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Analysis of the Coupling Coordination Relationship Between Green Finance and High-Quality Economic Development in China and Its Influencing Factors

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Abstract

Drawing on panel data from 31 Chinese provinces over the period 2010–2023, this study constructs evaluation indices for green finance and high-quality economic development. The entropy weight method, coupling coordination degree model, and Dagum Gini coefficient are employed to examine the spatiotemporal synergies and regional disparities between the two systems. Findings reveal that, although both system indices exhibit growth in overall development levels, a marked pattern of "relative lag in high-quality economic development" has emerged since 2018. With respect to coordination status, national coupling coordination fluctuates and remains suboptimal, characterised by "high coupling but low coordination"; by 2023, the system had regressed to a state of "severe disequilibrium". Spatially, a fundamental shift occurred after 2018, yielding a new pattern of differentiation: western and northeastern regions overtaking others, an inverted U-shaped decline in the east, and subsidence in the central region. Although the overall Gini coefficient has narrowed significantly, inter-regional disparities now constitute the predominant source of spatial imbalance, with their contribution rising to 65.38%. Economic development level, industrial structure optimisation, and government intervention emerge as the principal positive drivers of coordination. The analysis concludes that structural lag and pronounced spatial heterogeneity persist in the synergy between the two domains; policy priorities should therefore shift from "developing green finance" to "empowering high-quality development", complemented by differentiated inter-regional coordination strategies.

Keywords

green finance, high-quality economic development, coupling coordination degree, Dagum Gini coefficient, influencing factors, spatiotemporal differentiation

1. Introduction

China's economy has entered a new normal, undergoing a profound transformation in its development model. The 19th National Congress of the Communist Party of China explicitly stated that the economy has shifted from a phase of rapid growth to one of high-quality development, centered on the new development philosophy of innovation, coordination, green development, openness, and shared benefits. High-quality development transcends mere GDP expansion, encompassing multidimensional objectives including enhanced economic efficiency, structural optimization, environmental improvement, and greater public wellbeing. Within this transformation context, ecological civilization has been elevated to unprecedented priority, with carbon peak and carbon neutrality goals imposing stringent green imperatives on economic activity.

Conventional financial systems lack adequate mechanisms to address environmental externalities. Green finance has consequently emerged as a critical institutional innovation and market-based solution. It directs social capital toward environmentally sustainable sectors such as pollution control, energy efficiency, and clean energy, while simultaneously curbing expansion in high-pollution and high-energy-consumption industries. Through this mechanism, green finance optimizes resource allocation and facilitates the economy's green transition. It functions as an endogenous driver of high-quality development, which in turn provides a robust economic foundation and supportive policy environment for refining and strengthening the green finance system. The two domains consequently exhibit a coupled relationship characterized by mutual reinforcement and co-evolution.

A thorough investigation of the coupling coordination between green finance and high-quality economic development, along with their spatiotemporal dynamics and key influencing factors, holds substantial theoretical and practical significance for advancing the synergy between "green" and "developmental" objectives. This study proceeds accordingly. First, the entropy weight method is applied to derive objective weights and compute indices of green finance and high-quality economic development for China's 31 provinces. Second, the coupling coordination model and Dagum Gini coefficient are employed to systematically analyse the coupling coordination relationship, spatiotemporal evolution, and regional disparities between the two indices. Finally, an econometric model is constructed to identify the principal factors influencing their coordinated development. The analysis aims to furnish a scientific foundation for enhancing inter-regional collaborative development and refining differentiated green finance policies.

2. Literature Review

2.1 Connotation and Measurement of High-Quality Economic Development

High-quality economic development has become a focal point in macroeconomics and development economics. Both the report of the 19th National Congress of the Communist Party of China and the "Outline for Building a Quality Power" explicitly designate the promotion of high-quality development as a paramount task. Existing measurement studies fall into several principal categories. The predominant evaluation framework constructs comprehensive indicator systems grounded in the new development philosophy of "innovation, coordination, green development, openness, and shared benefits". Notable examples include Ma et al. (2019), Shi and Ren (2018), Chen et al. (2020), and Sun et al. (2020), all of whom developed assessment systems on this basis. Other studies adopt more specialised perspectives; for instance, Zhao et al. (2020) examined the interplay of the digital economy, entrepreneurial vitality, and high-quality development; Jian et al. (2024) investigated the non-linear effects of talent agglomeration on high-quality development; and Chen and Xing (2025) explored linkages among the digital economy, green innovation, and high-quality economic development. These contributions provide a theoretical foundation and practical guidance for constructing a rigorous and comprehensive evaluation system for high-quality economic development in the present study.

2.2 Connotation and Measurement of Green Finance

The conceptual delineation of green finance constitutes the foundation for empirical inquiry. In synthesis, green finance represents a market-oriented mechanism designed to channel social capital towards the green transformation of the economy through financial instruments and policy interventions. Rigorous measurement is a prerequisite for analysing its effects, with scholarly efforts evolving from early reliance on single indicators to the construction of multidimensional comprehensive evaluation systems, progressively expanding in both scope and depth. With respect to the development of integrated frameworks, Zeng et al. (2014) and Yue (2019) were among the first to assess and compare the development of green finance across multiple dimensions. At the level of regional empirical analysis, scholars have measured green finance in diverse contexts; examples include Tang et al. (2025) on Shaanxi Province, Kong (2019) who compiled a composite index for Gansu Province, and Cao et al. (2023) who focused on key provinces along the Belt and Road Initiative. More recent contributions have begun to employ spatial econometric techniques to examine spatiotemporal characteristics, such as Qin et al. (2024), who investigated regional disparities, dynamic evolution, and spatiotemporal convergence in China's green finance development, and Huang and Gao (2024), who conducted an in-depth analysis of measurement and spatiotemporal patterns of green finance in China. The establishment of these comprehensive indicator systems has laid a solid foundation for subsequent analyses of empirical effects.

2.3 Effects of Green Finance on High-Quality Economic Development

The relationship between green finance and economic development has been extensively examined in the literature, with a consensus that green finance exerts a significant positive influence on high-quality economic development. The transmission mechanisms operate primarily through several channels. First, with respect to direct contributions and efficiency gains, early studies focused on the direct economic impact of green finance, arguing that it channels capital towards green industries and optimises credit allocation. Shi and Shi (2022) provided both theoretical and empirical evidence that green finance serves as a pivotal force in advancing high-quality economic development. Zhang et al. (2021) identified green finance as a mediating factor in the promotion of green economic growth through public expenditure. Second, green finance stimulates technological and green innovation by providing financial support and imposing risk constraints on firms. Both Wen et al. (2022) and Yu and Fan (2022) confirmed the presence of a mediating effect of green innovation in the relationship between green finance and high-quality economic development. Lee and Lee (2022) explored the pathways through which green finance affects green total factor productivity, while Irfan et al. (2022) analysed the mechanisms linking green finance and green innovation. Third, studies consistently highlight regional heterogeneity in these effects. For instance, Liu and He (2021), drawing on evidence from 272 prefecture-level cities in China, found that the mechanisms by which green finance promotes high-quality urban economic development vary according to city size and resource endowments. Similarly, Zhou et al. (2022) demonstrated that the impact of green finance on high-quality development differs across regions, exhibiting marked spatial heterogeneity.

2.4 Current Research on Coupling Coordination Relationships

In recent years, scholars have increasingly examined the coupling coordination between green finance and economic systems. This perspective moves beyond unidirectional causality tests to investigate synergistic development patterns emerging from their interaction. Sun (2023) explored how green finance couples with high-quality economic development in China, while Liu and Xu (2024) applied coupling coordination models to analyze spatiotemporal characteristics between green finance and the low-carbon economy. Regional studies have similarly investigated coupling relationships in the Yellow River Basin (Cui et al., 2020; Liu et al., 2021) and the pan-Yangtze River Delta (Zhang and Jiao, 2015), examining connections between ecological protection, environmental quality, and high-quality development.

These contributions establish a solid theoretical foundation and methodological framework for the present study. Prior research has theoretically confirmed coupling relationships between green finance and economic systems (Liu and Xu, 2024; Sun, 2023) , providing a logical starting point for this analysis. Studies by Cui et al. (2020) and Zhang and Jiao (2015) offer well-established coupling coordination degree models that enable quantitative assessment of system synergies. However, several research gaps warrant attention. Most coupling studies concentrate on green finance's relationship with the low-carbon economy or ecological environment rather than broader economic quality. Many analyses measure coupling coordination levels and spatiotemporal patterns but stop short of deeper examination. Conventional panel regressions often overlook spatial autocorrelation in regional data, potentially producing biased estimates.

This study advances existing literature through three contributions. First, it applies the entropy weight method to objectively compute indices for both green finance and high-quality economic development, reducing subjective weighting biases. Second, it constructs an integrated analytical framework spanning index measurement, coupling coordination analysis, and regional disparity decomposition. Third, by utilizing data from all 31 Chinese provinces, it provides comprehensive national coverage while identifying regional heterogeneity patterns that inform differentiated policy design.

3. Research Methodology

3.1 Construction of the Indicator System

Scholars have previously constructed indicator systems for assessing green finance and high-quality economic development. Following established indicator selection principles and drawing on existing research, this study constructs separate systems for green finance and high-quality economic development (see Table 1 below). The green finance system is measured across five dimensions: green credit, green investment, green insurance, green bonds, and green support. High-quality economic development is assessed through five development concepts: innovative development, coordinated development, green development, open development, and shared development.

Table 1: Comprehensive Evaluation Indicator System for Green Finance and High-Quality Economic Development

Primary Indicator	Secondary Indicator	Tertiary Indicator	Indicator Description
Green Finance	Green Credit	Proportion of credit for environmental projects (+)	Total credit for environmental projects in the province / Total credit in the province
	Green Investment	Share of investment in environmental pollution control in GDP (+)	Investment in environmental pollution control / GDP
	Green Insurance	Extent of promotion of environmental pollution liability insurance (+)	Premium income from environmental pollution liability insurance / Total premium income
	Green Bonds	Degree of green bond development (+)	Total issuance of green bonds / Total issuance of all bonds
	Green Support	Share of fiscal expenditure on environmental protection (+)	Fiscal expenditure on environmental protection / General fiscal budget expenditure
	Green Funds	Proportion of green funds (+)	Total market value of green funds / Total market value of all funds
	Green Rights	Depth of green rights development (+)	Carbon trading, energy use rights trading, emissions trading / Total trading volume in rights markets
High-Quality Economic Development	Innovation-Driven Development	GDP growth rate (+)	Regional GDP growth rate
		R&D 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
		Technological transaction activity (+)	Value of technology transactions / Regional GDP
	Coordinated Development	Demand structure (+)	Total retail sales of consumer goods / Regional GDP
		Urban-rural structure (+)	Urbanisation rate
		Industrial structure (+)	Increase in the share of the tertiary sector in regional GDP
		Government debt burden (-)	Government debt balance / Regional GDP
	Green Development	Energy consumption per unit of GDP (-)	Standard coal equivalent / Regional GDP
		Energy consumption elasticity coefficient (-)	Energy consumption growth rate / Regional GDP growth rate
		Wastewater discharge per unit of output (-)	Total wastewater discharge / Regional GDP
		Waste gas emissions per unit of output (-)	Sulphur dioxide emissions / Regional GDP
	Open Development	Foreign trade dependence (+)	Total imports and exports / Regional GDP
		Share of foreign investment (+)	Actually utilised foreign investment / Regional GDP
		Degree of marketisation (+)	Regional marketisation index
		Financial development level (+)	Increase in various loans / Regional GDP
		Share of labour remuneration (+)	Labour remuneration / Regional GDP

	Shared Development	Elasticity of resident income growth (+)	Growth rate of per capita disposable income of residents / Regional GDP growth rate
		Urban-rural consumption gap (-)	Per capita consumption expenditure of urban residents / Per capita consumption expenditure of rural residents
		Share of livelihood-oriented fiscal expenditure (+)	Share of local fiscal expenditure on education, healthcare, housing security, social security, and employment in local fiscal budget expenditure

3.2 Coupling Coordination Degree Model

The level of coordinated development between two or more systems can be assessed by measuring the coupling coordination degree among them. Green finance and high-quality economic development constitute two complex systems rather than a simple binary relationship; the coupling coordination degree accounts for intricate internal associations, capturing the extent of mutual dependence and constraint between the systems. Accordingly, this study employs the coupling coordination degree model to evaluate the synergistic development of the two systems. The procedure is outlined as follows.

Data standardisation is first performed using the min-max normalisation method to process all raw data, thereby eliminating dimensional effects. The computation for positive and negative attribute indicators follows Equations (1) and (2), respectively.

$$X_{sj}=(x_{sj}-\min(x_{sj}))/(\max(x_{sj})-\min(x_{sj})) \tag{1}$$

$$X_{sj}=(\max(x_{sj})-x_{sj})/(\max(x_{sj})-\min(x_{sj})) \tag{2}$$

where X_{sj} denotes the standardised value of the j-th indicator for the two systems, and X_{sj} represents the original value of the j-th indicator for the two systems;

When s=as = as=a, it refers to the green finance system; when s=bs = bs=b, it denotes the high-quality economic development system.

Next, indicator weights are determined, and the comprehensive evaluation index for each system is calculated. To mitigate the influence of subjective human judgement, this study applies the entropy method to assign weights to the indicators. The formulae for information entropy(ei)and indicator weight (wj)are as follows:

$$e_j=-\frac{1}{ln(n)}\sum_{i=1}^{n}\mu_{sj}\times ln(\mu_{sj}) \tag{3}$$

$$w_j=\frac{g_j}{\sum_{j=1}^{m} g_j} \tag{4}$$

where $\mu_{sj}=(1+X_{sj})/\sum_{j=1}^{n}(1+X_{sj})$, represents the proportion of the j-th indicator in system s; n is the total number of samples i; $g_j=1e_j$ denotes the redundancy of information entropy; and m is the total number of indicators in each system. The weights thus obtained are then used to compute the comprehensive development level (Z_s) of the green finance system and the high-quality economic development system:

$$Z_s=\sum_{j=1}^{m} w_j \times X_{sj} \tag{5}$$

Finally, the coupling degree (C) and the coupling coordination degree (D) of the two systems are calculated:

$$C=\frac{2\sqrt{Z_a\times Z_b}}{Z_a+Z_b} \tag{6}$$

$$D=\sqrt{C\times T} \tag{7}$$

where T is the comprehensive evaluation index, defined as $T=\alpha Z_a+\beta Z_b$, α and β representing the contribution rates of the two systems to the coupling coordination degree. This study assumes equal contributions from both systems and thus sets α=β=0.5; The value of the coupling coordination degree (D) ranges from 0 to 1; values closer to 1 indicate higher levels of coupling coordination between the two systems. Table 2 presents the classification of coupling coordination types between the systems based on the uniform distribution method.

Table 2: Classification of Coupling Coordination Degree Types

Coupling Coordination Degree	Coordination Type	Coupling Coordination Degree	Coordination Type
$0 \leqslant D < 0.1$	Extreme disequilibrium	$0.5 \leqslant D < 0.6$	Barely coordinated
$0.1 \leqslant D < 0.2$	Severe disequilibrium	$0.6 \leqslant D < 0.7$	Primary coordination
$0.2 \leqslant D < 0.3$	Moderate disequilibrium	$0.7 \leqslant D < 0.8$	Intermediate coordination
$0.3 \leqslant D < 0.4$	Mild disequilibrium	$0.8 \leqslant D < 0.9$	Good coordination
$0.4 \leqslant D < 0.5$	Near disequilibrium	$0.9 \leqslant D \leqslant 1.0$	Superior coordination

$$G=(\sum_{i=1}^{k}\sum_{j=1}^{k}\sum_{h=1}^{n_i}\sum_{r=1}^{n_j}\left|y_{ih}-y_{jr}\right|)/2n^2\overline{y} \tag{8}$$

$$G_{ii}=(\frac{1}{2\overline{y}}\sum_{h=1}^{n_i}\sum_{r=1}^{n_j}\left|y_{ih}-y_{jr}\right|)/n^2 \tag{9}$$

$$G_w=\sum_{i=1}^{k}G_{ii}\,p_i s_i \tag{10}$$

$$G_{ij}=(\sum_{h=1}^{n_i}\sum_{r=1}^{n_j}\left|y_{ih}-y_{jr}\right|)/n_i n_j(\overline{y}_i+\overline{y}_j) \tag{11}$$

$$G_{nb}=\sum_{i=2}^{k}\sum_{j=1}^{i-1}G_{ij}(p_i s_j+p_j s_i)D_{ij} \tag{12}$$

$$G_t=\sum_{i=2}^{k}\sum_{j=1}^{i-1}G_{ij}(p_i s_j+p_j s_i)(1-D_{ij}) \tag{13}$$

Equation (8) represents the overall Gini coefficient, while Equations (9) and (10) denote the Gini coefficient for region i (G_{ii})and the contribution of intra-regional differences within region *i* (G_w) respectively. Equations (11) and (12) represent the Gini coefficient between regions *i* and *j* (G_{ij})and the net contribution of inter-regional differences between *i* and *j* (G_{nb}), respectively, with the hypervariable density contribution(G_t)given by Equation (13). Here, $y_{ih}(y_{jr})$ is the coupling coordination degree of province h (r) in region *i* (*j*), and $\overline{y}$ represents the average coupling coordination degree across all provinces; n is the total number of provinces, and k is the number of regions. $n_i(n_j)$ is the number of provinces in region *i*(j), and $\overline{y}_i(\overline{y}_j)$ is the average coupling coordination degree of provinces within region *i*(*j*). $D_{ij}=(d_{ij}p_{ij})/(d_{ij}+p_{ij})$ represents the relative influence of coupling coordination degree, where d_{ij} and p_{ij} are the expected values of the sum of all sample values satisfying $y_{ij}y_{hr}>0$ and $y_{hr}y_{ij}>0$ in regions i and j, respectively.

3.3 Data Sources

The data utilized in this study are primarily sourced from authoritative institutions, including the National Bureau of Statistics, the Ministry of Science and Technology, and the People's Bank of China, as well as various official statistical yearbooks. These encompass national and provincial statistical yearbooks, environmental status bulletins, and specialized statistical yearbooks such as the *China Statistical Yearbook for Science and Technology*, *China Energy Statistical Yearbook*, *China Financial Yearbook*, *China Agricultural Statistical Yearbook*, *China Industrial Statistical Yearbook*, *China Tertiary Industry Statistical Yearbook*, *China Statistical Yearbook*, and *China Environment Statistical Yearbook*. Additional sources include statistical bulletins on national economic and social development for each province and the *Annual Report on National Technology Market Statistics*. For indicators with a limited number of missing values, interpolation methods were employed to impute the data. Given the considerable challenges in data acquisition and the prevalence of missing values, the final sample comprises data from 31 provinces in China (excluding Hong Kong, Macao, and Taiwan) spanning the period from 2010 to 2023.

4. Empirical Analysis

4.1 Measurement of the Green Finance and High-Quality Economic Development Composite Indices

Based on the green finance evaluation indicator system and the entropy weight method outlined earlier, this study calculates the green finance development index for 31 provinces in China (excluding Hong Kong, Macao, and Taiwan) from 2010 to 2023. To intuitively illustrate the temporal evolution characteristics and spatial differentiation patterns of the green finance index across provinces, the 31 provinces are categorized by geographical regions. Trend graphs (see Figure 1) and spatial pattern evolution maps (see Figure 2) are plotted accordingly.

Figure 1: Temporal Evolution of the Green Finance Index Across Chinese Provinces

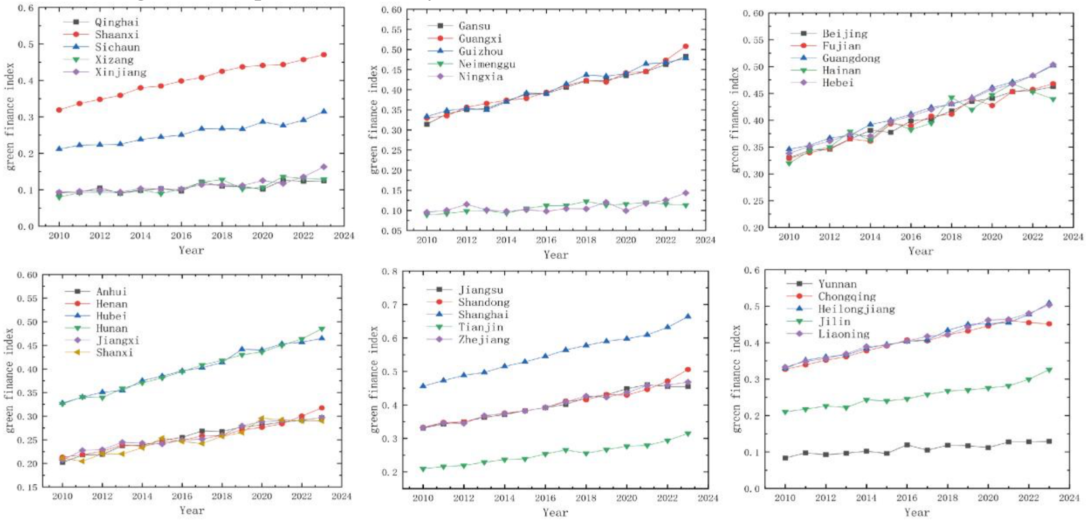
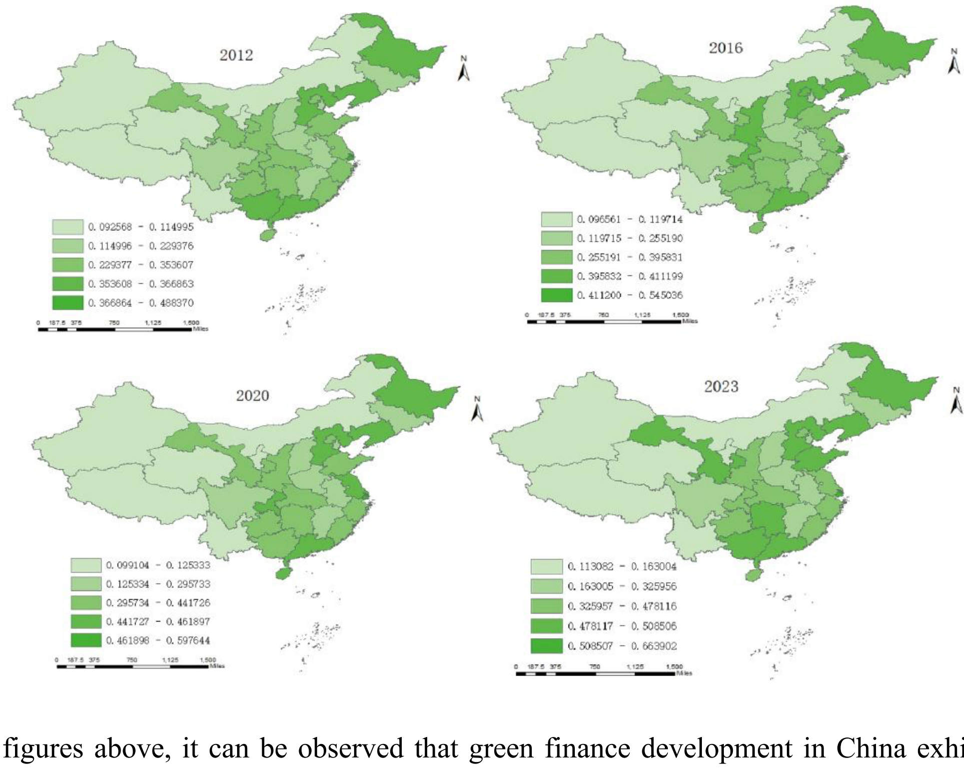


Figure 2: Spatial Pattern Evolution of Green Finance in China



From the figures above, it can be observed that green finance development in China exhibits a general upward trend, with the green finance index in the vast majority of provinces demonstrating a steady increase throughout the study period. This indicates that the promotion and implementation of green finance policies in China have achieved widespread effectiveness. Concurrently, green finance development in China displays pronounced spatial heterogeneity, characterized by high-level leadership, mid-tier catch-up, and the coexistence of low-level overtaking alongside sluggish growth. Significant disparities exist in green finance development levels across provinces, forming distinct "echelons."

Eastern provinces, represented by Shanghai, Beijing, Jiangsu, and Zhejiang, consistently rank at the national forefront in terms of their green finance indices. Central, eastern, and municipal regions, exemplified by Hubei, Hunan, Guangdong, Shandong, and Chongqing, constitute the second echelon, with indices generally exhibiting steady growth within the 0.4–0.5 range. Internal differentiation is also evident within western and northeastern regions. On one hand, certain provinces (e.g., Guizhou, Guangxi, Shaanxi, Sichuan, and Liaoning) demonstrate strong catch-up momentum; on the other hand, others (e.g., Qinghai, Tibet, Xinjiang, Yunnan, Jilin, and the eastern municipality of Tianjin) maintain green finance indices persistently below 0.3, reflecting relatively slow growth.

Based on the high-quality economic development evaluation indicator system, this study calculates the composite index of high-quality economic development for 31 Chinese provinces from 2010 to 2023. The temporal evolution trends and spatial differentiation patterns are presented in Figure 3 and Figure 4, respectively.

Figure 3: Temporal Evolution of the High-Quality Economic Development Composite Index Across Chinese Provinces

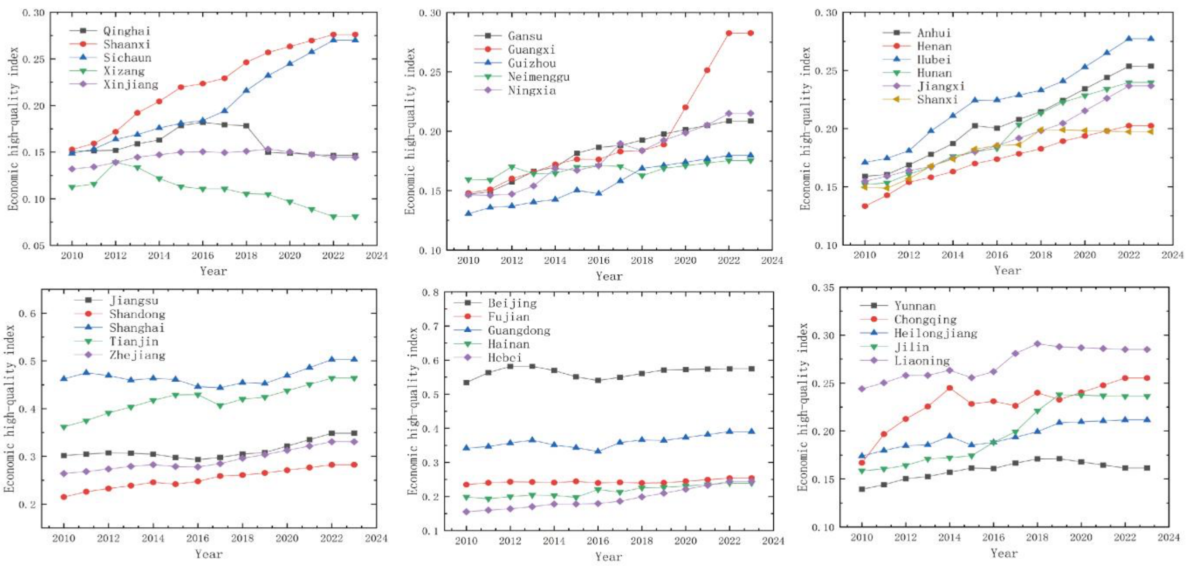
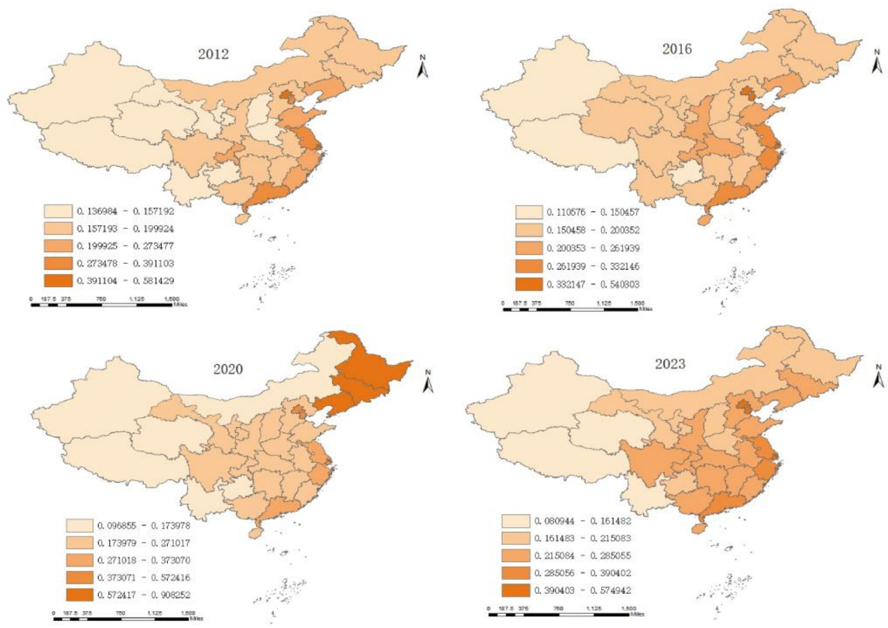


Figure 4: Spatial Pattern Evolution of High-Quality Economic Development in China



Compared to the widespread and rapid growth of the green finance index, China's high-quality economic development index exhibits pronounced absolute-level differentiation, with substantial disparities in index values across provinces. Beijing and Shanghai, leveraging their advantages in innovation and openness, consistently maintain index values in the highest national echelon, ranging from 0.45 to 0.6. In contrast, a large number of central and western provinces have index values persistently below 0.2. Growth trends also diverge, with not all provinces experiencing steady increases. On one hand, provinces such as Hubei, Sichuan, Shaanxi, and Guangxi demonstrate strong upward momentum; on the other hand, certain provinces (e.g., Xinjiang and Qinghai) exhibit growth stagnation or a plateau phase after 2018, while Tibet displays a clear downward trend. Relative to green finance, the growth of high-quality economic development lags behind. A comparison of the two sets of figures clearly reveals that in many provinces (e.g., Shanghai, Chongqing, and Liaoning), the green finance index has shown robust growth in recent years, whereas the high-quality economic development index has grown more gradually or even stagnated.

4.2 Coupling Coordination Analysis

4.2.1 Overall Characteristics

Based on the aforementioned coupling coordination degree model, the indicator data from 31 provinces are aggregated to the national level, yielding the coupling coordination degree between green finance and high-quality economic development in China over the sample period (see Table 3).

Table 3: Measurement Results of Coupling Coordination Degree Between Green Finance and High-Quality Economic Development at the National Level

Year	Green Finance Index	High-Quality Economic Development Composite Index	Coupling Degree	Coupling Type
2010	83.22210871	62.59511112	0.294390689	Moderate Discoord
2011	83.26029362	62.39519412	0.362262739	Mild Discoord
2012	83.26845326	62.17990992	0.365108227	Mild Discoord
2013	83.30020853	61.94997432	0.389645016	Mild Discoord
2014	85.76196875	63.46698854	0.994987437	High-Quality Coord
2015	85.53256146	63.05014214	0.942623455	High-Quality Coord
2016	83.37534558	61.27615672	0.405126675	Near Discoord
2017	83.38711994	61.09912702	0.398170123	Mild Discoord
2018	83.41507627	60.93403632	0.397613804	Mild Discoord
2019	83.42677444	60.74962552	0.384403157	Mild Discoord
2020	83.45943627	60.54348232	0.372194753	Mild Discoord
2021	83.49971901	60.33280712	0.352079761	Mild Discoord

2022	83.53413767	60.11759962	0.311533276	Mild Discoord
2023	83.57189727	59.89046832	0.195126368	Severe Discoord

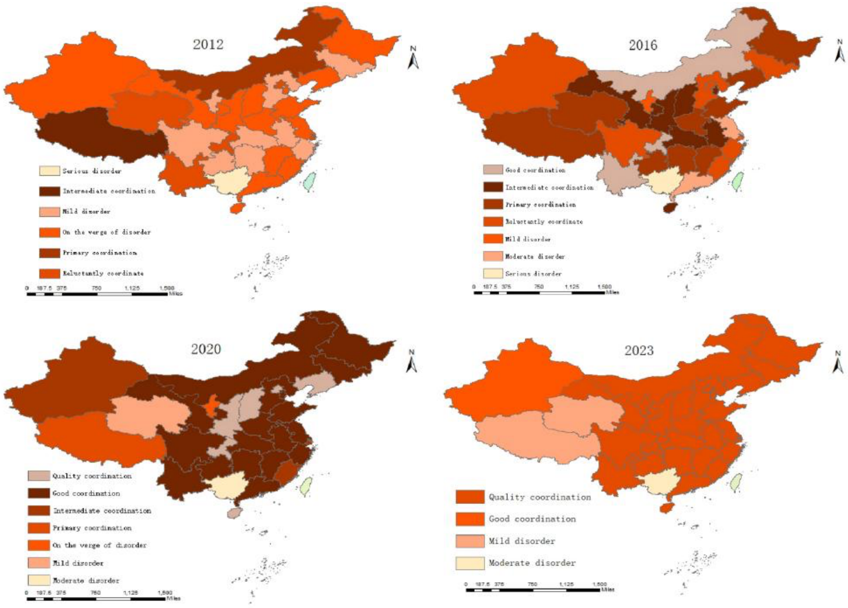
4.2.2 Regional Characteristics

In accordance with standard geographical divisions of China, this study categorizes the national sample into four major regions, including eastern, central, western, and northeastern, and conducts a comparative analysis of the regional characteristics of the coupling coordination degree between green finance and high-quality economic development. The spatial pattern evolution is illustrated in Figure 5, with the measurement results presented in Table 4 below.

Table 4: Measurement Results of Coupling Coordination Degree Between Green Finance and High-Quality Economic Development at the Regional Level

Year	Eastern Region		Central Region		Western Region		Northeastern Region	
	Coupling Degree	Coupling Type	Coordination Degree	Coupling Coordination Level	Coupling Degree	Coupling Coordination Level	Coordination Degree	Coupling Coordination Level
2010	0.315434215	Mild Discoord.	0.20963411	Moderate Discoord.	0.1	Severe Discoord.	0.1	Severe Discoord.
2011	0.576997008	Barely Coord.	0.211203611	Moderate Discoord.	0.318405375	Mild Discoord.	0.309872723	Mild Discoord.
2012	0.572220437	Barely Coord.	0.213835835	Moderate Discoord.	0.421279285	Near Discoord.	0.381760267	Mild Discoord.
2013	0.676260479	Primary Coord.	0.215044719	Moderate Discoord.	0.501267477	Barely Coord.	0.449824563	Near Discoord.
2014	0.691234638	Primary Coord.	0.994987437	High-Quality Coord.	0.604966069	Primary Coord.	0.549425153	Barely Coord.
2015	0.671501375	Primary Coord.	0.946399082	High-Quality Coord.	0.671524674	Primary Coord.	0.593559317	Barely Coord.
2016	0.691741413	Primary Coord.	0.219369514	Moderate Discoord.	0.728729382	Intermediate Coord.	0.642834751	Primary Coord.
2017	0.689830012	Primary Coord.	0.200707757	Moderate Discoord.	0.771054635	Intermediate Coord.	0.704204563	Intermediate Coord.
2018	0.706331784	Intermediate Coord.	0.182198997	Severe Discoord.	0.816837468	Good Coord.	0.762904617	Intermediate Coord.
2019	0.67714136	Primary Coord.	0.174236829	Severe Discoord.	0.848183996	Good Coord.	0.80372134	Good Coord.
2020	0.632841266	Primary Coord.	0.192948964	Severe Discoord.	0.895660636	Good Coord.	0.845430103	Good Coord.
2021	0.595979508	Barely Coord.	0.19116273	Severe Discoord.	0.946732055	High-Quality Coord.	0.884302811	Good Coord.
2022	0.515776436	Barely Coord.	0.171874678	Severe Discoord.	0.977816051	High-Quality Coord.	0.941495295	High-Quality Coord.
2023	0.315434215	Mild Discoord.	0.1222907	Severe Discoord.	0.98154146	High-Quality Coord.	0.994987437	High-Quality Coord.

Figure 5: Spatial Pattern Evolution of the Coupling Coordination Degree Between Green Finance and High-Quality Economic Development in China



Based on the measurement results in Table 4, the following analysis can be conducted:

From 2010 to 2023, the coupling coordination degree between green finance and high-quality economic development across China's four major regions exhibits pronounced differentiation trends. The western and northeastern regions achieved sustained and leapfrog growth, advancing from "severe discoordination" to "high-quality coordination"; in contrast, the eastern region displays an inverted U-shaped pattern of initial ascent followed by decline, while the central region remains predominantly in a state of discoordination.

Specifically, during the early development stage (2010–2017), the eastern region maintained a leading position. Throughout this period, the coupling coordination degree in the eastern region consistently outperformed the other three regions, being the first to enter the "primary coordination" stage in 2013 and reaching "intermediate coordination" by 2017. This may be attributable to the region's robust economic foundation and well-developed financial markets, which conferred first-mover advantages in promoting high-quality economic development and green finance innovation, thereby manifesting their mutual reinforcement earlier. Concurrently, the coordination levels in the central, western, and northeastern regions were relatively low, mostly lingering in "discoordination" or "near discoordination" states.

In the later development stage (2018–2023), the western and northeastern regions accomplished "overtaking on the curve." The year 2018 marked a distinct turning point, after which the coupling coordination degrees in the western and northeastern regions began to rise rapidly. The western region attained "good coordination" in 2018 and "high-quality coordination" by 2021; the northeastern region followed closely, reaching "good coordination" in 2019 and "high-quality coordination" by 2022. This progress may stem from national regional development strategies supporting the central-western areas and former industrial bases, coupled with the deepened implementation of green finance policies. Particularly in the western region, abundant clean energy resources (e.g., solar and wind power) offer substantial potential for high-quality economic transformation, with green finance intervention accelerating this process; in turn, high-quality economic development attracts additional green capital. In stark contrast, the eastern region's coupling coordination degree peaked in 2018 at 0.706; however, it has declined annually since then and reverted to "mild discoordination" (0.315) by 2023, a level equivalent to that of 2010. The central region has remained in "severe discoordination" since 2018.These patterns suggest that, upon reaching advanced economic levels, the eastern region encounters bottlenecks in aligning green requirements for industrial structural upgrading with the existing green finance system; meanwhile, the central region faces greater structural impediments in synergizing green finance with high-quality economic development.

4.3 Analysis of Disparities in the Coupling Coordination Degree Between Green Finance and High-Quality Economic Development

To further elucidate the intra-regional and inter-regional disparities in the coupling coordination degree between green finance and high-quality economic development, as well as their sources, this study employs MATLAB software to compute the Dagum Gini coefficient of the coupling coordination degree. The measurement results are presented in Table 5.

Table 5: Gini Coefficients of the Coupling Coordination Degree Between Green Finance and High-Quality Economic Development

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Overall Gini Coefficient		0.18	0.19	0.13	0.12	0.10	0.10	0.14	0.10	0.08	0.09	0.09	0.08	0.08	0.08
Intra-Regional Disparities	Eastern	0.19	0.14	0.09	0.07	0.06	0.07	0.17	0.10	0.06	0.06	0.03	0.02	0.01	0.01
	Central	0.13	0.16	0.06	0.04	0.03	0.06	0.04	0.02	0.03	0.02	0.02	0.02	0.01	0.00
	Western	0.20	0.22	0.18	0.19	0.15	0.13	0.16	0.12	0.12	0.14	0.16	0.15	0.18	0.17
	Northeastern	0.00	0.11	0.08	0.07	0.06	0.04	0.02	0.03	0.02	0.01	0.01	0.01	0.00	0.01
Inter-Regional Disparities	Eastern-Central	0.18	0.21	0.10	0.06	0.05	0.09	0.15	0.09	0.06	0.07	0.04	0.02	0.01	0.01
	Eastern-Western	0.21	0.19	0.14	0.16	0.12	0.12	0.19	0.14	0.11	0.11	0.11	0.10	0.12	0.11
	Eastern-Northeastern	0.18	0.14	0.10	0.09	0.08	0.06	0.12	0.08	0.07	0.07	0.03	0.02	0.01	0.01
	Central-Western	0.18	0.22	0.15	0.15	0.11	0.10	0.11	0.08	0.09	0.09	0.12	0.10	0.12	0.11
	Central-Northeastern	0.09	0.18	0.09	0.07	0.06	0.10	0.05	0.04	0.03	0.02	0.02	0.02	0.02	0.01
	Western-Northeastern	0.15	0.18	0.15	0.15	0.12	0.13	0.12	0.09	0.08	0.10	0.11	0.10	0.11	0.11
Contribution Rates	Intra-Regional	30.89	28.91	30.68	29.34	31.14	28.82	29.35	28.67	30.72	30.24	29.97	30.49	29.82	30.74
	Inter-Regional	27.96	32.50	20.62	34.17	13.26	33.51	39.08	36.94	26.77	39.51	54.12	55.11	65.82	65.38
	hypervariable density	41.14	38.59	48.70	36.49	55.60	37.68	31.57	34.40	42.51	30.24	15.91	14.40	4.36	3.88

Based on the Gini coefficient measurement results in Table 5, the spatial disparities in the coupling coordination degree between green finance and high-quality economic development can be analyzed as follows:

(1) Overall and Intra-Regional Disparities

Overall Disparities: Over the sample period (2010–2023), the overall Gini coefficient for the coupling coordination degree between green finance and high-quality economic development nationwide exhibits a pronounced "fluctuating decline" trend, decreasing from 0.19 in 2010 to 0.08 in 2023. This indicates that spatial disparities in coupling coordination at the national level are progressively narrowing, reflecting a favorable convergence trend overall.

Intra-Regional Disparities: Comparing disparities within each region, the eastern and central regions demonstrate the most significant reductions, with their Gini coefficients declining from 0.19 and 0.13 in 2010 to 0.01 and 0.00 in 2023, respectively, indicating a high degree of internal coordination. Intra-regional disparities in the western region follow an "N-shaped" fluctuation pattern but still show a slight overall decline (from 0.20 to 0.17). The northeastern region maintains consistently minimal intra-regional disparities throughout the period.

(2) Inter-Regional Disparities

During the sample period, disparities across all inter-regional pairs exhibit a clear declining trend. For instance, the largest disparity- "eastern-western"—decreases from 0.21 in 2010 to 0.11 in 2023; disparities between the "eastern-central" and "eastern-northeastern" pairs have narrowed to 0.01. This suggests that gaps in coupling coordination among the four major regional blocs are steadily diminishing.

(3) Sources of Disparities and Their Contributions

The contribution rates of disparity sources undergo a fundamental structural transformation over the sample period: the contribution of inter-regional disparities rises steadily from 27.96% in 2010 to 65.38% in 2023. This indicates that, although overall disparities are diminishing, inter-regional disparities have supplanted other factors to become the predominant source of aggregate spatial imbalance. In contrast, the contribution of hypervariable density experiences a precipitous decline, dropping from 41.14% in 2010 (then the largest contributor) to 3.88% in 2023. This suggests that the phenomenon of cross-regional overlap in coordination levels has been substantially reduced, with the characteristics of each regional bloc becoming increasingly distinct. The contribution of intra-regional disparities remains relatively stable, consistently hovering around 30%.

5. Conclusions and Policy Implications

This study reveals that, although both the green finance index and the high-quality economic development index in China exhibited growth from 2010 to 2023, a pronounced structural characteristic of "relative lag in high-quality economic development" has emerged since 2018. In terms of synergistic status, the national coupling coordination level remains volatile and of suboptimal quality, manifesting a pattern of "high coupling but low coordination." The spatial configuration has undergone a fundamental transformation, giving rise to a new differentiation pattern characterized by "western and northeastern regions overtaking, an inverted U-shaped decline in the eastern region, and subsidence in the central region." Although overall spatial disparities are narrowing, inter-regional disparities have become the predominant driver of spatial imbalance. Economic development level, industrial structure optimization, and government intervention emerge as critical positive factors in fostering coordination between the two domains.

Based on the aforementioned conclusions, this study proposes the following policy recommendations:

First, policy priorities should shift from merely expanding the scale of green finance to enhancing its efficacy in "empowering" high-quality economic development. Given that the "relative lag in high-quality economic development" has emerged as the primary contradiction, policies should steer green credit, green bonds, and other financial instruments toward precisely addressing shortcomings in high-quality development. Particular emphasis should be placed on supporting green technological innovation and industrial structural upgrading, thereby unblocking the transmission channels through which green capital is converted into high-quality transformation of the real economy.

Second, differentiated inter-regional coordination strategies must be implemented to address "inter-regional disparities," the predominant driver of imbalance. The eastern region should remain vigilant against the inverted U-shaped decline trajectory and leverage its fintech advantages to promote a "secondary integration" of green finance with industrial transformation. The western and northeastern regions should consolidate their "overtaking on the curve" achievements by continuously converting ecological and energy endowments into developmental strengths. As the focal point of policy intervention, the central region must strengthen government guidance, utilizing green financial instruments to compel the transformation of high-energy-consumption industries and extricate itself from the predicament of "severe discoordination."

Finally, key driving forces should be reinforced at the foundational level to solidify the basis for synergistic development. Empirical evidence confirms the significant positive effects of economic development, industrial upgrading, and government regulation. Accordingly, multifaceted measures are imperative: (i) sustain stable economic growth to provide a robust foundation for the dual-system advancement; (ii) position "industrial structure optimization" as the core lever for enhancing coordination, directing green capital toward green industries; and (iii) harness the government's proactive role through green fiscal policies and environmental regulations to rectify market failures, thereby safeguarding the coordinated evolution of the two systems.

References

Cao, M., Gao, Y. and Li, F., (2023). A study on the measurement and influencing factors of green finance development level in my country—based on an analysis of key provinces along the belt and road initiative. *Qinghai Finance*, no. 08, pp. 35-42.

Chen, J., Chen, Y. and Chen, M., (2020). China's high-quality economic development level,regional differences and dynamic evolution of distribution. *The Journal of Quantitative & Technical Economics,* vol. 37, no. 12, pp. 108-126.

Chen, Z. and Xing, R., (2025). Digital economy, green innovation and high-quality economic development. *International Review of Economics & Finance,* vol. 99, p. 104029.

Cui, P., Zhao, Y., Xia, S. and Yan, J., (2020). Level measures and temporal and spatial coupling analysis of ecological environment and high quality development in the yellow river basin. *Economic Geography,* vol. 40, no. 05, pp. 49-57+80.

Huang, X. and Gao, S., (2024). Measurement and spatiotemporal characteristics of China's green finance. *Environmental Science and Pollution Research,* vol. 31, no. 9, pp. 13100-13121.

Irfan, M., Razzaq, A., Sharif, A. and Yang, X., (2022). Influence mechanism between green finance and green innovation: exploring regional policy intervention effects in China. *Technological Forecasting and Social Change,* vol. 182, p. 121882.

Jian, X., Du, D. and Liang, D., (2024). Scale or effectiveness? The nonlinear impact of talent agglomeration on high-quality economic development in China. *Heliyon,* vol. 10**,** no. 9, p. e30121.

Kong, Q., (2019). Compilation and measurement of the green finance composite index: A case study of gansu province. *Gansu Finance***,** no. 2, pp. 20-24.

Lee, C.-C. and Lee, C.-C., (2022). How does green finance affect green total factor productivity? Evidence from China. *Energy economics,* vol. 107, p. 105863.

Liu, H. and He, C., (2021). Mechanisms and tests for green finance to promote urban economic high quality development: Empirical Evidence from 272 prefecture level cities in China. *Review of Investment Studies,* vol. 40**,** no. 07, pp. 37-52.

Liu, L., Liang, L., Gao, P., Fan, C., Wang, H. and Wang, H., (2021). Coupling relationship and interactive response between ecological protection and high-quality development in the Yellow River Basin. *Journal of Natural Resources,* vol. 36**,** no. 01, pp. 176-195.

Liu, T. and Xu, Z., (2024). Coupling coordination between green finance and low-carbon economy in China and spatial-temporal characteristics. *Statistics & Decision,* vol. 40**,** no. 08, pp. 144-149.

Ma, R., Luo, H., Wang, H. and Wang, T., (2019). Study of evaluating high-quality economic development in Chinese regions. *China Soft Science***,** no. 07, pp. 60-67.

Qin, L., Liu, S., Wang, Y., Gu, H. and Shen, T., (2024). Regional differences, dynamic evolution, and spatial–temporal convergence of green finance development level in China. *Environmental Science and Pollution Research,* vol. 31**,** no. 11, pp. 16342-16358.

Shi, B. and Ren, B. P., (2018). A measurement of China's provincial economic high quality development *On Economic Problems***,** no. 04, pp. 1-6.

Shi, D. and Shi, X., (2022). Green finance and high-quality economic development: Mechanism, characteristics and empirical study. *Statistical Research,* vol. 39**,** no. 01, pp. 31-48.

Sun, H., Gui, H. and Yang, D., (2020). Measurement and evaluation of the high-quality of China's provincial economic development. *Zhejiang Social Sciences***,** no. 08, pp. 4-14+155.

Sun, M. Y., (2023). A study on the coupling relationship between green finance and high-quality economic development in my country. *Management and Administration***,** no. 07, pp. 177-184.

Tang, W., Ding, N. and Sun, M., (2025). Measurement of green finance development level and policy enlightenment in shaanxi province under the "Double Carbon" goal:An empirical analysis based on regional differences. *Science Technology and Industry,* vol. 25**,** no. 19, pp. 232-239.

Wen, S., Liu, H. and Wang, H., (2022). Green finance, green innovation, and high-quality economic development. *Journal of Financial Research***,** no. 08, pp. 1-17.

Yu, B. and Fan, C., (2022). Green finance, technical innovation and high-quality economic development. *Nanjing Journal of Social Sciences***,** no. 09, pp. 31-43.

Yue, Y., (2019). Measurement and comparative analysis of green finance development level. *Journal of Regional Financial Research***,** no. 4, pp. 34-38.

Zeng, X., Liu, Y., Man, M. and Shen, Q., (2014). Measurement analysis of the development level of China's green finance. *Journal of China Executive Leadership Academy Yan'an,* vol. 7**,** no. 06, pp. 112-121+105.

Zhang, D., Mohsin, M., Rasheed, A. K., Chang, Y. and Taghizadeh-Hesary, F., (2021). Public spending and green economic growth in BRI region: mediating role of green finance. *Energy policy,* vol. 153, p. 112256.

Zhang, R. T. and Jiao, H. F., (2015). Coupling and coordinating between economic development and ecological environment in the pan yangtze river delta. *Resources and Environment in the Yangtze Basin,* vol. 24**,** no. 05, pp. 719-727.

Zhao, T., Zhang, Z. and Liang, S., (2020). Digital economy, entrepreneurship, and high-quality economic development: Empirical evidence from urban China. *Management World,* vol. 36, no. 10, pp. 65-76.

Zhou, C., Tian, F. and Zhou, T., (2022). Green finance and high-quality development: Mechanism and effects. *Journal of Chongqing University (Social Science Edition),* vol. 28, no. 06, pp. 1-13.

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Conflicts of Interest

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