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Analysis of Impact of Green New Deal on Development of Green Economy

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Abstract

Currently, nations worldwide are actively promoting various environmental movements to address the ecological crisis. Among these, the most prominent is the Green New Deal (GND). However, during the development of the GND, some scholars have identified that its advancement may lead to more severe environmental problems. Therefore, this study constructs indicators for green economic development and the GND. Utilizing an Ordinary Least Squares (OLS) regression model and a Spatial Durbin Model (SDM) and based on panel data from 30 Chinese provinces spanning 2008 to 2021, it specifically analyzes the impact of the GND on green economic development. The study further examines the spatial effects and externality impacts of the GND. Additionally, green finance is selected as a mediating variable to further explore the relationship between the GND, green finance and green economic development, analyzing the mediating role that green finance plays between them.

Keywords: Green New Deal, development of green economy, green finance, spatial Durbin model, mediator effect model

JEL Classification: H23, O44, Q28, Q58

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1. Introduction

With the increasing occurrence of extreme weather events, environmental degradation and other issues globally, people are gradually realizing the need for governments to implement more proactive and assertive policies to urge global citizens to collectively address the living environment. In this regard, entrepreneurs will invest more funds in technological innovation and governments will increase fiscal expenditure to promote environmental governance and improvement (Nersisyan and Wray, 2021). Especially after the global financial crisis of 2008, governments around the world have not only focused on environmental governance but also paid special attention to social fairness (Mazzucato, 2022), promoting "systemic changes" in the economic and social aspects. Following the global financial crisis, a global environmental movement advocating social justice has been underway. Among them, the most prominent is the Green New Deal (GND).

The following are the GND's primary contents: "First, the GND emphasizes tax reform, believing that governments must update the international financial system." Second, the GND underlines the importance of governments increasing their involvement in environmental regulation and allowing private spending and investment in environmental initiatives to limit the use of fossil fuels. Third, the GND is not a one-time policy. In the long run, the GND promotes social justice as well as people's health. The actual aims of the GND are to raise people's living standards and boost social welfare." These contents may be traced back to the 1970s' new green politics (McRobbie, 1990). The GND promotes changes in economic policy and social habits while also addressing particular environmental challenges. The GND challenges not just the underlying principles of capitalism and consumerism, but also the socialism-favored redistributive growth model (Bloomfield and Steward,2020). Governments and academics think that the creation and growth of the GND would not only drive a restructuring of the financial system, but will also catapult the environmental protection cause to new heights (Green New Deal Group, 2008).

The GND involves green investment while ensuring stable economic operation and achieving social fairness (Brown *et al*., 2023). In this process, the GND focuses on governments' public expenditure on the environment, particularly the construction of green infrastructure (Van Lerven, 2020). For example, Chomsky and Pollin (2020) emphasized that the transformation of infrastructure and energy construction would further promote the development of the GND. White (2020) believed that the transformation of the energy sector in the UK would bring dual benefits to the government, not only increasing employment opportunities but also saving costs for the environmental production sector. The role of the GND in promoting the development of green economies in various countries is evident. In regions where the GND is strongly implemented, such as the UK and the US, it can drive changes in the energy, resources and transportation industries (Pettifor, 2020). At the same time, under the promotion of the GND, some government

powers can be delegated to society and trade unions. This not only saves government regulatory costs but also gives more power to the public, which helps build public trust in the government and support environmental protection initiatives (White, 2020).

It is not enough to rely exclusively on government fiscal spending to further promote the GND. It also need financial services capable of promoting the growth of the green economy and directing societal surplus money to support the development of environmental companies. Influenced by Keynesian macroeconomics, the GND will use government fiscal and monetary policies for financing, as proposed by the GND. The concept of "green finance" is emphasized in the *Green New Deal Group,* highlighting its importance in public investment and social equity. The book emphasizes that green finance raises funds and issues bonds for the GND. These bonds can be issued by the government, companies, or publicly, and can be purchased by citizens and institutions. These financing activities will promote private investment and also convey positive government actions to the public, thus enhancing public trust in the government. In light of the expanding notion of green economic development, green financing is critical in boosting GND (Kelton, 2020). Green finance, as opposed to typical financial services, stresses the green aspects of financial services. Green finance better supports a variety of green economic activities, including environmental development, by integrating financial resources through enhanced financial markets, efficient information distribution settings, and solid regulatory frameworks (Pettifor, 2020). Through the intermediary role of green financing, the proper GND measures will be applied in this process with ease, promoting the expansion of the green economy.

Current scholars have the following shortcomings in their research on this subject:

(1) At the moment, scholars have various viewpoints on the GND's impact, and few have conducted experimental studies to determine whether the GND promotes the expansion of the green sector.Scholars emphasize the use of alternative resources to replace carbon emissions, but they fail to recognize the difficulty of obtaining other new energy-saving resources (Trainer, 2022). At the same time, most scholars or leaders fail to realize that the assumptions within the GND itself are contradictory. Most Western countries adopt policies of deflation and quantitative easing to encourage the public and businesses to make green investments. However, deflationary economic policies can easily lead to economic downturns, and wealthy areas exploit their own wealth to deprive poor regions of their natural resources, further exacerbating social instability (Ajl, 2021). Therefore, the portrayal of the GND itself needs to be analyzed and considered based on specific data.

(2) Governments and scholars have not given sufficient consideration to the negative spillover effects of the GND. Due to the inherent self-interest in Western society, both the public and businesses make decisions to ensure their own interests. Green and Healy (2022) believe that businesses

prioritize shareholder interests and cannot completely change their profit models for green policies. They are more focused on short-term financial benefits. Even if they undergo low-carbon transformations, they may transfer these environmental costs to third parties. If the government imposes carbon emission regulations and conducts large-scale transformations of carbon-intensive industries, some companies may engage in production activities in other regions to evade regulation, resulting in pollution being transferred spatially to other areas.

Based on this, this article has the following innovations:

(1) Due to the fact that the majority of scholars researching the GND are based on theoretical studies, discussing the pros and cons of the GND through various countries' green policies and measures seems to render some conclusions and policies regarding the GND as purely theoretical. Therefore, based on the theoretical analysis of these scholars, this article incorporates econometric analysis, combining theory and data to determine whether scholars' theoretical characterizations of the GND are reasonable and accurate. In doing so, it will make the feasibility of GND development more visible to more scholars. Although many scholars have recognized China's important position in the global green transformation and emphasized that China's ideology will be more conducive to the promotion of GND, few scholars have characterized China's GND and specifically analyzed the implementation of the GND in China. Therefore, this article constructs GND indicators to visually analyze the impact of China's GND on the development of the green economy. Furthermore, based on the construction of GND indicators, the article analyzes the development trends of GND in various provinces.

(2) Due to the fact that most scholars have recognized the externalities of the GND in the theoretical part (Ajl, 2021), but few scholars have used empirical analysis to prove the spatial spillover effects of the GND. Therefore, this article uses data from 30 provinces in China, and constructs a spatial Durbin model using the GND index and green economic development index. It demonstrates that even in China, which is "serving the people," in the early stages of GND implementation, regions that are lagging behind in economic development will inevitably suffer from more severe environmental crises. Regions with more developed economies need to be more cautious and coordinate regional development when implementing the GND.

(3) Considering that the implementation of the GND is a complex system, it requires the support of manpower and financial resources from all sectors of society. Although many scholars have questioned the role of green finance, it is undeniable that green finance will provide substantial funding to promote the development of the GND. Green finance currently plays an important role in China's green transformation, but the financial issues that green

finance may trigger could hinder economic and social development. Due to the fact that both the GND and green economic development emphasize not only environmental improvement but also the rational allocation of resources. Even if green finance can bring funds to the GND, it is not acceptable if it leads to more serious social problems causing economic decline. Therefore, this article introduces the intermediary effect model to further analyze the role of green finance in the relationship between the GND and green economic development.

In conclusion, the impact of GND on the economic and social aspects may have a dual nature. To further explore the effectiveness of GND on the development of green economy, this paper will carefully analyze the spatial spillover of GND. It will explore the impact of GND on the development of green economy by constructing GND indicators related to environmental governance, environmental investment, social security, and infrastructure construction, and analyze the development trends of GND in each province. By establishing indicators related to development efficiency, development quality, and development progress from three aspects, the paper will discuss the influence of GND on the development of green economy, and utilize the spatial Durbin model to specifically analyze the spatial impact of GND on the development of green economy. At the same time, the development of GND requires the support of all sectors of society, making the intermediary role of green finance in GND and green economic development crucial. However, the intermediary role of green finance also has a dual nature, so this paper introduces the intermediary effect model to explore the relationship among the three. Due to limited data availability, there may be certain limitations in some indicators.

2. Literature Review

2.1 GND and development of green economy

The first three main objectives of the GND are to achieve economic decarbonization, promote global economic development and change the structure of the global economy. The United Nations' 2015 announcement of the Millennium Development Goals (MDGs) gave the GND a new definition. At this point, the GND is viewed as a cohesive and coordinated approach to attaining economic development, sustainable global energy consumption and social fairness and justice. In their relevant theoretical study, several experts have proved that the GND may boost the growth of the green economy. What sets the GND apart from other green concepts is its emphasis on reforming the economic system to address environmental degradation and economic inequality, with the aim of improving green development, promoting economic construction and strengthening government governance (Cui *et al*., 2023; Stephan, 2023).

According to the content of the GND, most scholars believe that the implementation of the GND can promote the development of a green economy (Pollin, 2018; Ajl, 2021; Levidow, 2022). The proposal and development of the GND can not only encourage governments and institutions to invest in climate change and promote green economic development but also foster green economic growth and employment to restore the natural ecosystems that support the global economy. The GND is not only a common choice for the international community to address the crisis of ecological degradation and climate change but also an important opportunity for global economic development. Ajl (2021) argues that under the definition of the GND, achieving green economic development in various countries should not only focus on economic growth and carbon reduction but, more importantly, pay attention to social welfare and social security, emphasizing social equity. For instance, while focusing on the environment and economy, it is also essential to create high-quality job opportunities and ensure that residents can access a range of public services and facilities provided by the government or public institutions (Ma, 2023).

However, some scholars have also raised questions about the relationship between the GND and green economic development, arguing that the implementation of the GND fails to achieve its original intention of promoting green economic development from the following two perspectives:

From both theoretical and practical perspectives, some scholars believe that the related policies of the Green New Deal (GND) have an "idealized" feature. Some policies cannot be effectively implemented in the current realistic society, thus hindering the achievement of green economic development as desired (Ajl, 2021). Chomsky and Pollin (2020) point out that the GND advocates for renewable energy to completely replace fossil fuels, but the current technology for the extraction and utilization of renewable energy is limited. If renewable energy is vigorously promoted, it may lead to a new round of environmental pollution in the short term. Additionally, some renewable energy sources are more costly and less efficient compared to fossil fuels, and the extensive utilization of renewable energy may increase social costs (Pollin, 2018). At the same time, Ajl (2021) notes that the strong implementation of the GND in the initial stage may force many high-polluting enterprises to close down, resulting in an increase in the unemployment rate, which could trigger public dissatisfaction and resistance towards GND policies.

From the perspective of policy coordination, White (2020) points out that the initiation and implementation of the Green New Deal (GND) require coordinating actions among multiple government departments, businesses, and social organizations, involving multiple areas such as energy, transportation, and construction. Conflicts of interest and coordination difficulties between countries and regions may lead to a reduction in policy execution efficiency; simultaneously, the smooth implementation of the GND relies on the widespread application of emerging technologies to achieve industrial structural upgrading (Kelton, 2020). However, the mastery and

application of green emerging technologies are still in the early stages in various countries, posing multifaceted challenges concerning technology, funding, and the market, which will further increase the financial pressure on national governments; additionally, Green and Healy (2022) believe that GND policies are more suitable for developed regions with relatively good economic development, substantial economic strength, and sound infrastructure. However, as current economic development varies among countries, this implies that advanced regions will be the first to achieve industrial structural upgrading, while some phased-out high-polluting enterprises will enter underdeveloped regions, further polluting the environment of underdeveloped areas. This will lead to a further widening of the wealth gap and exacerbate issues of social inequality.

In summary, in the long term, the initiation of the Green New Deal (GND) can promote green economic development, address environmental and economic issues, and achieve social justice and equity through systemic transformation. However, due to significant differences in economic development among countries and the persistent issue of wealth inequality, the implementation of the GND may be constrained by certain factors, limiting its ability to effectively promote green economic development. Therefore, to further explore the relationship between the GND and green economic development, this paper proposes hypothesis 1(a):

Hypothesis 1(a): The GND will drive green economic development.

Furthermore, Green and Healy (2022) indicated that economic and social inequality is the primary cause of exacerbating climate issues. Regions with economic and social development inequality are more susceptible to environmental pollution. Data from the European Environment Agency indicate that because of their weaker economic bases, economically undeveloped and economically regressive regions are ill-equipped to deal with the adverse effects of extreme weather and environmental degradation.

Many academics are drawing attention to the detrimental effects of the GND because of the externality of environmental governance, which states that advancements in environmental governance in one location may result in pollution in another place. Scholars have explored the externality of the GND from the perspectives of consumption patterns and inequality. Firstly, consumers' consumption patterns play a significant role in carbon emissions. As people's material living standards improve and income increases, those with higher consumption demands tend to consume more goods, services and energy (Ma, 2023). However, resources in a region are limited and when the local resources cannot meet people's consumption needs, consumers will choose to consume in other regions. The process of consumption shifting inevitably increases the environmental pressure on other regions (Kartha *et al*., 2020). Meanwhile, Nielsen *et al*. (2021) argued that addressing carbon emissions is not only a matter of implementing policies

and limiting corporate emissions but also restricting the consumption of high-income individuals. Many affluent individuals tend to engage in "conspicuous" consumption, which is not driven by genuine resource needs. This kind of consumption leads to resource wastage and increased carbon emissions (Cui *et al*., 2022).

Secondly, economic and social inequality will exacerbate the negative impact of externalities. In regions with inequality, most underdeveloped areas have lower environmental costs, and some businesses or individuals may shift their pollution activities to these underdeveloped areas to increase their own interests (Pata and Olasehinde-Williams, 2023). However, underdeveloped areas lack adequate infrastructure and capacity to deal with the pollution caused by these businesses or individuals, which further worsens the environmental pollution in these underdeveloped areas (Hailemariam *et al*., 2020). Furthermore, high-income individuals, when facing environmental regulations and other related measures, can use their surplus wealth to avoid these regulations, shifting the environmental costs onto low-income individuals. Additionally, Oswald and Millward-Hopkins (2021) found that low-income individuals consume more energy services than high-income individuals. This is because new energy or green technologies are costly, and when facing cost issues, low-income individuals still choose carbon-intensive services with lower costs. Nielsen *et al*. (2021) pointed out that measures for high-income individuals and low-income individuals should be considered separately. The effective implementation of the GND needs to focus on issues of fairness, and only by improving the income of low-income individuals can their consumption habits be changed.

In conclusion, the GND looks to have a favorable influence on green economic development, although further study is needed to confirm this. Because experts think that the GND has externalities, more research on the geographical spillover effects of the GND is required. Furthermore, diverse policy responses to the GND may occur in impoverished and developed countries. Before delving into the GND's influence on green economic growth, it is critical to investigate the GND's success in various locations in order to properly assess its usefulness. As a result, hypothesis 1(b) is proposed in this study:

Hypothesis 1(b): The GND exhibits negative spatial spillover effects.

2.2 GND, green finance and green economic development

Supporters of the GND aspire to restructure the economy to solve environmental degradation and economic inequality, as well as to spur the creation of a green economy. The main measure of this reform is to democratize decision-making at the local government level, providing credit support to businesses or individuals engaged in environmental protection through a government + public

institution + trade union model, forming "community wealth". Kelton (2020) argued that in the subsequent governance of local environmental issues, the above-mentioned three parties can use "community wealth" for effective investment, promote the development of emerging green industries, provide more job opportunities for workers and promote the development of environmental protection. This "community wealth" not only creates new economic wealth for the local community but also forms a new form of financing, promoting industrial structure upgrading.

GND and green finance are clearly linked and complementary. Green finance, as an economic activity that promotes environmental betterment and addresses climate change, will give stronger financial support for the expansion of green firms, making green sector development more possible. In relevant studies on the development of green economy via green finance, most academics analyse the direct implications of green finance on the growth of green economy. Green finance, according to Zhang and Mei (2022), may pool idle assets from diverse sections of society to generate green investments and channel these funds to green enterprises via green credit, therefore encouraging growth of the green economy and optimizing resource allocation.

To summarize, there appears to be a link between green finance, green policies and the expansion of the green economy and green finance serves as a useful intermediary in this interaction. However, there may be certain drawbacks to the aggressive promotion and application of green financing. Firstly, there may be systemic hazards in the socioeconomic system if corporations use more financial leverage to engage in green initiatives. Rather than encouraging the growth of the green economy, it may help create a "green bubble" (Pettifor, 2020). Secondly, although the GND was first implemented in the United States in 2018 and gradually expanded to other regions such as Europe, some scholars still believe that the promotion of the GND is futile and meaningless. This is because companies inevitably harm the environment in the process of national economic development (Cui *et al*., 2023). Furthermore, Finnegan (2022) pointed out that the main obstacles to further promoting the GND lie with the government. The government's increased public expenditure in environmental governance is seen by many as serving themselves and the wealthy class. This will intensify resistance to environmental policies from ordinary businesses and citizens because they know that these policies may harm their interests. At the same time, some capable companies or individuals may bribe the government to evade environmental regulations, further deepening the public suspicion of the government. Furthermore, if public institutions and the government fund more environmental protection and other projects along the course of economic development, this would surely raise financial risks and maybe even the possibility of market failure (Fairbrother *et al*., 2021).

Due to the emphasis of the GND on addressing environmental degradation and economic inequality, its scope goes beyond just businesses and governments. It involves various aspects, ranging from national green economic development to individual enhancement of environmental

awareness. With these multiple links, it is necessary to further verify whether the green investment funds created by green finance can truly be used for the construction of green economic development. Furthermore, Earth's natural resources are limited, and the green production activities carried out by enterprises and individuals with green investment funds may, in another sense, cause new and unknown pollution to the Earth, adding to the burden on the environment. This also needs to be taken into consideration (Finnegan, 2022; Stephan, 2023). The rise of the green economy emphasizes not only the creation of green industries, but also resource stewardship and the harmonious coexistence of people and the natural world. This makes it necessary for this article to confirm if GND can indeed advance green financing, which would then propel the growth of the green economy. Thus, Hypothesis 2 is put out in this paper:

> **Hypothesis 2:** The GND can promote the development of green economy by promoting green finance.

2.3 Brief summary

Based on the literature review in the first two sections, the following conclusions can be drawn:

(1) Firstly, it is beyond doubt that GND will drive the whole society towards green transformation. In the process of transforming the industrial structure towards low carbon and high efficiency, it can promote the change in people's consumption and production concepts, increase their environmental awareness, and truly achieve harmonious coexistence between humans and nature (Ajl, 2021). Moreover, green transformation will also bring more job opportunities to society, thus maintaining social equity. However, there are also shortcomings in the current research on GND. Due to the extremely complex nature of GND, the positive comments from scholars on GND may be just a beautiful vision (Stephan, 2023). As the implementation of GND is a long-term process, the behaviors of governments, companies, and individuals involved in it will not be completely unified. Therefore, whether the current evaluations of GND by scholars are positive or negative, they only represent a short-term situation. In particular, some scholars have consistently emphasized the difficulties of implementing GND in a capitalist society (Bloomfield and Steward, 2020). However, few scholars have applied the theory of GND to discuss its implementation in socialist countries such as China. Therefore, the results of discussions on GND are subject to certain limitations.

(2) Secondly, it can be fairly clear that the majority of scholars have acknowledged the externalities of GND in its implementation process (Hailemariam *et al*., 2020). These externalities are expected to directly lead to rapid environmental improvement and industrial upgrading

in developed areas in the short term, but they may also directly cause accelerated environmental degradation and economic decline in impoverished areas. However, more scholars have focused their discussions on the externalities of GND at the enterprise level, emphasizing how businesses, in order to reduce costs, transfer highly polluting production to less developed areas with lower costs.

(3) Finally, scholars generally believe that GND can indeed promote the development of green finance. GND will help various sectors of society to make green investments in environmental causes. Green finance will in turn facilitate the use of specialized funds and technological inputs for green industries, promoting the development of a green economy. However, most scholars tend to characterize green finance more towards green investments, where businesses use specialized funds to nurture new technologies and talents (van Lerven *et a*l., 2020). At the same time, some scholars emphasize that social financing mainly comes from "community financing," where unions encourage local businesses and individuals to invest. Such green finance has certain limitations. Additionally, some Western scholars studying green finance include government behavior, which can lead to endogeneity issues when discussing the relationship between GND, green finance, and green economic development.

3. Methodology and Data

3.1 Methodology

3.1.1 OLS panel regression model construction

To verify the above hypothesis, we first construct a basic linear model (OLS) to explore the impact of the GND on the development of the green economy. The model is formulated as follows:

$$ged_{it} = a_0 + \beta_1 gp_{it} + \beta_2 theil_{it} + \beta_3 eri_{it} + \beta_4 \ln finance_{it} + \beta_5 urban_{it} + \varepsilon_{it} \quad (1)$$

In Equation (1), i represents the region and t represents the year; gp_{it} is the core explanatory variable, representing the GND; ged_{it} is the core dependent variable, representing the development of the green economy; *theil* represents the Theil index; *eri* represents environmental regulations; *finance* represents government public expenditure; *urban* represents the urbanization rate; $\beta_1 \sim \beta_5$ are the variable coefficients; a_0 is the constant term and ε is the random error term.

3.1.2 Construction of static space Durbin model

To explore the impact of carbon neutrality development on the high-quality development of spatial economy, this study constructs a spatial Durbin model (SDM) as shown in Equation (2):

$$score1_{it} = \rho \sum_{j=1}^{n} W_{ij} score1_{it} + \beta_1 old1_{it} + \theta_1 \sum_{j=1}^{n} W_{ij} old1_{it} + \lambda X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

In Equation (2), i represents the area, t represents the year; $\boldsymbol{W}$ is the $n \times n$ spatial weight matrix based on geographical distance; ρ is the spatial autocorrelation coefficient of the dependent variable, measuring the possible spatial correlation among regions for the dependent variable; β is the regression coefficient of the explanatory variable, measuring the influence of the explanatory variable on the explanatory variable within the region; θ is the spatial regression coefficient of the explanatory variable, measuring the spillover effect of the explanatory variable; X_{it} represents the control variables, including *theil*, *eri*, ln *finance* and *urban*; μ_i represents the spatial fixed effects, λ_t represents the time fixed effects and ε_{it} is a random error term.

3.1.3 Construction of mediation model

In order to understand the role and impact of green finance (*gfi*) on the green economic development in the GND, this paper constructs a mediation effect model as shown below:

$$ged_{it} = a_0 + \beta_1 gp_{it} + \beta_2 theil_{it} + \beta_3 eri_{it} + \beta_4 \ln finance_{it} + \beta_5 urban_{it} + \varepsilon_{it} \quad (3)$$

$$gfi_{it} = a_0 + \beta_1 gp_{it} + \beta_2 theil_{it} + \beta_3 eri_{it} + \beta_4 \ln finance_{it} + \beta_5 urban_{it} + \varepsilon_{it} \quad (4)$$

$$ged_{it} = a_0 + \beta_1 gp_{it} + \beta_2 gfi_{it} + \beta_3 theil_{it} + \beta_4 eri_{it} + \beta_5 \ln finance_{it} + \beta_6 urban_{it} + \varepsilon_{it} \quad (5)$$

In Equations (3)–(5), i represents the region, t represents the year; gp_{it} is the core explanatory variable, representing the GND; ged_{it} is the core dependent variable, representing green economic development; gri_{it} is the mediating variable, representing green finance. Control variables include: Theil index (*theil*), enviromental regulation (*eri*), government public expenditure (ln *finance*); urbanization rate (*urban*); $\beta_1 \sim \beta_6$ is variable coefficient; a_0 is the constant term and ε is the random error term.

3.2 Variable description and data source

3.2.1 Explained variable

The metrics of Liu and Deng (2017) and Chen and Wen (2023) were used to quantify green economic progress. After a detailed review of the country's current level of green economic growth (with the exclusion of Tibet, Taiwan, Hong Kong Special Administrative Region and Macau Special Administrative Region), data from 30 Chinese provinces between 2008 and 2021 were chosen. The entropy weight approach was used to the measurement. The China Statistical Yearbook and the China Environmental Statistical Yearbook were the data sources. Three factors were taken into consideration while creating the green economic development indicators: development quality, development efficiency and development progress. GDP and per capita GDP divided by the share of the tertiary industry constitutes development efficiency. Development quality consists of fixed asset reconstruction and technological transformation, number of patents and R&D. Development progress consists of end-of-year employment and undergraduate enrolment. The specific indicators are shown in Table 1 below.

Table 1: Green economy development indicators

Primary indicators	Secondary indicators	Third-level indicators	Code	Sign	Indicator description
Green economy development	Development efficiency	Proportion of tertiary industry to GDP	X1	+	GDP / total GDP of the third industry in each province
		Per capita GDP	X2	+	Per capita GDP of each province
	Developing quality	Fixed asset renovation and technological transformation	X3	+	Fixed asset renovation and technological transformation in various provinces
		Number of patents owned	X4	+	Number of patents owned by each province at the end of the year
		R&D funding	X5	+	Provincial R&D funding
	Development and progress	Number of employed people at year end	X6	+	Number of employed population by province at the end of the year
		Number of undergraduate students	X7	+	Number of undergraduate students in each province

Source: Authors' own elaboration

3.2.2 Core explanatory variable

The GND measurement and data selection mainly come from the definition of the GND itself. The purpose of the GND is to achieve the coordinated unity of economic development, sustainable use of global energy and maintenance of social fairness and justice. The goal is to address environmental issues and social inequality through economic system reform. In this process, the GND also emphasizes the importance of labour unions and infrastructure (Ajl, 2021). Thus, in light of the data at hand and with reference to Trainer (2022), Ajl (2021) and Mildenberger (2020) literature, this study builds GND indicators from the perspectives of environmental governance, social security, and infrastructure, in accordance with the objectives and purpose of GND. *China Statistical Yearbook* and *China Environmental Statistical Yearbook* are the sources of the data. 30 Chinese provinces' worth of data were chosen between 2008 and 2021, and the entropy weight technique was used to measure the data. Social security is determined by the number of people receiving unemployment insurance at the end of the year and the number of grassroots trade union organizations; infrastructure is determined by the number of public buses and trams as well as the per capita park green space area. Environmental governance is comprised of investments in environmental infrastructure and industrial pollution control. The particular indicators are displayed in Table 2:

Table 2: GND Indicators

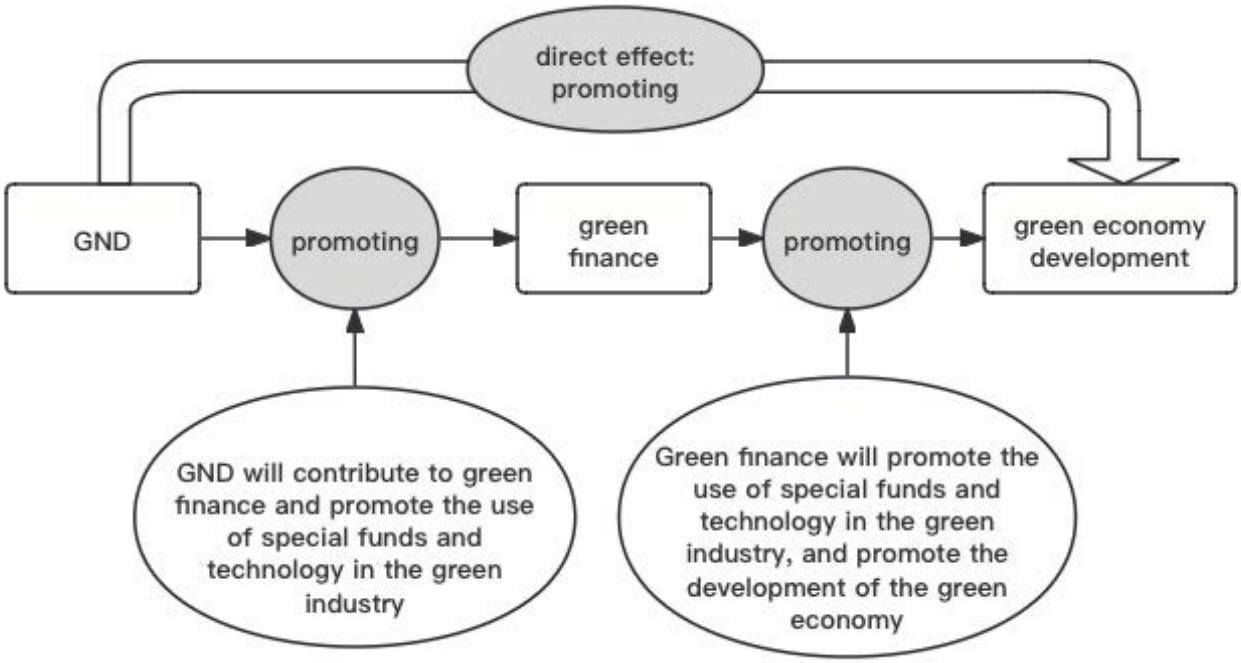
Primary indicators	Secondary indicators	Third-level indicators	Code	Sign	Indicator description
GND	Environmental governance	Investment in environmental infrastructure	X1	+	Investment in urban environmental infrastructure by province
		Investment in industrial pollution source control	X2	+	Investment in industrial pollution source control by province
	Social security	Number of people receiving unemployment insurance at year end	X3	+	Number of people receiving unemployment insurance at the end of the year in each province
		Number of grassroots trade union organizations	X4	+	Number of grassroots trade union organizations in each province
	Infrastructure construction	Bus and trolley bus	X5	+	Total population / bus volume by province
		Per capita park green area	X6	+	Green area of built-up areas in each province / total area of built-up areas

Source: Authors' own elaboration

3.2.3 Mediating variable

Green finance (*gfi*): In order to accomplish a logical allocation of resources and assist the growth of green industries, the implementation of the GND requires financing from green finance. The green economy will grow as a result of the green investments and structural improvements brought about by the ongoing advancement and promotion of green financing. As a result, green funding was chosen as the mediating variable. The data were obtained from the Peking University Digital Finance Research Centre (2020). Figure 1 shows the impact mechanism of green finance on GND and green economic development.

Figure 1: The Impact Mechanism of Green Finance on GND and Green Economy Development



Source: Authors' own elaboration

According to Figure 1, in the direct impact, this paper assumes that GND will promote the development of green economy. Under the mediating effect, the assumptions of this paper are as follows: Firstly, the implementation of GND will provide specialized funds, products, and services to society, further promoting the formation and development of green finance; at the same time, under the impetus of GND, green finance will allocate more funds to green industries, actively promoting the transformation of traditional high-polluting industries into green ones. It will also further promote the formation of people's concept of green consumption in society and further realize the long-term goal of promoting green development.

3.2.4 Control variable

(1) Theil Index (*theil*): Theil index refers to an indicator that measures the degree of inequality in income distribution in a country, region, or field. It can be obtained by sorting everyone's income and calculating the difference between any two income ranges. The higher the Theil index, the greater the degree of income inequality. Due to GND's emphasis on social equity, the Theil index was selected as the control variable.

(2) Environmental regulations (*eri*): Environmental restrictions will force high-polluting businesses to undertake technical reforms and will, in part, restrict their output. This will encourage the deployment of the GND. Regulations pertaining to the environment are therefore chosen as a control variable. The source is the *China Urban Statistical Yearbook* (see China National Bureau of Statistics, 2020b) for raw data on emissions of wastewater, sulphur dioxide and residues that are used to calculate the environmental regulatory index. Please see sections 2-6, 2-7 and 2-8 of the Yearbook for further information.

(3) Government public expenditure (ln *finance*): Government public expenditure will, to some extent, promote the implementation of the GND. Therefore, government public expenditure is selected as a control variable. The data source is the China Statistical Yearbook.

(4) Urbanization rate (*urban*): It makes the GND easier to execute and encourages the expansion of the green economy in areas with relatively advanced urban infrastructure. Therefore, another control variable that has been selected is the urbanization rate. The source of the information is the China Statistical Yearbook.

4. Results and Discussion

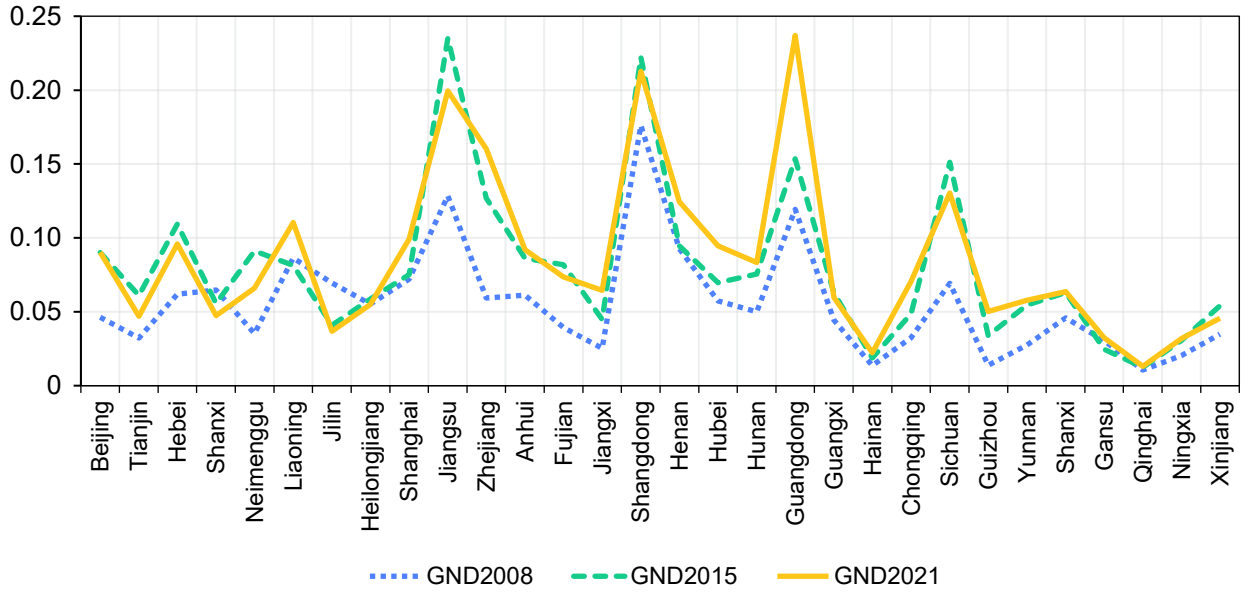
4.1 Calculation results and analysis of GND indicators

Using the entropy weight method, the GND index for 30 provinces from 2008 to 2021 was calculated and the GND index for the years 2008, 2015 and 2021 was extracted to create a line graph to observe the trend of the GND. The results are shown in Figure 2.

Figure 2 shows that the majority of Chinese provinces have a growing GND development pattern year after year. Nonetheless, the GND in 2021 is less than in 2015 in the port regions with a significant international trade sector. One theory is that the pandemic in 2020 had a negative influence on the number of businesses involved in international commerce, and environmental degradation in 2020 and 2021 was not a major issue. As a result, fewer GND initiatives were implemented in 2021. Furthermore, the eastern areas have greater GND ratings compared to the western regions. This is a result of the eastern areas' greater advantages over the western regions in terms of social security, infrastructure, and environmental governance. With GND scores more than 0.2 for Guang-

dong, Shandong, and Jiangsu, we can better forecast whether these policies will support the introduction of GND in China by implementing GND-related pilot projects in these three areas in the future. Furthermore, compared to other central areas, Henan has a somewhat higher GND score. The development of a region's green economy prioritizes the improvement of people's lives alongside the expansion of green industries and the progress of new technologies. In recent years, Henan has focused heavily on building infrastructure and social security, which helps to encourage the prudent use of local resources. The necessary GND principles can still be achieved, even in the event of unfavorable local economic situations. Moreover, Sichuan has a far higher GND score than other western provinces. It is easy to see that GND policies in resource-rich areas can only be implemented successfully if the local economy has reached a certain level of development.

Figure 2: GND trend



Source: Authors' own calculations

4.2 Descriptive statistics

It was at this pivotal period of China's economic development that the concept of GND emerged, which is why data covering the years 2008 to 2021 was chosen. GND's contribution to the advancement of green economic development is growing more and more significant as China transitions from fast to high-quality economic growth. Furthermore, this era is distinguished by the swift advancement of green finance, rendering it increasingly appropriate for examining the intervening function of green finance. The *China Statistical Yearbook*, *China Environmental Statistical Yearbook*, Wind database, are the primary sources of data for the different variables. Absolute

values of government public spending, the rate of urbanization, and other variables have undergone logarithmic adjustment to assure the scientific validity of the empirical study and lessen the effects of heteroscedasticity of variables. The descriptive statistics for every variable are shown in Table 3.

Table 3: Descriptive statistics

Variable	Obs	Mean	SD	Min	Max	Jarque-Bera (*P*-Value)	skewness	kurtosis
ged	420	0.141	0.119	0.012	0.832	0.000	2.387	10.334
gp	420	0.09	0.089	0.006	0.786	0.000	3.864	24.043
theil	420	0.094	0.044	0.018	0.23	0.000	0.633	3.361
eri	420	0.004	0.003	0.000	0.031	0.000	3.144	18.719
ln *finance*	420	8.193	0.742	4.573	9.812	0.000	−0.924	4.991
urban	420	0.57	0.131	0.291	0.95	0.000	0.827	3.625
gfi	420	0.175	0.107	0.057	0.839	0.000	2.919	14.852
ln *consume*	420	7.62	0.417	6.597	8.694	0.006	−0.186	2.329

Source: Authors' own calculations

The observed value in this article is 420, and all variables have undergone the Jarque–Bera test, with numerical values as shown in Table 3. Among them: the maximum value of green economic development is 0.832, the minimum value is 0.012, the average value is 0.141, the skewness is 2.387, and the kurtosis is 10.334, the data is sourced from *China Environmental Statistics Yearbook*; the maximum value of GND is 0.786, the minimum value is 0.006, the average value is 0.09, the skewness is 3.864, and the kurtosis is 24.043, the data is sourced from *China Environmental Statistics Yearbook* and *China Statistical Yearbook*; the maximum value of Thiel Index is 0.23, the minimum value is 0.018, the average value is 0.094, the skewness is 0.633, and the kurtosis is 3.361, the data is sourced from *China Statistical Yearbook*; the maximum value of environmental regulation is 0.031, the minimum value is 0.000, the average value is 0.004, the skewness is 3.144, and the kurtosis is 18.719, the data is sourced from *China Environmental Statistics Yearbook*; the maximum value of government public expenditure is 9.812, the minimum value is 4.573, the average value is 8.193, the skewness is −0.924, and the kurtosis is 4.991, the data is sourced from *China Statistical Yearbook*; the maximum value of urbanization rate is 0.95, the minimum value is 0.291, the average value is 0.57, the skewness is 0.827, and the kur-

tosis is 3.625, the data is sourced from *China Statistical Yearbook*; the maximum value of green finance is 0.839, the minimum value is 0.057, the average value is 0.175, the skewness is 2.919, and the kurtosis is 14.852, the data is sourced from *China Statistical Yearbook*, *China Environmental Statistics Yearbook*, Wind database, and Guotai Junan database.

4.3 Data stability test

This study tested the data for data stationarity using the unit root, autocorrelation, heteroscedasticity, cross-sectional correlation, and panel cointegration tests before doing the regression analysis. The results are shown in Table 4. Considering Table 4:

(1) To determine whether the data in this paper is stationary, unit root tests were conducted. As each unit root test method has its own advantages and disadvantages, to ensure the accuracy of econometric analysis, the data was first tested using the FISHER, LLC, IPS, and HADRI tests. Each variable passed at least two types of unit root tests, FISHER, LLC, IPS, and HADRI, indicating that the data is stationary. In addition, second-generation unit root tests, namely CIPS and CADF tests, were also conducted in this paper. Similarly, in the second-generation unit root tests, each variable passed at least one of the CIPS or CADF tests, thus further confirming the rationality of the selected variables.

(2) The paper conducted tests for autocorrelation, heteroskedasticity, and cross-sectional dependence on the data. As shown in Table 4, there exists autocorrelation, heteroskedasticity, and cross-sectional dependence, so corrective measures were taken for these situations using the FGLS and PCSE methods. The reason for selecting the FGLS and PCSE methods is that they can correct the residuals, consider the serial correlation of errors, and thus obtain more accurate standard errors and coefficient estimates. The corrected results are shown in Table 7, where the regression results from PCSE and FGLS are essentially consistent, proving that subsequent regression model construction can be carried out.

(3) According to Table 4, it can be seen that the panel data passed the Pedroni and Westerlund cointegration tests, indicating the existence of a long-term stable equilibrium relationship between variables. The regression residuals of the equation are stationary, allowing for direct regression of the original equation based on this, and the regression results at this point are more accurate.

(4) In order to verify whether there is multicollinearity among the variables, this study conducted a variance inflation factor (VIF) test. The results, as shown in Table 7, indicate that the average VIF value for each variable is 1.96, and none of the individual variable's VIF values exceed 5. Therefore, it is proven that there is no serious issue of collinearity among the variables, enabling the construction of subsequent models.

(5) In addition, this article also conducted tests for cross-section dependence, including the Pesaran test and the Friedman test. The Pesaran test is a method used to detect whether there is correlation among units in panel data. This test is particularly suitable for large panel datasets, especially when there are many cross-sectional units. The basic idea of the Pesaran test is to calculate the correlation coefficients between the various units in the panel data to check for significant cross-sectional dependence among these units. Specifically, it utilizes the residuals of each unit for testing. The Friedman test is a non-parametric test primarily used to examine the mean differences among multiple related samples, but it can also be used to test for cross-section dependence in panel data analysis. The basic idea of the Friedman test is to rank the observations for each individual, and then compare the ranking differences between different variables (or different time points). This test assumes that the distributions of the groups are the same, and if there are significant differences in rankings between groups, it can be concluded that there is dependence. The specific test results are shown in Table 4.

Table 4: Data stationarity test

unit root test		***ged***	***gp***	***theil***	***eri***	**ln *finance***
FISHER	Inverse chi-squared	20.033	69.021	384.161***	96.797***	64.314
	Inverse normal	5.045	–2.15	–13.22***	–0.96	4.306
	Inverse logit *t*	5.071	–1.929	–19.043***	–1.728**	4.112
	Modified inv. chi-squared	–3.648	0.824	4.066***	3.359***	0.394
LLC	Adjusted *t*	–5.42***	–7.463***	29.592***	–8.607**	–87.003***
IPS	*W-t*-bar	–2.19**	–4.051***	–1.367	0.676	0.082
HADRI	*z*	9.846***	10.566***	8.962***	8.168***	10.7343***
CIPS		–3.613***	–4.47***	–2.632	–4.312***	–4.385***
CADF		–2.743***	–3.131***	–2.6***	–2.436	–2.436
unit root test		***urban***	***gfi***			
FISHER	Inverse chi-squared	406.498***	43.6708			
	Inverse normal	–10.541***	1.849			
	Inverse logit *t*	–18711***	1.844			
	Modified inv. chi-squared	31.631***	–1.491			
LLC	Adjusted t	–16.317***	–3.744***			
IPS	*W-t*-bar	–1.75**	0.859			
HADRI	*z*	9.261***	9.854***			
CIPS		–1.959***	–4.477***			
CADF		–3.079***	–2.156			
panel cointegration tests					**statistic**	***p*–value**
Kao		**Modified Dickey–Fuller t**			3.57	0.0002
Kao		**Dickey–Fuller t**			4.756	0.0000
Kao		**Augmented Dickey–Fuller t**			1.959	0.0250
Kao		**Unadjusted Modified Dickey–Fuller t**			3.422	0.0003
Kao		**Unadjusted Dickey–Fuller t**			4.518	0.0000
Pedroni		**Modified Phillips–Perron t**			6.435	0.0000
Pedroni		**Phillips–Perron t**			–2.191	0.0142
Pedroni		**Augmented Dickey–Fuller t**			–1.98	0.0239
Westerlund		**Variance ratio**			7.918	0.0000
autocorrelation test						
Wooldridge		F (1, 29)			50.032	0.0000
Cross–section dependence						
Pesaran's					31.919	0.0000
Friedman's					137.444	0.0000
heteroscedasticity test						
Modified Wald		chi^2 (30)			3,273.65	0.0000

Standard errors in parentheses* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' own calculations

4.4 OLS panel regression and spatial Durbin regression

4.4.1 Analysis of OLS panel regression results

To better study the impact of GND on green economic development, this paper introduces the OLS panel regression model and the spatial Durbin regression model. First, OLS panel regression is conducted on the data. The OLS panel regression model combines cross-sectional data and time series data to investigate the relationships between variables across individuals and over time. The results of the OLS panel regression are shown in Table 6.

According to model 1(a) in Table 6, it can be seen that GND (*gp*) has a significant positive correlation with green economic development (*ged*) at a 1% level, with a coefficient of 0.361. Therefore, the implementation of GND promotes green economic development. This indicates that the implementation of GND will provide support such as policies, funds, and technology for environmental protection, while promoting the development of green industries and achieving the transformation of the green economy. Therefore, hypothesis 1(a) has been confirmed. According to the theory of green economy and ecological economics, by promoting environmental sustainability and efficient use of resources, it is possible to achieve the unity of economic growth, environmental protection, and social welfare.

At the government and corporate levels, the implementation of GND can guide the economy towards a green, low-carbon direction, transforming it into green industries with clean energy, circular economy, and ecotourism at its core, promoting the efficient use of resources and sustainable environmental development (Fairbrother *et al.*, 2021). At the individual level, the implementation of GND can change people's awareness and consumption habits. According to the theory of behavioral economics, people's behaviors have a "herd effect" (Ajl, 2021). If the government and enterprises can actively guide the public's environmental consumption concepts, individuals who originally favored high consumption and high pollution will gradually adopt green behavior under the leadership of environmentalists. In this way, it will also contribute to further implementation of relevant environmental protection policies, ultimately achieving the overall transformation to a green society. Although individual green consumption behaviors may seem small, the concerted efforts of people around the world will undoubtedly promote the development of green initiatives.

Meanwhile, the Theil index (*theil*) is significantly positive at the 1% level, with a coefficient of 1.217. This indicates that the higher the Theil index, the easier it is to promote green economic development. In terms of the Theil index, a higher Theil index coefficient indicates greater regional inequality. According to the marginal productivity theory, individuals with high productivity generally receive higher income. In regions with income inequality, some wealthy

individuals have higher per capita income and less financial pressure, making them more willing to improve the environment. In this process, they will use their funds to invest in companies and environmental transformation, promote industrial structure upgrading in the region, and achieve green development.

However, why is it that regions with income equality are not particularly conducive to the development of the green economy? Some scholars have given these speculations from the following perspectives: From an investment perspective, Ajl (2021) believes that in regions with income equality, due to the relatively close per capita income, there may be a lack of sufficient funds for investing in green economy projects. In contrast, regions with income inequality may have more affluent individuals willing to invest in environmental protection and green industries, thereby driving the development of the green economy; From a consumption perspective, Ma (2023) argues that in regions with income equality, due to the relatively low consumption levels of the population, there may be insufficient market demand for green products and services. In regions with income inequality, affluent individuals are more capable of purchasing environmentally friendly products, thereby stimulating market demand and promoting the development of the green economy; From a policy perspective, Mildenberger (2020) suggests that in regions with income equality, there may be a lack of government and corporate policy support and incentives for environmental protection, as the economic returns from investing in environmental protection may not be as pronounced as in other fields. In contrast, regions with income inequality may more easily attract attention to environmental issues, leading governments and corporations to be more inclined to promote the development of the green economy.

Therefore, in the actual promotion of green economic development, it is necessary to flexibly use policy tools according to local conditions to promote the effective support and development of the green economy in regions with income equality. Measures such as tax incentives, fiscal subsidies, etc., can be used to stimulate the development of the environmental protection industry and guide consumers to prefer green products, thus achieving a win-win situation for environmental protection and economic development.

At the 10% level, environmental regulations (*eri*) show a significant positive effect with a coefficient of 1.922. This indicates that environmental regulations will promote the development of the green economy. Strengthening environmental regulations can compel highly polluting enterprises to undergo technological transformation, achieving a green transition. This process will optimize resource allocation and realize the development of the green economy. In regions where environmental regulations are implemented, the government will also actively establish a fairer and more just carbon trading market, actively encouraging enterprises to engage in low-carbon production, which will motivate more enterprises and individuals to devote themselves to the development of the green industry; government public expenditure (ln *finance*) shows a signifi-

cant positive effect on the development of the green economy at the 1% level, with a coefficient of 0.038. This indicates that government public expenditure will all promote the development of the green economy. It is very clear that the government, as the main force driving the social green transformation, can greatly promote the social green transformation with more financial support for the development of the green industry. During the process of government support for the transformation of high-energy-consuming enterprises, the green industry will be developed, eliminating traditional polluting enterprises that cannot timely transform, promoting the development of the green economy.

The impact of the urbanization rate (*urban*) on the development of the green economy is significantly negative at the 10% level, with a coefficient of −0.237. This also confirms the point made in the previous text (Mastini, 2021). Government investments in the environment and the emphasis on people's livelihood will promote the development of the green economy. However, in areas with a high urbanization rate, the early stages of economic development will inevitably be accompanied by environmental pollution and destruction, which is unavoidable. If large-scale green transformation is carried out hastily in areas with a high urbanization rate, it will lower the economic living standards in these areas. Therefore, to some extent, a high urbanization rate in certain areas will hinder the development of the green economy.

4.4.2 Analysis spatial Durbin regression results

This article computes the worldwide Moran's index for GND and green economic development from 2008 to 2021 prior to building the geographical model. Table 5 displays the results of using the geographic distance matrix as the spatial matrix. Table 6 indicates the presence of strong spatial autocorrelation. For the years 2008–2021, the GND (*gp*) Moran's index is significant at the 10% confidence level, but the green economic development (*ged*) Moran's index is generally significant at the same level. Consequently, building a geographical model for more study makes sense.

Table 5: Moran's index

Year	*ged*	*gp*
2008	0.105* (0.095)	0.094* (0.09)
2009	0.106* (0.095)	0.121** (0.092)
2010	0.108* (0.094)	0.016 (0.087)
2011	0.12** (0.092)	0.103* (0.09)
2012	0.11* (0.092)	0.061 (0.09)
2013	0.104* (0.092)	0.105* (0.091)
2014	0.108* (0.091)	0.058 (0.091)
2015	0.11* (0.092)	0.083* (0.091)
2016	0.112* (0.091)	0.117** (0.091)
2017	0.121** (0.09)	0.12** (0.092)
2018	0.147** (0.09)	0.058 (0.094)
2019	0.161** (0.09)	0.098* (0.093)
2020	0.154** (0.09)	0.152** (0.093)
2021	0.164** (0.09)	0.084 (0.093)

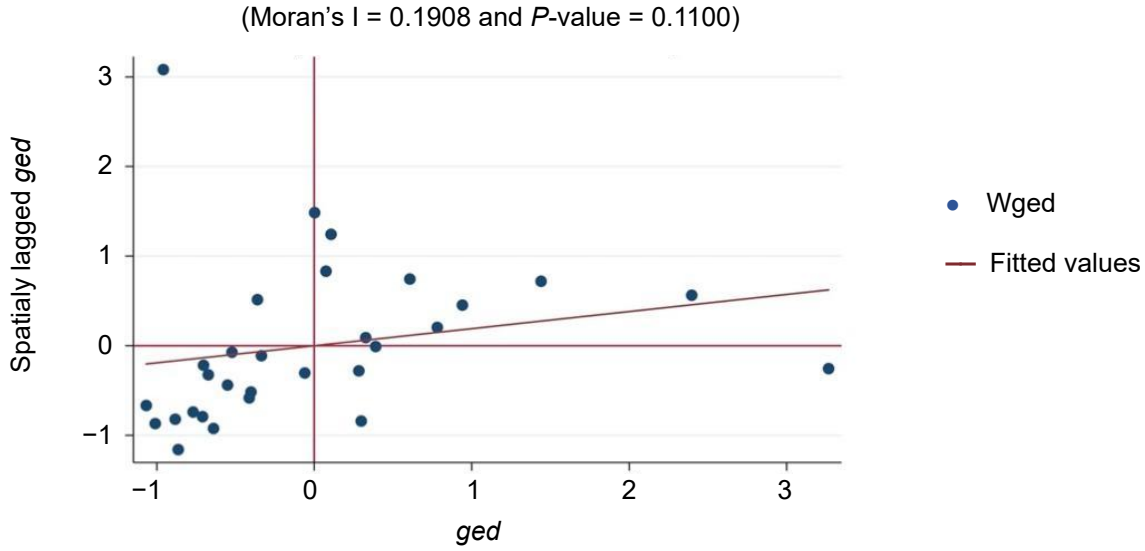
Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' own calculations

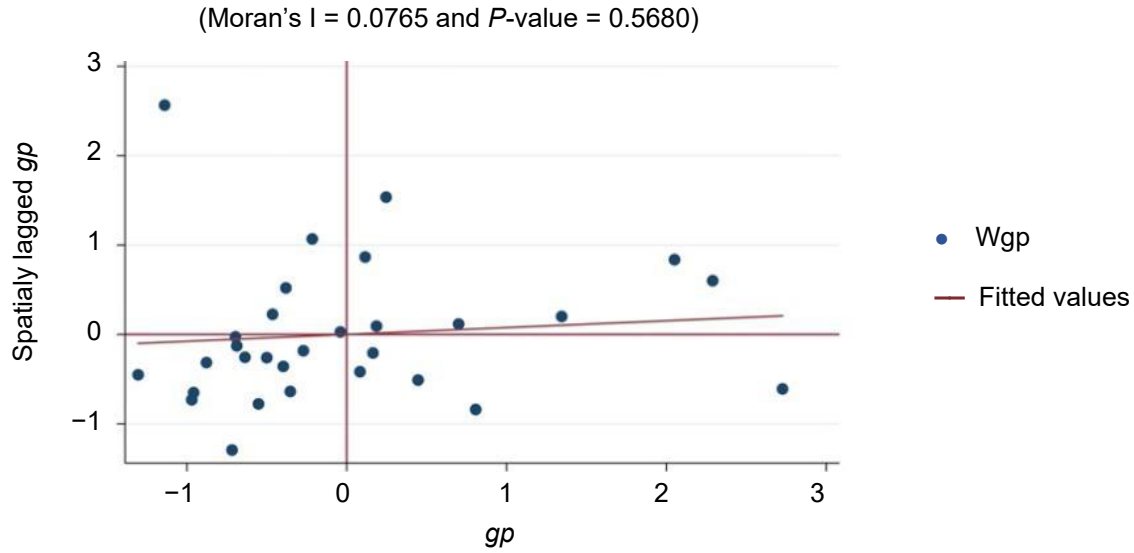
According to Figure 3, in 2021, 10 provinces (33.33%) would be in the first quadrant of the Moran's index scatter plot (3a) for green economy growth (*ged*), while 15 provinces (50%) would be in the third quadrant. This suggests that a positive spatial autocorrelation exists in the green economy. The presence of a positive spatial autocorrelation in the GND is further revealed by the Moran's index scatter plot (3b) of the GND in 2021, which reveals that 7 provinces (23.3%) are located in the first quadrant and 13 provinces (43.33%) are located in the third quadrant.

Figure 3: Moran´s scatter in 2021

(a) Moran's index scatter plot for *ged* in 2021



(b) Moran's index scatter plot for *gp* in 2021



Source: Authors' own elaboration

Table 6: OLS regression and spatial Durbin regression results

	OLS regression model				Spatial Durbin model	
	Model (1)				Model (2)	
	Model (1a): (OLS)	Model (1b): (PCSE)	Model (1b): (FGLS)	vif	Model (2a): (Main)	Model (2b): (Wx)
gp	0.361*** (0.05)	0.361* (0.198)	0.361*** (0.049)	1.46	0.363*** (0.05)	−0.341*** (0.059)
theil	1.217*** (0.331)	1.217*** (0.171)	1.217*** (0.311)	4.81	0.522 (0.381)	0.77 (0.635)
eri	1.922* (1.017)	1.922* (0.006)	1.922** (0.957)	1.32	0.326 (0.941)	0.717 (1.816)
ln *finance*	0.038*** (0.013)	0.038*** (0.013)	0.038*** (0.013)	1.97	0.037*** (0.012)	−0.02 (0.015)
urban	−0.237* (0.124)	−0.237*** (0.074)	−0.237** (0.116)	4.07	−0.098 (0.102)	0.759*** (0.199)
_cons	−0.099 (0.156)	−0.099 (0.124)	−0.099 (0.146)		−0.595*** (0.189)	– –
id	yes	yes	yes			
year	yes	yes	yes			
R^2	0.598	0.598	0.598		**LR_ind**	−197.37
Mean *vif*				2.73	**LR_time**	341.38***
					R^2	0.524
					Log-likelihood	661.4534
					Wald_lag	56.01***
					Wald_error	20.42***
					LR_lag	53.22***
					LR_error	22.79***
					rho	0.61*** (0.051)
					lgt_theta	−1.719*** (0.193)
					sigma2_e	0.002*** (0.000)
Obs.	420				420	
Province	30				30	

Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' own calculations

Furthermore, due to the spatial spillover effect of the Green New Deal (GND), would the vigorous implementation of the GND really have a negative impact on the development of the green economy in other regions? In order to explore the spatial relationship between the two, this article uses a spatial Durbin model regression to study its spatial effects, with the results shown in Table 6, as indicated by Model (2). Likelihood ratio tests have found that both spatial and time fixed effects are significant. The Wald tests and likelihood ratio tests of the spatial lag model (SLM) and spatial error model (SEM) have passed the significance test at the 1% level, rejecting the null hypothesis that the spatial Durbin model can be simplified to a spatial lag model or a spatial error model, proving that the use of the spatial Durbin model in this article is reasonable.

In Model (2a) (Main) and Model (2b) (Wx) in Table 6, it can be observed that the coefficients of the main regression variables are generally consistent in sign and significance with the OLS regression results. However, there are differences in the numerical values and levels of significance, indicating the necessity of studying spatial effects. Through Model (2a) (Main) and Model (2b) (Wx), it can be seen that the direct effect of the GND (*gp*) on the development of the green economy (*ged*) is significantly positively correlated at the 10% level, with a coefficient of 0.363. The spatial spillover effect is significantly negative at the 1% level, with a coefficient of −0.341, proving that local GND development has a significant promoting effect on the development of the green economy, thus validating hypothesis 1(a) once again. However, the GND has a significant inhibitory effect on the green economy development in other regions, thus confirming hypothesis 1(b). This is because in the process of implementing the GND, advanced green technology, manpower, and resources will inevitably be biased towards the local area, thereby restricting the development of the green economy in adjacent regions at the same time.

At the same time, the tilting of these resources will exacerbate inequality between regions, which is not conducive to economic development. This is because in areas where the GND is well developed, it will attract more high-tech companies to settle locally. These companies, taking advantage of the momentum, will provide higher wages for workers (Oswald and Millward-Hopkins, 2021), while relatively disadvantaged companies will gradually exit the market in this competition. Although emerging companies can provide more labor force with the development of the GND, workers who fail to keep up with the green transformation will lose their jobs in the GND's transformation, and social instability factors will rise sharply (Nersisyan and Wray, 2021). According to the core-periphery theory, as the GND unfolds, the core areas of the GND will have more resources to support the development of green industries, while underdeveloped areas in peripheral regions will become more isolated due to a lack of sufficient resources (Prakash and Girgenti, 2020).

It is important to note that the Green New Deal (GND) is not an overnight success and cannot be widely promoted all at once. Both businesses and individuals may need some time to adapt. During this process, some businesses and individuals may choose to relocate to other places to engage in their original economic activities in order to avoid local policies. Although the GND has a relatively positive impact locally, it may increase environmental burdens for other regions, thereby hindering the development of the green economy in those areas. Therefore, hypothesis 1(b) is once again confirmed.

Moreover, it can be seen that the direct effect of government public expenditure (ln*finance*) is significant at a 5% level, while the spatial spillover effect is not significant, with coefficients of 0.037 and −0.02, respectively, similar to the explanation of the Green New Deal (GND). If the nation and the government emphasize local environmental governance, then compared to other regions, more funds will definitely be allocated to environmental governance in the local area. This will inevitably lead to a reduction in government expenditure in other regions, which will hinder the development of the green economy in those areas. The direct effect of the urbanization rate (*urban*) is positive, while the spatial spillover effect is negative, with coefficients of −0.098 and 0.759, respectively. Areas with a higher urbanization rate will certainly include more industrial polluting enterprises. The concentration of these enterprises in the area will to some extent damage the local environment and hinder the development of the green economy. However, in neighboring provinces and regions, the development of the green economy will be promoted due to the presence of fewer polluting enterprises.

4.5 Regression results and analysis of mediation effect model

The present study employed the mediation effect model in regression analysis to examine the impact of green funding (*gfi*) on the growth of the green economy (*ged*), as determined by the GND (*gp*). This article first performed the Bootstrap and Sobel tests, the results of which are shown in Table 7, before analysing the mediation effect model using regression analysis. The results of the bootstrap test show that there is a significant indirect effect (_bs_1) of the GND on the expansion of the green economy at a 5% confidence level. The direct effect (_bs_2) is substantial at a 1% confidence level, with coefficients of 0.045 and 0.467, respectively, indicating a considerable contribution of the GND to the expansion of the green economy. The results of the Sobel test demonstrate the strength of the mediation effect and are significant at the 1% confidence level, with a coefficient of 0.045.

Table 7: Bootstrap and Soble tests

_bs_1	0.045** (0.012)
_bs_2	0.467*** (0.08)
soble	0.045*** (0.016)
Goodman-1 (Aroian)	0.045*** (0.016)
Goodman-2	0.045*** (0.015)

Notes: Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Authors' own calculations

As shown in Table 8, the impact of GND on green economic development in (1) is significantly positive at the 1% level, with a coefficient of 0.371, indicating that GND has a significant promoting effect on green economic development; the indirect regression results in (2) show that the impact of GND on green finance is significantly positive at the 1% level, with a coefficient of 0.078, indicating that GND has a significant promoting effect on green finance; as shown in (3), green finance has a significant positive effect on green economic development at the 1% level, with a coefficient of 0.352, indicating that GND will promote green economic development. Therefore, hypothesis 2 is validated. Also, from Table 8, it can be seen that the total effect of GND on green economic development is more significant than the direct effect in (3), with coefficients of 0.371 and 0.352, respectively. The reason for this is that the total effect considers the mediating effect of green finance, while the direct effect isolates the promoting effect of green finance on green economic development. Therefore, in the direct effect, the promoting effect of GND on green economic development is relatively small.

Based on empirical evidence, the GND is expected to stimulate the growth of green financing, thus driving the expansion of the green economy. As a result of the GND, the government will be forced to make investments in environmental protection and the combination of public and private capital will be promoted to accelerate the development of the green economy. Green finance will undoubtedly evolve and become richer throughout this process. The government can support and develop green finance through policy measures and channel these funds towards low-carbon and environmentally friendly enterprises via reasonable channels and policy constraints. The financing funds brought by green finance are not meant for all enterprises. Those enterprises that

cannot use green funds for technological innovation either need to strengthen internal restructuring or accept elimination. Limiting the amount of money used for green finance might encourage more businesses to engage in environmentally friendly manufacturing while also pushing more established, highly polluting businesses to innovate in technology, thereby advancing the green transformation.

Green finance realizes capital flow through investment in these environmental projects, providing capital for the development of green economy, promoting industrial structure upgrading, and achieving efficient allocation of resources. With the recruitment of more funds through green finance, society will reduce the financing costs of many green industries and environmental projects, which will further enhance investors' enthusiasm for investing in green projects. In this process, it will also provide society with a richer range of financial products and services. With more funds and investors entering the green industry, it will greatly stimulate the participation of enterprises and individuals in green economic construction, and promote the development and transformation of green industries.

It should be noted that there are some potential risks associated with green finance for the economy and society (Xie and Fan, 2023): Firstly, the emergence of green finance may lead to a shift of funds from traditional industries to the green sector, weakening the development and employment opportunities of traditional industries. This may result in issues such as unemployment and economic decline in certain regions or industries (Schuelke-Leech, 2021). Additionally, the policies and incentives of green finance may lead to market distortions, such as excessive subsidies for certain green projects or industries, distorting market competition and hindering efficient resource allocation. Furthermore, some green financial instruments rely on the concept of environmental equivalence, whereby organizations offset their environmental impact by purchasing environmental equivalence. However, the environmental equivalence market faces controversies regarding the authenticity, measurability, and regulatory issues of environmental benefits (Streeck, 2013). Therefore, in the process of promoting the development of green finance, it is essential to fully recognize these potential negative impacts and risks, strengthen the regulation of relevant policies, and enhance risk prevention measures to ensure that the development of green finance genuinely promotes sustainable development of the green economy and society.

Table 8: Mediation effect regression results

Variable	(1)	(2)	(3)
	ged	***gfi***	***ged***
gfi	–	–	0.244*** (0.088)
gp	0.371*** (0.046)	0.078*** (0.028)	0.352*** (0.046)
theil	0.926*** (0.319)	1.138*** (0.193)	0.648* (0.332)
eri	1.122 (0.921)	0.081 (0.557)	1.102 (0.912)
ln *finance*	0.024* (0.012)	0.022*** (0.007)	0.018 (0.013)
urban	−0.312*** (0.119)	−0.571*** (0.072)	−0.173 (0.128)
_cons	0.088 (0.146)	0.726*** (0.088)	−0.089 (0.158)

Notes: Standard errors in parentheses; *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.
Source: Authors' own calculations

4.6 Discussion on robustness test result

4.6.1 Robustness testing of OLS regression

In order to increase the robustness of the regression results, this paper employed the method of adding the control variable of government expenditure on education, culture, and entertainment (ln *consume)*, as well as two-stage least squares (2SLS). The regression results are shown in Table 9 (1) and (2) respectively. Each regression result is basically consistent with the baseline regression result, proving the robustness of the regression results. Additionally, this paper used Generalized Method of Moments (GMM) to test for endogeneity issues. The advantage of using GMM to test and address endogeneity issues lies in its wide applicability, bias correction, flexibility, efficiency, and statistical consistency. It can help the paper more accurately estimate parameters, obtain reliable endogeneity test results. The regression results are shown in Table 9 (3). Furthermore, this paper also tested for endogeneity issues using lagged one period

of GND (*gp*) and lagged one period of green economic development (*ged*). Testing for endogeneity issues using lagged one period of the explanatory variable and the dependent variable helps to avoid contemporaneous endogeneity, control for lagged endogeneity, utilize time series information, and improve the explanatory power of the model, thus more accurately estimating model parameters and making causal inferences. The regression results are shown in Table 9 (4) and (5). All three regression results demonstrate strong robustness, therefore the regression results of this paper are robust.

Table 9: Robustness test

Variable	(1)	(2) 2SLS	(3) GMM	(4) ged lagged	(5) gp lagged
***ged* L1.**	– –	– –	0.413*** (0.037)	– –	– –
***ged*1**	– –	– –	– –	0.248*** (0.047)	– –
***gp*1**	– –	– –	– –	– –	0.321*** (0.049)
gp	0.323*** (0.052)	4.788** (2.312)	0.119*** (0.022)	– –	– –
theil	1.106*** (0.327)	1.585 (1.456)	1.108*** (0.319)	1.372*** (0.323)	1.309*** (0.343)
eri	2.269** (1.007)	–15.805 (10.282)	0.009 (0.234)	1.652* (0.927)	2.213** (0.971)
ln *finance*	0.034*** (0.013)	–0.291 (0.212)	0.02 (0.017)	0.168*** (0.027)	0.195*** (0.029)
urban	–0.09 (0.13)	0.463 (0.388)	–0.609*** (0.11)	–0.207* (0.117)	–0.202 (0.124)
ln *consume*	–0.074*** (0.022)	– –	– –	– –	– –
_cons	0.385* (0.208)	1.762 (1.358)	– –	–1.141*** (0.244)	–1.343*** (0.26)
id	yes	yes	yes	yes	yes
year	yes	yes	yes	yes	yes
R^2	0.885	–	–	0.895	0.905
Obs	420	420	420	420	420
Province	30	30	30	30	30

Notes: Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Authors' own calculations

4.6.2 Robustness testing of spatial Durbin regression

Rather than using a weight matrix based on spatial-geographical distance, we employ a weight matrix based on 0–1 contiguity. The findings are shown in Table 10. The findings suggest that the regression conclusions drawn from the spatial-geographical distance weight matrix and the regression results obtained from the 0–1 matrix for the primary explanatory variables are roughly consistent, suggesting the validity of the empirical findings.

Table 10: Spatial Durbin model regression of 0–1 spatial weight matrix

	Model (distance)		**Model (0-1)**	
	MAIN	**WX**	**MAIN**	**WX**
gp	0.363*** (0.05)	−0.341*** (0.059)	0.313*** (0.049)	−0.225*** (0.048)
theil	0.522 (0.381)	0.77 (0.635)	0.755** (0.357)	0.608 (0.546)
eri	0.326 (0.941)	0.717 (1.816)	0.239 (1.011)	0.82 (1.655)
ln *finance*	0.037*** (0.012)	−0.02 (0.015)	0.0458*** (0.012)	−0.028** (0.014)
urban	−0.098 (0.102)	0.029 (0.024)	0.019 (0.106)	0.816*** (0.182)
_cons	−0.595*** (0.189)	0.759*** (0.199)	−0.665*** (0.184)	– –
Obs.	420			
Province	30			

Notes: Standard errors in parentheses* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.
Source: Authors' own calculations

5. Conclusion and Policy Implications

This paper mainly uses the entropy weighting method to calculate the GND index and green economic development index, and analyze the development trends of GND in various provinces, specifically analyzing the effects of GND in various provinces. At the same time, it introduces the OLS regression model, spatial Durbin model, and mediating variable model, based on panel

data from 30 provinces in China from 2008 to 2021 (excluding Tibet, Taiwan, Hong Kong Special Administrative Region, and Macau Special Administrative Region), to study the impact of GND on green economic development, discuss the spatial spillover effects of GND on green economic development, and further explore the related relationship between GND, green finance, and green economic development.

The results show that: Firstly, the GND scores in the eastern region are generally higher than in other regions, indicating that piloting GND in economically more developed areas will be more conducive to the government's prediction of the implementation effects of GND-related measures. At the same time, in economically underdeveloped areas, the focus should first be on local infrastructure construction and social equity issues, which is more beneficial for the implementation of GND in underdeveloped areas; Secondly, GND has externalities, when promoting green economic development in a local area, it may harm the environment in other areas, showing negative spillover effects; Finally, GND cannot promote green economic development without the support of green finance, and green finance, as a mediating variable, will bring more social funds to the development of green initiatives, support the further implementation of the GND movement, promote green economic development, and achieve regional green transformation.

Undoubtedly, from the long-term perspective of green development, the implementation of GND is crucial. However, in the current situation, some social inequality factors have not been resolved in a timely manner. If the entire society vigorously implements a uniform GND policy, it may easily lead to underdeveloped areas bearing more social burdens. Meanwhile, economically developed regions have strong technological and financial capabilities and can provide experience and models for achieving high-quality economic development through piloting GND policies. Initiating the GND in economically developed eastern regions contributes to shaping a green consumption mindset in society, exploring sustainable development paths, and driving industrial structural upgrades.

The green new policy establishes a framework and mechanism for green finance policies, encouraging financial institutions to develop more financial products and services, and guiding funds towards green industries such as environmental protection, energy conservation, and clean technologies. At the same time, the development of green finance provides financial support and policy guarantees for green industries, promoting the transformation and upgrading of the green economy, and facilitating the research and development as well as the promotion of green technologies and products. In this process, both enterprises and individuals will fully realize the importance of environmental protection and sustainable development, prompting them to increase their investments in environmental protection, driving the transformation of production and consumption patterns, and achieving green development.

By implementing the GND policy in selected areas, it will help promote it across the whole society. Meanwhile, due to the well-developed infrastructure in economically advanced regions, they have the ability to cope with the potential risks of GND implementation. This will help the government to timely introduce relevant policies and measures to prevent any negative impact of GND on the economy and society.

Due to the complexity of the categories involved in the GND, there may be certain negative impacts in the initial stage, such as negative spillover effects, exacerbation of social inequality, and the emergence of "green bubbles." Therefore, governments of all countries need to proceed with GND cautiously. As indicated in the "Guiding Opinions of the State Council on Accelerating the Establishment of a Sound Green, Low-Carbon, and Circular Economic Development System," during the process of transitioning production and lifestyles to green, significantly reducing carbon emissions, and continuously improving the ecological environment, the market-oriented system of green technological innovation needs further improvement. Additionally, relevant laws and regulations also need further improvement to establish the preliminary production, circulation, and consumption systems for green, low-carbon, and circular development.

This article is consistent with the views of scholars such as Ail (2021) and Brown et al. (2023), indicating that the implementation of GND is an inevitable trend, and governments of all countries need to actively promote it. However, in this process, countries need to customize the implementation of GND according to their actual conditions, in order to avoid serious negative impacts caused by its implementation. The implementation of GND is like a double-edged sword, with some negative impacts being unavoidable, but as long as the whole society works together, the harmonious coexistence of humans and nature will eventually be achieved.

Based on the above conclusions, this article proposes the following suggestions:

(1) Strongly support the implementation of GND in various regions, practice GND-related concepts, and further achieve the coordinated unity of economic development, environmental protection, and sustainable global energy utilization. Governments of all countries should continue to follow the *Paris Agreement* and the *United Nations Framework Convention on Climate Change*, emphasizing the role of the government. The government should establish appropriate carbon emission quotas, carbon trading mechanisms, and corresponding taxation, actively urging relevant high-polluting enterprises to transform. However, in this process, the government should implement appropriate measures in different industries and regions to guide high-polluting enterprises to achieve industrial transformation gradually. At the same time, facing enterprises and individuals who repeatedly engage in polluting activities and transfer polluting activities, more stringent laws and regulations should be implemented to restrain them.

Furthermore, GND emphasizes social equality. In order to further achieve green economic development, when governments of all countries strengthen promotional education on carbon emission reduction and environmental protection awareness, they should first improve the infrastructure construction that can promote the development of green businesses. Infrastructure construction is an important cornerstone of regional economic development and a guarantee for industrial structure adjustment. Improving infrastructure can enhance production efficiency and the level of economic development, providing important support for cultivating high-tech and talents locally. Only with improved production efficiency, will more idle capital and talents flow into the development of green businesses, ensuring the eternal youth and vitality of GND; while the improvement of the social security system can enhance social stability and sustainability, providing a more stable development environment for green businesses. In the process of upgrading green industries, underdeveloped regions often rely heavily on traditional high-pollution production. It is necessary to encourage the development of green energy enterprises in promoting industrial structure upgrading, in order to provide more job opportunities for these regions.

(2) Coordinate the coordinated development of green economy in various regions, and implement GND policies suitable for local conditions. One of the core goals of GND is to reduce carbon emissions and improve environmental quality. Through regional coordinated development, it is possible to promote joint efforts in various regions to address climate change and environmental issues, promote the innovative application of green technology, and achieve carbon emission reduction and environmental improvement. Due to the strong spatial spillover effect of GND, in order to avoid hindering the green economic development of other regions while promoting GND locally, the government should coordinate the implementation efforts of GND in various regions, strengthen inter-regional communication and cooperation, ensure healthy and stable economic development, and further promote the development of the green economy. Different regions have differences in resource endowment, industrial structure, environmental conditions, etc. Through regional coordinated development, complementary and mutually beneficial advantages of resources can be realized. Some regions may have abundant green energy resources, while other regions may be proficient in environmental protection technology innovation. Through coordinated development, resources can be better integrated to promote the development of green industries.

At the most fundamental level, regions can first engage in cross-regional environmental protection cooperation to promote cooperation in environmental protection among different regions, jointly address environmental issues, and promote the construction of an ecological civilization. Secondly, regions can further formulate regional coordinated development plans and establish regional green industrial chains. Regional governments can develop regional

coordinated development plans to clarify the positioning and division of tasks for different regions in the development of the green economy. At the same time, regions should promote cross-regional cooperation and resource sharing to optimize resource allocation. In addition, governments should strengthen efforts to control industrial pollution enterprises, guide these enterprises to upgrade their industries, and prevent these enterprises from moving to other regions to engage in the same economic activities to evade environmental pollution control, thus polluting the environment of other regions.

(3) Actively building a sound financial environment, utilizing green finance to guide green investments, and promoting the development of the green economy. Green finance provides necessary financial support for green development. GND-related projects typically require a large amount of capital investment, and traditional financial institutions may have insufficient risk awareness or allocate less capital for such projects. The emergence of green financial institutions has filled this gap, providing more sources of funding for the development of green projects. Additionally, green finance serves as an important platform for international cooperation and exchange. It not only promotes domestic green development, but also contributes to economic cooperation and exchange among nations, driving the global process of green economy and sustainable development.

Therefore, the government should actively guide public institutions to finance green industries, and encourage businesses and individuals to invest using green financial capital. The government can establish alliances of green financial institutions, green investment funds, mechanisms for shared green risks, etc., forming a cooperative mechanism involving the government, financial institutions, enterprises, and all sectors of society, to jointly promote the development of green finance and the transformation of the green economy. A healthy financial environment can effectively avoid systemic risks, while also enriching and improving the financial market, providing the public with more financial products. As green finance is still in the early stages of development in China, the government also needs to introduce relevant policy systems to support the development of green finance, thereby providing more capital self-sufficiency for GND and the development of the green economy.

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