impacts of Green Credit Guidelines on Renewable Energy Investment

To meet the parallel trend requirement is one important prerequisite for DID estimation [40]. In other words, before being processed, the control group and the treatment group must share a common trend. We assume the differences between these two groups will be kept after processing. As such, the extent to which the gap widens or narrows after being processed can be considered as the treat effect. Therefore, to examine the validity of the DID model, we compared the average investment scale between these two groups, and the results are displayed in Figure 1.

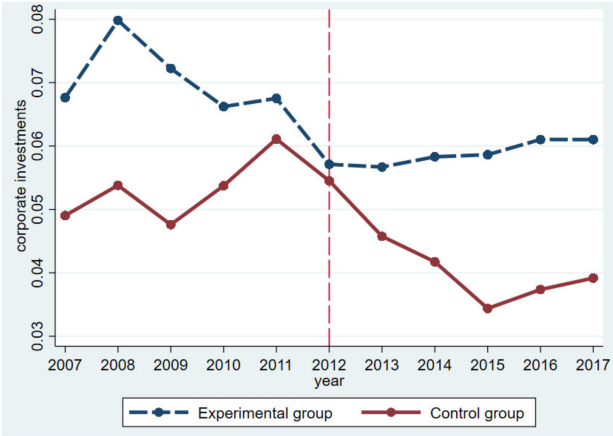

Figure 1. The comparison of the average investment scale between two groups.

As is shown in Figure 1, before the introduction of the policy in 2012, the investment level of these two groups maintained the same growth trend. Therefore, it can be preliminarily judged that our DID model adheres to the parallel trend hypothesis. We also find that after the introduction of this policy, the investments of enterprises in the experimental group increased slowly, while these investments in the control group decreased quickly. This reveals that the introduction of the policy can promote the investments of enterprises in the experimental group, but reduce investments in the control group. Besides this, we also use the event study method to test the parallel trend hypothesis. Specifically, based on the research of Bertrand and Mullainathan [41], the year before the green credit guidelines will be taken as a reference year and removed. Then, the interaction terms of year-dummy variable and group-dummy variable are generated to test the dynamic effect. The results of the parallel trend hypothesis tests are shown in Figure 2.

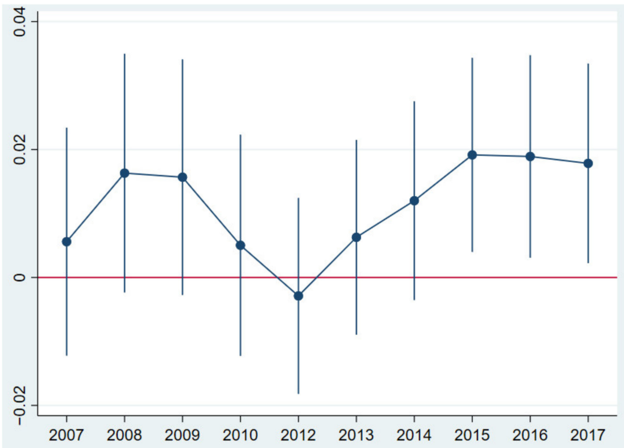

Figure 2. The test results of parallel trend hypothesis.

The results in Figure 2 show that before the implementation of the policy, the coefficients of the interaction terms are insignificant, but after the implementation of the policy, these coefficients are significantly positive. This again reveals that before the policy's implementation, there existed no obvious differences in the investment between these two groups. Therefore, we can infer that the parallel trend hypothesis is satisfied, and thus the differences between these two groups after the introduction can be considered the policy effect.

After confirming the parallel trend hypothesis, we are able to test the impact of the green credit policy, the results of which are displayed in Table 5.

Table 5. The impacts of green credit guidelines on renewable energy investment.

	(1)	(2)	(3)
Post × Treat	0.0083 ***	0.0081 ***	0.0095 ***
	(0.0030)	(0.0030)	(0.0029)
Post	−0.0189 ***	−0.0192 ***	−0.0792 ***
	(0.0026)	(0.0026)	(0.0088)
Treat	0.0699 ***	0.0677 ***	0.0503 ***
	(0.0208)	(0.0199)	(0.0161)
Tobin Q		−0.0009*	0.0020 ***
		(0.0005)	(0.0006)
CASH		−0.0447 ***	−0.0444 ***
		(0.0050)	(0.0049)
LEV		−0.0297 ***	−0.0372 ***
		(0.0046)	(0.0045)
ROA		0.0623 ***	0.0496 ***
		(0.0120)	(0.0117)
SIZE			0.0311 ***
			(0.0029)
Age			0.0039 ***
			(0.0008)
Year Dummies		Suppressed	
Firm Dummies		Suppressed	
N	9538	9538	9538
R^2	0.481	0.471	0.460

Note: Standard errors are shown in parentheses; * and *** denote that the coefficient has passed the significance test of 10% and 1%, respectively. We also suppress the year dummies and firm dummies in the model. Model (1) is the benchmark regression model. Model (2) controls the impact of enterprise financial factors on the basis of model (1), and mainly adds four control variables: Tobin Q, cash holding, leverage and ROA. Model (3) further adds to two control variables: enterprise scale and listed years.

As is reported in Table 5, the introduction of green credit guidelines can promote renewable energy investment. Specifically, in model (1)–(3), all the coefficients of *Post* × *Treat* are significantly positive, with values 0.0083, 0.0081 and 0.0095, respectively, which reveals that this policy has promoted renewable energy investment. The main reason is that the introduction of green credit guidelines requires that financial institutions strictly assess the environmental risks of loan projects, which increases the financial sector's preference for green loan projects. It will also guide social funds to flow to promote sustainable development through the loan market. As a result, after the implementation of the policy, heavily polluting enterprises will face more severe financial constraints, while green enterprises will receive more credit preferences. The reasonable allocation of credit resources plays an incentive role in renewable energy investment, resulting in the continuous improvement of the net cash flow and investment ability of renewable energy enterprises. As such, the implementation of the green credit guidelines is conducive to renewable energy investment.

4.3. The Impact Mechanism of Green Credit Guidelines on Renewable Energy Investment

According to the theoretical analysis, we can conduct an empirical analysis via the mediating effect model. In Table 6, we report the results of the impact mechanism between the green credit guidelines and renewable energy investment.

From the results in Table 6, it can be concluded that short-term debts plays a mediating role in the impacts of green credit guidelines on renewable energy investment; long-term borrowing plays a masking role, while financing constraints do not play a significant role. In model (1), the coefficient of *Post* × *Treat* is significantly negative, with a value −0.0110. In model (2), the coefficient of short-term debts (SD) is significantly negative, with a value −0.0160. This indicates that the mediating effect is 0.00018 (0.0110 × 0.0160), and that short-term debts play a partial intermediary role. In model (3), the coefficient of *Post* × *Treat* is also significantly negative, with a value −0.0099. However, in model (4), the coefficient of long-term debts (LD) is significantly positive, with a value 0.1410. This indicates that the masking effect is −0.0014 (−0.0099 × 0.1410) and that long-term debts play a masking role instead of an intermediary role. In model (5), the coefficient of *Post* × *Treat* is significantly positive, with the value 0.0051; the coefficient of financial constraint (FC) is insignificant. Furthermore, the results have not passed the Sobel test, with a *p* value 0.1190, indicating that there is no mediating effect. We can thus conclude that green credit guidelines cannot affect renewable energy investment via financial constraints.

Table 6. The mechanism of impact on renewable energy investment.

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	SD	**INV**	**LD**	**INV**	**FC**	**INV**
Post × Treat	−0.0110 **	0.0093 ***	−0.0099 **	0.0109 ***	0.0051 ***	0.0097 ***
	(0.0045)	(0.0029)	(0.0051)	(0.0029)	(0.0011)	(0.0029)
Post	−0.0492 ***	−0.0800 ***	−0.0703 ***	−0.0693 ***	−0.0153 ***	−0.0796 ***
	(0.0102)	(0.0088)	(0.0113)	(0.0088)	(0.0052)	(0.0087)
Treat	−0.0445 ***	0.0496 ***	0.2760 ***	0.0113	0.1290 ***	0.0539 ***
	(0.0157)	(0.0162)	(0.0133)	(0.0169)	(0.0201)	(0.0165)
SL		−0.0160 **				
		(0.0074)				
LL				0.1410 ***		
				(0.0117)		
FC						−0.0281
						(0.0258)
Control Variables	Suppressed					
Year dummies	Suppressed					
Firm dummies	Suppressed					
N	9538	9538	9538	9538	9538	9538
R^2	0.7260	0.4810	0.7550	0.4970	0.9960	0.4810

Note: Standard errors are shown in the parentheses; ** and *** denote that the coefficient has passed the significance test of 5% and 1%, respectively. Due to reducing the table length, we do not report the results of control variables. The added control variables are the same as those in the Table 5. We also suppress the year dummies and firm dummies in the model. In models (1) and (2), we investigate the impact mechanism through short debts. In models (3) and (4), we investigate the impact mechanism through long debts. In models (5) and (6), we investigate the impact mechanism through financial constraints.

The development and utilization of renewable energy belongs to the field of high technology. However, as far as China is concerned, its renewable energy development is still at an earlier stage, which means that the core technologies are not mature yet. Therefore, in addition to market risks, renewable energy investment is also vulnerable to high technical risks and policy risks. The main reason for the above empirical results is that, unlike other green enterprises, most renewable energy enterprises are faced with high uncertainty. Compared with long-term debt, short-term debt is more suitable for banks to assess the business dynamics of renewable energy enterprises. Therefore, for commercial banks, to reduce the credit risk, they will take measures to shorten the loan term, and will prefer short-term debts over long-term ones. After the implementation of the green credit policy, commercial banks mainly augment the supply of short-term debts for renewable energy enterprises, so as to promote renewable energy investment. Finally, this shows that the implementation of the green credit guidelines plays a greater incentive role in the short-term debts of renewable energy enterprises, rather than in the long-term ones. In general, green credit guidelines affect the renewable energy investments by affecting bank loans. Among these, it is the short-term debts, rather than the long-term ones, that play a mediating role in the impacts, while long-term debts play a masking role.

5. Further Discussions

5.1. Theoretical Analysis

The above analysis has confirmed the positive impact of green credit guidelines on renewable energy investment as a whole, but has ignored the heterogeneous relationships among different types of enterprises. Actually, due to different ownership structures and enterprise scales, enterprises exhibit heterogeneous investment decision-making when faced with certain policies.

Firstly, for enterprises with different ownership natures, renewable energy investments often exhibit heterogeneous characteristics under the impacts of green credit guidelines. Many scholars have confirmed that state-owned enterprises often exhibit different responses to policy changes, and state-owned enterprises are more responsive than non-state-owned enterprises when a policy is issued [42]. Therefore, green credit guidelines have a greater effect on state-owned enterprises. At the same time, the existence of adverse selection and moral hazards has made the information asymmetry in the credit market more serious. Non-state-owned enterprises are susceptible to this information asymmetry and thus loan discrimination in the credit market, while state-owned enterprises have priority in obtaining loans because of the implicit guarantee from the central and local governments. Therefore, state-owned and non-state-owned enterprises will exhibit different investments due to different financial constraints. Against this background, we put forward the hypothesis that green credit guidelines should have heterogonous impacts on renewable energy investment between state-owned enterprises and non-state-owned ones.

Secondly, enterprise scale is another important factor affecting the relationship between green credit guidelines and renewable energy investment. In general, enterprises of large scales own more assets, and thus more abundant funds for investment, than ones on a smaller scale, and the renewable energy industry is an industry that demands larger investments and sufficient funds. Therefore, the larger the enterprise scale, the more the renewable energy investment. However, enterprises of different scales may exhibit heterogonous sensitivities to policy changes [43]. Compared with large-scale enterprises, small-scale enterprises not only face serious external financing constraints, but also face internal financing difficulties. The introduction of green credit guidelines can facilitate the financing of small enterprises, ease their financing constraints, and greatly improve their investment scale. Based on this, we put forward another hypothesis, that green credit guidelines should have heterogonous impacts on renewable energy investment between large-scale enterprises and small-scale ones.

5.2. Empirical Analysis

5.2.1. The Heterogeneous Influence Degrees

According to the theoretical analysis, we can divide the samples into two categories according to the ownership structure and enterprise scale. Specifically, the samples are classified into state-owned enterprises and non-state-owned ones based on their classification in the CSMAR database; the samples are classified into small-scale enterprises and large-scale ones based on enterprise scale, among which the small 50% are considered small enterprises, while the larger 50% are considered large ones. Then, the regression analyses are carried out for each subsamples, and these are displayed in Table 7.

As reported in Table 7, the impacts of green credit guidelines on renewable energy investment are heterogeneous among enterprises with different ownership structures and enterprise scales. Specifically, as for the ownership structure, the coefficient of $Post \times Treat$ is significantly positive, with a value of 0.0069 in the subsamples of state-owned enterprises, while the coefficient of treat is insignificant in the subsample of non-state-owned enterprises. This shows that the effect of green credit guidance on renewable energy investment is higher in state-owned enterprises. The main reasons are twofold. On the one hand, the implicit guarantee from the government alleviates the information asymmetry in the credit market, making it easier for state-owned enterprises to obtain financing, which constitutes a good foundation for renewable energy investment. On the other hand, during their operation, state-owned enterprises usually exhibit more sensitivity to the policies issued by the government, so when the green credit guidelines are introduced, state-owned enterprises can often respond to policy changes faster. To this end, compared to non-state-owned enterprises, the green credit guidelines have significantly boosted renewable energy investment from state-owned enterprises.

Table 7. Heterogeneous impacts on renewable energy investment.

	(1)	(2)	(3)	(4)
	State-Owned Firms	**Not-State-Owned Firms**	**Large Firms**	**Small Firms**
Post × Treat	0.0069 **	0.0048	−0.0015	0.0179 **
	(0.0041)	(0.0044)	(0.0039)	(0.0073)
Post	−0.0424 ***	−0.0446 ***	−0.0370 ***	−0.0811 ***
	(0.0059)	(0.0147)	(0.0080)	(0.0116)
Treat	0.0639 ***	−0.0886 ***	0.0217	0.0924 ***
	(0.0165)	(0.0166)	(0.0178)	(0.0151)
Control Variables		Suppressed		
Year dummies		Suppressed		
Firm dummies		Suppressed		
N	9538	7032	2506	4769
R^2	0.481	0.489	0.462	0.599

Note: Standard errors are shown in the parentheses; ** and *** denote that the coefficient has passed the significance test of 5% and 1%, respectively. Due to reducing the table length, we do not report the results of control variables. The added control variables are the same as those in Table 5. We also suppress the year dummies and firm dummies in the model. In models (1) and (2), we investigate the impacts on state-owned enterprises and non-state-owned ones, respectively. In models (3) and (4), we investigate the impacts on large enterprises and small ones, respectively.

In the subsamples of large-scale enterprises, the coefficient of interaction term is insignificant. In the subsamples of small enterprises, the coefficient of interaction term is significantly positive. This shows that green credit guidance has a greater effect on small enterprises. The main reasons are also twofold. On the one hand, large enterprises usually have more sufficient capital and human resources, which constitutes a good foundation for energy investment. However, small and medium-sized enterprises are more vulnerable to inner fund shortages and external financial constraints, which makes their investment more susceptible to loan policy. On the other hand, compared with large enterprises, small and medium-sized enterprises are more sensitive to the introduction of green credit guidelines, so consequently green credit guidance has a more significant incentive effect on small and medium-sized enterprises. As such, the green credit guidelines have significantly boosted renewable energy investment in small and medium-sized enterprises compared with large enterprises.

5.2.2. The Heterogeneous Influence Mechanisms

Furthermore, we also analyze the heterogeneous impact mechanisms. Since the impacts on renewable energy investment are mainly reflected in state-owned enterprises and small ones, we focus the mechanism analysis on these two samples in our following analysis. And these are displayed in the Tables 8 and 9.

Table 8. The mechanism of impact on state-owned enterprises.

	(1)	(2)	(3)	(4)	(5)	(6)
	SD	**INV**	**LD**	**INV**	**FC**	**INV**
Post × Treat	−0.0157 ***	0.00662	−0.0238 ***	0.0106 ***	0.0047 ***	0.00694 *
	(0.00582)	(0.00405)	(0.00627)	(0.00400)	(0.00130)	(0.0041)
Post	−0.0879 ***	−0.0445 ***	−0.0447 ***	−0.0357 ***	−0.00479	−0.0424 ***
	(0.00949)	(0.00591)	(0.00881)	(0.00591)	(0.00511)	(0.00585)
Treat	−0.0379 **	0.0630 ***	0.308 ***	0.0175	0.141 ***	0.0624 ***
	(0.0175)	(0.0167)	(0.0138)	(0.0178)	(0.0157)	(0.0179)
SL		−0.0239 **				
		(0.00945)				
LL				0.1510 ***		
				(0.0145)		
FC						0.0103
						(0.0287)
Control Variables	Suppressed					
Year dummies	Suppressed					
Firm dummies	Suppressed					
N	7032	7032	7032	7032	7032	7032
R^2	0.741	0.490	0.786	0.504	0.997	0.489

Note: Standard errors are shown in the parentheses; *, ** and *** denote that the coefficient has passed the significance test of 10%, 5%, and 1%, respectively. Due to reducing the table length, we do not report the results of control variables. The added control variables are the same as those in Table 3. We also suppress the year dummies and firm dummies in the model. In models (1) and (2), we investigate the impact mechanism through short debts. In models (3) and (4), we investigate the impact mechanism through long debts. In models (5) and (6), we investigate the impact mechanism through financial constraints.

As is shown in Table 8, short-term debts play a mediating role in the impacts of green credit guidelines, with long-term debts play a masking role, while financial constraints do not play a significant role. Specifically, in model (1), the coefficient of variable *Post × Treat* is significantly negative, with the value −0.0157. In model (2), the coefficient of the variable SD (short-term debts) is significantly negative, with the value −0.0239. Then, the mediating effect is 0.00038 (0.0157 × 0.0239). This shows that short-term debts play a partial mediating role. In model (3), the coefficient of the interaction term is significantly negative, with the value −0.036. In model (4), both the coefficients of the variables *Post × Treat* and LD (long-term debts) are significant at the 1% level. The indirect effect is −0.0036 (−0.0238 × 0.1510). This shows that long-term loans play a masking role in the impacts of green credit guidelines. In model (5), the coefficient of the interaction term is 0.0047, and is significant at the 1% level. In model (6), the coefficient of the variable FC (financial constraint) is insignificant and also does not pass the Sobel test, which indicates that financial constraints do not play a significant mediating role in the impacts of green credit guidelines on renewable energy investment.

As is shown in Table 9, for small enterprises, short-term debts play a mediating role in the impacts of green credit guidelines; long-term debts play a masking role, while financing constraints do not play a significant role. In model (1), the interaction term is −0.0033, and is significant at the 5% level. In model (2), the coefficient of short-term debts (SD) is −0.0144, and this is significant at the 5% level. As such, the mediating effect is 0.0005 (0.0033 × 0144), indicating that short-term debts play an intermediary role in the impacts of green credit guidelines. In model (3), the coefficient of the interaction term is −0.0234. In model (4), the coefficient of long-term debts (LD) is 0.1330. As such, the masking effect is −0.0031 (−0.0234 × 1330), indicating that long-term debts plays a masking role in the relationship between green credit guidelines and renewable energy investment, and the masking effect accounts for 17.32% of the total effect. In model (5), the coefficient of the interaction term is −0.0015, and in model (6), the coefficient of financial constraints (FC) is 0.0294, both of which fail to pass the significance test. This shows that financial constraints play no mediating role in the impacts of green credit guidelines on renewable energy investment.

Table 9. The mechanism of impact on small enterprises.

	(1)	(2)	(3)	(4)	(5)	(6)
	SD	**INV**	**LD**	**INV**	**FC**	**INV**
Post × Treat	−0.0033 **	0.0179 **	−0.0234 ***	0.0210 ***	−0.00146	0.0180 **
	(0.0115)	(0.0073)	(0.0090)	(0.0072)	(0.0024)	(0.0073)
Post	−0.1390 ***	−0.0831 ***	−0.0421 ***	−0.0755 ***	0.0118	−0.0815 ***
	(0.0179)	(0.0117)	(0.0129)	(0.0120)	(0.0078)	(0.0117)
Treat	0.1000 ***	0.0938 ***	0.144 ***	0.0732 ***	−0.0044	0.0925 ***
	(0.0167)	(0.0151)	(0.0181)	(0.0145)	(0.0027)	(0.0151)
SL		−0.0144 **				
		(0.0111)				
LL				0.1330 ***		
				(0.0251)		
FC						0.0294
						(0.0730)
Control Variables	Suppressed					
Year dummies	Suppressed					
Firm dummies	Suppressed					
N	4769	4769	4769	4769	4769	4769
R^2	0.7670	0.5170	0.6680	0.5240	0.9990	0.5160

Note: Standard errors are shown in the parentheses; ** and *** denote that the coefficient has passed the significance test of 5% and 1%, respectively. Due to reducing the table length, we do not report the results of control variables. The added control variables are the same as those in Table 3. We also suppress the year dummies and firm dummies in the model. In models (1) and (2), we investigate the impact mechanism through short debts. In models (3) and (4), we investigate the impact mechanism through long debts. In models (5) and (6), we investigate the impact mechanism through financial constraints.

The results of the subsample analysis in Tables 8 and 9 are consistent with the whole-sample analysis. For state-owned enterprises and small enterprises, the implementation of the green credit guidelines mainly promotes renewable energy investment by increasing short-term debts, rather than long-term ones. The reason for this may be that, considering the high uncertainty in renewable energy investment, commercial banks are more willing to offer short-term debts to renewable energy enterprises, rather than long-term debts, in order to reduce the loan risk.

6. Conclusions and Policy Recommendations

Our paper uses China's 1021 listed enterprises, and constructs a DID model to examine the impact of green credit guidelines on renewable energy investment. The main conclusions are as follows.

First of all, the implementation of green credit guidelines can promote renewable energy investment. So far, the impact of this policy on renewable energy investment has not been investigated. Our paper conducts an empirical study using the samples of Chinese enterprises, and confirms the positive effects of this policy on renewable energy investment. The characteristics of high cost and high risk in the renewable energy industry mean renewable energy investment faces serious financing constraints. Green credit guidelines can cause the funds to gradually flow towards green industries, alleviating the financial constraints in the development and utilization of renewable energy and realizing the goal of sustainable development. Secondly, short-term debts play a partially mediating role in the impacts of green credit guidelines on renewable energy investment; long-term debts have a masking effect, while financial constraints have no significant effect. Green credit guidelines affect renewable energy investment by influencing bank loans. In terms of China's current situation, the development of renewable energy is still at its preliminary stage, and the core technologies in the industry are not mature yet. Renewable energy investments are faced with high technical risk, policy risk and market risk. In view of the high uncertainty faced by renewable energy enterprises, commercial banks prefer to provide short-term loans rather than long-term loans, so they can form timely responses according to the situation of the enterprise, in order to reduce the risk that loans are not reimbursed. To this end, after the implementation of this policy, commercial banks mainly increase the supply of short-term debts for renewable energy enterprises, so as to promote renewable energy investment. Therefore, on the whole, the implementation of green credit policy affects renewable energy investment via enterprises' short-term debts rather than long-term ones.

Finally, the impacts on renewable energy investment are heterogeneous under different ownership structures and enterprise scales. Enterprises with different ownership structures are often faced with different financing constraints, so they often exhibit different sensitivities to credit policies. State-owned enterprises are implicitly secured by the government, and often have closer ties with banks and other financial institutions. This will alleviate the financial constraints due to the information asymmetry in the credit market, and make it easier for state-owned enterprises to obtain financing. These advantageous conditions constitute a good foundation for the energy investment from state-owned enterprises. Therefore, for enterprises with different ownership structures, this policy can promote the renewable energy investment of state-owned enterprises, rather than non-state-owned enterprises. Enterprise scale is another important factor affecting enterprise investment behavior. Large enterprises usually have more sufficient funds to support their investment. Meanwhile, their social status makes it easier for them to gain the trust of commercial banks. Therefore, large enterprises are often faced with lower financing constraints. However, information asymmetry in the capital market leads to high external financing constraints, making small and medium-sized enterprises more dependent on the support of credit policies. As such, it is difficult for small and medium-sized enterprises to maintain renewable energy investment due to internal fund shortages and external financial constraints. As such, the effects of green credit guidelines on enterprises of different scales are heterogeneous, with significant effects on the renewable energy investment of small and medium-sized enterprises, rather than large enterprises. The results of the impact mechanism show that, for the state-owned enterprises and small and medium-sized enterprises, short-term debts play a mediating role in the impacts of green credit guidelines on renewable energy investment, while long-term debts play a masking role, and financial constraints have no significant effect. It can be seen that for state-owned enterprises and small and medium-sized enterprises, the effects of the green credit guidelines on renewable energy investment are mainly manifested through short-term loans, rather than long-term loans.

According to the empirical results, we put forward the following policy suggestions: Firstly, considering the positive effects of the green credit guidelines, the government should continue to introduce and improve green credit policy. Specifically, the government should monitor the policy implementation and introduce relevant incentive policies. Secondly, according to the results of the mechanism analysis, the government should broaden financing channels for renewable energy investment. China's renewable energy enterprises are still faced with serious financial constraints, caused by insufficient bank loans as the main financing channel, so the government should effectively increase the financial support for renewable energy enterprises. Thirdly, according to the results of the heterogeneity analysis, the government should put forward targeted and differentiated policies according to the enterprise types. Specifically, for non-state-owned enterprises and small ones, the government should improve the subsidy policy, increase financial support, and ease financial constraints. As for state-owned enterprises and large ones, the government should continue to strengthen the guidance and supervision for renewable energy development.

Our paper enriches the previous research results, but there are still some problems to be further investigated. First, because China's industry classification standard does not specifically classify renewable energy enterprises, our paper selects renewable energy enterprises according to their main business, so our paper may not include all renewable energy enterprises. Therefore, future research can be further improved with a more thorough industry division and enterprise selection. Second, the impact mechanisms still need to be investigated further. Our paper only studies the impact mechanism from the perspective of bank loans and financing constraints. However, financing channels may also be an impact mechanism. Therefore, future research can consider the impact mechanism of financing channels through which green credit guidelines may affect renewable energy enterprises.

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