Research on the Impact of Green Finance on Sustainable Economic Development in China

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Abstract—*This paper takes green credit, green investment, green insurance and financial support as the representatives of green finance, based on the panel data of 30 provinces (cities) in China from 2009 to 2020, constructs the panel data model, and conducts the empirical test.*

Keywords— *Green finance, sustainable development, and two-carbon goals.*

I. INTRODUCTION

In recent years, environmental and climate problems have become more and more prominent. The frequent occurrence of extreme weather and high temperatures makes it urgent to protect the environment and improve the climate. In order to better solve the environmental and climate problems and coordinate the economic and environmental development, green financial policies and tools have emerged at the historic moment. In 2020, China will clearly put forward the "double-carbon" goal, elevating China's green development road to a new height, and green finance will become one of the main keynote of China's social and economic development in the coming decades. In the future, green finance should strengthen financial innovation, further moment. In 2020, China will clearly put forward the "double-carbon" goal, elevating China's green development road to a new height, and green finance will become one of the main keynote of China's social and economic development in the coming decades. In the future, green finance should strengthen financial innovation, further test the energy structure optimization is the key node of green finance to promote sustainable development, argument "green finance, energy structure upgrade, economic sustainable development" path can achieve, to achieve the goal of "double carbon" and economic sustainable development to provide possible advice.

II. LITERATURE REVIEW

Green finance and economic development are inseparable. Foreign scholars have earlier carried out research on green finance and economic development related. For example, Raymond W Goldsmith (1990) believes that financial development can optimize the allocation of resources and optimize the economic structure. Salazar (1998) proposed that green finance is a bridge between environment and finance, which can achieve the goals of economic growth and environmental protection. Atkins (2011) believes that green finance plays an important role in sustainable economic development, and solves the problem of combining with the environment by optimizing the combination of green financial instruments for resources and the environment. Compared with foreign countries, domestic scholars' research on green finance and economic development started relatively late. Li

Lijun (2015) uses the Equator principle to guide green finance to promote sustainable economic development. Fu Jingyan and Liu Yingping (2019) analyzed the high-quality economic development of the Guangdong-Hong Kong-Macao Greater Bay Area and clarified the internal mechanism of local green finance on the quality of economic development. Liu Huake and He Chun (2021) analyzed the mechanism of green finance to promote high-quality economic development, and reached the conclusion that the intermediary effect of guiding green consumption to promote high-quality economic development is the largest, and the intermediary effect of industrial structure upgrading and enterprise technological innovation is relatively weak. CAI Qiang and Wang Xuxu (2022), on the basis of constructing reasonable evaluation indicators from various dimensions, use the spatial dubin model to analyze the influence mechanism of green finance on the high-quality development of China's economy. Guo Xiyu (2022) believes that green finance and low-carbon economy interact and promote each other. Moreover, there is a spatial spillover effect of green finance in promoting the transformation of low-carbon economy. The role of green finance in promoting high-quality economic development is unanimously recognized by scholars, and the mechanisms for studying its influence on economic development are also diverse. This paper constructs the high-quality economic development index from the perspective of development concept, and mainly studies the situation of green finance affecting economic development through technology effect.

This paper mainly studies the mechanism of green finance for the sustainable development of China's economy, constructs the economic sustainable development index from three dimensions of pressure, state and response, examines whether green finance will help the sustainable realization of China's economy; at the same time, whether green finance can promote the realization of carbon emission and promote the sustainable development of green economy by changing the energy structure. Based on relevant literature studies, hypotheses were proposed:

Hypothesis 1: The higher the green finance index, the higher the degree of economic sustainability.

Hypothesis 2: Energy structure is a node in the path of green finance to promote sustainable economic development. Therefore, green finance reduces carbon emissions and

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promotes sustainable economic development by improving the energy structure.

III. RESEARCH DESIGN

In order to analyze the impact of green finance on the economic sustainable development, this paper takes the sustainable development as the explanatory variable and green finance as the core explanatory variable, and selects the panel data from 30 provinces in China from 2009 to 2020 for empirical test. The constructed regression model is as follows:

$$LNCE_{2it} = \alpha_0 + \alpha_1 LNGF_{it} + \alpha_2 LNURB_{it} + \alpha_3 LNFDI_{it} + \alpha_4 LNTRAD_{it} + \mu_i + \varepsilon_{i,t} \quad (1)$$

Among it, i is the province, and t is the year, CE means the economic sustainable development index, which is the result of the entropy method. URB, FDI and TRAD represent urbanization level, the proportion of foreign direct investment, and the degree of opening up. The prefix "LN" represents taking the natural logarithm. μ_i represents the individual effect of heterogeneity between provinces, representing the random error term. Due to the large difference in the value of each index, in order to standardize the data, when the proportional data takes the log, the data adds 1 to take the log. Tables 1,2 and 3 illustrate the sustainability, green finance and each variable statistics, respectively.

In order to verify whether the development of green finance promotes the sustainable economic development through the intermediary variable of energy structure index, the following intermediary effect test model is set according to the gradual regression method:

$$LNES_{it} = \beta_0 + \beta_1 LNGF_{it} + \beta_2 LNURB_{it} + \beta_3 LNFDI_{it} + \beta_4 LNTRAD_{it} + \mu_i + \varepsilon_{i,t} \quad (2)$$

$$LNCE_{it} = \theta_0 + \theta_1 LNGF_{it} + \theta_2 LNES_{it} + \theta_3 LNURB_{it} + \theta_4 LNFDI_{it} + \theta_5 LNTRAD_{it} \quad (3)$$
$$+ \mu_i + \varepsilon_{i,t}$$

In the above equation, $LNES_{i,t}$ is the energy structure. Since the benchmark regression model (1) has investigated the direct effect of green finance on sustainable economic development, the analysis of the influence mechanism of sustainable economic development will focus on the regression coefficient θ_1, θ_2. On the basis of harmony, observe the significance and direction of θ_1, θ_2, if both of θ_1 and θ_2 are significant, the influence mechanism is established. The indirect effects of green finance on sustainable economic development are shown in Table 3.

The comparison of green finance index in 2009 and 2020 (Figure 1) shows that the green finance index in 2020, especially in Beijing, more than doubled in 2009, the green finance index in Shanghai, Jiangsu, Zhejiang and Guangdong also increased, due to its strong financial foundation. According to the results of the green finance index in 2020 (Figure 2), The development of green finance among provinces and cities, Beijing's green finance index has reached more than 0.8, And Xinjiang is only about 0.1; The green finance index of the eastern region (blue) provinces and cities is mostly more developed than that of the western region (orange) and the central region (green); However, the development difference of green finance index between provinces and cities in eastern China is also quite large, This may be related to the development of the industrial structure

between the provinces and cities, Some regions rely more on the development of energy-intensive enterprises to promote economic development, Insufficient development of innovative industries, Making it even more difficult to develop green finance.

TABLE 1. Composition of comprehensive indicators of sustainable development

Dimension	Index	Quality	Weight
Pressure	Energy consumption per GDP	-	0.334
	Urban population density	-	0.508
	Sulfur dioxide emissions per GDP	-	0.159
Condition	forest acreage	+	0.512
	Per capita green space area	+	0.302
	PM2.5	-	0.186
Respond	Share of industrial pollution control in GDP	+	0.264
	The proportion of technology investment in the government	+	0.503
	The ratio of the tertiary industry	+	0.234

TABLE 2. Composition of green finance indicators

Indicators	Indicator instructions	Quality
Green-credit	Interest expenditure for the six major energy-consuming industries /Total industrial interest expenses	–
Green investment	Investment in environmental pollution control/GDP	+
Green insurance	Income from agricultural insurance/total value of farm output	–
financial support	Fiscal spending on environmental protection/General fiscal budget expenditures	+

TABLE 3. Descriptive statistics for each variable

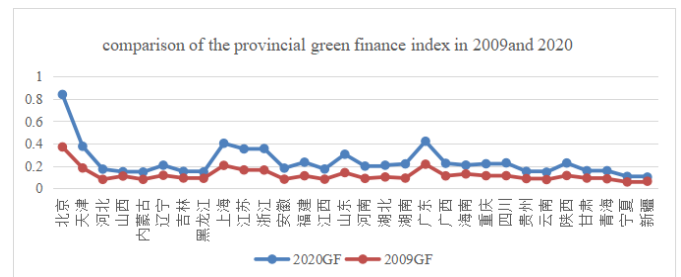| Variable		Obs	Mean	Std. Dev.	Min	Max
explained variable	CE	360	0.292	0.104	0.099	0.667
Core explanatory variables	GF	360	0.18	0.109	0.058	0.839
intermediate variable	ES	360	0.403	0.151	0.009	0.717
	URB	360	0.573	0.128	0.299	0.896
controlled variable	FDI	360	0.024	0.024	0.001	0.188
	TRAD	360	0.121	0.176	0.001	0.944

Fig. 1. Comparison of the provincial green finance index in 2009 and 2020

As can be seen from the scatter chart of the economic sustainable development and the green finance index (Figure 3), the economic sustainable development performance and the green finance index have a positive correlation. But most sample scatter are concentrated distribution in the lower left corner, namely the degree of green finance and sustainable economic development is relatively low, there are individual scatter distribution in the upper right corner, shows that individual provinces of green financial development and sustainable development degree is higher, and most of the provinces and cities, it also shows the green provinces and finance and sustainable development level is unbalanced.
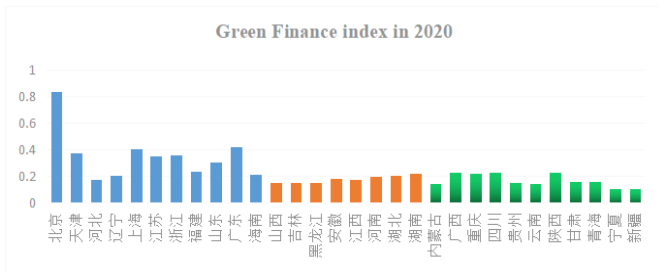
Fig. 2. Green finance index in each regional in 2020

The scatter chart of per capita carbon emission and green finance (Figure 4) shows that the per capita carbon emission and the green finance index are generally negatively correlated. Most of the sample scatter is distributed on the left, namely the state of low green finance and high carbon emission, and the lower right corner, namely high green finance and low carbon emission, which indicates the developed development of green finance in some provinces and less per capita carbon emission. Meanwhile, it also shows the imbalance of green finance and carbon emission in different provinces and cities, and the polarization is serious. Therefore, all provinces and cities should strive to play the role of green finance to promote emission reduction targets and sustainable economic development.
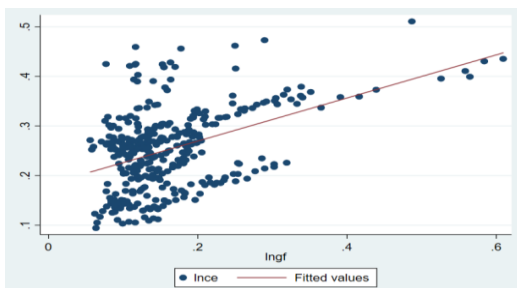

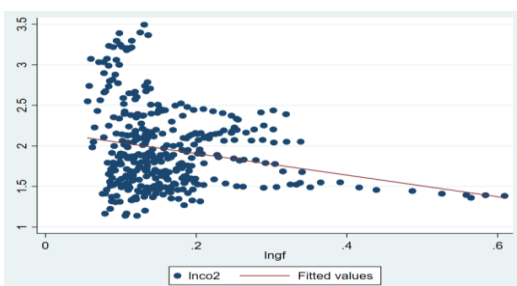Fig. 3. Scatter chart of sustainable Development and green Finance index

Fig. 4. Scatter chart of the per capita carbon emissions and green finance index

IV. EMPIRICAL RESULTS AND ANALYSIS

Table 4 reports the regression results of Equation (1), where columns (1), (2) and (3) and (4) are the OLS estimates and time-province, respectively. Regardless of whether the control variable was added or whether the estimation method was used, the coefficient of green finance was positive at the significance level of 1%, indicating that green finance significantly promoted the improvement of provincial

economic sustainable performance, that is, research hypothesis 1 was verified.

TABLE 4. Benchmark regression results

Variable	(1) POLS	(2) POLS	(3) FE	(4) FE
LNGF	0.435***	0.321***	0.442***	0.426**
	（0.045）	（0.070）	（0.118）	（0.163）
LNFDI		0.281		0.095*
		(0.071)		(0.048)
LNTRAD		0.027		0.053
		（0.039）		（0.054）
LNURB		0.102		-0.234
		(0.082)		（0.154）
Annual effect			yes	yes
Province effect			yes	yes
cons	0.183***	0.145***	0.191***	0.278***
	（0.008）	（0.029）	（0.014）	（0.066）
Adj R²	0.206	0.2183	0.2769	0.2098

Note: *, * * and * * * indicate significant at significance levels of 10%, 5% and 1% respectively, with standard error in parentheses, the same below.

The per capita carbon emission index is replaced with the comprehensive sustainable development index, and the log treatment is taken, and equation (1) is regression. The estimated results are shown in Table 5. Under the double fixed effect of OLS and green, green finance is significantly negative for the explained scalar of 1%, indicating that green finance has an inhibitory effect on per capita carbon dioxide emissions, that is, the development of green finance is conducive to reducing carbon emissions and boosting the realization of the dual-carbon target.

TABLE 5. The robustness test

Variable	(1) POLS	(2) POLS	(3) FE	(4) FE
LNGF	-1.332	-4.935***	-2.943***	-3.219***
	（0.303）	（0.35）	（0.573）	（0.807）
LNURB		7.138***		0.342
		（.413）		（0.884）
LNFDI		-3.929***		0.023
		（0.86）		（0.398）
LNTRAD		-1.385***		-0.322
		（0.197）		（0.27）
Annual effect			yes	yes
Province effect			yes	yes
cons	2.173***	0.145***	2.083***	0.278***
	（0.055）	（0.029）	（0.055）	（0.066）
Adj R²	0.051	0.488	0.600	0.604

The method of systematic GMM regression is used to show the dynamic relationship of green finance for sustainable economic development, and to conduct robustness regression for the model. The test results are shown in Table 6, and the coefficient of green finance is positive at the significance level of 1%, indicating that green finance plays a promoting role in promoting sustainable economic development. The simultaneous regression results show that at the 1%

significance level, AR (1) is significant and AR (2) is also significant, that is, the model has first order autocorrelation and second order autocorrelation. The systematic GMM method is applicable, and the robustness test of the model is passed.

TABLE 6. The GMM regression results

Variable	系数
L.LNCE	-0.117***
	（0 .004）
LNGF	0.576***
	（0.082）
LNURB	-0.413***
	（0.024）
LNFDI	2.496***
	（0.106）
LNTRAD	-0.683***
	（0.051）
Hansen	0.989
AR(1)	0.000
AR(2)	0.002

Based on the formulas (2) and (3) of the intermediary model, the gradual regression method is used to test the action mechanism of green finance on the sustainable economic development, and study whether the energy structure is the intermediary variable of green finance to promote the sustainable development of economy. The test results are shown in Table 7. According to Table 7, α_1 and β_1 are significant and β_1 is negative; θ_1 and θ_2 are highly significant; θ_1 is positive and θ_2 is negative. Hypothesis 2 was tested.

TABLE 7. Mechanism test

Variable	LNCE (1)	LNES (2)	LNCE (3)
LNGF	0.426**	-0.823***	0.34**
	（0.163）	（0.239）	（0.176）
LNES			-0.103**
			（0.043）
Annual effect	yes	yes	yes
Province effect	yes	yes	yes
control	yes	yes	yes
cons	0.278***	0.278***	0.696**
	（0.066）	（0.066）	（0.187）
Adj R2	0.922	0.708	0.925

Provinces were divided into high carbon regions and high carbon regions based on per capita carbon emission data, thus testing the heterogeneity of regions with different per capita carbon emissions. Where column (1) represents the low carbon group and column (2) represents the high carbon group. The test results are shown in Table 8. List (1) and (2) and show that the impact of green finance on the performance of sustainable economic development is positive at the level of 5%, that is, the development of green finance can significantly promote the sustainable development of economy, which to a certain extent shows the boosting role of green finance on the green and sustainable development of economy. At the same time, the energy structure has a negative effect on the performance of sustainable development, indicating that the

optimization of energy structure is conducive to the sustainable economic development; at the same time, green finance and energy structure optimization will have a greater impact on the sustainable economic development, indicating that the high-carbon areas need green finance policies to promote the optimization of energy structure and boost the sustainable economic development.

TABLE 8. The tests of heterogeneity

Variable	（1）	（2）
LGF	0.434**	0.455**
	（0.20）	（0.193）
LES	-0.075	-0.11*
	（0.053）	（0.059）
Annual effect	yes	yes
Province effect	yes	yes
Control	yes	yes
cons	0.339***	0.215*
	（0.082）	（0.119）
Adj R²	0.930	0.955

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