



# Relationship between China's Green Finance and Industrial Structure Upgrading Based on the Double Difference Model

Yingying Zhou, Panpan Meng\*, Fengyi Lei, Wanxuan Sun

School of Economics and Management, China University of Mining and Technology, Xuzhou, Jiangsu, 22116, China

\*mengpanpan@cumt.edu.cn

**Abstract.** Promoting the comprehensive green transformation of the economy and society, and deeply adjusting the industrial structure are of utmost importance in achieving the "dual carbon" goals. Green finance has the function of resource allocation, guiding funds to flow into the green environmental protection industry, thereby promoting the coordinated development of the economy and environment, and has a crucial impact on the upgrading of the industrial structure. This article uses the provincial panel data of China as the research sample, constructs a bidirectional fixed effects continuous double difference model, and uses regional differences in the degree of green finance development to estimate the impact of green finance development on industrial structure upgrading. Research has found that the development of green finance has a significant impact on the upgrading of China's industrial structure, especially in the central and eastern regions where the promotion of green finance on industrial structure upgrading is significant. Further suggestions were put forward to promote the synergy between green finance and environmental regulations, taking into account China's actual situation, in order to achieve industrial structure upgrading.

**Keywords:** Green finance; Industrial structure; Double difference model; Financing constraints; technological innovation.

## 1 Introduction

Since the reform and opening up, the Chinese economy has flourished, and the relationship between the three domestic industries has undergone significant changes. The 2022 government work report also mentioned the continuous improvement of the ecological environment and the promotion of green and low-carbon development. Yan et al. (2016) [1] believe that financial development can not only directly promote the development of low-carbon economy, but also indirectly promote the development of low-carbon economy through technological innovation and other channels. Therefore, how to promote the upgrading of industrial structure is an important issue that requires in-depth research to solve environmental pollution problems. At the same time, green

finance reduces financing constraints, reduces financing costs, and increases its funding scale through various green financial tools, thereby imposing financing constraints on high polluting industries. From this perspective, green finance has had a certain impact on industrial structure upgrading through investment and financing activities. Green finance not only plays a role in resource allocation, but also pays more attention to environmental protection, guiding capital to transfer to green and environmentally friendly industries, thereby promoting harmonious development of the economy and environment, and playing a crucial role in upgrading industrial structure. Therefore, it is of great significance to conduct in-depth research on the role of green finance in upgrading industrial structure and provide policy recommendations for the low-carbon and high-quality development of the Chinese economy.

## 2 Domestic and Foreign Literature Review

At present, research on the impact of developing green finance on industrial structure upgrading at home and abroad mainly focuses on guiding the allocation of funds to the environmental protection industry. The development of green finance not only drives technological innovation, but also promotes industrial structure upgrading, promoting the development and innovation of green finance business.

In terms of green product research, some scholars believe that investors will purchase environmental mutual funds with low investment returns for the development of enterprises. Also improved the evaluation and measurement standards based on the gaps and needs in sustainable investment; and by issuing green bonds, companies send a credible signal of environmental commitment. Only when the returns of green financial products increase and the risks decrease, will investors be attracted to invest more in this field. Capital constraints and trade regulations, analyzed green financing and cost sharing, and concluded that the interest rate of green finance does not have a negative impact on manufacturers' carbon emissions, but cost sharing may affect manufacturers and have an impact on their carbon emissions. However, some companies may lack or have almost no social responsibility, yet they can achieve impressive market performance (Zhou et al., 2021) <sup>[2]</sup>. For energy-saving and environmental protection enterprises, the higher their dependence on external financing, the greater their impact on green finance.

Other scholars believe that high carbon emitting enterprises require a large amount of transformation funds during the process of carbon peak and carbon neutrality. If companies undergoing transformation are unable to obtain financing, it will lead to financial and social risks. The effectiveness of green fiscal pollution control is influenced by economic and environmental factors as well as the public good attributes of green fiscal itself. The cost and risk sharing functions of green finance can more effectively address the funding gap for green development. The effectiveness of green credit policies requires the support of environmental protection policies and relevant laws and regulations. The micro foundation of industrial structure change is the continuous growth of enterprises and their entry into new industries. Zhan et al (2023) <sup>[3]</sup> believes that there is a "path dependence" effect between fintech and green finance development.

In areas with strong technological innovation and transformation capabilities, high material capital investment, and high regional population density, the synergistic promotion effect of fintech and green finance on industrial structure upgrading is stronger. Shao et al (2024) [4] pointed out that green finance has a positive impact on industrial structure upgrading through optimizing resource allocation, promoting the transformation of heavily polluting and high energy consuming enterprises, promoting green innovation, and enhancing corporate social responsibility awareness.

The existing literature has laid a good foundation for studying the effects of green finance policies, but the standard discrete double difference method requires that the intervention level is the same for all individuals, that is, the impact level of green finance policies on all treatment groups is the same. However, due to the different establishment times of green finance policies in different provinces and cities, there are different time differences in the specific implementation of policy provisions, as well as differences in the degree of policy implementation and green finance development among provinces and cities. Therefore, this article will focus on studying policy effects.

### 3 Model Construction and Variable Selection

#### 3.1 Model Construction

##### (1) Identifying Hypotheses

The identification hypothesis in this article utilizes two types of variability, the first of which comes from the temporal level. It is because with the passage of time, China's green finance has been continuously developing. The second variability comes from the differences in cross-section, which is due to the varying levels of green finance development in each province and city. That is, each province and city is affected by green finance policies, but the intensity of the impact varies.

##### (2) Double Difference Model

This article refers to the research of Bahar et al (2021) [5], selects the "Overall Plan for Ecological Civilization System Reform" as a national impact, uses continuous variables (degree of green finance development) as the processing variable, and uses continuous double difference to identify the impact of green finance development on industrial structure upgrading. This article establishes the following econometric model (1) as the benchmark model.

$$Y_{it} = \alpha_0 + \alpha_1 green_i \times policy_t + \alpha_i Controls_{it}^1 + \lambda_t + \lambda_i + \varepsilon_{it} \quad (1)$$

In the model (1),  $i$  represents the individual province,  $t$  represents the year, and  $\varepsilon_{it}$  represents the random disturbance term in model (1).  $Y_{it}$  represents the industrial structure upgrading index of province  $i$  in year  $t$ ;  $green_i$  represents the level of green finance development in province  $i$ , used to measure the impact of green finance policies

on each province. The higher the value, the higher the level of green finance development in the region, and the stronger the impact of green finance policies;  $policy_i$  is a dummy variable of policy time, used to represent the time point at which the policy impact of the Overall Plan for Ecological Civilization System Reform occurred. For years after 2015, take 1, and for years before 2015, take 0;  $Controls_{it}^1$  is the control variable in the (1) model,  $\lambda_i$  is the individual fixed effect, and  $\lambda_t$  is the time fixed effect.

The model (2) is for parallel trend testing and dynamic effect estimation.

$$Y_{it} = \alpha_0 + \sum_{k=2011}^{2019} \alpha_k green_i \times policy_k + \zeta_i Controls_{it}^1 + \lambda_t + \lambda_i + \varepsilon_{it} \quad (2)$$

Among them,  $k$  represents the year when the green finance policy was introduced. This article first replaces the policy time variable  $policy_i$  in the benchmark regression model with the time dummy variable  $policy_k$  for each year in the sample ( $k=2010, 2011, \dots, 2019$ ). Finally, 2010 was used as the reference period and omitted from the model. All other variables were defined the same as in model (2), and an extended econometric model was obtained.

### 3.2 Indicator Selection and Data Sources

#### (1) Dependent Variable

This article refers to the research of Gan et al (2011) [6] and uses the advanced industrial structure indicator, the ratio of the added value of the tertiary industry to the added value of the secondary industry, to measure industrial structure upgrading.

#### (2) Explanatory Variables

Due to the fact that the development of green finance in China is mainly driven by top-down policies (Liu et al, 2022) [7], this article uses the level of green finance development in each province and city to measure the intensity of the impact of green finance policies on each province and city. Constructing an indicator evaluation system from four aspects: green credit, green securities, green investment, and green insurance

#### (3) Control Variables

In order to control the impact of regional differences as far as possible and mitigate the deviation of results, referring to other literature and Gu et al (2021) [8] research, the following variables that have an important role in promoting industrial structure upgrading and green financial development are controlled in the model, mainly including urbanization (URB), research and development investment (R&B), government fiscal expenditure (GOV), savings and loans per unit GDP (FIN), fixed assets investment (FIX), human capital level (HUM), and degree of industrialization (IND).

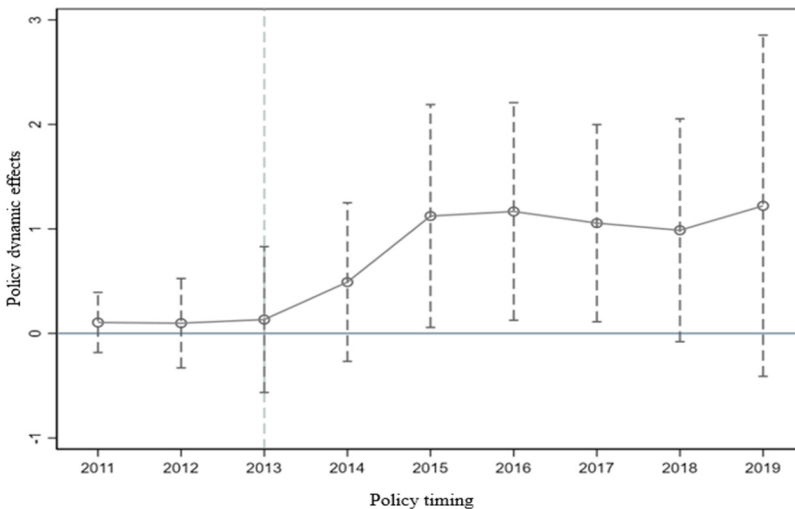
**(4) Data Source**

Due to the fact that the marketization indicator data of each province is only released until 2019, in order to unify the caliber, this study uses China's provincial panel data from 2010 to 2019 as the original research sample (the green finance development degree data is converted into cross sectional data by taking an average value during the sample period), including 30 provinces (municipalities directly under the Central Government, autonomous regions, Tibet, Hong Kong, Macao and Taiwan are not included due to the lack of data). The data is sourced from China Industrial Statistical Yearbook, and Guotai An Database etc.

## 4 Empirical Results and Analysis

### 4.1 Parallel Trends and Dynamic Effects Results

From Figure 1, it can be seen that after the promulgation of the Overall Plan for Ecological Civilization System Reform (i.e. from 2015 onwards), green finance policies have had a significant promoting effect on industrial structure upgrading. Further observation shows that after the promulgation of the overall plan for ecological civilization system reform, the marginal effect line has significantly deviated from the origin, and in most years, the 95% confidence interval does not include a zero value. This indicates that after 2015, green finance policies have had a long-term promoting effect on industrial structure upgrading. In summary, the transformation of industrial structure upgrading satisfies the assumption of parallel trends.



**Fig. 1.** Parallel Trends and Dynamic Effects

#### 4.2 Analysis of Benchmark Regression Results

Table 1 shows the differences in the development level of green finance among the three regions of East, West, and Central China. There are significant differences in the distribution characteristics of China's green development level in the central, eastern, and western regions.

**Table 1.** Green Finance Development Index by Region

Area	Observations	Mean Value	Standard Deviation	Minimum Value	Maximum Value
East	110	0.204	0.147	0.110	0.620
Central China	80	0.140	0.033	0.096	0.199
West	110	0.143	0.043	0.093	0.223

The first column of Table 2 reports the regression results after controlling for time fixed effects and provincial fixed effects, as well as corresponding control variables. According to the results, it can be found that the coefficient of the core explanatory variable is 0.941, which passes the statistical significance test at the 5% level. This means that the development of green finance in China significantly promotes industrial structure upgrading. Therefore, hypothesis 1 is supported that the development of green finance has a significant impact on China's industrial structure upgrading, and the economic significance of green finance development for industrial structure upgrading can be expressed as: after the promulgation of the Overall Plan for Ecological Civilization System Reform, when the green finance development index increases by one standard deviation  $\sigma_{green}$ , the impact on industrial structure upgrading will increase by 0.941

$\sigma_{green}$ .

**Table 2.** Impact of Green Finance Development on Industrial Structure Upgrading

Variable	Symbols	(1)	(2)	(3)	(4)
		All sample <i>Y</i>	East <i>Y</i>	Central China <i>Y</i>	West <i>Y</i>
<i>green</i> × <i>policy</i>		0.941** (0.373)	0.675* (0.327)	2.322* (0.990)	-1.069 (0.616)
Human Capital	<i>HUM</i>	0.188** (0.088)	0.479*** (0.106)	-0.027 (0.066)	-0.012 (0.058)
Urban Population Density	<i>POP</i>	-0.131 (0.085)	-0.515*** (0.159)	0.233*** (0.039)	-0.053 (0.056)
Unit GDP Deposit and Loan Amount	<i>FIN</i>	-0.026 (0.072)	-0.008 (0.101)	-0.056 (0.247)	0.028 (0.074)
Expenditure	<i>GOV</i>	3.113*** (0.710)	1.930 (1.400)	4.954** (1.714)	2.537*** (0.393)
R&D Investment Proportion	<i>R &amp; D</i>	-2.315 (9.504)	-3.849 (9.411)	5.502 (17.879)	-0.856 (8.849)
Constant Term	<i>Constant</i>	-0.247	0.443	-1.808*	0.597

	(0.897)	(1.792)	(0.889)	(0.944)
Year fixed effect	Control	Control	Control	Control
Provincial fixed effects	Control	Control	Control	Control
Sample Size	300	110	80	110
R <sup>2</sup>	0.833	0.899	0.911	0.881

Note: The brackets represent the robust standard error of clustering,\* p<0.1, \*\* p<0.05, \*\*\* p<0.01

## 5 Conclusion and Inspiration

### 5.1 Research Conclusion

"Top level design" is an important feature of China's green finance, which guides the market to make corresponding responses according to policy requirements by playing a "top-down" signal transmission function. Therefore, the development level of green finance in each region can be used to measure the intensity of the impact of green finance policies in each region. At the same time, based on theoretical analysis and existing literature, combined with the background of green finance, and taking into account the different time when green finance policies were established in each province and city, as well as the different implementation efforts of policies in each province and city, this article applies the exogenous policy impact of the "Overall Plan for Ecological Civilization System Reform", and considers the regional differences in exogenous policy impact. By comparing the differences in industrial structure upgrading between regions with higher levels of green finance development and regions with lower levels of green finance development, and before and after the release of the "Overall Plan for Ecological Civilization System Reform," the average processing effect of the policy is identified. This article enhances the credibility of empirical results by conducting parallel trend and dynamic effect tests, placebo tests, excluding the influence of extreme values, and two period double difference tests. Research has found that green finance significantly promotes industrial structure upgrading, and the development of green finance in both the central and eastern regions has a significant promoting effect on industrial structure upgrading.

### 5.2 Policy Implications

Based on the above research conclusions, this article proposes the following policy recommendations. Firstly, promote the synergy between green finance and environmental regulations to achieve industrial structure upgrading. Intensify the punishment for environmental violations by enterprises, reduce the cost of environmental violations, and increase the environmental protection costs of enterprises to promote their green transformation. Secondly, fully leverage the role of green finance market resource allocation. Establish a sound green finance market system, strengthen the disclosure of green

finance market information, establish an environmental protection information disclosure platform, strengthen the disclosure of enterprise environmental protection information, enable investors and the public to understand the environmental investment and impact of enterprises, encourage enterprises to strengthen environmental investment, promote the development of green industries, and promote sustainable economic development. Once again, promote innovation in green invention technology. Improve industrial policies, promote "green procurement" policies, encourage enterprises to adopt green products and technologies, and promote the industrialization of green economy. Finally, promote the coordinated development of green finance between regions. Strengthen policy guidance and support for green finance between regions, promote deep integration of green finance and the real economy, and at the same time, strengthen policy guidance and support for green finance between regions, promote deep integration of green finance and the real economy, and further promote industrial structure upgrading.

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## References

1. Yan C, Li T, Lan W.: Financial Development, Innovation and Carbon Emission. *Journal of Financial Research*(1), 14-30 (2016).
2. Zhou G, Liu C, Luo S.: Resource Allocation Effect of Green Credit Policy: Based on DID Model. *Mathematics* 9(2), 159 (2021).
3. Zhan S, Wang R, LIU Y.: Impact effects of fintech and green finance synergy on industrial structure upgrading: based on the perspective of heterogeneous environmental regulation. *China Population, Resources and Environment* 33(11), 152-162 (2023).
4. Shao J, Song Y.: Impact of Green Finance on Industrial Structure Upgrading. *China Journal of Commerce* (10), 97-100 (2024).
5. Bahar D, Ibáñez A M, Rozo S V.: Give me your tired and your poor: Impact of a large-scale amnesty program for undocumented refugees. *Journal of Development Economics* 151, 1-24 (2021).
6. Gan C, Zheng R, YU D.: An Empirical Study on the Effects of Industrial Structure on Economic Growth and Fluctuations in China. *Economic Research Journal* 46(5), 4-16+31 (2011).
7. Liu F, Huang P, Tang D.: The Carbon Emission Reduction Effect of Green Finance Development and Its Impact Pathways. *Financial Economics Research* 37(6), 144-158 (2022).
8. Gu B, Chen F, Zhang K.: The policy effect of green finance in promoting industrial transformation and upgrading efficiency in China: analysis from the perspective of government regulation and public environmental demands. *Environmental Science and Pollution Research* 28(34), 47474-47491 (2021).



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