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Carbon-Reduction, Green Finance, and High-Quality Economic Development: A Case of China

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Abstract: Development that is eco-friendly, coordinated, sustainable, and of the highest caliber is crucial to China's modernization. Based on the Cobb–Douglas production function and environmental Kuznets curve analysis, this paper investigates the link between green finance and the reduction of carbon emissions and high-quality economic development, then puts forward the hypothesis that green finance promotes high-quality economic development, and carbon emission reduction effect is its important transmission mechanism. This paper applies the bidirectional fixed effect model to a panel dataset of 30 Chinese provinces, cities, and autonomous regions from 2008 to 2019 to conduct an empirical test. The empirical results show that: (1) Green finance has a significant role in promoting high-quality economic development, which has passed the robustness test and has regional heterogeneity. (2) The growth of green financing reduces carbon emissions, which encourages high-quality development. (3) A positive spatial spillover effect results from the promotion of green finance to high-quality economic development. Given the aforementioned findings, this paper makes policy recommendations regarding how green financing, carbon emission reduction, and high-quality economic development might work together to support green development.

Keywords: green finance; high-quality development; carbon reduction; influence; China

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1. Introduction

Globally speaking, sustainable development is currently at a turning point. More and more nations recognize the necessity of reasonably limiting carbon emissions within a particular range as greenhouse gas emissions have reached record highs and rapid economic development is placing pressure on the ecological environment. In 2020, China committed to pursuing the goals of a carbon peak in 2030 and carbon neutrality in 2060. An eco-friendly, low-carbon lifestyle is promoted through the dual-carbon plan. The growth of green finance is crucial to promote the achievement of this goal. The report by the Communist Party of China's 20th National Congress places a strong emphasis on the necessity of fostering low-carbon, environmentally friendly economic and social development as well as reasonable economic and qualitative growth. Providing financial services to businesses engaged in environmental improvement, addressing climate change, and boosting low carbon growth through resource efficiency are the strategies at the heart of green finance. The development of green finance can directly or indirectly influence high-quality economic development. In the 14th five-year plan, it is highlighted that a green and low-carbon modern economic system should be developed together with sustainable development goals. One of the key methods to carry out this philosophy is green finance. The green finance sector in China has grown rapidly in recent years, supporting the capital need and ensuring the best use of resources in linked industries. Also, in the framework of the dual-carbon goal, green finance's diversity and policy, along with the financial instruments created from it during

the development process, are significant ways to reach the target of "3060". Currently, one of the most important research areas is how to successfully link carbon emission reduction, green finance, and high-quality economic development.

Green finance has evolved into a tool for implementing green policies that is being studied by academics both domestically and internationally. Given that environmental protection and sustainable development are still significant global hot topics, research on green finance can help financial institutions allocate resources judiciously to support high-quality economic development. This research can also offer useful research recommendations for policymakers during the implementation process. In addition to being one of the core components of China's "3060" target, the growth of green finance can also be advantageous in several ways: (1) it promotes the growth of the green economy and directs funding toward green, low-carbon, and other industries. (2) To achieve the objective of sustainable development, it assists in preserving the environment, improving the quality of the environment, and fostering resource efficiency. (3) It aids in lowering carbon emissions and reduces the risks associated with climatic conditions. (4) It helps Chinese enterprises become more inventive and competitive internationally, enhancing China's global competitiveness in the "low-carbon economy" sector. (5) It offers a new strategy to support the growth of green businesses.

In summary, the development of green finance is crucial in a number of ways. To fully realize the goal of a high-quality economy and sustainable development, it can effectively distribute funding to low-carbon and green industries and encourage businesses to innovate in green technology [1], and it can advocate for lowering carbon dioxide emissions and energy efficiency [2]. Green financing accounts for a sizable share of the carbon market, and its growth can aid initiatives to cut carbon emissions. Businesses may effectively reduce carbon emissions and support high-quality economic development while implementing green finance by developing green technology. The underlying assumption of this article is that green finance can both directly and indirectly support the high-quality growth of regional economies. This indirect support comes from the decrease in carbon emissions. Using panel data from 30 Chinese provinces, cities, and autonomous regions from 2008 to 2019, this study builds a two-way fixed effect model to investigate how green funding affects the high-quality expansion of local economies. The mechanism is then studied using an intermediary effect model. First, this paper analyzes the research context and significance of the study, then moves on to the research issue of how green finance affects high-quality economic development in the context of double carbon, which explains the innovative content of the paper. Second, the relevant literature on domestic and international green finance is outlined, and the theories of green finance, the impact of green finance on reducing carbon emissions, and green finance's role in fostering high-quality economic growth are all explored. Third, given the Cobb–Douglas production function and environmental Kuznets curve, the influence mechanism of green finance is analyzed, and on this basis, relevant assumptions are put forward. Finally, this paper builds a two-way fixed effect model, introduces provincial panel data for empirical test, and verifies the hypothesis through a robustness test, heterogeneity analysis, intermediary mechanism, and spatial measurement test, and finally draws a conclusion and puts forward policy suggestions.

This paper introduces the following innovations. (1) Index measurement: This study uses the entropy weight TOPSIS rule to measure the economic high-quality development levels of 30 provinces, cities, and autonomous areas of China from 2008 to 2019. It also uses the green credit ratio to calculate the level of regional green development as well as the CEADs China carbon accounting data to compute the intensity of China's carbon emissions. (2) Model: This paper tests the impact of green finance on the high-quality economic development through the two-way fixed benefit model and analyzes the provinces, cities, and autonomous regions in China by using the Moran index and spatial econometric model to test the spatial spillover effect of green finance development. (3) Impact mechanism: This study examines how green financing indirectly influences high-quality economic development in China using the intermediary effect model.

The establishment of the model in this paper considers the spatial factors. In addition to looking at how green finance directly affects the high-quality development of the economy, this paper also looked at how those effects have changed because of the inclusion of spatial factors. Based on theoretical construction and empirical analysis, this paper explores the influence of green finance in high-quality economic development and strengthens the theoretical case for encouraging the government and relevant financial institutions to develop green finance to promote the high-quality economic development.

The following is the organization of this paper. Section 2 reviews the existing literature. In Section 3, various presumptions are made and a theoretical analysis of the relationship between green finance, carbon emission reduction, and high-quality economic development is presented. Section 4 demonstrates an empirical evaluation of green finance's effects on carbon emission reduction and high-quality economic development. Section 5 presents empirical results, a robustness test, intermediary mechanism, and spatial measurement test. The paper is concluded in Section 6, which also offers suggestions for future research and policy.

2. Literature Review

Green finance is expanding quickly throughout the world due to the acceleration of climate change and the growing significance of environmental challenges. One of the most important methods for promoting high-quality economic growth in the context of dual-carbon goal is green finance. This paper explains how important green finance is for high-quality economic growth and offers advice on how to use it in a dual-carbon future. The following three sections provide the current research on: (1) Green finance, (2) Green finance in the context of dual carbon, and (3) The influence of green finance on high-quality economic development.

2.1. Research on Green Finance

2.1.1. Definition, Background, and Importance of Green Finance

Scholars both domestically and internationally have been developing the meaning of "green finance" since the term's inception. The definition of "green finance" has expanded and diversified with the passage of time and the economy's ongoing growth.

The term "green finance" was first studied in the 1990s, and Salazar was a forerunner of the idea of fusing the financial and environmental industries [3]. Since then, the definition has been deepened as increasing numbers of scholars use it to refer to economic activities that are undertaken to protect the environment and achieve sustainable development goals. According to Choi and Ivanov, "green finance" is primarily defined as financial investments that promote environmental protection and promote sustainable development of the economy [4]. Meanwhile, the G20 Green Finance Synthesis Report issued by China in 2016 also clearly states that green finance is the way to conduct investment and financing activities related to environmental protection. Numerous academics have researched and analyzed the strong connection between environment and finance [5–7].

The definition of green finance has also been examined by scholars from the standpoint of financial instruments. Green finance is defined by Labatt and Wright as financial mechanisms that can reduce environmental risk and improve environmental quality [8]. Green finance is a strategy suggested by Sachs et al. to increase investments in and financing for environmental protection by means of new financial tools and rules [9]. At the same time, a number of scholars have conducted new research on the concept of green finance. They define green finance as a public policy tool that blends commercial financial activity with environmental initiatives and view it as policy-oriented [10,11].

In conclusion, the idea of "green finance" firmly connects finance with the environment. As reduced carbon emissions are necessary for sustainable development, green finance is a financial activity to address environmental hazards in the course of economic development. Through a variety of derivative instruments have been created, green finance may not only carry out appropriate investment and financing activities throughout the application process, but it can also direct the wise allocation of resources through the use of policy impacts.

Pressure on the environment has been brought on by the effects of climate change. Many nations have proposed green finance as a crucial tool to alleviate the negative consequences and steer the global economy toward sustainable growth. According to Mohd and Kaushal, the creation of green finance may significantly resolve the issue that exists between the economy and nature by minimizing the emission of ozone-depleting compounds and air pollution, thereby resolving the harmful effect of environmental pollution [12]. Many scholars believe that green finance can bring returns in terms of investment. By internalizing environmental externalities and reducing risk perceptions, it can encourage investment in environmentally beneficial development with some positive impact on the environment [5,13]. Therefore, Sheraz thinks that, in the context of globalization, we should create a stronger financial system that promotes the growth of green finance to fulfill the aim of sustainable development [14]. Green finance affects the transition to sustainable energy, reducing carbon emissions, and preventing climate change [15].

2.1.2. Green Finance-Related Derivatives

Green finance has a close connection to the environment and, in some cases, can help mitigate the effects of environmental degradation. Derivatives produced by the green finance industry are numerous and reflect the variety of the sector, including green bonds, investments, insurance, etc. These financial derivatives have the potential to both generate beneficial economic effects and tackle environmental issues.

Li and Hu found that, in addition to the traditional command-and-control approaches, new green credit (GC), green securities (GS), and green insurance (GI) instruments that are driven by policy have been gradually developed to enhance the environmental management of business operations and sources of pollution [16]. Green bonds can not only mobilize financial resources for clean and sustainable investments [17], they can also be used to remove barriers to financing sustainable and green financial instruments [18]. Green credit instruments can guide credit resource allocation [19], increase energy efficient utilization [20], and also promote economic and environmental development [21].

2.2. Research on Green Finance in the Background of Double Carbon

2.2.1. The Effect of Green Finance on Carbon Reduction

Carbon emissions can be efficiently reduced with the help of green financing, and the effect is particularly prominent in Western and industrialized nations [22,23]. The primary transmission mechanisms are industrial structure, resource efficiency, and green innovation. According to empirical research, green finance can indirectly reduce carbon emissions by easing financial restrictions and encouraging the development of innovative green technologies [22,24]. The expansion of green financing has the potential to lower carbon emissions not only locally but also globally [25]. The creation of green finance, according to Muhammad et al., can greatly reduce ecological footprints and have the intended effect of environmental protection, which will help fulfill the goals of sustainable development [2]. Additionally, several researchers show that green finance can significantly lower carbon emissions in both industry and agriculture [26,27]. According to Ren et al., the rapid growth of green finance in China and the development of the Green Finance Development Index have both helped to lower carbon intensity [5].

2.2.2. The Carbon-Emission-Reduction-Related Green Finance Derivatives

The most important source of finance for green investments is through green bonds. Green financing will take the form of green bonds and accompanying legislation to help steer investments toward renewable energy sources, which will reduce carbon emissions [28]. Mamun et al. further point out that the ability of green bonds to lower carbon emissions can be more advantageous for developed credit markets, economies with higher rates of innovation success, and economies with greater risks connected with climate change [29]. Some authors point out that green financing bonds may negatively impact the environment and social responsibility in the process of implementation, but this problem

can be effectively solved under strict supervision by policy implementers [30]. It can be concluded that green bonds are an effective financial tool for facilitating the implementation of green energy projects and for significantly lowering carbon dioxide emissions [31].

Reduced carbon intensity is aided by the deployment of many green credit regimes [32], and environmental regulations are being strengthened to help enterprises lower their carbon emissions intensity [33].

In addition, Xu demonstrated that the introduction of green credit policies had some negative effects on the financing costs and expiry dates of high-emission, high-energy-consuming enterprises, raising the threshold of debt financing for this type of enterprises, which led enterprises to reduce carbon emissions [34]. Huang empirically found that China is on the left side of the u-shaped curve, i.e., under the intensity of environmental legislation, the amount of green credit can encourage the advancement of low-carbon technologies and overall factor efficiency [35].

2.2.3. Innovation in Green Technology and Its Effects on Carbon Emissions

Green finance may help to some extent with the growth of local green technology innovation. According to Irfan et al.'s findings, green finance pilot zones are more successful than other areas at fostering green innovation [36]. Green finance promotes regional green technology innovation capacity by coordinating with "market incentive" regulations and thereby, to some extent, reducing the detrimental impacts of strict environmental restrictions and environmental management on the development of green technology [37]. According to Huang, green innovation and green finance have a strong positive autocorrelation that influences surrounding regions' ability to pursue green innovation [38]. As an illustration, China's adoption of green financing legislation has significantly increased the ability of all areas to create green innovation [39]. According to Dong's study, financial development can, on the one hand, positively regulate how sensitive carbon emission efficiency is to advancements in green technology. On the other hand, increasing green technology innovation is one way to increase carbon emission efficiency [40]. The development of financial technology and China's green finance initiatives have both greatly reduced industrial gas emissions and sulfur dioxide emissions [27]. Green financing promotes environmental quality while also advancing technical innovation [1]. The interplay between green technology innovation and digital finance, while enhancing local carbon efficiency, has been hypothesized to some extent to limit the carbon efficiency of the neighboring cities [41].

2.3. Green Finance and High-Quality Economic Development

2.3.1. The Direct Impact of Green Financing on High-Quality Development

Green finance greatly helps to high-quality economic growth and has a substantial influence on the development of financial structures, financial efficiency, and environmental quality protection [42]. Zhou noted in his study how the growth of green financing has aided in the expansion of the economy. Rapid economic expansion hinders sustainable development, nevertheless, by also contributing to an environment that is somewhat polluted [43]. In order to decrease the negative effects of pollution on high-quality economic development, green finance measures can be introduced [44]. However, the cost is a slowdown in economic growth [45]. Changing the industrial structure and fostering technical advancement are two ways that green financing reduces pollution, according to the examination of the mechanism of action. Carbon emissions (CO_2) and green finance, real GDP, urbanization, and renewable energy have co-integration relationship under different specifications, and prove the existence of the environmental Kuznets curve [46].

When evaluated through the lens of green financial derivatives, the suggested green credit policy provides a Pareto improvement in the distribution of financial resources by introducing credit resources in the direction of green firms [47]. It can enhance not only businesses' capacity for green innovation [48], but also the expansion of green total factor productivity [49]. In the meantime, the implementation of green credit laws will stop these major polluters from becoming more environmentally friendly and bring funding

and investment opportunities to green businesses, which will support the high-quality growth of the economy [50]. It is clear that green financing encourages economic and environmental progress [21].

2.3.2. Analysis of the Mechanisms Underlying Green Financing for Superior Development

According to academic analysis at the macro level, to encourage industrial structure modernization, achieve green development, and hasten the rise of ecological civilization, green finance is being expanded. Sustainable development goals in China depend on efficient use of renewable resources and green financing. Green technology investment is closely related to sustainable economic growth [51]. For instance, the tertiary industry in China is significantly impacted by green finance, which will accelerate its growth and support the modernization of the industrial structure [52]. The structure of industrial energy consumption can be successfully adjusted by continuously raising the level of green finance development [53]. The development of green finance promotes green productivity [54], and affects three factors: the ecological environment, economic effectiveness, and economic structure, and hence contributes to the quality development of the economy [39].

Traditional financial systems still have some drawbacks, but digital finance has evolved and can help to some extent with the growth of green finance. Through the oncoming road of green technology innovation, digital banking has significantly increased China's efficiency in terms of energy and the environment [55]. At the macro level, digital money can increase the effectiveness of both green and social finance [56]. Additionally, it can reduce the burden of their financial restrictions and encourage investment in research and development [57]. It can also support firms' ability to innovate sustainably at the micro level [58].

Green financing development helps to improve the green innovation ability of local and surrounding provinces, which considerably encourages green innovation [38]. According to the empirical study, the advancement of green finance has undoubtedly contributed to green economic growth. Furthermore, additional study has revealed that technological innovation encourages green economic growth, mostly through green lending and green investment [59].

2.4. Summary and Prospect

Given the research on green finance, it is clear that one of the most significant strategies for achieving sustainability is the continued development of green financing. These studies suggest that, in addition to reducing carbon emissions, green finance can successfully alleviate the negative environmental effects brought on by rapid economic development through its diversification and the creation of linked derivatives. It may also continuously boost green innovation and high-quality economic development in the process. However, it has been found that there are a number of design faults in green financing. Although China's green finance is growing quickly, and the green finance development index is improving, it still lags behind the index of economic growth development. Furthermore, due to the weak coordination between green finance and economic growth, there is very little support for green finance for economic growth in China. In China, the concepts of "carbon peaking" and "carbon neutrality", as well as the transition from rapid to high-quality economic development, are crucial tools for achieving these goals. In this study, the empirical effects of green finance on lowering carbon emissions and promoting superior economic growth are investigated.

3. Theoretical Analysis

The relationship among green finance, carbon emission, and economic development is complex. The Cobb–Douglas production function is used as the basis of establishing the model, and the influence of green finance on high-quality economic development is analyzed theoretically. This study investigates the function of green finance in enhancing environmental quality, i.e., reducing carbon emissions, and supports high-quality economic development. It introduces the environmental Kuznets curve hypothesis.

3.1. Extended Cobb–Douglas Production Function

According to the Cobb–Douglas production function, economic growth is influenced by a variety of factors, including the amount of labor and fixed assets, a broad technical level (including management level, labor quality, introduction of contemporary technology, etc.), and other factors. Energy use, production, and pollutant emission are intimately connected. The production function is given by

$$Y = AK^{\alpha}E^{\lambda}L^{\beta}\varepsilon^{\mu} \quad (1)$$

where Y denotes economic output, A denotes the level of technology, K denotes capital, E denotes the energy consumption in production, L denotes labor, and ε denotes the error term. α, λ, and β are the elasticity coefficients of capital stock, energy consumption, and labor force, respectively. The technical level of Cobb–Douglas production function is limited, that is, when $\alpha + \lambda + \beta = 1$, the return to scale remains unchanged.

When the technical level is given, the link between energy consumption (E) and environmental pollutant emission (P) is $E = bP$ [60], and b is a constant, then Formula (1) can be deformed as:

$$Y = AK^{\alpha}b^{\lambda}P^{\lambda}L^{\beta}\varepsilon^{\mu} \quad (2)$$

This paper offers a theoretical analysis based on Equation (2). The development of green finance can also pool idle funds and savings in the social economy and effectively transform them into green investments, improve capital stock and green technology level, and play a beneficial role in promoting economic development under the direction of governmental policies and financial institutions.

The main distinction between green finance and conventional finance is the emphasis on resource and environmental preservation in the former. Green finance will guide capital, workforce, and other resource elements into green industries through green financial instruments; it will also provide resource support for green environmental protection enterprises after thoroughly investigating the economic benefits of the environment. The effective and rational allocation of resources will be realized with the continuous transfer of resources from traditional "double-high" enterprises to environment-friendly enterprises. The proportion of traditional industrial output will gradually decrease, the output of green industries will gradually increase, and the industrial structure will be optimized.

Last but not least, the study above enables us to conclude that green finance may successfully direct financial and technological resources to flow towards green enterprises. However, traditional industries that have lost the support of resources must change their traditional business and carry out technological innovation in order to adapt to the trend of green development to survive in the market. Under this condition of inclined resources, green enterprises supported by resources make rational use of resources, improving their own technical level, and realizing technological progress. The modernization of the industrial structure has gained new momentum. In this situation, the market will observe an increase in innovation-driven businesses, which is very beneficial for economic growth. We present the following hypothesis:

Hypothesis 1. *Green finance has a direct and positive role in promoting economic development.*

3.2. Environmental Kuznets Curve Theory

Grossman and Krueger conducted the first empirical investigation of the relationship between environmental quality and per capita income in the early 1990s to address the concern that the fall of free trade would have a negative influence on the environment. They held that a country's environmental quality was higher and its pollution levels were lower when its economic development was in its early stages, and that as per capita income continuously climbed, so did the level of environmental pollution. They believed that, as per capita income rose, the level of environmental pollution would fall decrease and the environment would get cleaner once the nation's economy had advanced to a certain point and passed a crucial threshold. When there is a significant combined effect, it is referred to

as the environmental Kuznets curve [61]. The graph of environmental Kuznets curve is shown in Figure 1. The significance of environmental pollution caused by economic growth in China is illustrated by the inverted U-shaped environmental Kuznets curve, as well as the correlation between environmental pollution caused by the economic development model and the change in per capita income.

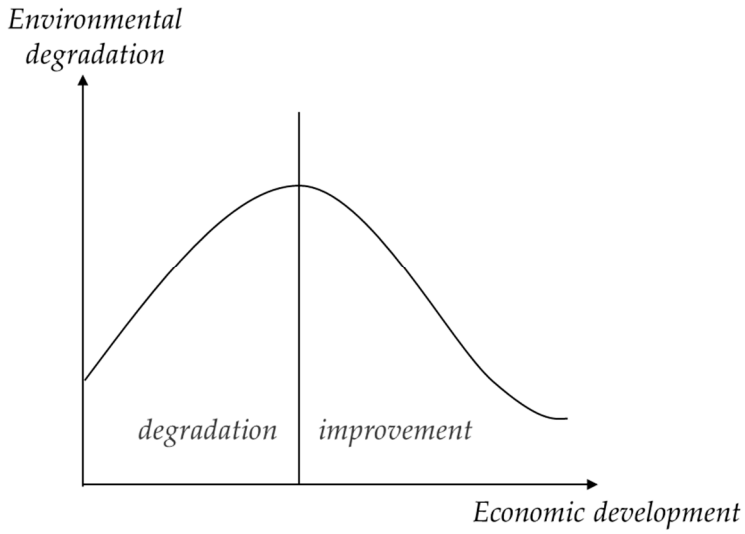

Figure 1. Environmental Kuznets curve.

The emergence of green finance may directly affect carbon emissions. In contrast to currently used command-based environmental regulation and incentive-based environmental regulation, green bonds contain both the characteristics of market-based environmental regulation and the resource allocation function of the financial sector. Their focus is on encouraging the best distribution of financial resources among economic and environmental agencies. To effectively allocate resources in the market and support the green development of industries, which has an impact on economic growth, by shifting talent, technology, capital, and other resources away from traditional sectors with high energy consumption and high pollution to environmentally friendly green industries with low energy consumption and high production, green finance can fulfill its duty as a resource-oriented industry.

On the other hand, in the new phase of China's economic and social transition to a green economy, the government would fully support the growth of green financing. Relevant government departments heavily subsidize green bonds as part of government policy, making green bonds in China far more affordable to finance than comparable bonds. These elements work together to lower the cost of borrowing for businesses using green bonds. Therefore, green bonds can aid in easing the financial constraints faced by businesses while increasing their investment in environmental protection to lower carbon emissions.

In conclusion, given that the total amount of regional financial capital is known, green bonds on the one hand help direct more social funds toward the green industry sector, improving the effectiveness of green development; on the other hand, increased green bond financing will result in less money being allocated to other pollution projects, preventing the growth of heavily polluting industries, lowering unexpected output, and improving green total factor productivity.

This paper presents the following hypothesis based on the analysis previously mentioned:

Hypothesis 2. *Green finance helps to increase carbon productivity, fostering high-quality economic development.*

4. Empirical Design

4.1. Model Construction

This paper investigates the impact of green finance on the superior growth of the regional economy. With green finance serving as the primary explanatory variable, a multiple regression model based on panel data of 30 Chinese provinces, cities, and autonomous areas from 2008 to 2019 is constructed, accounting for the effects of fixed asset investment, the proportion of fiscal expenditure, consumer price level, and the number of industrial enterprises on the high-quality development of regional economy.

$$HQD_{i,t} = \alpha_0 + \alpha x_{i,t} + \beta_1 z1_{i,t} + \beta_2 z2_{i,t} + \beta_3 z3_{i,t} + \beta_4 z4_{i,t} + \tau_i + \gamma_t + \epsilon_{i,t} \quad (3)$$

In Formula (3), $HQD_{i,t}$ represents the high-quality development level of regional economy of i provinces and autonomous regions in t years, which is the explained variable. $x_{i,t}$ is the regional green financial index of i provinces and autonomous regions in t years, which are the core explanatory variables of the model, and $z1_{i,t}$, $z2_{i,t}$, $z3_{i,t}$, $z4_{i,t}$ are the control variables. $\epsilon_{i,t}$ is a random interference term, and at the same time, the fixed effect of provinces and cities (τ_i) and the fixed effect of years (γ_t) are added.

4.2. Selection of Variable

4.2.1. Independent Variable

In this paper, regional green financial indicators are taken as the independent variables. China's green finance sector got off to a slow start and has not yet developed an index system to gauge its performance. Additionally, it is challenging to find accurate information about green finance in different provinces; only data based on national perspective statistics are available. As a result, it is challenging to analyze the development level of regional green finance. By the end of 2020, the total volume of green finance will reach about CNY 13 trillion, including about CNY 12 trillion of green credit and about CNY 800 billion of green bonds. The oldest, most established, and largest financial product in China's green financial system is green credit. Green credit accounts for more than 90% of all green funding. Most scholars choose this index to measure the development level of green finance.

Provinces in China do not publicly release information about green finance-related products such green credit, green securities, and green insurance. Using the data's accessibility and representativeness, the green credit ratio is used to determine the state of local green finance development. The primary quantitative techniques of green credit are presently the fraction of green credit, the proportion of energy conservation and environmental protection projects and service loans, and the share of interest charges of six high energy-consuming industries. Because the first two green credit measurement indicators only contain national data and cannot be accurate to the region, there may not be a suitable replacement variable for the provincial quantitative indicators of green credit in the available literature [62]. This paper using the proportion of interest expenses of high energy-consuming industries to measure the regional green credit level can indirectly reflect the development level of regional green credit to a certain extent.

Therefore, this paper chooses the method of Formula (4) to measure the level of green credit. The six most energy-intensive industries are manufacturing of chemical raw materials and finished chemical products, coking and nuclear fuel processing, non-metallic mineral products, ferrous and non-ferrous metal smelting and rolling processing, and power and heat production and supply.

$$x_{i,t} = GF = 1 - \frac{Interest\ expense\ of\ six\ high\ energy - consuming\ industries}{Total\ interest\ expenditure\ on\ indutrial\ output} \quad (4)$$

4.2.2. Explained Variable

High-quality economic development depends on a number of aspects, including economic, social, cultural, and ecological ones. The report of the 19th National Congress emphasized the need for scientific progress and the unwavering application of the devel-

opment idea of innovation, coordination, green living, openness, and sharing. Innovation drive development, and co-ordination invades sustainable and healthy development.

The best strategy to encourage high-quality development in the present and future periods is to insist on applying the new development concept, which also offers action instructions to comprehend the new developmental stage and create a new development pattern. The indicator system for high-quality economic growth is built in this study based on the new development idea of innovation, coordination, greenness, openness, and sharing. Drawing on the indicator construction methods and other related studies [63–65], representative primary indicators and 11 secondary indicators are selected based on high-quality development, and the indicator system is shown in Table 1.

Table 1. Economic quality development index system.

First-Level Index	Second-Level Index	Data Processing Method	Properties	Weight
Innovation	R&D Investment	R&D expenses (internal)/GDP (%)	+	6.3535
	R&D Level	Number of patents granted/year-end resident population	+	16.0072
Coordination	Industry Cluster	Tertiary industry output value/Secondary industry output value	+	3.0956
	Income Gap	Per capita disposable income of urban residents/per capita disposable income of rural residents	-	1.8838
Green	Greening Construction	Greening coverage of built-up areas (%)	+	1.8923
	Pollution Control	Sulfur dioxide emissions (%)	–	1.3729
Opening	Trade Dependency	Total import & export/GDP (%)	+	11.6156
	Foreign Business Introduction	Total investment in foreign-invested enterprises/GDP (%)	+	27.8749
Sharing	Income Level	Average salary of employees in employment	+	6.5613
	Health & Wellness	Number of beds in medical beds per capita/year-end resident population	+	3.8167
	Education Input	Financial education expenditure/general public finance budget expenditure (%)	+	19.5271

This study measured the high-quality economic development level of 30 Chinese provinces, cities, and autonomous areas using the entropy weight TOPSIS method, which successfully ensures the objectivity and efficacy of the calculation results.

4.2.3. Mediating Variable

This paper proposes that the growth of green finance can improve the high-quality development of regional economy through the effect of urban carbon emission reduction and selects the intermediary variable as GDP output value per unit carbon emission to express the level of carbon productivity. To eliminate multicollinearity and heteroscedasticity, logarithmic processing is carried out on the original data, and the calculation formula is shown in Formula (5).

$$CP = \ln\left(\frac{Regional\ GDP}{Regional\ CO_2\ emissions}\right) \quad (5)$$

4.2.4. Control Variable

To control the factors affecting regional economic stability and high-quality development as much as possible, this paper controls the following variables: (1) Fixed assets investment rate (FAI): This paper uses the growth rate of fixed assets investment in various provinces, municipalities and autonomous regions to express the investment level of the region. (2) The proportion of fiscal expenditure (PFE): the proportion of local general budget expenditure to regional GDP is taken as the measurement index of fiscal level. (3) Consumer price index (CPI): this reflects the consumption level and macroeconomic inflation degree and is logarithmic for a unified dimension. (4) The number of industrial

enterprises (IE): This study utilizes the number of industrial firms that are larger than a predetermined size as the control variable for industrial development.

4.3. Statistical Characteristics of Variable Data

The data of variables used in this paper came from the China Industrial Statistical Yearbook, China Statistical Yearbook, China Carbon Accounting Database (CEADs), and the statistical yearbooks of various provinces. For the explanatory variable-green credit, since the yearbooks of 2019 and 2018 have not yet been published, the 2018 data were drawn from China Economic Census Yearbook, and the 2017 data were filled using the interpolation method. Given the comprehensiveness and availability of the data as of 2019, the accounting data regarding carbon emissions in the Tibet Autonomous Region was insufficient and was eliminated. Therefore, this paper finally obtains the balance panel data of 30 provinces, cities, and autonomous areas in China from 2008 to 2019, and the data frequency is annual. This paper uses Stata/MP 17 as the empirical analysis software. Table 2 reports the descriptive statistics of the above variables.

Table 2. Descriptive statistics of variables.

Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
HQD	360	0.144	0.062	0.0.48	0.382
GF	360	0.461	0.149	0.094	0.808
CP	360	3.999	0.788	2.053	6.219
FAI	360	0.140	0.118	−0.567	0.413
PFE	360	0.253	0.112	0.100	0.758
CPI	360	4.631	0.018	4.582	4.701
IE	360	8.850	1.208	5.814	11.090

The variance expansion coefficient test was used to rule out multicollinearity, and the results are displayed in Table 3 for that test. GF reported VIF of 1.095, FAI reported VIF of 1.095, PFE reported VIF of 3.205, CPI reported VIF of 1.107, and IE reported VIF of 3.155. Each variable's VIF value is less than 10, and the model's mean VIF value is 1.931. It shows that the model is well constructed, there is no multicollinearity, and it can be analyzed empirically.

Table 3. Multicollinearity test results.

Variable	VIF	1/VIF
PFE	3.205	0.312
IE	3.155	0.317
CPI	1.107	0.903
FAI	1.095	0.913
GF	1.095	0.913
Mean VIF	1.931	

5. Results Analysis

5.1. Results of Baseline Regression

We selected the two-way fixed effect model of provinces and cities and years to test the influence of green finance on high-quality economic development. The results of baseline regression are presented in Table 4.

The baseline regression of the model is carried out to test the influence of green finance on the high-quality development of regional economy. Table 4 shows the baseline regression results. Column (1) displays the regression results without any control variables, while columns (2) through (5) display the regression results after each control variable has been included to the model. The data in column (1) indicate that GF has a direct impact coefficient on HQD of 0.044 and that it passed the 5% significance test, indicating that GF has a highly positive impact on HQD. As control variables are gradually included,

the regression coefficient for the primary explanatory components is consistently positive. The coefficient of GF is steady at 0.051 after the introduction of all control variables and passes the 1% significance test. The model is robust and the R^2 is maintained at a particular level, supporting the first hypothesis. Green finance may directly help the local economy's high-quality growth.

Table 4. Results of baseline regression.

Variable	HQD				
	(1)	(2)	(3)	(4)	(5)
GF	0.044 **	0.046 **	0.051 ***	0.049 ***	0.051 ***
	(0.018)	(0.018)	(0.016)	(0.017)	(0.018)
FAI		0.019	0.020	0.021	0.022
		(0.017)	(0.017)	(0.017)	(0.019)
PFE			−0.073	−0.081	−0.083
			(0.051)	(0.051)	(0.053)
CPI				−0.140	−0.172
				(0.257)	(0.280)
IE					−0.004
					(0.011)
Cons	0.124 ***	0.119 ***	0.786	0.786	0.972
	(0.007)	(0.009)	(1.200)	(1.200)	(1.346)
Regional fixed effect	Yes	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes	Yes
Observations	360	360	360	360	360
R^2	0.543	0.546	0.548	0.549	0.549
F-value	0.000	0.000	0.000	0.000	0.000

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$. Standard errors in (). Data source: 2008–2019 China Industrial Statistical Yearbook, China Statistical Yearbook.

In terms of control variables, the fixed assets investment rate is positive, the proportion of fiscal expenditure is negative, the consumer price index is negative, and the number of industrial enterprises is negative.

5.2. Model Verification

5.2.1. Robustness Test

The baseline regression employs the regional economy's high-quality development level, or HQD, as measured after the creation of an index system. In the robustness test, this paper will replace the explanatory variable with per capita GDP. Column (6) in Table 5 shows the regression results after replacement. After controlling the provinces and time, the result remains positive and significant; indicating that the benchmark regression result is robust and credible.

5.2.2. Heterogeneity Test

In view of China's vast territory, different regions are affected by geographical location, natural conditions, economic foundation, and other factors, and there is regional heterogeneity. Following the economic belt division of China Statistical Yearbook, the sample data in this study are divided into three key areas: East, Middle, and West. The heterogeneity test analysis using the sample regression approach is used to look at how green finance affects regional high-quality development in various regions. The regression results are presented in columns (7)–(9) of Table 5. The research demonstrates that the central and western regions have a positive promotion effect, whereas the eastern region's regression results demonstrate that GF significantly promotes the high-quality growth of the regional economy. At the level of model fitting data, R^2 in the western region is the highest, followed by that in the central region, which shows that the role of GF in the high-quality development level of the central and western regions did not show in 2008–2019. The eastern area has a mature industrial structure and leads the nation in economic development. The eastern area has a distinct advantage in terms of development because China's green financing development mostly depends on technologically advanced businesses like new energy. The degree of green finance development in the eastern, central, and western regions actively complies with the state's request, implements

the green finance development policy, continuously widens the channels for green finance development, enriches its product system, and actively contributes to China's "double carbon" goal. These regions have advanced in a variety of additional categories.

Table 5. Model Verification results.

Variable	GDPPC	East	Middle	West
	(6)	(7)	(8)	(9)
GF	0.340 ***	0.055 ***	0.003	0.035
	(0.061)	(0.017)	(0.068)	(0.046)
Cons	4.240	−0.364	1.745	1.118
	(2.978)	(2.137)	(3.770)	(1.478)
Control variable	Yes	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes	Yes
Observations	360	132	96	132
R^2-	0.870	0.469	0.626	0.785
F	0.000	0.000	0.000	0.000

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$. Standard errors in (). Data source: 2008–2019 China Industrial Statistical Yearbook, China Statistical Yearbook.

5.3. Intermediary Mechanism

Theoretically, increasing the quantity of green credits will result in a reduction in carbon emissions and, in turn, will increase carbon productivity, fostering the high-quality growth of the local economy. Table 6 reports the regression results of mediation effect. From column (10), it can be seen that GF has a promoting effect on improving carbon productivity. The regression coefficient of the key explanatory variable GF in column (12) is smaller than that in column (10), which confirms Hypothesis 2 and shows that the improvement of carbon productivity plays a partial mediating effect.

Table 6. Intermediary mechanism results.

Variable	HQD	CP	HQD
	(10)	(11)	(12)
GF	0.051 ***	0.004 **	0.040 **
	(0.018)	(0.151)	(0.014)
CP			0.032 ***
			(0.009)
Cons	0.972	3.378 ***	0.649
	(1.346)	(0.522)	(1.264)
Control variable	Yes	Yes	Yes
Regional fixed effect	Yes	Yes	Yes
Time fixed effect	Yes	Yes	Yes
Observations	360	360	360
R^2-	0.549	0.764	0.571
F	0.000	0.000	0.000

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$. Standard errors in (). Data source: 2008–2019 China Industrial Statistical Yearbook, China Statistical Yearbook, CEADs.

5.4. Space Measurement Test

5.4.1. Moran Index and Model Selection

The location components of each spatial unit are introduced as spatial weights on the right side of the equation in the spatial econometric model that includes spatial factors, which can examine the degree of the spatial lag vector of the dependent variable's influence on the interpreted variable. Its coefficient estimation value represents the intensity of the spatial dependence of the observed value of the interpreted quantity sample, thereby resolving the estimation error. First, it is important to determine if the research item exhibits spatial autocorrelation. Choose the common measuring technique to model if it doesn't exist; if it does, pick a spatial metric model.

In order to determine whether there is a spatial association and to provide a foundation for future development of spatial econometric models, the spatial dependence of the

development of green financing in China is tested using Moran's I statistics from both a global and local perspective. Moran's I is used to measure whether there is spatial autocorrelation in the research object, and its calculation expression is:

$$I = \frac{n \times \sum_i^n \sum_{j \neq i}^n W_{ij} \times (x_i - \overline{x})(x_j - \overline{x})}{\left(\sum_i^n \sum_{j \neq i}^n W_{ij}\right) \times \sum_i^n (x_i - \overline{x})^2} \quad (6)$$

I stands for Moran's I index, n is the number of samples, and x_i and x_j, respectively, are the attribute values of the study variables for regions i and j; the average attribute value across all geographic units is represented by the symbol x; a positive value for Moran's I, a spatial weight matrix, implies that there is a spatially positive correlation between variables, and its value range is $[-1, 1]$. A negative value denotes a negative correlation in space; when the Moran exponent is zero, objects are seen to be scattered randomly in space. The Moran's I, as measured by three spatial weight matrices: 0-1 adjacency matrix (W1), economic distance space weight matrix (W2), and geographical distance space weight matrix (W3) is shown in Table 7. In this paper, the global Moran index of HQD met the 5% significance test, which shows that the high-quality development of regional economy in 30 provinces and cities in China has significant spatial positive correlation, which can be empirically tested by spatial econometric model.

5.4.2. Model Selection

Three different kinds of spatial econometric models exist: the spatial error model (SEM), the spatial auto-regressive model (SAR), and the spatial Durbin model (SDM). Equation (7) displays the model's general expression.

$$HQD_{i,t} = \rho \sum_{j=1}^n W_{ij} HQD_{jt} + \beta X_{it} + \gamma \sum_{j=1}^n W_{ij} X_{jt} + \tau_i + \gamma_t + u_{i,t} \quad (7)$$

$$u_{i,t} = \lambda \sum_{i=1}^n W_{ij} u_{jt} + \varepsilon_{it} \quad (8)$$

Among them, $HQD_{i,t}$ is the explained variable in benchmark regression; ρ is the spatial autocorrelation coefficient of the explained variable; X_{it} is the set of all explanatory variables in the first region of year t; β is the relevant explanatory variable's estimation coefficient; γ is the explanatory variables' spatial autocorrelation indices; W_{ij} is the spatial weight matrix element; τ_i and γ_t are the fixed effects of space and time respectively, and $u_{i,t}$ is the spatial error term. Lambda is the spatial autocorrelation coefficient of each disturbance term. When $\rho = 0$, $\gamma = 0$, it is SEM model; when $\lambda = 0$ and $\gamma = 0$, it is SAR model; when $\lambda = 0$, it is SDM model.

In the aspect of model selection, through the results of the LM test and LR test, it can be seen that the spatial Durbin model (SDM) should be selected for estimation under W1 and W2 weight matrices to ensure the robustness of the model. The spatial autoregressive model (SAR) should be selected for empirical testing under the condition with the W3 weight matrix. According to Hausman test results and the comparison of Log-L and other key coefficients, bidirectional fixed effect regression should be selected in W1 and W3 cases, and random effect regression should be adopted in W2 cases.

Table 7. Moran index & model selection results.

Variable	W1	W2	W3
2008	0.341 *** (4.262)	0.467 *** (4.022)	0.369 *** (3.336)
2009	0.369 *** (3.336)	0.114 *** (4.186)	0.552 *** (4.666)
2010	0.385 *** (3.551)	0.112 *** (4.218)	0.592 *** (5.099)

Table 7. *Cont.*

Variable		W1	W2	W3
2011		0.330 *** (3.079)	0.105 *** (3.996)	0.584 *** (5.025)
2012		0.305 *** (2.816)	0.094 *** (3.642)	0.566 *** (4.791)
2013		0.409 *** (3.684)	0.126 *** (4.547)	0.603 *** (5.092)
2014		0.341 *** (3.143)	0.104 *** (3.943)	0.573 *** (4.889)
2015		0.438 *** (4.068)	0.123 *** (4.602)	0.486 *** (4.309)
2016		0.274 ** (2.558)	0.095 *** (3.663)	0.581 *** (4.910)
2017		0.351 *** (3.249)	0.102 *** (3.901)	0.632 *** (5.398)
2018		0.282 *** (2.631)	0.082 *** (3.295)	0.561 *** (4.768)
2019		0.360 *** (3.221)	0.081 *** (3.199)	0.199 * (1.836)
LM test	*LM-Lag*	30.948 ***	34.218 ***	4.168 **
	R LM-Lag	44.434 ***	5.800 **	6.768 ***
	LM-error	0.404	67.889 ***	0.340
	R LM-error	13.890 ***	39.472 ***	2.940 *
LR test	*LR-SDM-SAR*	30.45 ***	13.14 **	6.21
	LR-SDM-SEM	30.40 ***	12.60 **	5.38
Hausman test		1033.67 ***	4.78	20.54 ***

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$. Standard errors in (). Data source: 2008–2019 China Industrial Statistical Yearbook, China Statistical Yearbook.

5.4.3. Spatial Econometric Regression

Given the spatial econometric regression results (Table 8), the spatial autoregressive coefficient rho under the economic distance spatial weight matrix (W2) and geographical distance spatial weight matrix (W3) is significantly positive. The results show that green finance has a sizable spatial spillover effect, which causes the high-quality regional economy to exhibit positive spatial agglomeration. This shows that the growth of green finance in this area not only fosters the high-quality growth of the regional economy here, but also propels the high-quality growth of the regional economy in the surrounding areas. For the three weight matrices, the development level coefficient of green finance is significantly favorable, demonstrating that the growth of green finance encourages high-quality development and causes geographical spillover effects. Under the W2 spatial matrix, the coefficient of W*GF is 0.217, and it has passed the significance test of 1%, which shows that the spatial spillover effect of green finance development is significant between provinces and cities with close geographical distance. Therefore, the cooperative development pattern of green finance between provinces and cities with adjacent geographical location is formed, and the high-quality development of regional economies promote each other and make common progress.

The model R^2 of the regression result of SDM model using the W2 matrix is 0.483, which has the best fitting degree, and the core explanatory variables have the best significance and rho value. Therefore, economic distance space is the main form of the spatial spillover effect of green finance on high-quality economic development.

Table 8. Spatial econometric regression results.

Variable	SDM(W1)	SDM(W2)	SAR(W3)
	(13)	(14)	(15)
GF	0.034 *	0.058 ***	0.043 **
	(0.018)	(0.019)	(0.021)
FAI	0.016	0.020	0.024
	(0.023)	(0.019)	(0.015)
PFE	0.043	−0.089 *	−0.084 *
	(0.040)	(0.052)	(0.048)
CPI	−0.209	−0.073	−0.191
	(0.254)	(0.260)	(0.219)
IE	−0.007	−0.005	−0.005
	(0.009)	(0.004)	(0.007)
*W*GF*	0.061	0.217 ***	
	(0.053)	(0.083)	
*W*FAI*	0.003	−0.077 **	
	(0.034)	(0.038)	
*W*PFE*	0.671 ***	−0.148	
	(0.179)	(0.130)	
*W*CPI*	−0.474	0.156	
	(0.386)	(0.251)	
*W*IE*	−0.010	0.019	
	(0.019)	(0.017)	
rho	0.115	0.493 ***	0.237 ***
	(0.073)	(0.099)	(0.072)
Regional fixed effect	Yes	No	Yes
Time fixed effect	Yes	No	Yes
Observations	360	360	360
R^2	0.126	0.483	0.372
F	0.000	0.000	0.000

*** means $p < 0.01$, ** means $p < 0.05$, * means $p < 0.1$. Standard errors in (). Data source: 2008–2019 China Industrial Statistical Yearbook, China Statistical Yearbooks.

5.5. Discussion

Green finance is a vital tool for all countries to relieve environmental pressure, and it supports the growth of high-quality economies. Based on the Cobb–Douglas production function and environmental Kuznets curve theory, this paper investigates the effect of green finance on high-quality economic development and environmental quality improvement. The empirical results show that: (1) Green finance has a significant role in promoting high-quality economic development, and this relationship is heterogeneous in various regions; (2) the growth of green financing reduces carbon emissions, which encourages high-quality development; and (3) a positive spatial spillover effect results from the promotion of green finance to high-quality economic development.

5.5.1. Green Finance's Effect on High-Quality Economic Growth

The empirical findings show that that green finance has successfully passed the stability test and has a favorable and significant impact on China's economy's high-quality development level. This supports the findings from [39,44,54,66]. Green finance plays a resource-focused role by directing talent, technology, capital, and other resources from industries that consume high energy and produce high pollution to environmentally friendly green industries with low energy consumption and high output, allowing for the market's rational resource allocation and fostering the growth of green industries [67]. The ongoing improvement of the development level of green finance can change the industrial energy consumption structure and encourage superior economic growth. In 2021, China submitted a "dual-carbon" goal to the United Nations, focusing on ecological civilization construction and carbon reduction. The goal aims to promote synergies between pollution reduction and carbon reduction, promoting economic and social development through a comprehen-

sive green transformation, and improving the quality of the ecological environment from quantitative to qualitative changes. The development of China's ecological civilization has reached a crucial stage where carbon reduction is the main strategic goal, pollution control and carbon synergy are supported, economic and social development is being comprehensively greened, and quantitative to qualitative changes in ecological and environmental quality are being achieved. China's carbon peak carbon neutral "1 + N" policy system is being built in this environment.

In terms of control variables, the fixed assets investment rate is positive, the proportion of fiscal expenditure is negative, the consumer price index is negative, and the number of industrial enterprises is negative. This is mostly due to the fact that market-oriented methods have steadily taken the lead in terms of being the most effective ways to raise the level of economic development, and that the need for high-quality regional economic development are diverse. Price stability and inflation suppression are one of the goals of macroeconomic development, so the consumer price index shows negative changes. In addition, industrial enterprises are facing the requirements of low carbon, energy conservation, and emission reduction in the new development stage, and need to transform to a tertiary industry to better help the high-quality economic development.

According to heterogeneity analysis, the eastern region is significantly more affected by the favorable promotion of green financing to high-quality economic growth, but the middle and western regions are not significantly affected. Zhou and Gao also came to the conclusion that there is significant regional heterogeneity in China when it comes to the influence of green finance on economic growth, with the impact in the eastern region being clearly greater than that in the central and western regions [38,44].

5.5.2. The Joint Impact of Green Finance, Carbon Emission Reduction and High-Quality Economic Development

Carbon productivity can be increased through green finance, which will also support high-quality economic growth. Green finance helps to encourage the reduction of carbon emissions [15,25,29]. Given the market recent expansion, the role of finance in reducing carbon emissions has received increasing attention, and carbon trading prices have been impacted in a variety of ways [68]. Carbon trading can motivate businesses to innovate more highly-skilled green technologies [69]. The implementation of green credit policy has had some negative effects on the cost and length of debt financing for high-emission and high-energy-consumption organizations, raising that threshold and encouraging such companies to reduce their carbon emissions [34]. Green financing can also help with the enhancement of environmental quality and the pursuit of high-quality economic development by favorably changing the sensitivity of carbon emission efficiency to green technology innovation.

5.5.3. The Spatial Impact of Green Finance on High-Quality Development

It is evident that the level of high-quality economic growth positively spatially relates to how much green finance has developed. According to Gao et al.'s spatial autoregressive and spatial error model test, regional green finance and high-quality economic development have a geographic spillover impact in China [44]. Green finance has greatly promoted high-quality economic development, but the aggravation of environmental pollution has hindered the high-quality development of the economy. With regard to reducing carbon emissions, green finance has a significant regional spillover effect. The growth of green finance has the potential to reduce carbon emissions, not only locally but also regionally, lessening the burden of environmental pollution on high-quality economic development and promoting high-quality coordinated economic growth [25].

6. Conclusions and Recommendations

6.1. Conclusions

Based on panel data from the provinces from 2008 to 2019, this study develops a two-way fixed effect model for theoretical analysis and empirical testing of the role of green finance on high-quality economic development. By analyzing the research results, the following conclusions are drawn:

First, green finance directly promotes the improvement of China's high-quality economic development level. After replacing variables, it can be seen that the result is robust and credible. Green finance promotes the high-quality economic development of the region by integrating idle funds in the market into green investment, guiding people to carry out green consumption and playing a resource-oriented role. Various institutions have actively responded to the green finance policy and developed diversified green financial products, with green credit and green bonds performing particularly well in the market. Heterogeneity analysis demonstrates that, whereas the central and western regions do not have a significant positive impact on high-quality economic development, the eastern region experiences a more positive promotion of green finance. With a focus on technologically intensive industries like new energy, the eastern area offers advanced development advantages and a high degree of green financing development.

Green finance can support the enhancement of carbon productivity and further support the high-quality economic development. The growth of the green finance industry is advantageous for upholding environmental regulations, fostering low-carbon development, creating a green recycling industry system, effectively fostering green technology innovation, enhancing the capacity to reduce pollution and carbon, and quickening the conversion of traditional and alternative energy sources. By encouraging the coordinated growth of industries, raising the technical level of energy conservation and emission reduction, promote the high-quality growth of the regional economy.

Overall, under three spatial weight matrices, the development level of green financing has a positive spatial spillover effect on the level of high-quality economic development. The growth of green finance in these provinces has the potential to not only contribute significantly to the high-quality development of the local economy, but also to that of the nearby provinces. The promotion effect is amplified by geographic distance.

6.2. Recommendations

6.2.1. Vigorously Support the Development of Green Finance

Environmental protection and the idea of being "green" are receiving more and more attention from the general public. Therefore, economic agents need to integrate sustainable development into their strategies to help solve environmental problems [70]. The government should actively encourage the promotion of green finance, introduce pertinent green finance development policies, direct investment into green industries, enhance the system for green consumption, and direct green consumption. We should also enhance the legal framework pertaining to green finance in China, provide a productive and reliable green financial development market, and adopt pertinent incentive measures. The government should also monitor how statistics and information about green financing are disclosed in different provinces, localities, or publicly traded banks and businesses.

6.2.2. Financial Institutions Actively Cooperate with Development

Financial institutions must actively support the government's plans for policies and actions. The guiding role of the government cannot be separated from the growth of green finance; nevertheless, it also requires the support of assisting enterprises in the financial sector. Financial institutions need to keep their business systems up to date in order for financial products to develop more quickly, meet the demands of a shift to a green economy, and create a system of varied green financial products. At the moment, green credit makes up more than 90% of China's green credit products, demonstrating that our green finance

still suffers from issues, including a monolithic structure and a lack of innovation, which financial institutions must urgently address.

6.2.3. Attach Importance to Regional Differences and Develop Green Finance

When it comes to green finance development, different regions started at different times, which results in varying degrees of progress. The central and western regions must perform well in the fundamental tasks of developing green finance, such as system development and extending financing options. They must also utilize the benefits of talent capital, green technology, and capital in developed areas, amplify the radiation effect in central areas, make up for the shortcomings of economic development in surrounding areas, and encourage regional coordinated development.

6.2.4. Strengthen the Development Role of Green Finance in Low-Carbon Production

The role of green finance in fostering high-quality economic growth must be enhanced, and the interaction of such growth with environmental protection must be fostered. To achieve competitive advantages from sustainable development, businesses should actively change their financing strategies, increase the proportion of green financial financing, and fully utilize green bonds. On the other hand, we should increase tax incentives and investment scale in green and low-carbon fields and encourage market players to actively participate in green development to enhance public awareness of environmental issues.

6.3. Limitations

This study examines the relationship between green finance, carbon emission reduction, and high-quality economic development in China. It does so by calculating the interest expense ratio of green finance, developing an index system for high-quality economic development, using the method of carbon productivity to measure the effect of carbon emission reduction, establishing an econometric model, and obtaining hypothetical results. However, it is very challenging to evaluate the development level of green funding in more depth given the dearth of trustworthy data measuring indicators and the fact that the provincial data used in this study only covers the years 2008 through 2019. Another factor that may be lacking for high-quality economic development is a consistent and well-defined index system and measuring technique. In future research, we should improve the theoretical model derivation and data comprehensiveness.

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