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Original Research

Environmental Regulation, Spatial Spillovers and High Quality Economic Development – The Moderating Effect of Green Technology Innovation

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Abstract

This study selects the data of 30 provinces in China (excluding Hong Kong, Macao, Taiwan, and Xizang) from 2011 to 2021 as a sample, and explains the mechanism of the role of environmental regulation on the high-quality development of the economy from direct and indirect aspects by constructing an index of high-quality development of the economy, and at the same time, analyzes the green technological innovation with the GTFP index measured by the super-efficiency SBM-GML method as a proxy variable for the green technology innovation as a proxy variable to analyze the moderating effect of green technology innovation in the process of environmental regulation and economic high-quality development. The main conclusions are as follows: Environmental regulation can significantly promote high-quality economic development, and its promotion effect is still very obvious after combining it with the moderating variable of green technological innovation. There is a positive spatial spillover effect of environmental regulations in the process of promoting high-quality economic development. The main contribution of this paper is to enrich the research in the field of environmental regulation and high-quality economic development, which not only provides a theoretical and empirical basis for China's future development, but also provides empirical support for developing countries.

Keywords: environmental regulation, high-quality economic development, green technological progress, spatial spillovers, moderating effects

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Introduction

High-quality development is the primary task of China's comprehensive construction of a modern socialist country, and green transformation is an important condition for realizing high-quality development. At present, in the face of the increasingly prominent environmental pollution problem, under the development motive of "Golden Mountains" and "Green Waters and Green Mountains", the traditional crude development mode of "only GDP" theory no longer meet the needs of China's economic development. The traditional "GDP-only" model of crude development is no longer in line with the current needs of China's economic development. Environmental regulation is an important means for the government to stimulate enterprises to carry out eco-environmental protection, green technological transformation, and industrial structure upgrading, and it is the key link to promote the transformation from high economic growth to high-quality development. The characteristic of China's environmental regulation is to realize the synergy between green and development, and environmental regulation is not only the result derived from China's industrialization development, but also the measures taken by the visible hand to deal with the ecological environment crisis. To control environmental pollution, not only the government should implement the corresponding environmental protection regulation policies, but also economic entities as an important source of pollution. It is also necessary to carry out self-innovation and reform to fundamentally solve the pollution problem. Green technological innovation is not only the fundamental path to solving the environmental pollution problem, but also the inherent potential power of market players to step towards high-end, green, and intelligent. At the same time, it has become an important combination point and focus point of China's implementation of the innovation-driven development strategy and green transformation of the development mode. How to effectively utilize green finance to promote green technological innovation of enterprises, accelerate the green low-carbon transformation of development mode, give full play to the regulating effect of green technological innovation, and provide strong scientific and technological support for high-quality development have become realistic issues to be studied.

From the point of view of existing research, around the issue of environmental regulation to promote the high-quality development of the economy, scholars have mainly studied the three aspects of the intrinsic mechanism, influencing factors, and influencing effects. In the study of the internal mechanism of environmental regulation to promote high-quality economic development, He et al. [1] believed that the cost of environmental compliance has become an important factor affecting the development of enterprises. While enterprises are improving environmental quality, strict environmental regulations may reduce corporate profits and investment, reduce total factor productivity, and have a negative impact on business performance. Baudot and Wakkace [2] also believed that flexible economic means and market-oriented means can promote productivity more obviously than mandatory environmental regulation tools and will encourage enterprises to strengthen end-pollution treatment and front-end pollution prevention at the same time, and the latter may even hinder production and innovation. Zhang et al. [3] argue that under the dual missions of industrial growth and emission reduction, environmental regulation will inhibit the growth of environmental efficiency in a short period of time while effectively promoting the growth of environmental productivity in the long term. Heyes [4] argued that there is a two-way relationship between environmental regulation and economic development. On the one hand, environmental regulation may promote economic development, for example, by reducing pollution and resource waste, improving productivity and resource utilization efficiency, and thus promoting economic growth. On the other hand, environmental regulation may also have a negative impact on economic development, for example, by increasing the costs and burdens of enterprises and restricting the development of certain industries, thus affecting economic growth. Therefore, the relationship between environmental regulation and economic development needs to be considered comprehensively to formulate reasonable environmental regulation policies in order to realize a win-win situation for both economic development and environmental protection. Wu et al. [5] believe that increasing environmental taxes can incentivize industrial companies to adopt green transition practices and promote oversight and enforcement of environmental regulations at all levels of government. In addition, in the context of vertical decentralization, the financial incentives provided by the central government to local governments have become a key driver of the green transition. Ryspaeva et al. [6] emphasized that financial and environmental regulation in the process of economic development have a close connection. It argues that environmental regulation promotes the synergistic effects of the system elements interacting with each other to produce effects that make the system have higher overall efficiency. Feng and Yuan [7] combined public choice theory and civil republicanism theory and pointed out that the enactment of environmental regulations has a positive correlation effect on political entrepreneurship and interest group behavior.

In terms of research on the influencing factors of environmental regulation to promote high-quality economic development, Zhang et al. [8] concluded that there is a positive association between strengthened environmental policies and economic growth by comparing the environmental policy scores of different states in the United States. The degree of influence of environmental policies on economic performance varies in different economic periods. Yu and Sun [9] believe that skill premium is conducive to better playing the role of environmental regulation in enhancing the international competitiveness of the manufacturing industry. The international competitiveness of the manufacturing industry can be enhanced by formulating classified regulatory

policies, strengthening the training of skilled talents, optimizing the factor endowment structure, and promoting the integration of capital and technology. Zhao and Sun [10] analyzed empirical data on the relationship between innovation capacity, environmental regulations, and green total factor productivity and found that both innovation capacity and environmental regulations can effectively promote green productivity, and the impact of environmental regulations on green productivity is more obvious. Luo et al. [11] role of environmental regulation in it through empirical research. It is argued that green innovation has a positive impact on financial development, while environmental regulation plays a key role in promoting green industrial development. Environmental regulation and green innovation have a positive effect on the smart upgrading of manufacturing enterprises, while technological progress plays an important role in economic growth. Therefore, environmental rules policymakers should strengthen human resources investment, promote green technology progress and sustainable development, and at the same time strengthen the regulation of corporate environmental behavior. Wang and Li [12] believed that both environmental regulation and managers' environmental concerns have a negative moderating effect on the relationship between government R&D subsidies and strategic green innovation performance, while a positive moderating effect on the relationship between government R&D subsidies and substantive green innovation performance. Luo et al. [13] argued that environmental regulation is regarded as an important factor in improving the productivity of the digital economy, and environmental regulation plays a role in optimizing resource allocation in the development of the digital economy. Chen et al. [14] argued that new environmental regulation accomplishes the improvement of the environmental performance of polluting firms by improving the quality of disclosure of their environmental investment and pollution treatment information and by reducing government subsidies. Therefore, environmental regulation policymakers should focus on environmental investment and disclosure of heavily polluting firms, improve the flexibility of environmental regulation, and reduce the dependence on government subsidies on firms so as to encourage firms to improve their environmental performance.

In the study of the impact effect of environmental regulation on promoting high-quality economic development, Magat [15] argued that environmental regulation leads firms toward cleaner technological innovation with less efficiency loss. Different environmental regulations may affect firms' technological innovation and production decisions to different degrees. Lower standards may make firms more reliant on clean technology innovation. Bai et al. [16] believed that the pilot policy of ecological civilization can effectively promote the increase of "substantive innovation" and "strategic innovation" of enterprises by influencing the government's environmental regulation intensity to encourage enterprises to invest in green technology innovation. Kelman [17] empirically analyzed that environmental regulations may induce firms to reduce production costs and increase profits, but have different impacts on industry innovation. The relationship between environmental regulation stringency and innovative activity varies by industry and time. There is a significant positive correlation between R&D and environmental regulation in different industries, and there is some degree of positive correlation between environmental regulation expenditures and the number of patent applications. Han et al. [18] believed that to properly deal with the relationship between economic growth and environmental protection, the government will actively encourage enterprises to carry out digital transformation and effectively promote enterprises' green technology innovation by improving environmental information disclosure and reducing environmental uncertainty. Meirun et al. [19] applied the ARDL model to study the dynamic effects of green technology innovation on economic growth and carbon dioxide emissions in Singapore, and the research results showed that there was a significant positive relationship between green technology innovation and economic growth. Najjar and Cherniwchan [20] emphasized that environmental regulation impacts have a significant influence on the promotion of different production technologies. It is argued that environmental regulation has a positive correlation with industrial productivity through regulation, thereby increasing the competitiveness of the U.S. manufacturing industry. Wang et al. [21] argued that environmental regulation has a significant impact on the protection of firms and that productivity improvements can be realized by adjusting the production process and improving the level of environmentally friendly technology. The empirical test results of Shao et al. [22] show that the improvement of enterprise technical efficiency makes enterprises closer to the potential production boundary, makes full use of production technology and production resources, offsets the environmental cost brought by environmental regulations to a certain extent, and promotes the green transformation of enterprises. Deantis et al. [23] used empirical evidence to show that environmental regulations contribute to productivity growth and are particularly evident in capital accumulation in highly informationalized countries and that stricter environmental regulations may lead to an increase in innovation to offset their costs. Cui et al. [24] argued that there is a positive association between the intensity of environmental regulation and the green sustainable development performance of enterprises and that environmental regulation improves performance through green finance and green technological innovation. To this end, an evolutionary model should be constructed between the government and enterprises, including the formulation of differentiated environmental regulatory policies, the construction of a more complete green financial system, and the encouragement of enterprises to actively participate in green technological innovation. Lu [25] argued that environmental regulation leads to increased firm productivity and performance, but there is a trade-off between productivity and emissions. Small and private firms benefit more, while large and state-owned firms are

less affected. Environmental efficiency differences are also magnified within the same industry.

The main purpose of this study is to explore the impact of environmental regulation and high-quality economic development from both theoretical and empirical aspects. After studying and analyzing the previous literature, the innovation and advantages of this study are mainly reflected in three aspects. Firstly, the research on environmental regulation on economic high-quality development mainly favors qualitative analysis, and there are relatively few quantitative analyses. This paper intends to use the panel data of 30 provinces in China from 2011 to 2021 and apply the System GMM model to conduct an empirical study on the impact of environmental regulation on regional high-quality development in China, aiming to scientifically answer whether environmental regulation can promote economic high-quality development. Second, this study provides the mechanism of the impact of environmental regulation on high-quality economic development. It not only answers whether environmental regulation can promote economic high-quality development but also demonstrates how environmental regulation can promote economic regional high-quality development through the test of moderating effect. Finally, the paper suggests corresponding countermeasures to enrich knowledge in the fields of environmental regulation and high-quality economic development.

The research results will focus on improving the development of environmental regulation and deepening the application of environmental regulation in economic high-quality development. The paper is organized as follows: Next section reviews the existing theoretical literature, examines the determinants of environmental regulation on high-quality economic development, and formulates corresponding hypotheses to construct a theoretical framework. Materials and Methods section describes the data and methodology, provides information on data sources and model use, and shows the evolutionary dynamics of high-quality economic development. In Results and Discussion section, the empirical results and regional heterogeneity of environmental regulation on economic high-quality development are shown, the moderating variables are constructed, and the results of the mechanism test are given. Conclusions section gives the conclusions of the paper based on the empirical results and suggests some policy implications.

Theoretical Analysis and Hypothesis

Environmental Regulation and Economic Quantity Growth

The mechanism of environmental regulation on economic growth can be discussed from the following three aspects: First, environmental regulation will agree with the theory of "cost of compliance" and thus inhibit economic growth. Although environmental regulation is conducive to the governance and protection of the environment, the environmental regulatory policy will increase the operating costs of enterprises, thus "crowding out" the productive investment and technological research and development investment. The competitiveness of enterprises in the market will gradually weaken and thus inhibit economic growth. "Squeeze" the enterprise's productive investment and technological research and development investment, the enterprise's competitiveness in the market gradually weakened and then inhibited economic growth; on the other hand, the use of environmental investment increased, although improved the quality of the environment, but due to the differences in economic development and the endowment of factors and resources, developing countries in the pollution-intensive products have an advantage in the production of the environmental regulatory policies. The implementation of environmental regulation policies may encourage developing country enterprises to relocate polluting industries to countries with less environmental regulation, the pollution paradise hypothesis.

Secondly, the theory of "Strong Porter's hypothesis" is put forward, which believes that moderate environmental regulation can stimulate or force enterprises to innovate and make up for the "crowding out effect" formed by the high cost of pollution treatment with the "innovation compensation effect" so as to improve the productivity of enterprises. The "innovation compensation effect" compensates for the "crowding out effect" caused by the high cost of pollution control, improves the productivity of enterprises, and thus promotes economic growth. However, in the implementation of environmental regulation, although it can enhance the attractiveness of the city, attract all kinds of talents to gather in the city, and further give full play to the agglomeration effect of the city and the externalities of human capital, enhance the labor productivity and total factor productivity of the city, and promote the development of urbanization to a higher degree, the agglomeration effect and the enhancement of human capital in the course of the process will surely lead to pollution, resulting in the rise of enterprise production costs, and inhibit the economic development.

Third, environmental regulations accelerate green transformation and upgrading. Enterprises will change the combination of production factors or invest in energy-saving and environmentally friendly production equipment in order to meet the emission standards. At the same time, with the increasing intensity of environmental regulations, the market green threshold continues to improve. In the face of high standards and strict requirements of the market green barriers, new entrants to the market must have green production concepts, production technology, and production capacity, and for the original existence of the market of highly polluting and high energy-consuming enterprises in the strict green market under the elimination of the survival of the fittest mechanism, either through the transformation and upgrading of the green enterprise, or be eliminated from the market. Through the mechanism of "one up, one

down" the cost of survival of enterprises has been further increased, thus making it difficult to promote the level of local economic development.

Based on this, this paper proposes hypothesis H1: Environmental regulation inhibits quantitative economic growth.

Environmental Regulation and Economic Quality Development

As China's economy enters a "new normal", the government's economic focus and objectives have gradually shifted from growth rate to economic restructuring and improving the quality and efficiency of development, which has triggered a gradual shift in the government's investment preferences towards environmental governance and green development. As a result, China has put more weight on the effectiveness of environmental governance to provide a solid foundation for promoting China's transformation and upgrading from high-speed development to high-quality development. First of all, environmental regulation can prompt enterprises to adopt more environmentally friendly and energy-saving technologies to produce products, and this innovation in technology level can improve the resource utilization efficiency per unit of output, reduce environmental pollution and resource waste, and thus increase the core competitiveness and profitability of enterprises. The proposed environmental regulation through technological innovation not only reduces the cost of enterprises in green production but also significantly improves the production efficiency of enterprises in the process of production and management activities, providing momentum for enterprises to create higher value. Secondly, the development of environmental regulation has put forward higher requirements for the three industries, prompting the industry to change from high-speed development to the direction of green development. On the one hand, environmental regulations optimize the industrial structure so that industrial production activities shall not be carried out in a greener direction, effectively protecting the ecological environment; on the other hand, industrial reform towards a higher quality of the direction of evolution, prompting the improvement of industrial technology and efficiency. This undoubtedly provides more vitality for driving the green and high-quality development of industry. Finally, environmental regulation will promote the enhancement of resource allocation efficiency.

The development of environmental regulation will not only accelerate the integration of environmental resources technological resources and other factors but, at the same time, make enterprises pay more attention to the production and sale of green products and services, promote the economy in a more environmentally friendly and sustainable direction, and improve the quality and efficiency of the economy.

Based on this, this paper makes the hypothesis H2: Environmental regulation can promote high-quality economic development.

Moderating Effects of Green Technology Innovation

Environmental regulation will inhibit quantitative economic growth, but whether it will form a strong Porter effect on high-quality economic development through green technological innovation needs to be rationally explored. As a key influencing factor of product value-added, green technology innovation is an important driving force for the greening of enterprises and a key focus point for promoting high-quality economic development. First of all, through the introduction of green technology, enterprises transform and upgrade traditional production methods and production factor combinations. With the greening and upgrading of an enterprise, from one band to many, the market will gradually phase out the high pollution and high energy consumption enterprises, the proportion of green enterprises will continue to increase, and the level of society's greening development will also be upgraded. Secondly, when green technology is successfully developed and put into practice, it will lead to the green innovation of products and processes based on green technology, accelerate the development of emerging green industries, enrich the green products of enterprises, and drive the development of enterprises in the green direction. Meanwhile, the close backward and forward linkage between industries will promote the diffusion and application of green technological innovation among industries, thus driving the development of more green industries. Moreover, enterprises carry out green technological innovation and optimize and upgrade the existing production methods and production structure, which can improve the production capacity of green products and enhance the profitability of enterprises. For consumers, the increase in the proportion of green products will drive the consumption trend of green products, stimulate the green consumption potential of residents, stimulate consumption upgrading, and satisfy the diversified consumption needs of the people, thereby improving the people's living standards and enhancing the sense of well-being, and accelerating the formation of the main cycle - the domestic macrocycle.

Based on this, this paper puts forward the hypothesis H3: Green technological innovation has a moderating effect on the process of environmental regulation to promote high-quality economic development.

Materials and Methods

Variables Definition and Description

Explanatory variable. Regarding the research on high-quality economic development, domestic academics mainly focus on its connotation, measurement, evaluation, influencing factors, and development countermeasures. Although there are differences in the focus of the interpretation of the connotation of high-quality development, in general, it is centered on the five development concepts of "innovation, coordination, green,

Table 1. Measurement system for the level of high-quality economic development.

Primary index	Secondary index	Three-level index	Indicator specification
High quality economic development	Green	Energy consumption per unit of GDP (-)	Standard coal/Regional GDP
		Energy consumption elasticity coefficient (-)	Energy consumption growth rate/GDP growth rate
		Wastewater per unit of output (-)	Total wastewater discharge/Regional GDP
		Exhaust gas per unit of output (-)	Sulfur dioxide emissions/Regional GDP
	Innovate	GDP Growth rate (+)	Regional GDP growth rate
		R&D investment intensity (+)	R&D expenditure of industrial enterprises above designated size/Regional GDP
		Investment efficiency (-)	Incremental capital-output ratio (ICOR) = Investment rate/Regional GDP growth rate
		Technical Activity (+)	Technology transaction turnover/Regional GDP
	Coordinate	Demand structure (+)	Total retail sales of consumer goods/Regional GDP
		Urban and rural structure (+)	Urbanization rate
		Industrial structure (+)	The proportion of tertiary industry in regional GDP has increased
		Government debt burden (-)	Government debt balance/Regional GDP
	Open	Foreign trade dependence (+)	Total imports and exports/Regional GDP
		Proportion of foreign investment (+)	Actual utilization of foreign investment/Regional GDP
		Degree of marketization (+)	Regional marketization index
		Degree of financial development (+)	Loan growth by category/Regional GDP
	Share	Proportion of workers' compensation (+)	Workers' Compensation/Regional GDP
		Elasticity of personal income growth (+)	Per capita disposable income growth rate/Regional GDP growth rate
		Urban-rural consumption gap (-)	Per capita consumption expenditure of urban residents/Per capita consumption expenditure of rural residents
		Share of public expenditure (+)	The proportion of local fiscal expenditure on education, medical and health care, housing security, social security, and employment/Local fiscal budget expenditure

Note: In column 3, "+" indicates that the indicator is positive, and "-" indicates that the indicator is negative.

openness, and sharing" to build indicators. This paper refers to the practice of Sun et al. [26] where the entropy method is used to measure the index of the level of high-quality development of the economy of China's 30 provinces, and the greater the index, the higher the level of high-quality development of the economy, and the construction of indicators is shown in Table 1.

Core explanatory variables. Environmental regulation, referring to the approach of He and Luo [27], used the amount of completed investment in industrial pollution control per 1,000 yuan of industrial added value as an indicator to measure the intensity of environmental regulation.

Control variable. After referring to related literature [28–32]. The following partial variables are selected as control variables in this study. The degree of openness to the outside world FDI is measured by the ratio of foreign trade volume to regional GDP; financial development (FA) is characterized by loans from financial institutions per capita; infrastructure development (IR) is represented by the per capita area of road construction; the level of urbanization (FR) is constructed as the ratio of the number of urban residents to the resident population; human capital (HC) is measured by the average years of schooling; industrial structure (IS) is represented by the ratio of tertiary industry to total regional GDP in each province.

Moderator variable. Green technological innovation, with reference to the relevant research of Zhu et al. [33] uses green total factor productivity to characterize green technological innovation. Green technological innovation can effectively mitigate the additional cost impacts brought by environmental regulations, inject new endogenous power for positive development, improve investment

Table 2. Descriptive statistics of variables.

Variable	Sample size	Average	Standard	Min	Max
EPHQ	330	0.300	0.129	0.128	0.786
PGDP	330	58567	28896	16413	183980
ER	330	8.211	6.279	2.576	36.053
GTFP	330	1.016	0.137	0.608	1.928
FDI	330	0.268	0.283	0.001	1.464
FA	330	0.179	0.114	0.020	0.639
IR	330	5.682	2.228	1.100	13.109
FR	330	0.596	0.121	0.350	0.896
HC	330	0.020	0.006	0.008	0.042
IS	330	1.246	0.705	0.518	5.297

returns, promote the green transformation of industries, and then promote the high-quality development of regional economies. This paper adopts the super-efficiency SBM model for measurement, compared with the traditional DEA model. The advantage of the super-efficiency SBM model is that it takes into account the unexpected output, which enables it to accurately reflect the actual effect of green technology innovation in reducing environmental pollution and to evaluate the dual benefits of the environment and economy more comprehensively [34]. Compared with stochastic frontier analysis (SFA) and other statistical methods, the super-efficient SBM model does not require a preset production function form and has greater flexibility and applicability [35]. At the same time, the SBM model is particularly suitable for dealing with relaxation variables, which enables it to more accurately identify inefficient areas in resource utilization and pollution control when evaluating green technology innovation, so as to provide a scientific basis for optimizing resource allocation [36].

Data Sources and Descriptive Statistics

This paper collects the panel data of 30 provinces and cities from 2011 to 2021, and Hong Kong, Macao, Taiwan, and Xizang are excluded from the statistics due to the serious lack of data. The data for the relevant variables in this paper comes from the China Statistical Yearbook, China Environmental Statistical Yearbook, China Energy Statistical Yearbook, statistical bulletins of national economic and social development of each province, and annual reports of national technology market statistics in previous years. The description of variables and descriptive statistics are detailed in Table 2.

Measurement Model and Estimation Method

Reference regression model. From the above theoretical analysis, it can be seen that the intensity of environmental regulation can directly affect the high-quality development of the economy, so this paper will take the intensity of environmental regulation as the core explanatory variable into the traditional panel model for empirical testing. At the same time, in order to alleviate the heteroskedasticity and reduce the order of magnitude, this paper logarithmized all the variables and thus constructed the model as follows:

$$LnEPHQ_{it} = \alpha_0 + a_1 LnER_{it} + a_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (1)$$

$$LnPGDP_{it} = \alpha_0 + a_1 LnER_{it} + a_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (2)$$

$$LnEPHQ_{it} = \alpha_0 + a_1 LnER_{it} + a_2 LnEPHQ_{\text{it-1}} + a_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \quad (3)$$

In the above Equation, $EPHQ_{it}$ is an explanatory variable representing the level of economic high-quality development in province i in period *t*, ER_{it} is a core explanatory variable representing the strength of environmental regulation in province i in period *t*, the vector represents a series of control variables, μ_i represents the individual fixed effect of province i that does not change over time, δ_t represents the control time fixed effect, and ε_{it} represents the random perturbation term.

Meanwhile, in order to verify the relationship between environmental regulation and local economic growth in the previous theoretical analysis, this paper constructs model (2) by taking economic growth (PGDP) as a proxy variable for high-quality economic development. Considering the problems of model endogeneity and heteroskedasticity, this paper tries to construct a two-step dynamic system GMM model with multiple models to comprehensively assess the impact of environmental regulation on the high-quality development of the economy, and the specific formula is shown in the model (3).

Threshold effect model. Moreover, since the impact of environmental regulation on the high quality of the economy may have a nonlinear effect, this paper refers to the existing literature and constructs a threshold effect model with environmental regulation as the threshold variable, and the calculation formula is shown in Equation (4):

$$\begin{aligned} LnEPHQ_{it} = \alpha_0 + a_1 LnER_{it} I\ (ER_{it} \le \beta_1) + \\ a_2 LnER_{it} I\ (\beta_1 \le ER_{it} \le \beta_2) + \\ a_n LnER_{it} I\ (\beta_{n-1} \le ER_{it} \le \beta_n) + \\ + a_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \end{aligned} \tag{4}$$

In the above model, I(•) is the expressive function, which takes 1 when the condition in parentheses is satisfied and 0 otherwise, and β_1, β_2, ... β_n are threshold values, and the other parameters have the same economic significance as in the previous section.

Regulatory effect model. In addition, in order to examine the moderating effect of green technological progress in the impact of environmental regulation on the high-quality development of the economy, we add the interaction term between environmental regulation and green technological progress to the baseline model (1) to obtain model (5):

$$\begin{aligned} LnEPHQ_{it} = \gamma_0 + \gamma_1 LnER_{it} + \gamma_2 GTFP_{it} + \\ \gamma_3 (LnER_{it} \times GTFP_{it}) + \gamma_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \end{aligned} \tag{5}$$

Spatial regression model. Finally, to further discuss the spatial spillover effects of environmental regulation on high-quality economic development, this paper introduces the spatial interaction terms of these two and other control variables in Equation (1), further expanding it into a spatial panel econometric model. The spatial econometric model is shown in Equation (6) below:

$$\begin{aligned} LnEPHQ_{it} = \alpha_0 + \rho WLnEPHQ_{it} + \phi_1 WLnER_{it} + \\ a_1 LnER_{it} + \phi_c WLnZ_{it} + a_c LnZ_{it} + \mu_i + \delta_t + \varepsilon_{it} \end{aligned} \tag{6}$$

Where ρ represents the spatial autoregressive coefficient, W is the spatial weight matrix, φ_1 and φ_c are the elasticity coefficients of the spatial interaction in terms of the core explanatory variables as well as the control variables. Model (6) includes the spatial interaction terms of the explanatory variables and the explanatory variables, which is the spatial Durbin model (SDM). In order to ensure the quality of spatial test regression, two types of spatial weight matrices are used in this paper. The adjacency (0-1) weight matrix is mainly determined by the adjacency relation. If the two provinces are adjacent, the value is 1, if the two provinces are not adjacent, the value is 0. The second is the spatial geographical distance weight matrix, which is mainly constructed by the square ratio of the distance between the capital cities of each province. The adjacency order matrix can be used to analyze the topology structure of the network, while the spatial geographic distance matrix is helpful for spatial analysis, such as finding the shortest path and cluster analysis. When used together, they can represent and analyze complex spatial relationships very effectively.

Results and Discussion

Direct Effects Analysis

In Table 3, models (1) and (2) are the results estimated by the static panel method, model (1) is the fitting result of the impact of environmental regulation on the high-quality development of the economy, and model (2) is the fitting result of environmental regulation on the growth of economic quantity. From the regression results of model (2), there is a significant inhibition of environmental regulation on the growth of economic quantity, verifying the previous hypothesis 1. Environmental regulation will inhibit the growth of economic quantity. From the regression results of model (1), environmental regulation has a significant role in promoting high-quality economic development, which still holds after considering the endogeneity and robustness of the model (model 3, model 5), verifying the previous hypothesis 2. Environmental regulation can significantly promote high-quality economic development.

The coefficient of the effect of environmental regulation on the growth of economic quantity is -0.514 and is significant at the 5% level. This indicates that the current environmental regulation policy in China is at the expense of high economic growth, which is in line with the viewpoint of the "compliance cost" theory. The possible reason is that China has an advantage in the production of pollution-intensive products, and the implementation of environmental regulation policies will relocate the polluting industries to countries with less environmental regulation, and some of the environmentally polluting enterprises will be shut down directly. At the same time, the current system conditions in China are relatively weak, the distortion of factor allocation is heavy, and the environmental regulation of the innovation compensation effect is lower than the cost effect of the cost of enterprises in environmental pollution above the cost of squeezing the production of investment and technological research and development investment, and enterprise market competitiveness is weakened.

The coefficient of the impact of environmental regulation on the development of high quality of the economy is 0.427, and it is significant at the level of 1%. This indicates that although environmental regulation affects the quantitative growth of China's economy, it significantly contributes to the quality of China's economic development. This means that environmental regulation has prompted our country to move from rapid economic growth towards high-quality economic development and to gradually change

Table 3. Benchmark regression results of environmental regulation and impact on high-quality economic development.

Variable	EPHQ		PGDP		EPHQ	
	RE	FE	RE	FE	GMM One step	GMM Two step
L.LNEPHQ	–	–	–	–	0.252** (0.114)	0.235** (0.100)
LNER	0.063* (0.038)	0.427*** (0.066)	-0.307*** (0.302)	-0.514** (0.048)	0.388** (0.192)	0.432*** (0.148)
LNFDI	0.087*** (0.017)	0.045** (0.019)	-0.110 (0.013)	-0.109 (0.014)	0.097 (0.074)	0.103** (0.056)
LNFA	0.083** (0.036)	0.041 (0.039)	-0.208*** (0.027)	-0.189*** (0.029)	0.362 (0.244)	0.361 (0.241)
LNIR	-0.187*** (0.063)	0.016 (0.085)	0.271*** (0.049)	0.269*** (0.063)	-0.404* (0.230)	-0.440** (0.210)
LNFR	1.240*** (0.193)	0.079*** (0.268)	0.991*** (0.151)	0.916*** (0.197)	-0.573 (0.562)	-0.627 (0.569)
LNHC	0.066 (0.085)	-0.114 (0.121)	0.039 (0.068)	0.101 (0.089)	0.324 (0.034)	0.279 (0.034)
LNIS	0.106** (0.053)	0.194*** (0.073)	0.109*** (0.041)	0.265*** (0.053)	1.305** (0.624)	1.391** (0.585)
R^2	0.221	0.322	0.878	0.870	–	–
AR (1)	–	–	–	–	0.000	0.000
AR (2)	–	–	–	–	0.877	0.990
Hansen	–	–	–	–	0.943	0.943
N	330	330	330	330	300	300
Hausman	–	84.89***	–	33.70***	–	–

Note: Standard errors are in parentheses; *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively, as in the following tables.

from a crude economic development model to a high-quality development model that integrates innovation, coordination, greenness, openness, and sharing.

Analysis of regional heterogeneity. According to the National Bureau of Statistics' criteria for geographic location and level of economic development, the samples in the observation period were divided into three groups: eastern, central, and western regions, and the regression results are shown in Table 4. The results show that the regression coefficients of environmental regulation on economic quality development in western, central, and eastern regions are decreasing in order. The coefficient is positive but not significant in the eastern region, where environmental regulation is stronger, while environmental regulation in the central and western regions, where environmental regulation is relatively weak, can significantly promote the growth of economic quality. There are two possible reasons. On the one hand, the economy of the central and western regions is relatively underdeveloped, and traditional manufacturing and resource-based industries account for a relatively large proportion. These industries tend to be heavily polluting and highly responsive to environmental regulations. Through environmental regulation, these areas can be forced to carry out technological upgrading and industrial transformation, so as to have a strong role in promoting high-quality economic development. In the eastern region, where economic development is more mature, a relatively complete industrial structure has been formed, especially in the fields of high-tech, finance, and services. These industries are less sensitive to environmental regulation because their production processes themselves are relatively clean, so environmental regulation has a weaker marginal effect on economic development. On the other hand, the central and western regions have a stronger motivation for industrial upgrading and green development under the promotion of policies to narrow the gap with the eastern region, and the implementation of policies may be greater and the effect is more significant. The eastern region can focus more on maintaining the existing high-quality development situation, and policy implementation may focus on fine management rather than large-scale industrial adjustment. At the same time, there may be a certain relationship with the intensity of environmental

regulation. When the intensity of environmental regulation exceeds a certain threshold value, the promotion effect may be significantly reduced; this phenomenon can be visualized by the econometric model threshold regression model.

The impact of environmental regulation on economic volume growth is characterized by a gradient of decreasing regression coefficients in the eastern, central, and western regions, which indicates that the current environmental regulation policy has the largest inhibitory effect on economic volume growth in the eastern part of the country, followed by the central part of the country, and the western part of the country is the smallest. There may be the following reasons: First, policy implementation and enforcement intensity. Due to the early rapid industrialization, the eastern region attaches more importance to environmental issues, and the implementation and enforcement of policies are more vigorous. Environmental regulations can be quickly transmitted to the management level of enterprises, affecting their production decisions and economic performance. Because the central and western regions enjoy policy flexibility to support their economic development and industrialization processes, the implementation of regulations may be less stringent than in the east and therefore have less direct impact on economic growth. The second is the impact of investment and foreign capital. The eastern region has attracted a large amount of domestic and foreign investment, and strict environmental regulations may cause investors to reassess investment risks and costs, which in turn directly affects economic growth. However, due to the relatively backward development of the central and western regions, the efforts to attract environmental protection technology and green investment are limited, so the implementation of environmental regulations has a less obvious impact on economic growth. The third is the technical level and adaptability. The technical level of enterprises in the eastern region is relatively high, but due to the pressure of industrial green transformation and large investments, adjustments are needed to adapt to strict environmental regulations in the short term, which may lead to a slowdown in economic growth. While the technical level of enterprises in the central and western regions is relatively low, although the adaptability is weak, due to low regulatory standards, the impact on economic growth in the short term is small.

Comprehensive economic quality development and pure economic growth results in Table 5, the eastern region of environmental regulation on economic quality development to promote the role of small, the inhibition of economic growth of the number of large impacts. In the Midwest, environmental regulation has made a large contribution to high-quality economic development and a small dampening effect on quantitative economic growth. In order to effectively deal with the difference in environmental regulation on economic quality and economic quantity in different regions, this paper puts forward the following policy recommendations:

For the eastern region. First, we will promote green technology innovation. Increase investment in green technology research and development and strengthen cooperation with international green technology enterprises to reduce the economic burden of environmental regulations. Provide tax incentives and subsidies to support enterprises in technological transformation and upgrading and reduce the proportion of industries with high pollution and high energy consumption. Second, we will improve the industrial structure. We will accelerate industrial transformation and upgrading, and encourage the development of low-carbon, environmentally friendly, and high-value-added industries. Through policy guidance and market mechanisms, we will phase out backward production capacity and promote the transformation of traditional enterprises into green industries. Third, improve regulatory flexibility. On the premise of ensuring environmental quality, the implementation of environmental regulations should be flexibly adjusted to provide enterprises with an adaptation period. Implement differentiated environmental policies, which are dynamically adjusted according to the characteristics of different industries and the actual environmental performance of enterprises.

For the Midwest. First, we will strengthen infrastructure development. Increase investment in environmental protection infrastructure, improve the environmental governance capacity of the central and western regions, and create conditions for the implementation of strict environmental regulations. Infrastructure such as green transportation and clean energy will be built to support sustainable economic development in the region. Second, we will guide green investment. We will encourage the development of green finance and guide more funds into the environmental protection industry through green credit and green bonds. Attract foreign investment in green projects and use international capital to promote the green upgrading of local industries. Third, enhance environmental awareness and capacity building. Strengthen environmental protection education for enterprises and the public, improve environmental awareness and technical level, and encourage more enterprises to take environmental protection measures. Provide training and technical support to help companies improve green production capacity and adapt to higher environmental standards.

In terms of comprehensive proposals, first, we should actively strengthen regional coordination. We will promote coordination and cooperation between the eastern and central regions in environmental protection and economic development and share successful experiences and technological achievements. Promote the coordination of environmental policies and economic policies through regional cooperation mechanisms to maximize the positive effects of environmental regulations. Second, we will actively evaluate and adjust policies. Regularly assess the impact of environmental regulations on the economy and adjust policies in a timely manner based on the assessment results to ensure that the dual objectives of the economy and the environment are achieved. Through these policy measures, we can better balance the relationship between environmental protection and economic development and promote the sustainable development of eastern, central, and western regions.

Table 4. Tests for regional heterogeneity.

EPHQ				
Variable	Nationwide	East	Center	West
	FE	FE	FE	FE
LNER	0.427*** (0.066)	0.161 (0.108)	0.535*** (0.137)	0.597*** (0.128)
Control variable	Control	Control	Control	Control
R^2	0.322	0.305	0.430	0.252
N	330	121	88	121
PGDP				
Variable	Nationwide	East	Center	West
	FE	FE	FE	FE
LNER	-0.514*** (0.048)	-0.850*** (0.082)	-0.309*** (0.071)	-0.208*** (0.062)
Control variable	Control	Control	Control	Control
R^2	0.870	0.887	0.950	0.945
N	330	121	88	121

Table 5. Subregional studies of integrated economic quality and economic quantity.

Comprehensive economic quality versus economic quantity analysis			
Item	East	Center	West
EPHQ (Positive promotion)	Lowest	Moderation	Highest
PGDP (Negative influence)	Max	Moderation	Min

Table 6. Panel threshold effects test results.

Threshold variables	Number of thresholds	F	P	10% Critical level	5% Critical level	1% Critical level
Environmental regulation	Single threshold	18.55	0.07	17.74	19.97	26.57
	Double threshold	8.99	0.56	20.46	23.79	33.74

Threshold effect analysis. In this paper, we estimated the single-threshold and double-threshold effects separately and calculated the F-value using Bootstrap, repeatedly sampling 300 times. The results in Table 6 show that environmental regulation passes the single-threshold test at the 10% significance level. This indicates that the threshold effect of environmental regulation affecting high-quality economic development does exist, and there is a "single-threshold effect", with a threshold value of 1.1037.

Table 7 shows the regression estimation results of the panel threshold model, and the results show that when the value of environmental regulation is lower than the threshold value of 1.1037, its regression coefficient is 0.725, and it is significant at the 1% level; while when the value of environmental regulation exceeds the threshold value of 1.1037, its regression coefficient is 0.415 and it is significant at the 1% level, which indicates that the increasing intensity of environmental regulation and its positive contribution to the economic high-quality development will decline after reaching the threshold value. Therefore, when considering the formulation of high-intensity environmental regulation policy, the stage impact of the threshold vector 1.1037 should be considered, and the balance between high-quality economic development and high-quantity growth should be grasped, so as to achieve both the mountains of gold and the mountains of green water.

Table 7. Panel threshold model regression estimates.

Variable	Coefficient	Standard	T	P
LNFDI	0.033*	0.019	1.71	0.088
LNFA	-0.014	0.014	-1.00	0.320
LNIR	0.041	0.040	1.02	0.309
LNFR	0.066	0.084	0.78	0.437
LNHC	0.737***	0.262	2.81	0.005
LNIS	-0.155**	0.074	-2.09	0.037
ER-1	0.725***	0.101	7.18	0.000
ER-2	0.415***	0.065	7.29	0.000
Cons	-2.09***	0.551	-3.79	0.000

Note: ER-1 denotes LnERit I (ER≤1.1037), ER-2 denotes LnERit I (ER>1.1037).

Table 8. Moderating effects test results.

Variable	EPHQ	
	RE	FE
LNER	0.130*** (0.055)	0.113** (0.052)
GTFP	0.083** (0.043)	0.513*** (0.076)
LNER×GTFP	0.375*** (0.097)	0.260*** (0.091)
Control variable	Control	Control
R^2	0.231	0.333
N	330	330

Moderating effects test. According to the results of the previous empirical tests, because environmental regulation inhibits economic quantitative growth, this paper only examines the moderating effect of green technological innovation in the process of environmental regulation to promote the impact of high-quality development of the economy, and the regression results are shown in Table 8. From the regression results, in the fixed-effects and random-effects panel models, the interaction between environmental regulation and green technological innovation is significantly positive, and at the 1% levels, it is significant. This indicates that green technological innovation and environmental regulation influence each other and promote the high-quality development of the economy in the same direction, which verifies the previous H3.

The empirical results show that although green technology innovation cannot directly reverse the impact of environmental regulations on economic growth, in the long run, green technology innovation can promote the transformation of market players to high-end, green, and intelligent through coordination, promote the formation of new quality productivity in the market, and provide "innovation compensation" for high-quality economic development. So as to realize the "win-win" strategy of environmental governance and high-quality economic development.

Indirect Effects Analysis

Spatial correlation test. Before model construction, it is necessary to examine whether there is a spatial correlation between environmental regulation and economic high-quality development and other related variables. In spatial econometric analysis, the global Moran's index focuses on the examination of portraying global spatial autocorrelation, which is usually used to conduct spatial correlation tests. From the test results in Table 9, Moran's I indexes of environmental regulation and economic high-quality development all passed the significance test at the 10% level, indicating that there is a significant spatial autocorrelation between environmental regulation

Table 9. Spatial autocorrelation test between environmental regulation and high-quality economic development.

Year	ER		EPHQ	
	Moran's I	Z-value	Moran's I	Z-value
2011	0.161*	1.700	0.287***	3.013
2012	0.166*	1.740	0.294***	3.025
2013	0.172*	1.791	0.300***	3.062
2014	0.167*	1.756	0.346***	3.446
2015	0.147*	1.622	0.299***	3.029
2016	0.181*	1.906	0.206**	2.082
2017	0.270***	2.722	0.318***	3.080
2018	0.239**	2.467	0.352***	3.335
2019	0.386***	3.625	0.322***	3.137
2020	0.376***	3.535	0.302***	2.991
2021	0.403***	3.770	0.322***	3.096

Table 10. Localized Moran's I index scatterplot four quadrant province distribution.

Vintages	High-High	Low-High	Low-Low	High-Low
2011	Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, Fujian	Guangdong, Liaoning, Chongqing	Shandong, Hubei, Hunan, Henan, Shanxi, Inner Mongolia, Jilin, Heilongjiang, Guangxi, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Hebei, Jiangxi, Hainan, Anhui
2016	Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, Fujian, Hainan	Guangdong, Liaoning	Shandong, Hubei, Hunan, Henan, Shanxi, Inner Mongolia, Heilongjiang, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Hebei, Jilin, Jiangxi, Anhui
2021	Beijing, Shanghai, Tianjin, Jiangsu, Zhejiang, Hainan, Shandong	Guangdong, Liaoning, Sichuan	Hubei, Henan, Shanxi, Inner Mongolia, Heilongjiang, Guangxi, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang	Hebei, Fujian, Jilin, Jiangxi, Anhui, Hunan

and economic high-quality development in China from 2011 to 2021. The positive distribution characteristics of "high-high" agglomeration and "low-low" agglomeration require the use of spatial econometric models to further analyze the relationship between the two.

Table 10 shows the distribution of provinces in each of the four quadrants of Moran's I Index for the localized high-quality economic development for representative years (2011, 2016, 2021) under the spatial weight 0-1 matrix. Each of the four quadrants represents a different spatial correlation, with the provinces in the first and third quadrant regions showing positive spatial correlations and the regions in the second and fourth quadrants showing negative spatial correlations.

Observing the results in the above table, it can be seen that the provinces in the first quadrant of "high-high" and the third quadrant of "low-low" agglomeration in 2011, 2016, and 2021 account for most of the provinces, which indicates that the phenomenon of homogeneous agglomeration of high-quality development of China's economy is in a dominant position, showing positive spatial correlation with the results of the global Moran Index. This indicates that the phenomenon of homogeneous agglomeration in China's high-quality economic development is dominant and shows a positive spatial correlation, which is consistent with the results of the global Moran Index.

Spatial econometric model selection test. For the selection of a spatial econometric model, this paper discriminates by Moran's I index and Lagrange multiplier test. From Table 11, we can find that the test results of Moran's I, LM error, and LM lag are all significant at the 1% level, which indicates that the model has both a spatial lag term and a spatial error term and should be selected to use a combination of both spatial Durbin model (SDM) for empirical analysis; LR test and Wald test results are significant at the 1% level, indicating that the spatial Durbin model cannot be simplified to the spatial lag model and spatial error model, and thus, the choice of spatial Durbin model for spatial measurement is reasonable.

Table 11. Spatial econometric model LM, effects, Wald, LR test.

Test	Enterprise	Statistic	Test	Enterprise	Statistic
LM test	Moran's I	8.407***	Wald test	Degradation to SAR	41.00***
	LM error	63.541***		Degradation to SER	31.92***
	LM error (Robust)	7.290***	LR test	LR SDM SAR	38.76***
	LM lag	64.311***		LR SDM SEM	41.77***
	LM lag (Robust)	8.060***	Hausman test	FE and RE	-34.37
Effect test	Effect test both and ind	62.39***	–	–	–
	Effect test both and time	312.75***	–	–	–

Table 12. Spatial Durbin model regression results.

Variable	EPHQ	
	Adjacency matrix (0-1)	Geographic distance matrix
LNER	0.147** (0.073)	0.115** (0.058)
W×LNER	0.223** (0.211)	0.652*** (0.225)
Control variable	Control	Control
Direct effect	0.140* (0.077)	0.153** (0.065)
Indirect effect	0.151 (0.068)	1.697*** (0.588)
Total effect	0.291*** (0.085)	1.850*** (0.625)
Double fixed effect	Control	Control
P	-0.266*** (0.087)	0.584*** (0.086)
Log-l	400.796	282.148
R^2	0.177	0.734
N	330	330

The Hausman test results show negative, so this paper selects the fixed effects model for regression. The effect test result shows that the separate time effect and space effect are rejected, so the time and space double effect model should be chosen for the test.

Spatial Durbin model regression. The regression results using the spatial Durbin model two-effects fixed model are shown in Table 12, where the coefficients of the spatial interaction terms for environmental regulation are significantly positive at 0.233 and 0.652 in the regression models with two different matrices. This suggests that there may be positive spatial spillovers from environmental regulation. From the effect regression results of the two matrices, the coefficient of the indirect effect in the adjacency matrix is 0.151, which is not significant. The coefficient in the geographic distance weight matrix is 1.697, which is significantly positive at the 1% level. This indicates that there is a positive spatial spillover of environmental regulation, and the spillover effect is more pronounced after considering the distance weights. We can conclude that environmental regulation has a positive spatial spillover effect in the process of promoting high-quality economic development.

Conclusions

This study selects the data of 30 provinces in China (excluding Hong Kong, Macao, Taiwan, and Xizang) from 2011 to 2021 as samples and empirically examines

the impact of environmental regulation on the high-quality development of the economy through the ordinary panel model, the dynamic GMM model, and the spatial panel econometric model, respectively. The results show that:

(1) Environmental regulation can significantly promote the high-quality development of the economy, and environmental regulation and green technological innovation as a coordinated variable can effectively promote the high-quality development of the economy, realizing the environmental governance and high-quality development of the economy "win-win" strategy.

(2) There is regional heterogeneity in the impact of environmental regulation on high-quality economic development that is manifested in the decreasing effect of environmental regulation on high-quality economic development in the western, central, and eastern regions.

(3) There is a positive spatial spillover effect of environmental regulation in the process of high-quality economic development, which indicates that environmental regulation helps to synchronize the pattern of high-quality economic development in neighboring regions. In general, this paper provides ideas for China's high-quality development from the perspective of environmental regulation the practice of environmental regulation, China has actively explored an effective path for the coordinated development of ecological protection and economic growth, which provides a certain reference for other developing countries. First, through comprehensive policy design, China ensures that environmental protection policies not only focus on the ecological environment itself, but also closely integrate with economic development strategies, which indicates that other countries should consider multiple economic, social, and environmental objectives when formulating policies. Second, China emphasizes the key role of scientific and technological innovation in promoting green development by supporting the research and application of green technologies, improving resource utilization efficiency, and reducing pollution, which suggests that other countries should also attach importance to scientific and technological innovation as an important driving force for green transformation. In addition, China uses a variety of tools, including laws and regulations, economic incentives, and market mechanisms, to enhance the flexibility and effectiveness of environmental regulations, emphasizing the importance of diversifying policy tools. Strengthening regulation and enforcement to ensure effective implementation of policies, as well as enhancing the social basis for environmental governance by raising public awareness and encouraging public participation, are also part of the Chinese experience. Finally, China's active participation in international cooperation and experience exchange shows that in the context of globalization, developing countries can promote their own sustainable development and high-quality economic transformation by strengthening international cooperation and learning from successful experiences.

Based on the previous theoretical analysis and empirical investigation, in order to better realize the win-win strategy of environmental regulation and high-quality economic development, this paper has the following policy recommendations:

First, under the premise that environmental regulation can significantly promote high-quality economic development, each region, according to the actual economic development, the establishment of regional differences, and a timely and appropriate environmental regulation policy system, does not have a "one size fits all" approach. At this stage, the eastern region of environmental regulation on the promotion of high-quality development of the economy is small, the negative impact on the economic growth of the number of large, comprehensive considerations of the application of the environmental regulation strategy of weaker regulation. In the central and western regions, on the contrary, environmental regulation has a large role in promoting high-quality economic development and a small impact on economic volume growth, so it is appropriate to continue to maintain or enhance the strength of environmental regulation policies while paying attention to the impact of threshold variables.

Secondly, the coordinating effect of green technological innovation should be emphasized. In the early stage of high-quality economic development, green technological innovation needs to be gradually accumulated, and at this time, the regulating effect plays a role in environmental regulation as the "medicine guide" role, combined with the synergistic force of the two, and jointly promotes high-quality economic development. At the same time, improves the green innovation technology cross-regional and cross-industry flow mechanism. Because of the strong spatial spillover effect of environmental regulation, local governments should create an environment conducive to the development of green technological innovation, further play a role in promoting green innovation technology, smooth green technology research and development, application and promotion channels, and promote green technology research and development personnel, research and development funds, and other trans-regional flows, so as to effectively unleash the endogenous momentum of green technology.

Thirdly, it is necessary to continue to maintain the assessment of the contribution of "green GDP" and to give more weight to the assessment of environmental protection and green development indicators in the competition for local governments. At present, although the environmental regulations will have a certain inhibition on the rapid growth of economic quantity, they are really conducive to the improvement of the quality of the economy and help people's demand for a better life. Therefore, in order to prevent local governments from pursuing the economic growth rate and taking the old path of sacrificing the environment for economic growth, local governments should incorporate the "green GDP" into the assessment system to realize the win-win strategy of environmental governance and high-quality economic development.

This paper explores the impact of environmental regulation on China's high-quality economic development from both theoretical and empirical levels and proves that the development of environmental regulation will

effectively promote high-quality economic development, which provides a solid foundation for China and developing countries to use environmental regulation to promote high-quality economic development and provides effective policy suggestions. This has provided new impetus and new momentum for China's future economic and environmental development. From the perspective of research limitations, this paper uses the GMM model to evaluate the relationship between the two and analyzes its spatial spillover effect. Although this method can effectively verify the relationship between the two, due to the differences in measurement methods and measurement methods between environmental regulation and high-quality economic development in China, different measurement methods and estimation methods may lead to different results. In addition, this study did not consider the actual impact of other influencing factors such as scientific and technological innovation ability, green innovation, and carbon emission transmission factors on the relationship between the two. Therefore, from the perspective of future research, future research may benefit from more scientific and reasonable measurement and more accurate data selection, and at the same time, more conduction factors can be selected to explore and analyze their dynamics and transmission mechanisms, so as to assess the impact on the economy and society.

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Conflict of Interest

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Authors Contribution

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