Impact of Green Credit on Industrial Carbon Emissions in Guangxi

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Abstract. Since the "double carbon" goal was proposed, a series of deployments have been made at the national level to accelerate the development of green finance in order to realize the path of carbon peak and carbon neutrality. In the green financial system, green credit is a very important form of finance. This study measures the industrial carbon emissions and the level of green credit in Guangxi Zhuang Autonomous Region and utilizes the VAR model to test between the two. The study finds that: when the level of green credit is low in the early stage, green credit has an inhibitory effect on the development of green and low-carbon technology of enterprises, and after the level of green credit develops to a certain degree, it significantly reduces the intensity of carbon emissions of high-energy-consuming industrial sectors.

Keywords: Carbon Emission; Green credit; VAR Model

1 INTRODUCTION

The new development concept of the Fifth Plenary Session of the 18th Central Committee mentions that green development means vigorously advocating a low-carbon and recycling development model. Guangxi, as an important gateway for ASEAN and a key area for western development in China, the industry is facing the pressure of green and low-carbon transformation, through empirical research on the impact of green credit on industrial carbon emissions in Guangxi, analyzing the conclusions according to the conclusions and putting forward relevant suggestions, which will help to enhance the contribution of green credit to environmental protection in Guangxi, and also promote the development of Guangxi industry in the direction of green and low-carbon, which has a positive social and economic Impact significance.

Domestic scholars have in-depth research and analysis on the impact of green credit on green enterprises: Lian Lili (2015) compares the debt financing costs of green enterprises and high energy-consuming enterprises, and the study shows that green credit effectively promotes the development of green enterprises and curbs the development of the "two-high" enterprises [1] [2] [3]. Wang Yi (2021) used the fixed effects model to empirically analyze and found that the impact of green credit on industrial structure

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is obvious in the reform pilot area, greatly promoting the upgrading of industrial structure [4] [5].

From the relevant foreign literature, scholars generally take environmental regulation as an important factor in reducing energy consumption, so some scholars have proposed the development of finance can alleviate the financing constraints faced by polluting enterprises, which will lead to the disorderly development of polluting enterprises, resulting in the deterioration of the quality of the environment (Dasgupta, 2001)[6].Bello and Abimbola's (2010) analytical results show that failure to provide the necessary supervision of investments in the process of financial development can lead to the degradation of environmental quality [7].

At present, it is recognized in academia that there is some degree of correlation between financial development and carbon emissions; empirical studies on the impact of emerging green finance on reducing carbon emissions are not common, but most agree that green finance, especially green credit, plays an important role in energy conservation and emission reduction. The paper selects the carbon emissions, green credit level ratio and GDP growth ratio of Guangxi from 2007-2019 to analyze the association and impact between the three using vector autoregressive model.

2 VARIABLE SELECTION AND MODEL CONSTRUCTION

2.1 Indicator selection and data sources

1. Measurement of carbon dioxide emissions

According to the Fourth Assessment of the International Panel on Climate Change (IPCC), an important cause of global warming is the burning of fossil fuels. For this reason, this paper intends to take the Guangxi Zhuang Autonomous Region as an example to calculate its CO2 emissions by utilizing terminal energy consumption data over the years. The method of calculation refers to the IPCC Guidelines for National Greenhouse Gas Emission Inventories, 2006 edition [8]. The formula is as follows:

$$C_t = \sum E_{tj} \times \eta_j (t = 2007,2008, \ldots 2019; j = 1,2, \ldots 9) \quad (1)$$

Ct is the total carbon emission of Guangxi in year t; Etj is the jth energy consumption of Guangxi in year t; and is the carbon emission coefficient of the jth energy. Because each energy consumption is a physical statistic in the initial statistics, it needs to be transformed into a standardized statistic when calculating carbon emissions. According to the caliber of China Energy Statistical Yearbook, China's energy consumption can be divided into nine categories, including raw coal, coke, crude oil, gasoline, kerosene, diesel, fuel oil, natural gas, and electricity. The unit of measurement of the conversion factor is t standard coal/million m3 for natural gas, t standard coal/million Kwh for electricity, and kg standard coal/kg for the rest of the energy, while the unit of the carbon emission factor is t carbon/t standard coal [9].

2. Measurement of green credit level

Green credit is to curb the blind expansion of high-energy-consuming and high-polluting industries, so with reference to Tingting Xie and Jinhua Liu's "How Green Credit

Affects China's Green Economic Growth", we choose the ratio of the interest expenses of Guangxi's six high-energy-consuming industries to the total interest expenses of the industrial industries as the inverse indicator to measure the level of green credit in Guangxi [10].

3. Selection of other variables

Considering that in addition to the influence of financial factors on CO2 emissions, there are also other factors affecting CO2 emissions, this paper refers to Han Mengyao's research analysis and findings, regards the development of GPD as one of the important factors affecting China's CO2 emissions, and adopts the ratio of the growth of Guangxi's GDP from 2007 to 2019, and the relevant data are obtained from Guangxi Statistical Yearbook.

2.2 Construction of Vector Autoregressive Model (VAR)

Vector Auto Regression (VAR) model, an unstructured multiple equation model proposed by Christopher Sims in 1980, belongs to the form of multiple equation linkage and is a useful model for short-term time series analysis, which can be used to describe the relationship between multiple time series and can be used to predict the future values, it is widely used by the academia as a for predicting the effects of time series and random disturbances on variable systems. The mathematical expression of VAR model is as follows:

$$\mathrm{LNCO2} = C + \phi_1 LNGCL + \phi_2 LNRGDP + \varepsilon_t \qquad (2)$$

Where is a constant vector of n × 1 dimensions; $\phi_i(i = 1,2,\dots,p)$is the matrix of autoregressive coefficients in n×n dimensions:ε_t is an n×1 dimensional vector white noise and satisfies $\mathrm{E}(\varepsilon_t) = 0, E(\varepsilon_t \varepsilon_t') = \Omega, E = (\varepsilon_t \varepsilon_s') = 0(s \neq t)$.

3 MODEL TESTING

3.1 Variables smoothness test

To construct the vector autoregressive model VAR, variable smoothness test is needed to exclude pseudo-regression. The three variables unit GPD carbon dioxide emissions (CO2), green credit level (GCL) and Guangxi gross domestic product growth ratio (RGDP) are taken logarithmic treatment, which can reduce the volatility, and then the ADF test.

From the test results in Table 1, it can be seen that the ADF test is performed on the original series of LNCO2, the test model contains constant and trend terms, and the original hypothesis is rejected, so the series of LNCO2 is smooth; the ADF test is performed on the series of LNGCL, the test model contains constant terms, and the original hypothesis is rejected, so the series of LNGCL is smooth; and the first-order difference is performed on the series of LNRGDP, and the test model contains constant term and trend term, rejecting the original hypothesis, so the first-order difference series is smooth. There is a long-term stable equilibrium relationship, i.e., cointegration,

between carbon dioxide emissions per unit of GPD and the level of green credit and the growth ratio of Guangxi's gross domestic product.

Table 1. Results of variable smoothness test

Variable	ADF test value	Threshold (5%)	Smooth or not
LN (CO_2)	-4.266575	-4.008157	Yes
LN (GCL)	-3.346731	-3.212692	Yes
LN (RGDP)	-3.739375	-4.008157	No
dLN (CO2)	-2.387870	-1.977738	Yes
dLN (GCL)	-5.695092	-3.933364	Yes
dLN (RGDP)	-5.496027	-3.933364	Yes

[Note] d stands for First-order difference

3.2 Results of VAR model stability test

The test results are shown in Figure 1, all the eigenvalues are within the unit circle, that is, all the points are within the circle, at this time, it shows that the VAR model is stable and can be impulse response analysis

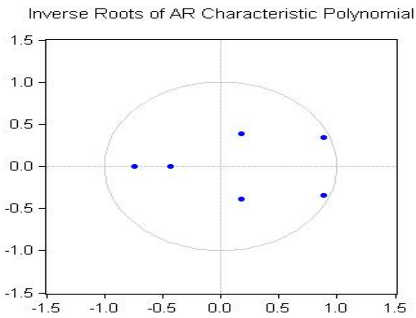


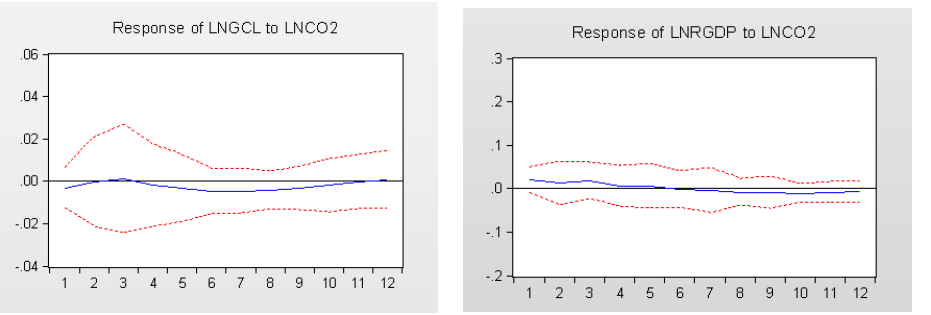
Fig. 1. VAR model stability test

3.3 Impulse Response Analysis

As can be seen from Figure 2(a), in the face of the green credit level (LNGCL) shock, the unit GDP carbon dioxide emissions (LNCO2) from the first period began to increase and the effect is significant, and continues to play a role in the third period to reach a larger value, and then the green credit level (LNGCL) on the unit of GDP carbon dioxide emissions (LNCO2)) remains the same, the fluctuation of the more stable, and in the later period gradually expanding. This further validates the effectiveness of green credit in long-term energy saving and emission reduction.

As can be seen from Figures 2 (b), the effect of the LNRGDP shock on carbon dioxide emissions per unit of GDP (LNCO2) is stronger in the early stage, and then the effect is gradually calmed down, which confirms that the LNRGDP can have a

relatively significant effect on carbon dioxide emissions per unit of GDP (LNCO2) for a short period of time, but such an effect is slowly weakened with the development of time.



(a) (b)

Fig. 2. Dynamic Response of Green Credit Levels to Unit CO2 Emission Shocks and GDP Growth Ratio

3.4 Granger Causality Test

From Table 2, the original hypothesis that the level of green credit (LNGCL) is not a Granger cause of carbon dioxide emissions per unit of GDP (LNCO2) is rejected at a confidence rate of 10%, and the original hypothesis that the gross product growth ratio (LNRGDP) is not a Granger cause of carbon dioxide emissions per unit of GDP (LNCO2) is rejected at a confidence rate of 5%, so its variable also shows a causal relationship between the two variables. rejected, so its variables also show a more pronounced causal relationship. Therefore, it can be known that carbon dioxide emissions per unit of GDP (LNCO2) are affected by the level of green credit (LNGCL) and gross product growth ratio (LNRGDP). The better the green credit is developed, the more loan funds can be obtained for green projects with the support of economic development, and the enterprises undertaking energy-saving and emission reduction projects can utilize the good green credit policy for further development, such as the issuance of green bonds or green stocks, which further expands the source of funds. On the other hand, sufficient sources of capital also ensure the alternation and renewal of enterprise equipment and the innovation and progress of production technology, accelerate the development of new energy sources, solve the problem of over-consumption of old energy sources, and further curb carbon dioxide emissions per unit of GDP.

Table 2. Results of Granger causality test

Hypothesis	Chi-sq	df	Prob
LNGCL is not the Granger cause of LNY	9.85124	2	0.0127
LNRGDP is not a Granger cause for LNY	11.7456	2	0.0084

3.5 Variance Decomposition

As shown in Table 3, the fluctuation of carbon dioxide emissions per unit of GDP (LNCO2) is more strongly influenced by green credit. The contribution of green credit level (LNGCL) to carbon dioxide emissions per unit of GDP (LNCO2)) gradually strengthens in the period 2-12, and the change of influence is stronger in the first period, which also coincides with the conclusions of the impulse response and Granger causality test analyzed above. The perturbation of Guangxi GDP growth ratio (LNRGDP) on carbon dioxide emissions per unit of GDP (LNCO2) has been maintained at around 2% in the subsequent period, and its influence on carbon dioxide emissions per unit of GDP is much smaller than that of the level of green credits, and its contribution to carbon dioxide emissions per unit of GDP (LNCO2) is more limited.

The variance decomposition further proves that the green credit level has a significant impact on the carbon emissions of Guangxi industry, and the role will gradually and steadily expand in the later period, which can pay more attention to the implementation of green credit policy and improve the level of green credit and promote the transformation of Guangxi's economy into a green economy and sustainable development of the economic situation.

Table 3. Results of Variance Decomposition of LNCO2 and LNGCL, LNRGDP

Number of periods	LNCO2 variance decomposition		
	LNCO2	LNGCL	LNRGDP
1	100.0000	0.000000	0.000000
2	61.14868	33.31544	5.535884
3	55.96594	39.61570	4.418359
4	50.46590	45.13169	4.402409
5	34.34007	62.73661	2.923322
6	28.13702	69.36097	2.501991
7	23.03915	74.91510	2.045744
8	21.51576	76.60650	1.877734
9	21.26848	76.91738	1.814138
10	22.03761	76.15352	1.808871
11	22.84287	75.31312	1.844004
12	22.94619	75.22872	1.825088

4 RESEARCH CONCLUSIONS

The study shows that: in recent years, the level of green credit in Guangxi has been significantly improved, green credit and Guangxi GDP significantly inhibit the credit scale of high energy-consuming industrial industries, effectively inhibit the emission of carbon dioxide per unit, in the pre-green in the pre-green credit level is low, the green credit has an inhibitory effect on the development of enterprise green low-carbon technology, while after the green credit level develops to a certain degree, the green credit has a significant positive effect on the Green low-carbon technology progress has a

significant positive effect, the level of green credit also significantly reduces the carbon emission intensity of high energy-consuming industrial sectors.

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