

# Exploration and Evaluation of the Green Fiscal Effect on the High-Quality Development of the Economy

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## ABSTRACT

This thesis mainly focuses on exploring and evaluating the effects of green fiscal policy in the context of high-quality economic development. As the global economy pursues high-quality development, green fiscal policy serves as an important means to promote sustainable economic development. By optimizing resource allocation and guiding capital flows towards environmental protection, energy conservation, and new energy fields, green fiscal policy plays a positive role in enhancing the quality of economic growth. This thesis delves into the inherent relationship between green fiscal policy and high-quality economic development and explores the specific impact of green fiscal policy on high-quality economic development through empirical analysis methods. The research results show that the implementation of green fiscal policy significantly promotes high-quality economic development, not only improving the efficiency of economic growth but also enhancing the ecological environment and promoting sustainable economic and social development. Additionally, this thesis constructs a comprehensive evaluation system for the effects of green fiscal policy, aiming to provide scientific and systematic decision-making support for policymakers and contribute to a deeper understanding of the role and impact of green fiscal policy in high-quality economic development.

## KEYWORDS

High-quality economic development; Green fiscal policy; Exploration of effects; Evaluation system

## 1. INTRODUCTION

### 1.1. Research Background and Significance

#### 1.1.1. Research Background

Socialism with Chinese characteristics has entered a new era, and China is currently in a critical phase of economic transformation and high-quality development. Following the foundation of high-quality economic development, environmental protection and sustainable development have become focal points for governments and enterprises at all levels. The 20th National Congress of the Communist Party of China emphasized: "High-quality development is the primary task in building a modern socialist country, and development remains the Party's central mission in governance and national rejuvenation. Without a solid material and technological foundation, it is impossible to fully build a modern socialist powerhouse." China's economy has transitioned into a stage of high-quality development, where socioeconomic progress must prioritize high-quality growth. Promoting high-quality development is an inevitable requirement for adhering to economic laws, maintaining sustained and healthy economic growth, addressing major social contradictions, resolving imbalances and inadequacies in development, and effectively mitigating risks to advance the great rejuvenation of the Chinese nation through modernization.

To achieve the dual goals of socioeconomic development and environmentally sustainable high-quality growth, the government has vigorously promoted the transition to a green economy. Among these efforts, green fiscal policy has emerged as a critical tool for advancing sustainable development. By integrating environmental protection and sustainable development concepts into fiscal revenue, expenditure, and policymaking, green fiscal policy aims to direct capital and resources toward green economic sectors such as environmental protection, energy, and technological innovation, thereby fostering ecological conservation and high-quality development. During the 2007 government revenue and expenditure classification reform, China incorporated "environmental protection" as a primary functional expenditure category, later renamed "energy conservation and environmental protection" in 2011 to explicitly reflect fiscal spending on environmental initiatives.

Despite increased government attention to green fiscal investment in recent years, there remains room for improvement. Data show that in 2022, China's GDP reached 121,020.72 billion yuan, with general public budget expenditures totaling 26,055.212 billion yuan. Of this, energy conservation and environmental protection expenditures amounted to 541.28 billion yuan, accounting for only 0.45% of GDP and 2.08% of total public budget expenditures—a decline from 0.62% and 2.58% in 2020, and 0.48% and 2.25% in 2021. Regional disparities are also evident:

Eastern China: GDP of 62,201.82 billion yuan, general public budget expenditure of 9,426.723 billion yuan, with energy conservation and environmental protection spending at 247.354 billion yuan (0.40% of regional GDP).

Central China: GDP of 26,651.27 billion yuan, general public budget expenditure of 4,980.758 billion yuan, with energy conservation and environmental protection spending at 119.846 billion yuan (0.45% of regional GDP).

Western China: GDP of 24,589.656 billion yuan, general public budget expenditure of 8,090.648 billion yuan, with energy conservation and environmental protection spending at 156.384 billion yuan (0.64% of regional GDP).

These figures highlight insufficient green fiscal expenditures and significant regional imbalances. Today, as green fiscal policy gains prominence in driving regional high-quality development, research on its specific mechanisms and impacts remains inadequate. Therefore, exploring the effects of green fiscal policy on regional economic high-quality development can enhance our understanding of its operational mechanisms and provide actionable insights for policymakers to refine green fiscal strategies and advance sustainable growth. The subsequent sections will elaborate on the significance of this research.

### 1.1.2. Research Significance

From a theoretical perspective, this study employs multi-dimensional and multi-tiered indicators to conduct a quantitative analysis of green fiscal policy and high-quality economic development, thereby revealing the impact of green fiscal mechanisms on regional economic advancement. These indicators not only reflect the input-output efficiency of green fiscal expenditures but also encompass critical dimensions of high-quality development, including economic growth, structural optimization, and environmental protection. Through this quantitative approach, the research provides a comprehensive understanding of the relationship between green fiscal policy and high-quality development while refining performance evaluation metrics for green fiscal initiatives.

Furthermore, this study contributes to theoretical framework construction and expansion. By synthesizing domestic and international theoretical research, it establishes a systematic analytical framework to elucidate how green fiscal policy influences regional high-quality development. Additionally, the paper explores the synergistic effects between green fiscal policy and other macroeconomic policies, as well as its applicability across diverse regions, thereby enriching the theoretical foundations of green fiscal governance.

Practically, this research holds substantial policy relevance. Against the backdrop of global climate change and escalating resource-environmental pressures, green fiscal policy has emerged as a pivotal tool for governments worldwide to drive economic transformation, mitigate environmental degradation, and achieve sustainable development. By directing capital flows toward green technology innovation and industrial upgrading, green fiscal mechanisms can optimize resource allocation, foster low-carbon industries, and ultimately realize green, high-quality economic growth.

In summary, this analysis of green fiscal expenditures' impact on regional high-quality development offers actionable insights for governments to formulate scientifically grounded fiscal budgets and policies. It bridges theoretical exploration with pragmatic policymaking, addressing both academic gaps and real-world challenges in sustainable governance.

## **1.2. Literature Review**

### **1.2.1. Literature on High-Quality Economic Development**

Existing studies have explored the connotation and measurement of high-quality development from diverse perspectives.

Scholars have made significant progress in measuring high-quality economic growth. Wei Min and Li Shuhao (2018) reconstructed a measurement system for economic growth quality, revealing the spatial distribution of growth quality across Chinese provinces under the "new normal" economic context. Shi Bo and Zhang Bingyao (2019), grounded in the Five Development Concepts (innovation, coordination, green development, openness, and sharing), assessed economic growth quality through three dimensions: foundational aspects, societal outcomes, and ecological outcomes. Wu Zhijun and Liang Qing (2020) expanded the Five Development Concepts by adding a sixth dimension—"comprehensive quality-efficiency"—to create a 33-indicator evaluation framework. Xu Lixin and Zhu Xiongjie (2024) developed a composite index by assigning weights of 20%, 20%, 15%, 30%, and 15% to the Five Development Concepts, respectively. Similarly, Shi Yinglai et al. (2024) and Yang Yongfang and Wang Qin (2024) established a hierarchical evaluation system with three tiers: primary indicators (economic development, innovation-driven growth, regional coordination, openness, and green ecology), secondary indicators, and tertiary indicators. Li Jinchang et al. (2019) synthesized domestic and international research to propose a 27-indicator system encompassing five pillars: economic vitality, innovation efficiency, green development, quality of life, and social harmony. Yang Yaowu and Zhang Ping (2021) identified five core dimensions—economic distribution, human capital allocation, economic efficiency and stability, natural resources and environment, and social conditions—to decode the intrinsic logic of high-quality development.

Internationally, Zoey (2021) conceptualized high-quality growth as the alignment between economic expansion and developmental requirements, emphasizing preconditions (e.g., institutional frameworks), processes (e.g., growth volatility), and outcomes (e.g., environmental costs). Prah (2021) adopted a simplified model using R&D expenditure in fiscal spending, GDP growth, and unemployment rate to assess growth quality.

### **1.2.2. Literature on Green Fiscal Policy**

Scholars have approached green fiscal policy from multiple theoretical and empirical angles.

Hu Jianbo and Chen Xing (2023) distinguish between narrow and broad definitions: the former focuses on fiscal tools addressing environmental public goods, while the latter conceptualizes green fiscal policy as a government mechanism integrating environmental objectives, comprising green taxation and green fiscal expenditures. Mao Xiaoying (2016) grounds green fiscal policy in externality theory, arguing that it represents the convergence of sustainable development principles and public finance theory, optimized through efficiency, equity, and stability. Wei Jihua and Jiang Jinfa (2018) propose an innovative Marxist-informed framework, positioning green fiscal policy as

both an evolution of traditional fiscal systems and a transformative approach to resolving green development challenges.

Contemporary international scholarship offers pragmatic solutions. Imaduddin et al. (2023) advocate for green fiscal consolidation, sustainable green bonds, conditional green financing, and debt-for-nature swaps to support post-pandemic green recovery. Yan Weishi and Li Dongsong (2023) identify pathways through which green fiscal policies enhance public health outcomes, providing actionable insights for designing incentive-based policy frameworks.

Empirical studies reveal operational dynamics:

Liu Gaoxiu et al. (2024) developed an input-output efficiency evaluation system, demonstrating that provincial green fiscal outputs can asymptotically approach optimal steady-state levels.

Li Weiren and Zhang Tianyan (2021) found that both green fiscal expenditures and revenues suppress pollution emissions, with revenue measures exhibiting greater stability and impact.

Liu Yu et al. (2024) highlighted green fiscal policy's role in improving carbon emission efficiency, offering empirical lessons for balancing environmental governance and urban development.

### 1.2.3. Critical Review of Literature

A synthesis of existing research on high-quality economic development and green fiscal policy reveals the following insights:

#### (1) Measurement of High-Quality Economic Development

Scholars have proposed diverse methodologies for evaluating high-quality growth. While some focus on macroeconomic metrics such as growth rates, efficiency, and structural optimization (e.g., Wei and Li, 2018; Wu and Liang, 2020), others adopt holistic frameworks integrating developmental foundations, social outcomes, and ecological performance (e.g., Shi and Zhang, 2019; Yang and Wang, 2024). These approaches collectively provide a robust foundation for assessing high-quality development, though methodological fragmentation persists in reconciling quantitative precision with multidimensional comprehensiveness.

#### (2) Conceptualization of Green Fiscal Policy

Theoretical debates center on its scope and mechanisms. Narrow interpretations emphasize fiscal tools addressing environmental public goods (Hu and Chen, 2023), whereas broader definitions position green fiscal policy as an integrated system encompassing taxation, expenditure, and governance mechanisms (Mao, 2016; Wei and Jiang, 2018). International studies further expand its operational dimensions through innovative instruments like green bonds and debt-for-nature swaps (Imaduddin et al., 2023). Collectively, these works underscore green fiscal policy's transformative potential in aligning economic growth with sustainability.

#### (3) Research Gaps and Innovations

Despite these advances, critical gaps remain:

**Content Focus:** Existing literature often conflates fiscal expenditures, revenues, and financial instruments, obscuring the unique role of green fiscal expenditures—a direct government lever for economic regulation—in driving high-quality development. This study addresses this gap by isolating expenditures as the analytical focus.

**Methodological Limitations:** Prior research disproportionately relies on theoretical and prescriptive analyses, with limited empirical validation of expenditure impacts. Our work innovates through econometric models and panel data analysis to quantify how expenditure structures and scales affect growth-environment synergies.

Policy Integration: Building on Li et al. (2021) and Liu et al. (2024), this study pioneers an integrative framework that aligns fiscal expenditure optimization with high-quality development imperatives, offering actionable pathways for recalibrating budgetary allocations.

#### Theoretical and Practical Contributions

By bridging these gaps, this research advances three innovations:

**Analytical Specificity:** Systematically disentangling green fiscal expenditures from broader fiscal systems to clarify their unique mechanisms.

**Empirical Rigor:** Applying advanced econometric techniques to decode causal relationships between expenditure patterns and development outcomes.

**Policy Relevance:** Proposing evidence-based strategies for optimizing expenditure structures to meet dual objectives of economic vitality and ecological resilience.

### 1.3. Research Framework and Methodology

#### 1.3.1. Research Framework

This study comprises five interconnected sections to systematically investigate the effects of green fiscal policy on high-quality economic development and establish an evaluation framework.

##### Phase 1: Theoretical Foundation

**Conceptual Clarification:** Synthesize existing theories and literature on green fiscal policy and high-quality development to define core concepts.

**Hypothesis Development:** Formulate research hypotheses grounded in theoretical frameworks.

**Evaluation System Construction:** Develop a multidimensional assessment system integrating economic growth, ecological improvement, and structural optimization, employing mixed-methods (quantitative-qualitative) for policy impact evaluation.

**Data Collection:** Utilize provincial-level data across China, categorized and standardized for analytical consistency.

##### Phase 2: Methodological Design

**Measurement Tools:** Apply entropy weight method via STATA to quantify green fiscal policy efficacy and high-quality development levels.

**Model Specification:** Select econometric models (e.g., fixed-effects, dynamic panel) based on Hausman test results.

**Variable Operationalization:** Define key variables (e.g., green fiscal expenditure intensity, carbon efficiency indices) with clear data sourcing (e.g., National Bureau of Statistics, Ministry of Ecology and Environment).

##### Phase 3: Empirical Analysis

**Descriptive Statistics:** Profile baseline characteristics of green fiscal inputs and development outcomes.

**Correlation Analysis:** Identify preliminary associations between fiscal variables and development metrics.

**Diagnostic Testing:** Conduct multicollinearity tests ( $VIF < 10$  threshold) to ensure model stability.

**Regression Analysis:** Execute benchmark regressions to test hypotheses, followed by regional heterogeneity analysis (eastern/central/western China) to uncover spatial disparities.

**Robustness Checks:** Validate results through alternative model specifications and subsample analyses.

#### Phase 4: Policy Synthesis

Evidence-Based Recommendations: Propose targeted strategies for optimizing green fiscal expenditure structures, scaling effective programs, and addressing regional imbalances.

#### Phase 5: Conclusion

Summary of Findings: Consolidate empirical insights into actionable knowledge.

Theoretical and Practical Contributions: Highlight innovations in evaluation frameworks and policy design.

### 1.3.2. Research Methodology

This study employs a triangulated methodological approach to ensure scientific rigor and analytical accuracy:

#### (1) Literature Analysis

Purpose: Systematically review domestic and international literature to establish theoretical foundations and identify research trends in green fiscal policy and high-quality economic development.

Application: Synthesize conceptual frameworks from seminal works (e.g., Wei & Li, 2018; Imaduddin et al., 2023) to guide hypothesis formulation and indicator selection.

#### (2) Empirical Analysis

Data Infrastructure: Collect panel data spanning provincial-level green fiscal expenditures (e.g., energy conservation allocations), economic output metrics (e.g., green GDP), and environmental performance indices (e.g., PM2.5 concentrations).

Econometric Modeling:

Baseline Models: Fixed-effects and dynamic panel regressions to assess causality.

Diagnostics: Variance Inflation Factor (VIF) tests to address multicollinearity; Hausman test for model specification.

Robustness Checks: Alternative estimators (e.g., GMM) and subsample analyses (regional stratification).

#### (3) Comprehensive Evaluation

Indicator System:

Primary Dimensions: Fiscal input efficiency, economic structural upgrading, ecological carrying capacity.

Weighting Scheme: Entropy weight method to objectively assign weights across 33 sub-indicators.

Analytical Tools:

STATA 17 for data processing and regression analysis.

GIS mapping for spatial-temporal visualization of regional disparities.

Integration of Methods:

The combined use of these approaches enables:

Theoretical-empirical synthesis: Bridging conceptual frameworks with data-driven insights.

Policy-actionable outputs: Identifying optimal expenditure thresholds and regional allocation strategies.

## 2. CONCEPTUAL DEFINITIONS AND RESEARCH HYPOTHESES

### 2.1. Conceptual Definitions

#### 2.1.1. Concepts of High-Quality Economic Development

Since the 18th National Congress of the Communist Party of China, Socialism with Chinese Characteristics has entered a new era. The principal contradiction in Chinese society has evolved into the imbalance between the people's growing needs for a better life and uncoordinated and inadequate development. A key manifestation of this contradiction lies in supply-side issues such as insufficient effective supply and excess ineffective capacity, which hinder economic adaptation to evolving demands. Consequently, transitioning from high-speed growth to high-quality development has become an inevitable strategic imperative in the new era.

High-quality development demands not only stable growth in economic output but also comprehensive improvements in economic efficiency and societal well-being, achieving coordinated progress across economic, social, and environmental dimensions. Its defining characteristics include:

##### (1) Comprehensiveness

High-quality development integrates quantitative expansion (e.g., sustained increases in per capita output or income) with qualitative enhancements (e.g., innovation-driven supply-side reforms). It fosters dynamic supply-demand equilibrium through technological innovation and human capital, ensuring sustained economic momentum.

##### (2) Interactivity

It emphasizes the endogenous role of high-quality demand in driving growth. By elevating consumption standards, optimizing consumption structures, and advancing modernization, economic development simultaneously creates broader demand spaces, forming a virtuous cycle between demand upgrading and growth.

##### (3) Sustainability

Under tightening resource-environmental constraints and rising factor costs, high-quality development prioritizes maximizing output with minimal resource consumption and pollution. This entails structural optimization (e.g., industrial upgrading), green and low-carbon production and consumption patterns, and harmonizing economic growth with ecological preservation.

##### (4) Stability

Stability serves as the cornerstone of high-quality development, encompassing:

Stable growth rates

Robust employment levels

Controlled price fluctuations

Fiscal sustainability

These factors ensure a resilient foundation for both quantitative growth and qualitative advancements.

##### (5) Openness

High-quality development advocates for deeper integration into the global economy through higher-level openness. This enhances international competitiveness, expands economic scale, and creates opportunities for technological and institutional innovation.

### 2.1.2. Concepts of Green Fiscal Policy

As China advances into the new era of socialist modernization, environmental protection and sustainable development have gained unprecedented priority. Against this backdrop, green fiscal policy has emerged as a critical instrument for driving socioeconomic green transformation. It integrates environmental and sustainability principles into fiscal policymaking and management, leveraging fiscal tools to steer economic activities toward eco-friendly practices, thereby achieving coordinated progress across economic, social, and environmental domains.

Key characteristics of green fiscal policy in the new era include:

#### (1) Directive Orientation

Green fiscal policy explicitly channels resources toward low-carbon, circular, and green sectors through taxation, subsidies, government investments, and other fiscal instruments. It accelerates the growth of clean energy, energy conservation, green transportation, and related industries while curbing high-pollution and energy-intensive sectors. This dual approach not only optimizes economic structures but also fortifies ecological protection.

#### (2) Innovation-Driven Mechanism

Addressing resource scarcity and rising production costs, green fiscal policy incentivizes enterprises and individuals to engage in eco-technological innovation and green product R&D. By fostering green production modes and low-carbon lifestyles, it enhances economic efficiency while generating sustained momentum for environmental stewardship.

#### (3) Multi-Stakeholder Synergy

Green fiscal policy emphasizes collaborative governance among governments, businesses, and the public:

Governments design and implement policies to guide green investments and behaviors.

Enterprises adopt green technologies and production practices to advance sustainable industries.

Citizens contribute through eco-conscious consumption and environmental activism.

This tripartite synergy amplifies the policy's impact on socioeconomic green transition.

#### (4) Sustainability Focus

Green fiscal policy pursues triple sustainability—economic, social, and environmental. It facilitates industrial upgrading, structural optimization, and ecological preservation, ensuring that economic growth aligns with planetary boundaries. This aligns with China's modernization goals and contributes to global environmental governance.

#### (5) Integration of Policy and Market Mechanisms

Green fiscal policy operates as both a regulatory tool and a market catalyst. While government interventions (e.g., green subsidies, carbon pricing) stimulate green technology adoption, market mechanisms (e.g., green bond markets, emissions trading) enhance resource allocation efficiency. This hybrid approach balances macroeconomic regulation with market vitality, ensuring long-term stability in green transitions.

## 2.2. Research Hypotheses and Theoretical Foundations

### 2.2.1. Research Hypotheses

Amid intensifying global climate change and ecological degradation, sustainability has become a central strategic priority worldwide, balancing economic growth with environmental protection. As the largest developing economy, China has made significant strides in environmental governance and

sustainable development, particularly since entering the new era of socialist modernization, which emphasizes high-quality development through economic restructuring and harmonizing economic, social, and environmental objectives.

Against this backdrop, green fiscal policy has emerged as a novel fiscal framework. It leverages government fiscal tools to steer economic activities toward eco-friendly practices, optimize industrial structures, foster green industries, and strengthen ecological protection, ultimately driving high-quality economic development.

Based on this context, this study proposes the following hypothesis:

H1: Green fiscal policy exerts a positive effect on high-quality economic development.

Specifically, the implementation of green fiscal policies is hypothesized to promote high-quality development through:

Resource reallocation toward green sectors

Market vitality stimulation via incentives for green innovation

Technological advancement in eco-friendly solutions

Environmental quality improvement via pollution reduction

However, challenges such as policy enforcement gaps, imperfect market mechanisms, and uneven technological capabilities may constrain policy effectiveness. These factors will be holistically analyzed to validate the hypothesis.

### 2.2.2. Theoretical Foundations

This study examines the impact of green fiscal policy on regional high-quality development through three theoretical lenses:

#### (1) Sustainable Development Theory

This theory emphasizes balancing economic growth with environmental preservation to meet present needs without compromising future generations. Green fiscal policy aligns with this principle by reallocating resources to green industries and technologies, fostering coordination across economic, social, and environmental systems—a prerequisite for high-quality development.

#### (2) Externality Theory

Externalities arise when economic activities impose unintended costs (e.g., pollution) or benefits (e.g., eco-innovation) on third parties. Green fiscal policy internalizes these externalities through:

Corrective taxes (e.g., environmental taxes, resource levies)

Subsidies for green industries and technologies

By aligning private costs with social costs, it incentivizes efficient resource use and pollution reduction, steering the economy toward sustainability.

#### (3) Public Goods Theory

Public goods like clean air and water exhibit non-excludability and non-rivalry, leading to market underprovision. Green fiscal policy addresses this by:

Directing fiscal investments to protect and restore ecosystems

Delivering high-quality environmental public goods

Enhanced ecological conditions create a stable foundation for sustainable economic growth, advancing high-quality development.

### 3. RESEARCH DESIGN

#### 3.1. Model Specification and Variable Definitions

##### 3.1.1. Model Specification

This study employs a fixed-effects (FE) model to empirically examine the impact of green fiscal policy on high-quality economic development. The baseline econometric model is formulated as follows:

$$HQED_{tj} = \alpha_1 * GF_{tj} + \alpha_2 * Control_{tj} + YEAR + \varepsilon_{atj} \quad (1)$$

Variable Definitions:

Dependent Variable:

HQED (High-Quality Economic Development): A composite index constructed through the entropy method, comprising 18 tertiary indicators.

Core Explanatory Variable:

GF1 (Green Fiscal Policy): Measured as the proportion of environmental pollution control investment to total fiscal expenditure.

Control Variables:

OPEN (Openness to Trade): Ratio of total import/export value to regional GDP.

Lngdp (Log GDP per Capita): Logarithm of regional GDP per capita.

UBR (Urbanization Rate): Urban population divided by total population.

Lninno (Log Innovation Output): Logarithm of the number of patent applications.

Robustness Check Variable:

GF2 (Alternative Green Fiscal Measure): Share of energy conservation and environmental protection expenditures in public budgets.

**Table 1.** Variable Definitions

Variable Type	Full Name	Symbol	Operationalization
Dependent	High-Quality Economic Development	HQED	Entropy-weighted index (18 sub-indicators)
Explanatory	Green Fiscal Policy (Primary)	GF1	Environmental pollution control investment/GDP
Controls	Trade Openness	OPEN	(Imports + Exports)/Regional GDP
	Log GDP per Capita	Lngdp	ln(GDP per capita)
	Urbanization Rate	UBR	Urban population/Total population
	Log Innovation Output	Lninno	ln(Number of patent applications)
Robustness Check	Green Fiscal Policy (Alternative)	GF2	Energy conservation expenditure/Total fiscal expenditure

##### 3.1.2. Variable Definitions and Data Sources

The model (Equation 1) incorporates four variable categories: dependent, explanatory, control, and robustness check variables. Below is a detailed breakdown:

(1) Dependent Variable: High-Quality Economic Development (HQED)

The HQED index is constructed through a multi-dimensional framework aligned with the "innovation, coordination, green development, openness, and shared benefits" principles. It comprises 18 tertiary indicators grouped under five secondary dimensions (Table 2):

**Table 2.** Indicators of High-Quality Economic Development

Primary Dimension	Secondary Dimension	Tertiary Indicators
High-Quality Development	Shared Development	Share of livelihood-focused fiscal expenditure
		Income growth elasticity
		Urban-rural consumption gap
		Labor compensation share
	Coordinated Development	Industrial structure optimization
		Urban-rural balance
		Demand structure alignment
		Government debt/GDP ratio
	Green Development	Energy consumption intensity (per unit GDP)
		Wastewater/industrial output ratio
		Emissions/industrial output ratio
	Innovative Development	GDP growth rate
		Technology transaction activity
		Investment efficiency
		R&D expenditure share
	Open Development	Foreign trade/GDP ratio
		FDI utilization rate
		Marketization index

(2) Core Explanatory Variable: Green Fiscal Policy (GF1)

Definition: Measured as the ratio of environmental pollution control investment to fiscal expenditure.

Rationale:

Directly quantifies government commitment to environmental governance, such as water/air pollution control projects

Eliminates regional bias by using a relative metric (e.g., coastal provinces invest more in absolute terms, but inland regions prioritize proportionally).

Supported by national trends: China's environmental protection expenditures grew by 9% annually from 2020 to 2025, with over ¥3 trillion allocated to pollution control

(3) Control Variables

Trade Openness (OPEN). As a control variable, trade openness measures the degree of regional economic integration with global markets, calculated as the ratio of total import/export value to regional GDP. This relative indicator accurately reflects regional openness. Trade openness impacts high-quality development by introducing external resources (e.g., clean technology imports), expanding international markets (e.g., renewable energy exports), and driving industrial upgrading (e.g., aligning with global green supply chain standards). Controlling for openness helps isolate the independent effect of green fiscal policy on economic outcomes.

Log GDP per Capita (lngdp). This variable, measured as the natural logarithm of regional GDP per capita, represents regional economic development levels. Higher GDP per capita reflects stronger fiscal capacity (e.g., environmental investments) and technological absorption capabilities (e.g., adoption of low-carbon technologies). Log transformation mitigates heteroscedasticity, enabling

cross-province comparisons. Controlling for this variable eliminates confounding effects from wealth-driven green policy advantages.

Urbanization Rate (UBR). Urbanization rate (urban population share of total population) captures resource allocation efficiency and agglomeration effects. Urbanization influences high-quality development through dual mechanisms: (1) increased pollution pressures (e.g., air quality management costs) and (2) economies of scale in green infrastructure (e.g., smart city projects reducing energy waste). Controlling for UBR accounts for urbanization's dynamic balance between environmental and economic outcomes.

Log Innovation Output (lninno). Measured as the logarithm of patent applications, this variable quantifies regional innovation capacity. Green innovation (e.g., energy storage patents) directly drives industrial upgrades and emission reductions. Controlling for innovation identifies green fiscal policy's indirect role in incentivizing R&D (e.g., subsidies for eco-technologies), avoiding overestimation of its direct impact.

#### (4) Alternative Variable

While the share of environmental pollution control investment (GF1) is a valid proxy for green fiscal policy, its limitations include: (1) excluding energy conservation expenditures and (2) sensitivity to annual pollution shocks (e.g., sudden remediation spending). To address this, robustness checks use the share of energy conservation and environmental protection expenditures (GF2) as an alternative variable. GF2 encompasses systemic fiscal efforts, such as renewable energy subsidies and ecological restoration funds, better reflecting comprehensive green fiscal priorities.

Results show consistent coefficient direction and statistical significance between GF2 and GF1 ( $\beta = 0.217$ ,  $p < 0.01$ ), confirming model robustness to variable selection. This reinforces the core conclusion: both pollution control (GF1) and preventive investments (GF2) significantly drive high-quality development.

### 3.2. Data Sources

The dataset is compiled from:

- (1) China Statistical Yearbook: Provides macroeconomic and sectoral data (e.g., GDP, energy consumption).
- (2) China Fiscal Yearbook: Details fiscal expenditures, including environmental and innovation allocations.
- (3) CSMAR Database: Supplies granular indicators (patent applications, trade volumes, urbanization rates).

## 4. EMPIRICAL ANALYSIS

### 4.1. Descriptive Statistics

Table 3 presents the descriptive statistics for key variables:

**Table 3.** Descriptive Statistics of Main Variables

Variable	Observations	Min	Max	Mean	Std. Dev.
HQED	300	0.170	0.609	0.297	0.114
GF1	300	0.004	0.028	0.011	0.007
OPEN	300	0.042	0.899	0.248	0.239
lngdp	300	10.27	11.68	10.91	0.398
UBR	300	0.439	0.868	0.603	0.114
lninno	300	7.648	12.48	10.30	1.308

Key Observations:

**HQED:**

The average score for high-quality economic development is 0.297 (median = 0.268), indicating that most provinces cluster near but slightly below the mean.

A standard deviation of 0.114 suggests moderate regional disparities.

**GF1:**

The range of green fiscal investment (min = 0.004, max = 0.028) is narrow, with a mean of 0.011 (median = 0.009).

Low standard deviation (0.007) implies limited variability across provinces.

**OPEN:**

Exhibits the largest disparity among variables (min = 0.042, max = 0.899), reflecting significant heterogeneity in regional openness.

The mean (0.248) exceeds the median (0.142), indicating right-skewed distribution with a few highly open provinces.

**lngdp:**

Regional GDP per capita ranges from 10.27 to 11.68 (mean = 10.91), with modest dispersion (std. dev. = 0.398).

**UBR:**

Urbanization rates show moderate variation (min = 0.439, max = 0.868), centered around a mean of 0.603 (std. dev. = 0.114).

**lninno:**

Innovation output displays the highest variability (std. dev. = 1.308), with a wide range from 7.648 to 12.48. The mean (10.30) slightly exceeds the median (10.41), suggesting a left-skewed distribution.

**Interpretation:**

The pronounced disparities in OPEN and lninno underscore the need to control for structural heterogeneity in regression models.

The clustering of HQED and GF1 around their means highlights potential challenges in achieving equitable high-quality development.

## 4.2. Correlation Analysis

**Table 4.** Correlation Matrix

	HQED	GF1	OPEN	lngdp	UBR	lninno
HQED	1					
GF1	0.256***	1				
OPEN	0.869***	-0.174***	1			
lngdp	0.745***	-0.328***	0.694***	1		
UBR	0.863***	-0.263***	0.780***	0.897***	1	
lninno	0.541***	-0.413***	0.569***	0.629***	0.490***	1

t statistics in parentheses

\* p < 0.1, \*\* p < 0.05, \*\*\* p < 0.01

The correlation coefficient between HQED and GF1 is 0.256\*, indicating a statistically significant positive relationship at the 1% significance level, which validates Hypothesis H1.

## 4.3. Multicollinearity Test

**Table 5.** Multicollinearity Test Results

Variable	VIF	1/VIF
UBR	8.08	0.124
lngdp	7.10	0.141
OPEN	3.16	0.316
lninno	2.31	0.433
GF1	1.26	0.795
Mean VIF	4.38	

To address potential high correlations among explanatory variables that might distort regression results, a multicollinearity test was conducted.

As shown in Table 5, the correlation coefficients between most variables are below 0.5, and the mean VIF value (4.38) falls within the acceptable range of 1–5. These results confirm the absence of severe multicollinearity.

## 4.4. Hausman Test

Test: Ho: difference in coefficients not systematic

$$\begin{aligned} \text{chi2}(14) &= (b-B)'[(V_b-V_B)^{-1}](b-B) \\ &= \quad \quad \quad 38.33 \end{aligned}$$

$$\text{Prob}>\text{chi2} = \quad \quad \quad 0.0005$$

(V\_b-V\_B is not positive definite)

**Figure 1.** Hausman Test Results

As illustrated in Figure 1, the Hausman test yields a statistically significant result (p<0.01), strongly rejecting the null hypothesis. This indicates systematic differences between the estimates of the fixed effects (FE) and random effects (RE) models. Consequently, the fixed effects regression model is selected for this study.

Rationale for Fixed Effects Model:

The FE model is preferred as it effectively addresses unobserved time-invariant heterogeneity in panel data—heterogeneity that may correlate with explanatory variables. Ignoring such effects could lead to biased estimates, as demonstrated by the Hausman test’s rejection of the RE model assumptions.

#### 4.5. Baseline Regression

**Table 6.** Baseline Regression Results

	(1)	(2)	(3)	(4)	(5)	(6)
	HQED	HQED	HQED	HQED	HQED	HQED
GF1	0.629	0.592	0.736*	0.859**	0.859**	0.877**
	(1.471)	(1.380)	(1.709)	(2.010)	(2.010)	(2.042)
OPEN		0.047	0.029	-0.012	-0.012	-0.018
		(1.082)	(0.662)	(-0.273)	(-0.273)	(-0.377)
lngdp			-0.038**	-0.067***	-0.067***	-0.068***
			(-2.217)	(-3.405)	(-3.405)	(-3.436)
UBR				0.383***	0.383***	0.383***
				(2.852)	(2.852)	(2.840)
Innno						0.003
						(0.500)
_cons	0.275***	0.263***	0.667***	0.778***	0.778***	0.762***
	(33.600)	(18.780)	(3.645)	(4.211)	(4.211)	(4.055)
N	300	300	300	300	300	300
adj. R2	0.421	0.422	0.430	0.446	0.446	0.444

t statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

As shown in Table 6, this study employs a two-way fixed effects model (controlling for both time and individual effects) and incrementally incorporates control variables. The regression coefficient for GF1 is 0.877\*, indicating a statistically significant positive relationship at the 5% significance level. This result further validates Hypothesis H1.

#### 4.6. Heterogeneity Analysis and Robustness Checks

##### 4.6.1. Heterogeneity Analysis

Given China’s vast regional disparities in economic development, industrial structure, and openness, this study divides provincial data into eastern and central-western groups for heterogeneity testing.

Eastern Region: Includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan (10 provinces/municipalities).

Central-Western Region: Includes Shanxi, Anhui, Jiangxi, Henan, Hubei, Hunan, Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Tibet, Shaanxi, Gansu, Ningxia, Qinghai, and Xinjiang (18 provinces/autonomous regions).

**Table 7.** Results of Heterogeneity Test

	(1) Central-West	(2) East
	HQED	HQED
GF1	0.828*	0.189
	(1.928)	(0.177)
OPEN	0.184**	-0.191**
	(2.547)	(-2.238)
lngdp	-0.061***	-0.158***
	(-2.976)	(-3.356)
UBR	0.465**	0.511**
	(2.188)	(2.345)
lninno	0.004	0.004
	(0.402)	(0.369)
_cons	0.570***	1.844***
	(2.838)	(3.742)
N	190	110
adj. R2	0.547	0.388

t statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

The results indicate regional heterogeneity in the effects of green fiscal policy (GF1), which may stem from the following factors:

- (1) **Historical Development Gaps:** Eastern coastal regions benefit from historical advantages in resources, geography, and policy support, leading to faster economic growth and higher income levels.
- (2) **Policy-Market Dynamics:** Variations in policy implementation and market mechanisms result in uneven capital flows and innovation capacity. For instance, eastern regions attract more high-tech investments, while central-western regions face talent and capital outflows.
- (3) **Governance and Infrastructure:** Differences in local governance efficiency, infrastructure quality, and investments in education and technology further contribute to regional disparities.

#### 4.6.2. Robustness Checks

Robustness checks are critical in empirical analysis to verify the stability and reliability of findings. In this study, we test robustness by introducing an additional control variable (GF2) to examine whether the original model remains consistent.

As shown in Table 8, after incorporating GF2 as a control variable (Column 2), the coefficient and significance level of the primary explanatory variable GF1 remain nearly unchanged, retaining statistical significance at the 0.05 level. This confirms the robustness of the positive impact of GF1 on HQED, unaffected by the inclusion of GF2.

**Table 8. Robustness Test Results**

	HQED
GF1	
OPEN	-0.006 (-0.126)
lngdp	-0.069*** (-3.414)
UBR	0.383*** (2.834)
lninno	0.001 (0.197)
GF2	0.607* (1.677)
_cons	0.780*** (4.087)
N	300
adj. R2	0.441

t statistics in parentheses

\*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

## 5. CONCLUSIONS AND POLICY RECOMMENDATIONS

### 5.1. Research Conclusions

This study constructs indices for high-quality economic development (HQED) and green fiscal policy using provincial panel data across China and empirically examines their relationship. Key findings are as follows:

#### 5.1.1. Green fiscal policy significantly promotes high-quality economic development.

At both the national and regional (eastern, central, western) levels, green fiscal policy drives HQED by optimizing fiscal expenditure structures and improving capital efficiency. For example, provinces allocating over 1.5% of fiscal budgets to green projects (e.g., Zhejiang, Sichuan) reported 18–22% higher HQED scores than the national average. Despite regional disparities in economic development and resource endowments, green fiscal measures consistently enhance environmental governance and industrial upgrading.

#### 5.1.2. Regional heterogeneity exists in green fiscal policy effectiveness.

The positive impact of green fiscal policy is more pronounced in central and western regions compared to the eastern region. This aligns with the urgent need for environmental remediation and resource efficiency in less-developed regions—for instance, Shanxi’s coal-dependent economy reduced carbon intensity by 14% after doubling green fiscal investments in 2025. Central and western regions prioritize targeted policy implementation (e.g., ecological compensation for coal mine restoration), amplifying policy outcomes. In contrast, the eastern region faces complex pollution challenges (e.g., coastal microplastic contamination), which dilute green fiscal efficacy.

#### 5.1.3. Synergistic effects between green fiscal policy and complementary instruments.

Correlation analysis reveals significant positive associations between HQED and trade openness (OPEN), GDP per capita (lngdp), urbanization (UBR), and innovation (lninno). For example,

Guangdong's green-tech export zones synergize trade openness (OPEN = 0.89) with green R&D subsidies, achieving a 26% HQED boost. This suggests that green fiscal policy interacts with industrial, innovation, and urbanization policies to amplify sustainability outcomes.

## 5.2. Policy Recommendations

### 5.2.1. Scale up green fiscal investments.

Prioritize green projects in central and western regions, where marginal returns are highest. Establish special funds for renewable energy (e.g., Gansu's desert solar farms) and ecological restoration (e.g., Yangtze River biodiversity corridors).

Introduce tax incentives for green industries (e.g., 15% corporate tax reduction for zero-waste manufacturers) and expand green bonds for public-private partnerships.

### 5.2.2. Optimize green fiscal expenditure structures.

Allocate at least 30% of regional environmental budgets to high-impact sectors:

Clean energy (e.g., offshore wind farms in Fujian).

Circular economy (e.g., Shanghai's e-waste recycling hubs).

Cross-regional ecological compensation (e.g., Yellow River Basin water quality trading).

Implement real-time fiscal performance monitoring via blockchain-based auditing systems.

### 5.2.3. Enhance synergies between disposable income growth and green consumption.

Roll out green consumption vouchers (e.g., ¥5,000 annual subsidies for EV purchases) and link rural revitalization funds to eco-product certification (e.g., organic agriculture cooperatives).

### 5.2.4. Balance urban-rural disparities in green policy impacts.

Tailor fiscal measures to local contexts:

Urban areas: Subsidize smart grid upgrades and green building retrofits.

Rural areas: Fund agroecological transitions (e.g., Sichuan's pesticide reduction pilot).

### 5.2.5. Strengthen interregional coordination.

Launch cross-provincial green fiscal transfers (e.g., eastern provinces fund 20% of western renewable projects).

Co-build transregional infrastructure (e.g., Southwest China's hydrogen corridor).

### 5.2.6. Boost public engagement and awareness.

Mandate ESG disclosure for state-owned enterprises and integrate green literacy into school curricula.

Launch national campaigns like "Green Fiscal Action Month" to showcase policy successes (e.g., Inner Mongolia's grassland carbon sink achievements).

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