



The Impact of Credit Support on Low Carbon Economy: An Empirical Study Base on Macro and Micro Economic Level in China

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Abstract: Financial support is an important boost power for low carbon economy. From macroeconomic and microeconomic level, this paper analyzes the impact of credit support on low carbon economy. At the macro level, this paper uses VAR model to analyze the relationship between credit support, low carbon economy and GDP. At the micro level, this paper uses dynamic panel data model to analyze the relationship between green loan, operational efficiency and financial performance. The empirical result shows that under the macroeconomic analysis framework, the support effect of the loan on low carbon economy is significant, on the other hand, the decreasing of energy consumption caused by the low carbon economy is not the granger cause of the credit loan, the endogenous development ability still needs to be formed, while under the microeconomic analysis framework, we find that the short-term loan negatively related with the operation efficiency, and long-term loan positively related with the operational efficiency, while combining the influence of these two categories, the loan does not have a significant impact on the operational efficiency and financial performance of the energy-saving and environment enterprises. From the micro level, the role of credit is still constrained for supporting the low carbon economy, and the efficiency. Although society pays more and more attention to low carbon economy, there is a far distance to fill the goal of low carbon economy establishment.

Keywords: Credit Support, Low Carbon Economy, Granger Causality Test

1. Introduction

The environment has been attracted more and more attention since the 21st century, and people gradually realize that the importance of the environment protection. European Commission's low-carbon economy roadmap suggests that the EU should cut emissions to 80% below 1990 levels by 2050. In the *Report on the Work of the Government (2015)*, the Chinese government also provides the suggestions that the government should be responsible for a blue sky, clean rivers, and sustainable economic development. Meanwhile, the government should also pursue green development. However, the health of the environment has been seriously damaged by the development model of high energy consumption. The serious environmental problem not only affects the sustainable development of the economy but also leads to public health

problems, thus the governments set more and more policies to protect the environment. In 2015, the Chinese government has set goals to cut the intensity of carbon dioxide by at least 3.1%, reduce both chemical oxygen demand and ammonia nitrogen emissions by around 2%. The policies made by the State Council also push the development of a low carbon economy, encourage energy saving, environmental protection, and ecological conservation projects.

China is one of the largest developing countries, and it is on its way to a low carbon economy. To fulfill this development goal, China is currently exploring a variety of policies, among which the financial support is paid more and more attention. For transforming the traditional energy intensified economy to a cleaner economy, the new technology is an essential support tool. While during the development of such energy-saving technology, it is important to allocate the capital to a

low-carbon economy. Among the different kinds of financial ways, the loans provide efficient capital for environmental protection and economic development. Due to the banking system plays a major role in supporting the development of enterprise in China, credit support has played an irreplaceable role for decreasing the energy consumption and realizing the sustainable economic development.

Although the credit loan has significantly supported the development of the low-carbon economy, it also raises the fundamental issue on its role during this process. It can be observed the amount of loans allocated to low-carbon related industries is increasing in recent years. Is the debt allocation merely externally guided by the government, or internally attracted by the lucrative opportunity and potential growth of the low-carbon related industries? In other words, Has the low carbon economy acquired the endogenous growth ability? To answer this question, we use the provincial data to examine the relationship between the low-carbon economy and credit support, thus provide a new perspective on the development of a low-carbon economy.

2. Literature Review

Some scholars have carried out a series of pioneering research on the necessity of developing low carbon economy and the way of realizing it. Kramer and Haigh believe that the development of low-carbon economy needs the support of the government which is reflected in the development of financial and non-financial policies [1]. Colombage use a VECM model and Granger causality test to conduct the empirical research and examine the relationship between finance and economy, and the empirical results show that financial support has an important impact on the economic development and verify the demand-driven hypothesis as well [2]. Additionally, El-Karmi and Abu-Shikhah believe that venture capital and credit can promote the development of a low carbon economy [3]. Campiglio analyzes the important role of banks and monetary policy in the development of low carbon economy [4]. Üрге-Vorsatz et al. find green energy investment can bring benefits for the green economy, but the transaction cost may lower the level of those benefits [5]. Rovere et. al presents two low GHG emission scenarios for Brazil up to 2050, and discusses the impact in the implementation of a deep decarbonization scenario of a financial device allowing for decreasing capital costs of mitigation investments [6].

Considering the specialty of the Chinese economy, some Chinese scholars also examine the role of financial support on low carbon economy. Yang finds China's capital market's overall support for environmentally friendly listed companies is not significantly better than the market average [7]. The financial performance of environmentally-friendly listed companies and the policy effects of macro authorities are all possible reasons for this result. Guo and Panquantitatively analyzes the financial support for the development of low-carbon economy in Zhejiang Province and its impact mechanism based on the measurement of economic

transformation and upgrading in Zhejiang Province from 1995 to 2010, they also find that although Zhejiang's economic structure has made significant improvements, it still does not achieve transformation and upgrading in the essential sense [8-9]. Wang et. al analyzes the general mechanism of financial support for low carbon development from three aspects: the connotation, unique role and staged law of financial support for low carbon economy development. builds a model based on Malmquist index through the relevant data of low carbon industry listed companies in 2008-2014, empirically analyzes the financial support efficiency of low carbon industry in listed companies in China, and concludes that the financial industry needs to further improve technological innovation and achieve efficient resource allocation support. China's financial development is inconsistent with the development level of a low-carbon economy, and the guiding role of financial development in the low-carbon economy has not been exerted [10, 11].

Judging by the above literature, we can find that financial support is an important factor in the development of a low carbon economy. Nevertheless, the existing literature has the following limitations. Firstly, it mainly focuses on the overall financial system and its impact on the low carbon economy, while the debt financing, which is one of most important part of the financial system in China is not well addressed. Secondly, the endogenous growth ability of the low carbon economy is not well examined, and it is not clear whether the capital inflow as the form of credit loan to low carbon economy is driven by the low carbon industries or external forces, such as government guidance. To overcome the above limitations, this paper takes the credit loan and the development of low carbon economy as the research object, and investigate the relationship among them, thus provides implication for both academicians and practitioners.

3. Empirical Study

3.1. Empirical Study Based on Macroeconomic Level

3.1.1. Hunan Province Case

- (1) Data and samples. As the Changsha-Zhuzhou-Xiangtan city cluster in Hunan province is the pilot of the low carbon economy of China, We select the Hunan province as the sample. The data is collected from the website of the Statistical Bureau of Hunan Province (<http://www.hntj.gov.cn/>) and National Bureau of Statistics of China (<http://www.stats.gov.cn/english/>). The sample period is from 1997 to 2013. The energy consumption data is illustrated in Figure.1. The degree of low carbon economy is measured by the relative amount of the Gross Domestic Product and energy consumption. Specifically, the calculation equation is as follow:

$$LC=EN/GDP \quad (1)$$

In equation 1, *LC* is the degree of the low carbon economy,

EN is the energy consumption, and the unit is 1000-kilogram standard coal. *GDP* is the Gross Domestic Product of Hunan

province, and the unit is 10 thousand Yuan. *LC* and *GDP* are displayed in Figure 1.

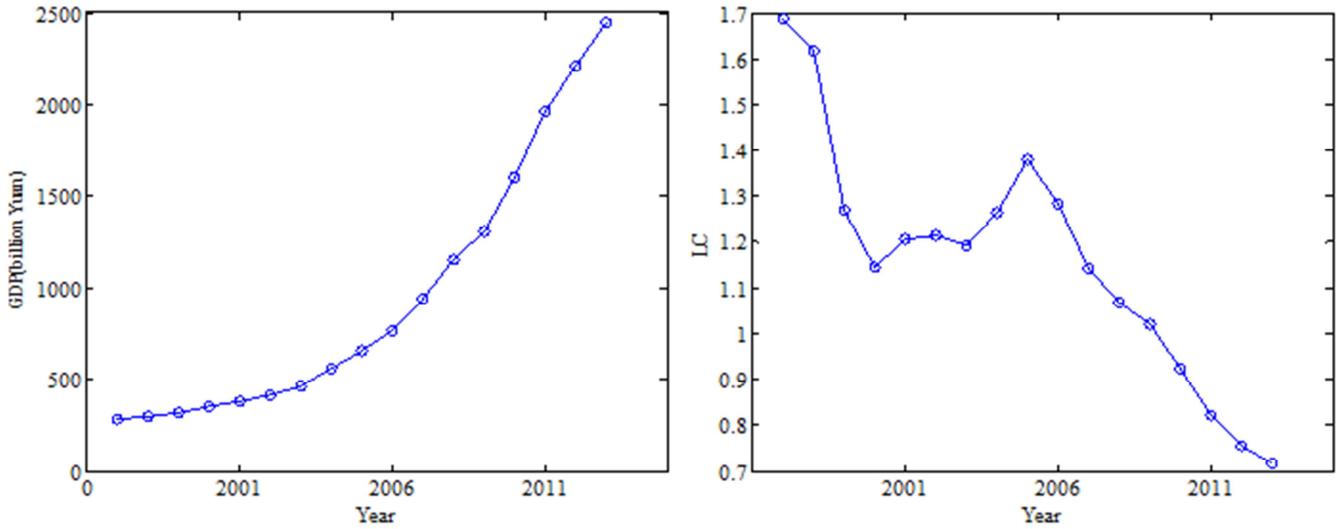


Figure 1. Dynamic change of variable GDP and LC.

From Figure 1, we can find that the value of *LC* is under a decreasing trend, thus the Hunan province has achieved a significant performance in developing the low carbon economy. The credit issued by the commercial banks is shown in Figure 2.

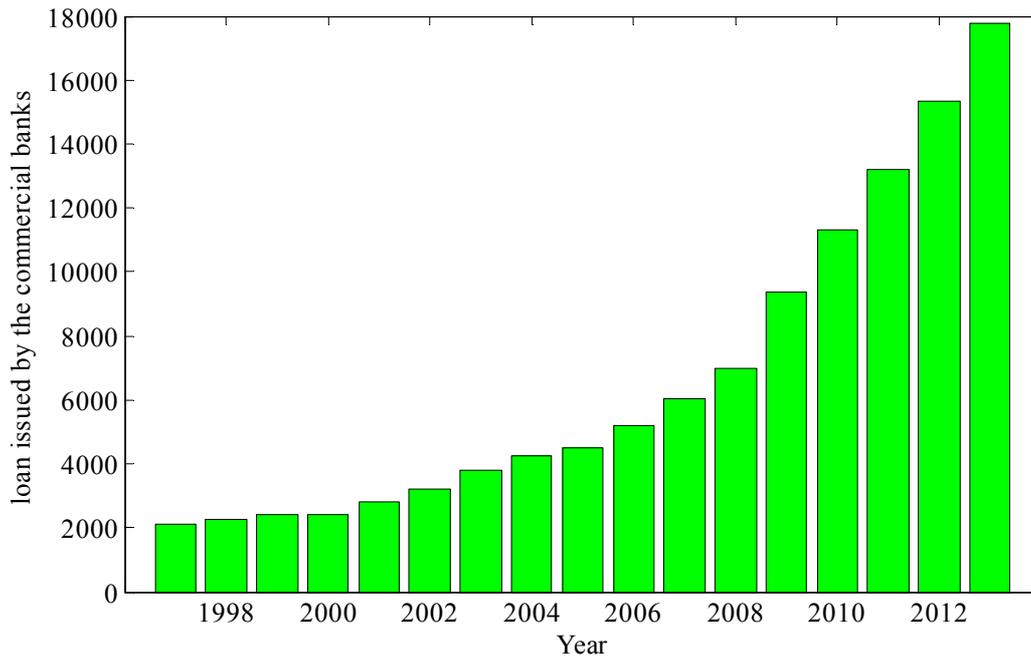


Figure 2. Loan issued by the commercial banks in Hunan Province (1997-2013).

The loan issued by the commercial bank has been increasing since 1997, while the Low carbon economy is developing in the sample period, thus we are curious about whether the low carbon economy is supported by the commercial loans. In the next part, we will conduct an empirical analysis to verify the above assumption.

(2) Unit root test. To avoid heteroscedasticity, we get the logarithms of the original variables. Before modeling the vector autoregressive model, a unit root test is conducted to test the stationarity of the variables. The unit root test result is displayed in Table 1.

Table 1. Unit root test results.

Variable	type	ADF statistics	1% C.R.value	5% C.R.value	10% C.R.value	conclusion
EN	(C,T,0)	0.831248	-4.004425	-3.098896	-2.690439	Non-stationary
D (EN, 2)	(C,T,2)	-5.776365	-4.057910	-3.119910	-2.701103	1%stationary
LN	(C,T,0)	2.291824	-3.920350	-3.065585	-2.673459	Non-stationary
D (LN, 2)	(C,T,2)	-4.864175	-4.004425	-3.098896	-2.690439	1%stationary
GDP	(C,T,0)	2.111703	-3.920350	-3.065585	-2.673459	Non-stationary
D (GDP, 2)	(C,T,2)	-4.751431	-4.057910	-3.119910	-2.701103	1%stationary

Judging from the above result, we can conclude that the second order of the original data is stationary at the level of 1% level, thus we can use the data to construct the vector autoregression model.

(3) Cointegration test. To verify the relationship among the low carbon economy, credit support and the whole economy, we conduct a cointegration test. The test method we adopted is the Engle-Granger method. The null hypothesis in the Engle-Granger procedure is no-cointegration and the alternative is cointegration. Suppose: $LC = \beta_1 LN + \beta_2 GDP + u$, then we perform a unit root test on u to determine if it is $I(0)$, if it is a stationary series, then we can conclude that there is a cointegration relationship among the low carbon economy, credit support and the whole economy. The result of unit root test on u is reported as Table 2.

Table 2. Unit root test on u .

		T statistics	P value
ADF Statistics		-4.519875	0.0046
	1% level	-4.057910	
C.R. Value	5% level	-3.119910	
	10% level	-2.701103	

In Table 2, the t statistic is smaller than the critical value at 1%, 5% and 10% confidence level, thus we can find cointegration relationship is significant among the tested variables.

(4) Granger causality test and Impulse function. After the cointegration test, we take Granger Causality test to examine the relationship among the low carbon economy, GDP and credit support. Table 3 reports the test results.

Table 3. Granger test result of Hunan Province.

Null hypothesis	Lags:2	
	F statistic	P value
LN does not Granger Cause LC	5.50315	0.0244
LC does not Granger Cause LN	0.68610	0.5257
GDP does not Granger Cause LC	2.80178	0.1081
LC does not Granger Cause GDP	5.53935	0.0240
LN does not Granger Cause GDP	4.56235	0.0391
GDP does not Granger Cause LN	3.88521	0.0564

In Table 3, the results show that the credit support is the granger cause of the development of low carbon economy at 5% confidence level, while the low carbon economy is not the granger cause of the credit support. These results indicate the low carbon economy has not formed an intrinsic mechanism for attracting the credit funds from financial markets.

Next, we estimate the VAR model of the economic variables. The result shows that the VAR model has a relatively high goodness-of-fit, and it is appropriate to use the VAR model to generate the response to innovation. Next, we get the impulse function of the tested variables, and the response is illustrated in Figure 3.

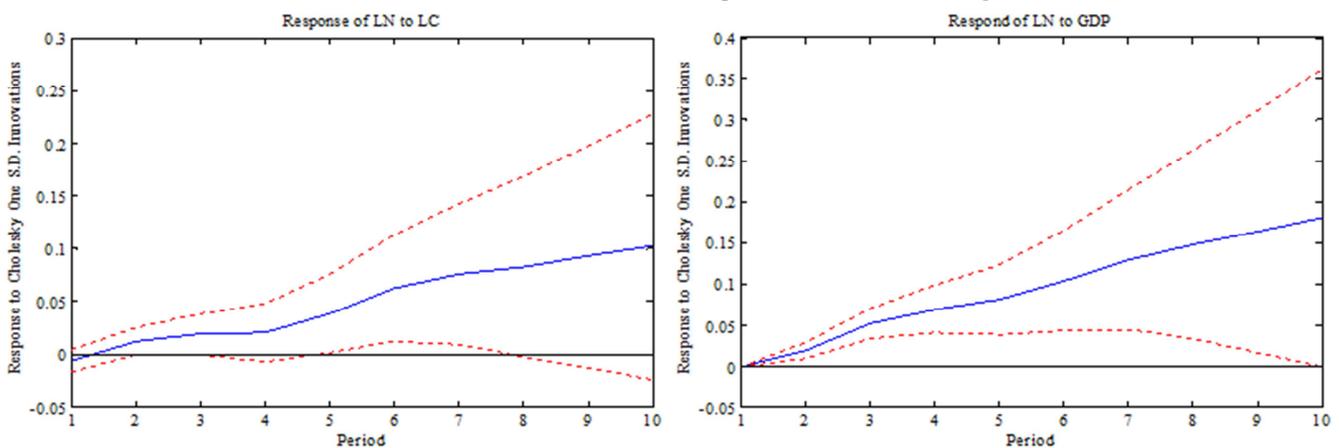


Figure 3. Response of LN to LC and GDP.

In Figure 3, we can find that in Hunan province, the credit support has a gradually increased impact on the low carbon economy and the GDP. Thus the credit support is a useful tool to lower the energy consumption per unit of GDP, and the environmental pollution of Hunan province is gradually under

control.

3.1.2. National Case

To further examine the role of credit support, we conduct an empirical research by using the national data. The ratio of

energy consumption/GDP is gradually decreasing since 2004 (as shown in Figure 4), and the loan issued to energy-saving and environmental industry is increasing significantly (as shown in Figure 5).

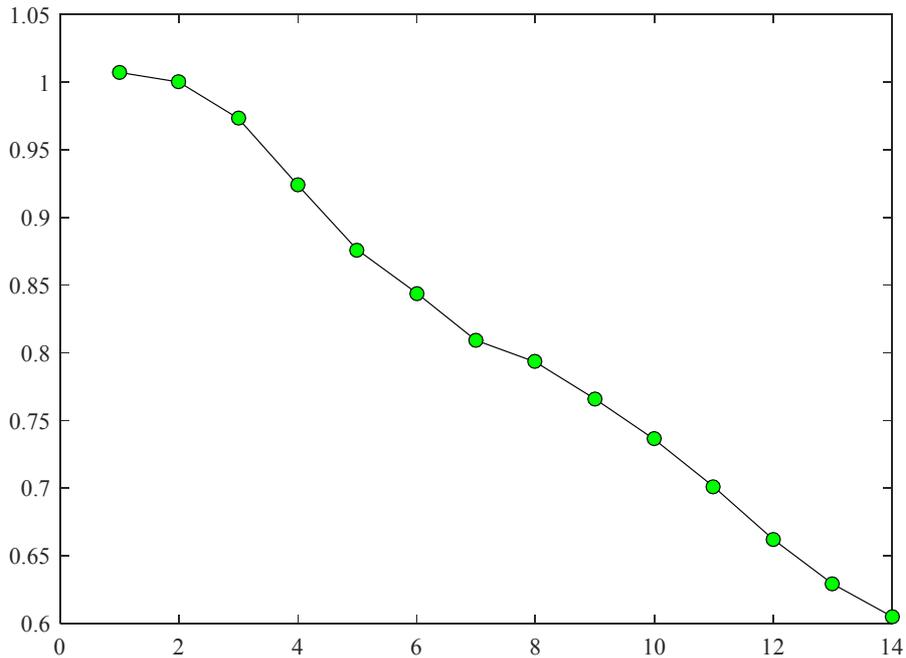


Figure 4. Energy consumption/GDP (2014-2017)

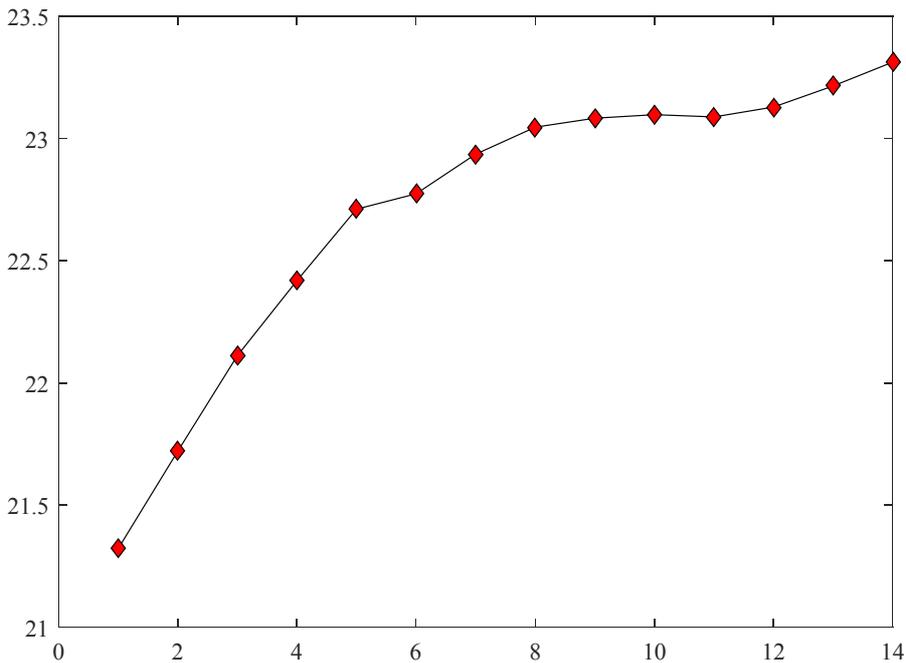


Figure 5. Loan issued to energy-saving and environmental industry (2014-2017).

Note: since there is no disclosure of loan issued to low carbon related industries, we use the loan data of listed companies in Stock Exchanges as the substitutes.

Judging from Figure 4 and Figure 5, we can find that the low carbon economy has been developing since the last decade in China. By using the similar method, we conduct the empirical research, and the Granger causality test results are shown in Table 4.

Table 4. Granger test result (National case).

Null hypothesis	Lags:2	
	F statistic	P value
LN does not Granger Cause LC	3.66670	0.0814
LC does not Granger Cause LN	0.11268	0.8950
GDP does not Granger Cause LC	0.92988	0.4384
LC does not Granger Cause GDP	1.49450	0.2881
LN does not Granger Cause GDP	1.30051	0.3309
GDP does not Granger Cause LN	0.87119	0.4593

As Table 4 shows, LN does not Granger Cause LC, In national wide, the credit loan is also a Granger causality of the low carbon economy, and the low carbon economy, however does not affect the loan of the energy saving and environmental industries.

$$PER_{i,t} = \alpha_1 PER_{i,t-1} + \alpha_2 sloan_t + \alpha_3 lloan_t + \alpha_4 fiasset_t + \alpha_5 sharatio_t + \alpha_6 OE_t + \varepsilon_1$$

Where *PER* is the performance of the listed companies, denoting the operation of the low carbon economy from the microeconomic level. Variables *sloan* and *lloan* are respectively represents the short term and long-term loan, which measures the credit support. Variables *fiasset*, *sharatio* and *uhat* are control variables, which are fixed assets, the shareholding ratio of largest 10 major shareholders, inefficiency item of the companies. The inefficiency item is calculated as the methods provided by Luo, Fan and Zhang (2017). To further examine the impact of credit support on operation efficiency of the listed companies, we also use dynamic panel data model to conduct the empirical research by following Luo, Fan and Zhang (2017). The dynamic panel data model is as follow:

$$OE_{i,t} = \beta_2 sloan_t + \beta_3 lloan_t + \beta_4 fiasset_t + \beta_5 sharatio_t + \beta_6 OE_{t-1} + \varepsilon_8$$

Where *OE* is the operation efficiency of the listed companies. The other variables are as same with model (3).

To examine the relationship between credit support and low carbon economy from the microeconomic level, this paper uses the listed companies in Shanghai Stock Exchanges and Shenzhen Stock exchanges as the research sample. The loan of the listed companies is considered as the credit support, and the financial performance of the listed companies is measured as the low carbon economy from the microeconomic level. As for the listed companies, we take the energy-saving and environment industry as the samples. Specifically, these industries are comprised of CDM projects, wind power generation, nuclear power generation, environmental conservation, building energy conservation, garbage power, green energy-saving lighting, tail gas treatment, sewage treatment, new energy production, new energy vehicles and new coal chemical industries. This industry includes 274 enterprises. We get the data from Wind database. The sample period is from 2007-2017.

3.2.2. Model Estimation

To test the hypotheses in Section 3.2.1, we used the dynamic panel data model (DPM) to examine the relationship between green loans, operational efficiency and financial performance.

Firstly, we estimate the model I (Eq.3), the results are shown in Table 5. The left part of Table 5 shows the estimation results of the original model, and as shown in Table 5, the coefficients of some variables are not significant, thus, we exclude these variables and conduct the second-step estimation, the results are shown in the right part of Table 5 (Model I (a)). Judging from Table 5, we can find that the

3.2. Empirical Study Based on Microeconomic Level

3.2.1. Model and Data

To examine the relationship between the credit support and low carbon economy, we set the dynamic panel data model as follows:

financial performance is significantly influenced by the previous performance, shareholder behavior and operational efficiency. While the green credit or credit support does not have a significant impact on the enterprise performance, which contradicts our hypothesis.

Table 5. Influence of green credit on financial performance (based on DPD models).

Variables	Model I		The model I (a)	
	Coef.	Z	Coef.	Z
PERt-1	0.849***	6.53	0.901	6.56
sloant	-0.002	-0.20		
lloant	-0.000	-0.01		
fiassett	-0.000	-0.39		
sharatiot	0.001***	2.80	0.001	2.85
OEt	1.022***	2.56	1.121	2.45
constant	0.025	0.74		
Sargon test	/	35.21	/	35.21 (0.130)

Similarly, we conduct empirical research on the relationship between green credit on the operational efficiency of the energy-saving and environment enterprises. The results are displayed in Table 6.

Table 6. Influence of green credit on operational efficiency (based on DPD models).

Variables	Model II		Model II (a)	
	Coef.	Z (p> z)	Coef.	Z (p> z)
sloant	-0.001***	3.45	-0.001***	3.76
lloant	0.002***	2.84	0.002***	2.92
fiassett	0.000***	3.21	0.000***	3.55
sharatiot	-0.001	0.11		
OEt-1	0.292***	3.43	0.330***	3.48
constant	0.039***	4.89	0.041***	4.39
Sargon test		54.22		56.11

Table 6 shows the lagged operation efficiency and green credit have statistically impact on the operational efficiency of the energy-saving and environmental enterprises. The lagged operational efficiency has a positive influence on operational efficiency. For the green credit, we find that the short-term loan negatively affects the operational efficiency, while the long-term loan positively affects the operational efficiency. By jointly considering the result of Table 5 and 6, it is interesting to find that there is a controversy: the green loan affect the operational efficiency of the enterprises which subsequently has an impact on financial performance, however, the green loan does not exert a significant impact on the financial performance. We notice that the coefficient of short-term loan and the long-term loan is negative and positive, thus, the influence may be offset after the combination.

4. Conclusion

From the macroeconomic and microeconomic level, we investigate the relationship between credit support and a low-carbon economy. The main findings are as follow.

- (1) Under the macroeconomic analysis framework, the credit support is the granger cause of the low carbon economy, the credit support can lower the energy consumption of per-capita GDP. The credit support plays an important role in the process of the low carbon economy development. While on the other hand, the decreasing of energy consumption caused by the low carbon economy is not the granger cause of the credit loan, the endogenous development ability still needs to be formed.
- (2) Under the microeconomic analysis framework, we find that the short-term loan negatively related with the operation efficiency, and long-term loan positively related with the operational efficiency, while combining the influence of these two categories, the loan does not have a significant impact on the operational efficiency and financial performance of the energy-saving and environment enterprises. Thus, form the micro level, the role of credit is still constrained for supporting the low carbon economy, and the efficiency, as well as the financial performance should be enhanced for energy-saving and environment enterprises which is the fundamentals for the low carbon economy.

Based on the above conclusion, there are some implications for developing the low carbon economy and strengthening the function of the credit loan.

- (1) Increase the credit support for the development of low carbon economy. The financial institution has important significance for the development of low carbon economy, and the intensity and depth of the financing have decided the process and the speed of the low carbon economy development. Therefore, we should continue to maintain the support of financial institutions for the development of low carbon development. The government needs to implement environmental and technological innovation projects, build a platform for environmental technology innovation, and enhance scientific innovation of low carbon and environmental protection industry. At the same time, for the sake of making low carbon and the environmental protection industry to attract more credit, the authorities need to improve the innovation ability of the industry and improve the market competitiveness of products. Furthermore, the low carbon industry will have the ability to possess endogenous development and change the status of passive investment funds. Meanwhile, we should deepen financial innovation. Financial institutions are leaders and facilitators in the development of low carbon economy. Without the financial support of financial institutions, the development of low carbon economy can only be empty talk.
- (2) It is necessary to establish an effective incentive and restraint mechanisms to promote the driving force for green credit implementation. Place the role of

supervision of green credit on enterprises' internal governance and operations. Enterprise managers are supposed to focus on debt risk management, reduce unnecessary costs and inhibit overinvestment. Commercial banks or independent third parties could audit the green credit business and evaluate the green credit risk more strictly, thus executing more pressure on the enterprise managers to improve operational efficiency and financial performance. For the energy-saving and environment enterprises, they should enhance the core competence. For example, enterprises should promote scientific cooperation with universities, and they could also establish their own R&D institutions and absorb advanced technology to boost their capability for technological innovation, thus form its endogenous growth ability and attract more external funds.

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