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Study on the Effect of Fiscal, Tax and Financial Policies Synergizing to Promote Enterprises' Green and Low-Carbon Transformation

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Abstract

There is a consensus to strengthen the synergy of fiscal and financial policies to promote the green and low-carbon transformation of enterprises. This study uses data on A-share listed companies from 2007 to 2020 to construct a fixed-effects model to compare and analyze the impact of fiscal and financial policies on the green and low-carbon transformation of enterprises, as well as the impact of the synergistic effect of fiscal and financial policies on the green and low-carbon transformation of enterprises from a micro point of view, and calculates the degree of coupling and coordination between fiscal and financial policies from a macro point of view. The results show that fiscal and financial policies can significantly affect the green and low-carbon transformation of enterprises; however, the impact of financial policies on the green and low-carbon transformation of enterprises is not significant under the condition of greater support for fiscal policies, and the coupling synergy degree of fiscal, tax, and financial policies as a whole shows an upward trend.

Keywords

Fiscal Policy; Financial Policy; Green and Low-carbon Transition.

1. Introduction

Enterprises are key players in realizing the "dual-carbon" goal. Under the background of "dual-carbon", green and low-carbon transformation, upgrading, and sustainable development have become the road to the high-quality development of enterprises. Adhering to ecological priority and promoting green and low-carbon transformation of the development mode is an important part of realizing high-quality development; it is also an important part of completing the "Fourteenth Five-Year Plan" to "continuously improve the quality of the environment" and realizing the visionary goal of "fundamental improvement of the ecological environment" by 2035. It is also a realistic requirement to complete the "Fourteenth Five-Year Plan" to "continuously improve environmental quality" and to realize the 2035 "fundamental improvement of the ecological environment"s vision; therefore, promoting the green and low-carbon transformation of enterprises as well as solving the shackles of enterprise energy efficiency enhancement have become key issues in realizing green development. Therefore, the promotion of green and low-carbon transformation of enterprises and solving the shackles in enterprise energy efficiency improvement have become key issues for realizing green development. Fiscal, tax, and financial policies are important means to support the green and low-carbon transformation of enterprises, and it is of great significance to explore the effects of fiscal, tax, and financial policies in supporting the green and low-carbon transformation of enterprises and the direction of future improvement to promote the green and low-carbon transformation of enterprises

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Scholars have conducted extensive research on fiscal and taxation policies, financial policies, and the green and low-carbon transformation of enterprises, focusing mainly on the motivation for green and low-carbon transformation of enterprises, the path, and the supporting effect of fiscal and taxation policies and financial policies on the green and low-carbon transformation of enterprises. The green and low-carbon transformation of enterprises focuses on the following two aspects. The first is the motivation for green and low-carbon transformation of enterprises. On the one hand, due to external pressure, enterprises are forced to transform towards green and low-carbon development. Ma Pingping et al.[1] found that public environmental concerns can positively promote the green and low-carbon transformation of enterprises as a form of informal regulation. Xu Jie etal.[2] used the establishment of environmental protection courts by local intermediate people's courts as a quasi-natural experiment and found, using a multi-period double difference model, that the establishment of environmental protection courts has a significant positive impact on the green and low-carbon transformation of enterprises. Yuan Can et al.[3] believe that command-type environmental regulation and investment-type environmental regulation have an inverted “U”-shaped effect on the green and low-carbon transformation of the manufacturing industry is characterized by an inverted “U”-shaped pattern, with the impact of command-type environmental regulation and investment-type environmental regulation on the green and low-carbon transformation of the manufacturing industry first promoting and then inhibiting, and the impact of fee-based environmental regulation on the green and low-carbon transformation of the manufacturing industry first inhibiting and then promoting. On the other hand, based on the internal factors, such as enhancing enterprise competitiveness and sustainable development, which drive enterprises to carry out green and low-carbon transformation, Wu Zhixiang et al.[4] found that the improvement of technological innovation level brought about by green and low-carbon transformation has to a certain extent compensated for the cost of enterprises in carrying out transformation, while effectively alleviating financing constraints and promoting industry competition, thus promoting enterprises to achieve a win-win situation in terms of economic and environmental goals. Guo Jinhua[5] found through research that green and low-carbon transformation can not only improve the level of green innovation in enterprises, but also increase government subsidies for enterprises, alleviate financing constraints on enterprises, increase cash flow, and stimulate the enthusiasm of enterprises to invest in research and development and other industries. The second is a measurement method for the green and low-carbon transformation of enterprises. Sun Chuanwang et al.[6] measured the level of green and low-carbon transformation of enterprises by constructing a comprehensive index evaluation system; Zhu Shiyin et al.[7] measured the green and low-carbon transformation index of enterprises from the perspectives of economic performance, Huanyun, etc.[8] measured the green and low-carbon transformation index of enterprises from the perspectives of innovation performance and environmental performance; Ma Pingping et al.[1] measured it based on text analysis.

Research on fiscal and taxation policies mainly focuses on the supporting effects of fiscal and taxation policies on the green and low-carbon transformation of enterprises. Li Xiaoyi[9] found that financial subsidies can significantly stimulate the green and low-carbon transformation of the manufacturing industry. An effective way to stimulate the green and low-carbon transformation of the manufacturing industry is to focus on the promotion and incentive assessment model of officials, who pay attention to the comprehensive performance of regional scientific and technological innovation capabilities. However, government officials’ rent-seeking incentives are an important channel for inhibiting the green and low-carbon transformation of the manufacturing industry. Wu Fei and Li Wei[10] believe that the accelerated depreciation policy for fixed assets in tax incentives has significantly driven the green and low-carbon transformation of enterprises green and low-carbon transformation, and

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this policy's driving force for transformation is more significant when there is uncertainty in economic policies; Jia Yidan[11] found that tax policies can alleviate financing constraints on enterprises, thereby improving their green development behavior and improving their green development performance; Liu Xuexin and Wang Shupeng[12] believe that tax incentives can motivate enterprises to engage in green innovation activities and have a positive impact on their green innovation behavior.

Research on financial policies has mainly focused on the supporting effect of financial policies on the green and low-carbon transformation of enterprises. Jing Guowen[13] found through research that green finance reform pilot zones can effectively promote green technological innovation and the clean-up of industrial structures, thereby increasing green total factor productivity, and that the policy effects are more significant in western regions and non-resource-based regions. Qin Teng et al.[14] believe that green credit policies can accelerate the green and low-carbon transformation and upgrading of heavily polluting enterprises by improving the efficiency of green technologies. However, when enterprises are at a relatively high level of marketization, the role of green credit policies in improving the efficiency of green technologies will be weakened, and correspondingly, the role of promoting green and low-carbon transformation and upgrading of enterprises will also be weakened. Hu Tianyang et al.[15] believe that the inhibitory effect of financial policies is better for heavily polluting enterprises, while the incentive effect of financial policies is relatively better for lightly polluting enterprises, and that green credit has the most significant incentive transformation effect on non-state-owned domestic enterprises. Liu Shan[16] found through research that the level of green finance can reduce the energy consumption and pollution emission intensity of enterprises in two ways: by financing constraints and technological innovation, it can drive the overall expansion of enterprises and local emission reduction governance. In addition, green finance has a greater effect on the green transformation of enterprises in heavily polluting industries, capital-intensive enterprises, small and medium-sized enterprises, enterprises in the eastern region, and enterprises in non-resource-based regions.

The above literature shows that previous scholars' studies on fiscal policy, financial policy, and enterprise green low-carbon transition are rich and diverse, which provides a reference for this paper to carry out the research. However, there is little literature on the comparative analysis of the impact of fiscal and financial policies on enterprises' green and low-carbon transformation and the coupling and synergy between the policies. Therefore, this study utilizes the panel data of listed enterprises to construct a fixed-effects model to comparatively analyze the impacts of fiscal and financial policies on enterprises' green and low-carbon transformation, study the impacts of the synergy of the two on enterprises' green and low-carbon transformation, and calculate the coupling synergy degree between the policies, with a view to providing countermeasures and suggestions for strengthening the synergy of fiscal and financial policies and accelerating the process of green and low-carbon transformation of China's enterprises.

2. Rationale and Basic Assumptions

2.1. Fiscal and Financial Policies and Enterprises' Green and Low-carbon Transition

2.1.1. Mechanism Analysis of Fiscal and Tax Incentive Policies to Support Green and Low-carbon Transformation of Enterprises

Fiscal incentives mainly include financial subsidies and tax concessions. Financial subsidies are ex ante incentive policies, mainly supporting the green transformation of specific areas and projects selected by the government, with an obvious support orientation. From the perspective of financing constraints, the subsidy channel reduces the difficulty of enterprises

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in obtaining external funds, enriches the cash flow of enterprises, eases financing constraints, encourages enterprises to research and develop cleaner technologies, reduces pollution emissions, internalizes the positive externality of energy saving and emission reduction, and incentivizes enterprises to participate in environmental governance[17] . From the perspective of R&D and innovation incentives, the government has set up special funds to support enterprises in carrying out green technology R&D and innovation, reducing the cost of enterprise R&D and innovation through subsidies, and at the same time compensating for part of the losses caused by the failure of green technology R&D, increasing the enthusiasm of enterprises to carry out green innovation[18] . From the perspective of supporting green finance, supporting its development of green finance through financial subsidies attracts more financial resources to be invested in the green field, such as providing subsidized interest rates on loans for green projects, reducing the cost of enterprise financing, and improving the efficiency of capital use.

Tax incentives are ex-post incentive policies, and the behavior of enterprises carrying out green transformation determines whether they can obtain tax incentives; tax incentives can internally drive enterprises to carry out green and low-carbon transformation. In the field of production, tax regulation reduces the production costs of enterprises that support environmental protection and green development, encourages enterprises to invest in green projects such as environmental protection and low-carbon development, develops cleaner production technologies, guides green and environmentally friendly enterprises to expand their production scale, promotes green production and cleaner production, and promotes green and low-carbon transformation of enterprises. Such as the implementation of environmental protection tax incentives, regular reduction, and exemption of corporate income tax on income from engaging in qualified environmental protection, through tax incentives to reduce the tax burden on enterprises, bring indirect resource support for enterprises, promote the enhancement of the efficiency of enterprise resource allocation, and stimulate enterprises to carry out the production of green and low-carbon transformation initiatives to guide the flow of capital to the green field. In the field of consumption, the government encourages enterprises through tax regulations to purchase products and equipment that support environmental protection, promote energy conservation and environmental protection, reduce energy consumption and pollution emissions, and promote green production and clean production by enterprises to realize green and low-carbon transformation. For example, for enterprises purchasing specialized equipment for environmental protection, enterprise income tax credits can be provided according to a certain percentage based on the amount of investment in the equipment, which encourages enterprises to adopt environmentally friendly equipment and incentivizes them to carry out green and low-carbon transformation. Accordingly, hypothesis 1 is proposed:

H1: Fiscal policies can promote green and low-carbon transformation of enterprises.

2.1.2. Analysis of the Mechanism of Financial Policy to Support the Green and Low-carbon Transformation of Enterprises

Financial policy support for enterprise green and low-carbon transformation is mainly manifested in the following three aspects. First, incentives for enterprises to increase environmental investment. Support for the green and low-carbon transformation of green finance inceases the environment pollution enterprise environmental pollution cost, prompting enterprises to improve the level of green technological innovation to reduce the amount of pollution generated by the front end and increase the end of environmental governance and other behaviors to the financial institutions to signal to obtain preferential credit support. Second, adjust the financing constraints. On the one hand, green finance through the provision of a rich variety of financial products to meet the needs of enterprises to invest in green projects from the outside to alleviate the pressure of financing constraints, such as the main investment

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in the green field of green credit, support for green projects of green bonds for active green production, and green and low-carbon transformation of enterprises to provide low-cost financial support. On the other hand, by setting loan approval conditions, constraints on environmental governance failed high-pollution and high-energy-consumption enterprises, the enterprise capital restrictions to improve the level of corporate financing constraints, forcing enterprises to carry out a green and low-carbon transformation from the internal plight of financing difficulties. Third, enterprises should be encouraged to adjust their production scale. Under the pressure of green financial policy, enterprises pursue profits at the same time, but also increase environmental governance inputs, internalize the cost of pollution, and thus reduce the cost of financing from internal and external financing constraints. Reducing pollution costs by adjusting the production scale is lower; therefore, the motivation of heavily polluting enterprises constrained by green financial policy to reduce pollution generation by reducing production scale is stronger[19] . Accordingly, hypothesis 2 is proposed:

H2: Financial policies can promote green and low-carbon transitions in enterprises.

2.1.3. Analysis of the Impact of Fiscal, Tax and Financial Synergy on the Green and Low-carbon Transformation of Enterprises

On the one hand, the synergy of fiscal and financial policies may strengthen the policy effect and form policy synergy to jointly promote the green and low-carbon transformation of enterprises. From the perspective of the mutual complementarity of fiscal and financial policies, fiscal policy reduces the burden on enterprises through financial subsidies, tax incentives, and other incentives to alleviate the pressure on capital, promote the enhancement of the efficiency of enterprise resource allocation, and guide the flow of capital to the green field. Financial policy through green credit, green bonds, and other financial tools for green enterprises to provide financial support to reduce the financing cost of green projects, while limiting the scale of loans to polluting enterprises to increase the cost of enterprise financing, fiscal policy, and financial policy complement each other, and guidance and restrictions to promote the combination of enterprises for green and low-carbon transformation. From the perspective of mutual support of fiscal, tax, and financial policies, first, using the signaling mechanism of financial subsidies to guide the flow of funds from financial institutions, the government provides financial subsidies to enterprises developing green technologies and clean energy industries, which transmits the signals of encouraging enterprises to carry out green technological innovation and green and low-carbon transformation. The financial institutions, according to the direction of the government's provision of financial subsidies, provide low-interest green credits to reduce the capital cost of green and low-carbon transformation of enterprises. Financial institutions provide low-interest green credit according to the direction of financial subsidies provided by the government, reducing the capital cost of enterprises' green and low-carbon transformation. Second, the use of fiscal and tax incentives to support financial institutions to provide funds for enterprises in green and low-carbon transformation, the government through green credit, green bond financial subsidy policy, and green guarantee award policy to encourage financial institutions to support the green field, in order to finance the green and low-carbon transformation of enterprises to alleviate difficulties. In addition, some local governments support issuers of green bonds with tax exemptions and reductions. By reducing issuers issuance costs, they increase the enthusiasm of issuers, expand the scale of green bond issuance, and satisfy the financing needs of enterprises in green and low-carbon transformation.

On the other hand, when fiscal and financial policies are implemented in tandem, they may not be able to achieve the result of strengthening the policy effect and significantly influence the green and low-carbon transformation of enterprises. First, both fiscal and financial policies can alleviate the financial constraints of enterprises to a certain extent, but too high an incentive degree for fiscal and tax policies may make enterprises rely too much on government subsidies and squeeze out the effect of financial policies. Second, the combined implementation of fiscal

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and financial policies may make enterprises slack off in green technological innovation because of the reduced pressure on production and operation after obtaining financial support, and the low efficiency of capital utilization makes the policy effect unsatisfactory, which is not conducive to promoting the green and low-carbon transformation of enterprises[20] . Third, due to the strengthening of government environmental regulations, some enterprises are limited in their participation in the capital market, and they try to use bleaching green behavior to link green finance to obtain more financial support and financing facilities, but they do not make substantial changes after obtaining the corresponding green funds and financial subsidies. Accordingly, a competing hypothesis is proposed:

H3a: The synergy of fiscal and financial policies can significantly influence the green and low-carbon transition of enterprises.

H3b: The synergy of fiscal and financial policies cannot significantly influence the green and low-carbon transition of enterprises.

2.2. Mechanism of Mediating Effect of Green Technology Innovation

Fiscal policy and financial policy through the provision of direct financial subsidies, reduce the tax burden, ease the financing constraints, guide the flow of funds, etc, so that the enterprise funds to increase and then increase R&D investment in green technology innovation, improve the efficiency of green technology innovation, and accelerate the transformation of technological achievements. Enterprises are the main body of carbon and pollutant emissions, and green technology innovation is the key driving force for promoting the green and low-carbon transformation of enterprises. The impact of green technology innovation on the green and low-carbon transformation of enterprises is manifested in the following ways: first, enterprises transform backward energy technologies and develop new energy technologies, reduce the consumption of high-pollution energy, and enhance the consumption of clean energy through green technology innovation to improve the efficiency of resource utilization; second, enterprises transform technologically backward and seriously polluted production equipment and upgrade the resource-dependent serious resource system through green technology innovation, and guide enterprises to save energy, improve the efficiency of resource utilization, and improve the efficiency of resource utilization. resource system, guiding enterprises to save energy and low-consumption production; Third, green technology innovation can guide enterprises to green production, enterprises in order to improve their own competitive advantage gradually through innovation to develop green products and services to meet consumer demand for environmental protection, thus conveying the signal of environmental protection, reducing energy consumption and pollution emissions in the production process, and promoting the green and low-carbon transformation of enterprises. Accordingly, hypothesis 4 is proposed.

H4: Fiscal and financial policies can promote green and low-carbon transformation of enterprises through green technological innovation.

3. Research Design

3.1. Model Setup

To test the actual policy impact of various fiscal and financial policies, including government subsidies and green finance, on the green and low-carbon transformation of enterprises, this study constructs the following fixed effects model:

$$Y_{i,t} = \alpha_0 + \alpha_1 X_{i,t} + \sum \alpha_m \times Controls_{i,t} + \gamma_i + \theta_t + \xi_{i,t} \quad (1)$$

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In addition, to test whether fiscal and tax policy incentives and financial policy support can promote the green and low-carbon transformation of enterprises by improving the level of green innovation, this study takes the level of green innovation as the mediating variable, draws on the practice of Jiangboat[21] , combines theoretical analysis with model testing, and constructs the following empirical model based on the realistic conclusions of the impact of green innovation[22] on the green transformation of enterprises in the existing literature to test the mediating effect:

$$Gtec_{i,t} = \beta_0 + \beta_1 X_{i,t} + \sum \beta_m \times Controls_{i,t} + \gamma_i + \theta_t + \xi_{i,t} \quad (2)$$

Among them,$Y_{i,t}$ denotes the degree of green and low-carbon transformation and development of enterprises;$X_{i,t}$ denotes the two core explanatory variables of this study, which are fiscal policy incentives and financial policy support;$Gtec_{i,t}$ is the mediator variable, which denotes the level of green technological innovation of enterprises;$Controls_{i,t}$ is the control variable of this study;γ_i ,θ_t ,and$\xi_{i,t}$ are the individual fixed, time-fixed, and random error terms, respectively.

3.2. Description of Variables

3.2.1. Explained Variables

Degree of green and low-carbon transformation of enterprises: In this study, the three dimensions of green, economy, and development, the four indicators of pollutant emissions, carbon emissions, return on net assets, and total factor productivity are selected to objectively calculate the weights of the indicators according to the entropy method. Then, the TOPSIS model is used to comprehensively assess the degree of green and low-carbon transformation of enterprises.

3.2.2. Explanatory Variables

Degree of fiscal policy incentives: Referring to Guo Jiang[23] , government grants partially reflect both the tax incentives enjoyed by the enterprise and the complete reflection of the enterprise's enjoyment of the fiscal subsidy policy. Therefore, this study uses government grants to jointly reflect the fiscal policy, and the degree of policy incentives is measured by dividing the total amount of government grants by the total assets.

Degree of green financial support: To measure the degree of green financial support, three indicators-green credit, green investment, and green securities, are selected to construct an indicator system using the entropy method. This study characterizes green credit by the proportion of interest of non-six high-energy-consuming industrial industries to the proportion of interest of industrial industries, selects the proportion of investment in environmental pollution control to GDP as a measure of green investment, and measures green securities by the market value of six high-energy-consuming industries in the A-share market value ratio as a negative indicator.

3.2.3. Mediating Variables

Green technological innovation: Referring to Wang[24] , the sum of the number of green invention patent applications and the number of green utility model applications, plus 1 to take the logarithm, is used as an indicator of green technological innovation.

3.2.4. Control Variables

In this study, firm size, return on net assets, inventory ratio, total asset turnover ratio, proportion of independent directors, and proportion of shares held by the first largest shareholder are selected as control variables, and the definitions of the variables are shown in Table 1.

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Table 1. Variable Attributes and Definitions

Variable Properties	variable name			variable symbol	Variable Meaning
explanatory variable	Level of fiscal policy incentives			Sub	Total government grants / total assets
	green finance	Green credits (+)		Gfinal	Non-energy-consuming industrial interest/industrial interest
		Green investments (+)			Investment in pollution control/GDP
		Green securities (-)			Value of the six most energy-intensive A-shares/total A-share market capitalization
explanatory variable	Green and Low Carbon Transition of Enterprises	greener	Pollutant emissions	Y	Sulfur dioxide emissions/enterprise revenue
			carbon footprint		Carbon dioxide emissions/enterprise revenue
		economics	return on net assets		Net profit/average net worth
		developmental	Total factor productivity		Measurement of enterprise productivity using the LP method
control variable	Enterprise size			Size	Logarithm of total assets
	Net profit margin on total assets			ROA	Average total net profit/total assets
	Inventory as a percentage			INV	Net inventory/total assets
	Total asset turnover			ATO	Operating income/average total assets
	Proportion of independent directors			Indep	Number of independent directors/directors
	Shareholding ratio of the largest shareholder			Top1	Number of shares held by the largest shareholder/total number of shares
intermediary variable	Green Technology Innovation			Gtec	Ln (number of green invention patent applications + number of green utility model

3.3. Sample Selection and Data Sources

This study selects A-share listed companies from 2007 to 2020 as the research samples, excludes ST, *ST companies, financial industry enterprises, and samples of enterprises with serious data missing, and Winsorize continuous variables at 1% and 99% quantile to make the sample data more complete, this paper adopts interpolation to make up for a small portion of missing values, and ultimately use 19,312 samples To conduct the study, the descriptive statistical characteristics of the main variables are shown in Table 2, and the data of the study are from CSMAR database, EPS database, National Bureau of Statistics, and China Industrial Statistical Yearbook.

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Table 2. Descriptive Statistics

variant	sample size	average value	median	standard deviation	minimum value	maximum values
Y	19132	0.405	0.400	0.048	0.302	0.557
Sub	19132	0.005	0.003	0.007	0.000	0.225
Gfinal	19132	0.248	0.229	0.0921	0.145	0.727
Gtec	19132	0.374	0.000	0.823	0.000	6.848
Size	19132	22.23	22.05	1.310	19.37	26.40
ROA	19132	0.041	0.039	0.0614	-0.382	0.339
INV	19132	0.146	0.121	0.114	0.000	0.778
ATO	19132	0.703	0.598	0.453	0.546	3.106
Indep	19132	0.373	0.333	0.055	0.223	0.708
Top1	19132	0.348	0.331	0.149	0.0167	0.820

4. Analysis of Empirical results

4.1. Base Regression Analysis

The actual influence of fiscal and taxation policies and financial policies on the degree of enterprise green low-carbon transition are shown in Table 3. Model (1) shows the regression results of fiscal policy and enterprise green low-carbon transition, and model (2) shows the regression results of financial policy and enterprise green low-carbon transition. There is a significant positive correlation between the support of fiscal and taxation policies and financial policies and the degree of enterprise green and low-carbon transformation. This indicates that in promoting the development of enterprise green transformation, the support of fiscal and financial policies can bring apparent effects. Hypothesis 1 of this paper is confirmed.

Table 3. Benchmark regression results

variant	Model (1)	Model (2)
	Y	Y
Sub	0.222***	
	(0.050)	
Gfinal		0.013***
		(0.005)
cons	0.119***	0.120***
	(0.013)	(0.013)
individual fixed effect	yes	yes
time fixed effect	yes	yes
N	19132	19132
adj. R^2	0.799	0.799

Note: Data in parentheses are standard errors, and ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Same as below.

4.2. Robustness Check

This paper verifies the reliability of the regression results through the following robustness tests: first, replacing the measurement of the explanatory variables for the measurement of the composite index of green and low-carbon transformation of enterprises, in addition to the Topsis-entropy weighting method, it can also be measured using the criterion method; second, using a more robust standard error, adjusting the standard error clustering, and clustering to the industry level; and third, narrowing the sample interval, considering the that the new crown

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epidemic may have an impact on business development by excluding data from 2020. The regression results in Table 4 show that after replacing the measurement of the explanatory variables, using more robust standard errors, and reducing the sample interval, the coefficients of fiscal policy incentives in model (3), model (5), and model (7) are still significant. The coefficients of financial policy support in model (4), model (6), and model (8) are still considerable, which suggests that the results of the benchmark regression above are robust.

Table 4. Robustness test

Variable	Models (3)	Models (4)	Models (5)	Models (6)	Models (7)	Models (8)
	Adjustment of standard errors	Adjustment of standard errors	Substitution of variables	Substitution of variables	Shorter sample intervals	Shorter sample intervals
Sub	0.222***		0.117***		0.225***	
	(0.028)		(0.038)		(0.052)	
Gfinal		0.013***		0.024***		0.011**
		(0.004)		(0.006)		(0.005)
cons	0.119***	0.120***	0.290***	0.286***	0.123***	0.125***
	(0.017)	(0.017)	(0.015)	(0.015)	(0.014)	(0.014)
individual fixed effect	yes	yes	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes	yes	yes
N	19132	19132.	19132.	19132.	17506.	17506
adj. R^2	0.799	0.799	0.732	0.732	0.808	0.807

4.3. Endogeneity Test

In this paper, the system GMM method is chosen to deal with the potential endogeneity problem in the empirical study of the impact of fiscal and taxation policies and financial policies on enterprises' green and low-carbon transformation. As can be seen from Table 5, after controlling the potential endogeneity problems, fiscal and taxation policies and financial policies still significantly impact promoting enterprises' green and low-carbon transition.

Table 5. Endogeneity test

variant	Models (9)	Models (10)
	Y	Y
L.Y	0.2095***	0.1903***
	(0.0280)	(0.0416)
Sub	0.8261***	
	(0.2312)	
Gfinal		0.3474*
		(0.2042)
cons	0.0288***	-0.1588
	(0.0094)	(0.0999)
individual fixed effect	yes	yes
time fixed effect	yes	yes
N	16829	16829
AR(1)	0.000	0.000
AR(2)	0.504	0.421
Hansen	0.467	0.609

Note: AR(1), AR(2), and Hansen report p-values.

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4.4. Heterogeneity Analysis

4.4.1. Type of Business

According to the Guidelines for Industry Classification of Listed Companies revised by the China Securities Regulatory Commission in 2012, industries are divided into heavy and light pollution industries. According to the regression results in Table 6, the fiscal and tax policy incentives in model (11) and model (12) are significant at the 10% and 1% levels, indicating that fiscal and tax policy incentives are more important for non-heavily polluting enterprises compared to heavily polluting enterprises, and the results in model (13) show that the financial policy support does not have a substantial impact on the green and low-carbon transformation of the heavily polluting enterprises. In contrast, the results in model (14) show that the financial policy support can significantly promote the green and low-carbon transformation of non-heavy polluting enterprises.

The government's fiscal incentive policy is mainly for the government-selected specific areas and projects to support, to a certain extent, to alleviate the pressure of enterprise cash flow, and heavy pollution enterprises pollution degree is heavy, and the government's fiscal incentives support less, it is difficult to mobilize the enthusiasm of the enterprise, so that it is easy to form a policy to rely on to meet the sewage standard stagnation, non-heavy pollution enterprises to enjoy the fiscal policy to improve the governance of the pollution brings non-heavy pollution enterprises to enjoy the dividends of the policy governance to improve the pollution brought about by the environmental protection implementation of investment and transformation, focusing on reducing pollutant emissions for green and low-carbon transformation. Support enterprise green and low-carbon transformation of green finance on the one hand, through a rich variety of financial products for green environmental protection enterprises to provide financial support to alleviate its financing constraints. On the other hand, through the setting of loan approval conditions constraints on the environmental governance of unqualified heavy pollutants, the enterprise to improve the level of financial constraints on the enterprise funding restrictions, forcing enterprises to carry out the green and low-carbon transformation. Heavily polluting enterprises to carry out green, low-carbon transformation is a long-term and complex process; financial institutions to avoid a greater risk of default, will choose to reduce the provision of long-term loans, inhibiting the scale and efficiency of their investment.

Table 6. Heterogeneity analysis: types of enterprises

variant	Models (11)	Models (12)	Models (13)	Models (14)
	heavy pollution	non-heavy pollution	heavy pollution	non-heavy pollution
Sub	0.181*	0.180***		
	(0.105)	(0.059)		
Gfinal			0.003	0.016***
			(0.009)	(0.006)
cons	0.074***	0.118***	0.077***	0.118***
	(0.028)	(0.016)	(0.028)	(0.016)
individual fixed effect	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes
N	4801	14331	4801	14331
adj. R^2	0.788	0.809	0.787	0.809

4.4.2. Enterprise Technology Level

The technological level of enterprises also affects the level of green, low-carbon transformation of enterprises. From the regression results of model (15) and model (16) in Table 7, it can be

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seen that the impact of fiscal policy on the green and low-carbon transformation of enterprises in high-tech industries and enterprises in non-high-tech industries are both significant at the 1% level, with an insignificant differentiation. In contrast, according to the results of model (17) and model (18), the financial policy can significantly promote the green and low-carbon transformation of enterprises in high-tech industries but has no significant impact on non-high-tech industry enterprises, the effect is not apparent.

High-tech industry enterprises have a relatively higher level of production technology, the production process is more intelligent and green, the difficulty of obtaining support from financial institutions is relatively small, and their high level of research and development and innovation can accelerate the process of upgrading green technology and accelerate the promotion of green and low-carbon transformation of enterprises.

Table 7. Heterogeneity analysis: firms' technology level

	Models (15)	Models (16)	Models (17)	Models (18)
	High-tech industries	Non-high-tech industries	High-tech industries	Non-high-tech industries
Sub	0.172***	0.361***		
	(0.060)	(0.078)		
Gfinal			0.018***	0.002
			(0.006)	(0.008)
cons	0.109***	0.088***	0.109***	0.095***
	(0.017)	(0.022)	(0.017)	(0.021)
individual fixed effect	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes
N	12547	6585	12547	6585
adj. R^2	0.788	0.831	0.788	0.830

4.5. Mediation Effect Test

Fiscal policy and financial policy can alleviate the financial difficulties enterprises face in green innovation, etc., promote enterprises to increase R&D investment, help enterprises to enhance green innovation ability, and further promote the green transformation of the manufacturing industry. Table 8 shows the regression results of the mediation effect test, from which it can be seen that the regression coefficients of fiscal incentives and financial policy support are positive at the significance level of 5% and 10%, respectively, i.e., fiscal incentives and financial policy support have a positive promotion effect on the level of green technological innovation.

Table 8. Mechanism test results

variant	Models (19)	Models (20)
	Gtec	Gtec
Sub	1.111**	
	(0.565)	
Gfinal		0.191*
		(0.106)
cons	-0.958***	-0.989***
	(0.210)	(0.212)
individual fixed effect	yes	yes
time fixed effect	yes	yes
N	19132	19132
adj. R^2	0.644	0.644

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4.6. Synergy Analysis

In this study, the degree of fiscal policy incentives and financial policy support are divided into four groups based on the median size: strong fiscal policy support, weak fiscal policy support, strong financial policy support, and weak financial policy support. The regression results in Table 9 show that, compared with strong financial policy support, the impact of fiscal policy on the green and low-carbon transformation of enterprises is more significant under weak financial policy support. While the effects of financial policy on enterprise green and low-carbon transformation under the condition of strong fiscal policy support is not significant, on the contrary, the effect of financial policy on enterprise green and low-carbon transformation under the condition of weak fiscal policy support is significant at 5%. In recent years, the government has increased fiscal policy support to support the green development of enterprises. Still, some enterprises overly rely on fiscal subsidies and ignore the role of financial products, reducing the demand for green financial products, which impacts financial policy on the green and low-carbon transformation of enterprises weaker.

Table 9. Results of synergy analysis

	Models (21)	Models (22)	Models (23)	Models (24)
	Financial policy support		Fiscal and tax policy support	
	strong	week	strong	week
Sub	0.159**	0.271***		
	(0.071)	(0.077)		
Gfinal			0.006	0.017**
			(0.007)	(0.007)
cons	0.114***	0.136***	0.078***	0.141***
	(0.019)	(0.023)	(0.020)	(0.020)
individual fixed effect	yes	yes	yes	yes
time fixed effect	yes	yes	yes	yes
N	10380	8752	9566	9566
adj. R^2	0.796	0.810	0.805	0.809

4.7. Coupled Coordination Effect

The degree of coupled coordination describes the coordinated development of fiscal and financial policies. The ratio of local fiscal environmental protection expenditure to fiscal general budget expenditure is used to represent green finance, and green finance and green finance are utilized to measure the degree of coupling and coordination of fiscal and financial policies in each province and region according to the coupling and coordination degree model. Fig. 1 shows the results of the measurement of the degree of coupling and synergistic development between policies in each province and city from 2007 to 2020. Overall, the degree of coordinated development of each province and city shows an overall upward trend. Specifically, in 2020, Hebei, Shanxi, and Heilongjiang provinces are at the moderate level of coordination, Inner Mongolia, Jilin, Beijing, Fujian, Jiangxi, Hunan, Guangdong, and Chongqing are at the primary level of coordination, Shandong, Henan, Hubei, Sichuan, Guizhou, Jiangsu, Zhejiang, Anhui, and Shaanxi are at the barely coordinated level, and the rest of the provinces and municipalities such as Guangxi, Yunnan, and Tibet, Gansu, Qinghai, Ningxia, etc. are at the level of on the verge of dissonance or dislocation. This situation may be due to the following reasons: regions at the moderate level of coordination, such as Hebei Province, Shanxi Province, Heilongjiang Province, etc., as well as regions at the primary level of coordination, such as

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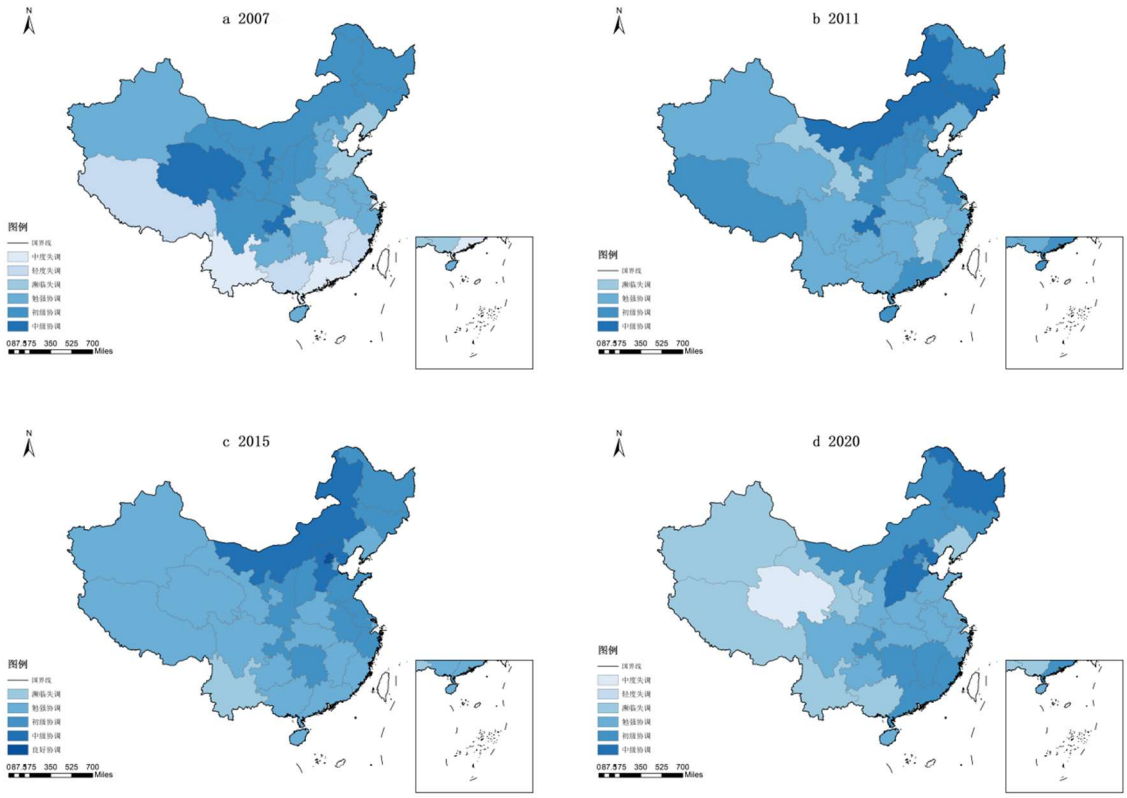
Guangdong Province, Chongqing Municipality, etc., have a concentration of heavy industry, more heavily polluting enterprises, serious pollution problems, a strong incentive to utilize financial resources and strong government support for the green development of enterprises in terms of fiscal and tax policies, which makes the coordinated development of financial policies and fiscal and tax policies Higher degree; on the verge of dislocation or dislocation level of the region such as Guangxi, Yunnan Province, Qinghai Province and other relatively low level of economic development, low degree of development of the financial level, the state's policy support is weak, so that the financial policy and fiscal policy in the coupling of the degree of coordination of the existence of certain challenges.



Note: This map is based on the standard map with review number GS (2020) 4619 downloaded from the Standard Map Service website of the Ministry of Natural Resources, with no modifications to the base map.

Figure 1. Coupled synergy of fiscal and financial policies by provinces and cities, 2007-2020

5. Conclusion and Recommendations

5.1. Findings

Taking the data of A-share listed companies from 2007 to 2020 as the research sample, this paper utilizes the fixed effect model to study the impact of fiscal and financial policies on the green and low-carbon transformation of enterprises, and draws the following conclusions:

The support of fiscal and financial policies has a significant effect on promoting the green and low-carbon transformation of enterprises. Specifically, compared with heavy polluters and non-high-tech enterprises, fiscal and tax policy incentives and financial policy support are more effective in promoting the green and low-carbon transformation of non-heavy polluters and high-tech enterprises.

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Fiscal and financial policies promote green and low-carbon transformation of enterprises through green technological innovation.

From a micro point of view, financial policies cannot significantly promote the green and low-carbon transformation of enterprises under the high intensity of fiscal and taxation policy support. From a macro point of view, the overall coupling and coordination degree of fiscal and taxation policies and financial policies is on the rise, and there are some differences in the coupling and coordination degree among different provinces and cities.

5.2. Policy Recommendations

Based on the above findings and related analysis results, this paper makes the following recommendations:

Differentiated and precise implementation of fiscal and taxation policies. According to different types of industries and enterprises, formulate and implement corresponding tax incentives and set up special funds to provide financial subsidies, adopt subsidy policies to encourage green technology research and development and innovation for enterprises with good operating efficiency and large scale, and reward enterprises that have realized green technological innovations, to mobilize enterprises to carry out green research and development and avoid slacking off in carrying out green innovations after meeting the emission standards. To prevent enterprises from neglecting green innovation after meeting the emission standards and to avoid the inefficient utilization of funds, the supportive subsidy policy is mainly adopted for enterprises with poor operating efficiency and small scale. Clear objectives and conditions of financial subsidies, strict review of subsidies issued, and increase in the efficiency of the use of funds to assess the strength of the implementation of the policy to monitor the effectiveness of the implementation of the policy, according to the situation of different enterprises to adjust the implementation of the policy promptly. At the same time, local governments should formulate appropriate transformation policies according to local industrial structure and resource conditions.

Strengthening green financial regulation and information disclosure. Further, improve the relevant standards and regulatory system of green finance, promote the "domestic unification and international convergence" of green classification standards, and increase the number of pilot zones for green financial reform and innovation, as well as innovate the types of financial products and improve the financial product system. At the same time, it is recommended that the punishment and exposure of greenwash behavior, as well as information disclosure and data sharing, be strengthened. It is also recommended to cultivate professional third-party assessment and certification institutions, strengthen the management of third-party assessment and certification institutions, and encourage institutions to improve the efficiency and accuracy of assessment institutions by introducing advanced technologies and tools such as artificial intelligence, big data, blockchain, etc. In addition to this, financial institutions should make full use of financial technology to promote information sharing and resolve information discrepancies-technology to encourage sharing information and solve the problem of information asymmetry.

Strengthening the synergy of fiscal and financial policies. The government and relevant departments should establish a regular communication and coordination mechanism to ensure that fiscal and financial policy objectives are consistent and synergistic policies are formulated. Regions not included in the pilot zones for green financial reform and innovation should also introduce fiscal and taxation policies to support the development of green finance. Regions with different levels of financial development should be given different levels of fiscal policy support, regions with low levels of green financial development should increase the degree of fiscal policy incentives, and regions with high levels of green financial development should gradually reduce the intensity of fiscal policy to reduce the degree of intervention. For different types of

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financial products, targeted fiscal policies should be chosen to incentivize financial institutions to provide green funds to enterprises and to ensure that fiscal and financial policies form a synergy in supporting enterprise innovation, promoting industrial development, and guiding the flow of funds, to resolve the financing constraints and capital efficiency problems faced by enterprises in the green and low-carbon transformation.

Strengthening the key supporting role of green technological innovation in enterprises' green and low-carbon transformation. Strengthen the status of the main innovation body, vigorously cultivate and build green technology innovation enterprises, and increase support for green technology innovation projects. Strengthen the training of green technology innovation talents, improve the evaluation and incentive mechanism for scientific researchers, and stimulate the innovation vitality of talents. Promote the transformation and demonstration application of green technology innovation achievements, optimize the green technology innovation environment, and strengthen the protection and service of green technology intellectual property rights. Strengthen financial support for green technology innovation, formulate fiscal and tax policies specifically for enterprise innovation, continue to give subsidies to enterprises with a better degree of historical innovation to stimulate their continuous innovation, and analyze the reasons for enterprises with a poorer degree of historical innovation to assess whether to support them more vigorously.

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