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A Study on the Measurement of Sustainability and Regional Differences of Chinese-Style Modernization

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ABSTRACT

This paper focuses on measuring and analyzing the sustainability and regional differences of Chinese-style modernization.

By studying the existing theories and current national forms and policies, and based on the five principles of constructing the indicator system, a set of scientific and reasonable evaluation indicator system is established for measuring the sustainability level of Chinese-style modernization. This article mainly selects various statistical data of China from 2015 to 2022 to measure the sustainability of Chinese-style modernization, in addition, in order to analyze the regional differences of modernization, the statistical data of provinces in 2015 and 2022 are also collected, and the data are obtained from the statistical yearbooks of each province in each year.

The article first measures the indicators of the five dimensions from 2015 to 2022 with the help of the improved entropy weight method and TOPSIS method, and then conducts a macro-analysis of the trends and characteristics of China's modernization sustainability level in recent years in terms of time span.

Then, the 31 provinces were divided into three regions, namely, east, central and west, and the Dagum Gini coefficient decomposition method was applied to decompose the overall differences in the level of modernized sustainable development of the country into the differences within subgroups of the east, central and west regions, the differences between subgroups, and the sources of the differences were measured quantitatively.

KEYWORDS: *Chinese-style modernization, sustainable development, regional differences, entropy weight method and TOPSIS method, Dagum Gini coefficient.*

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INTRODUCTION

General Secretary Xi Jinping once proposed that we should unswervingly advance along this new path of Chinese-style modernization. At the same time, although countries around the world have actively engaged in the pursuit of modernization in modern times, only a few countries have truly been able to successfully achieve their modernization goals. For developing countries, this challenge is particularly prominent, and the difficulties and challenges they face are even more severe. Of course, this does not mean that these countries have not made efforts or achieved any progress. The fundamental problem lies in the lack of sustainability in their modernization processes.

It is worth noting that even many developed countries are currently encountering various unsustainable challenges in their modernization development, including the Increasingly deteriorating ecological environment, the imbalance of the population structure, and the significant differences in the level of regional modernization [1]. These phenomena all point to a core issue: how to ensure the sustainability of development on the road to modernization. We are well aware that if we want to comprehensively build a modern socialist country with Chinese characteristics, then Chinese-style modernization must follow the path of sustainable development, because only by adhering to sustainable development can we ensure

the comprehensive building of a great modern socialist country.

In the Report to the 20th National Congress of the Communist Party of China, the core mission of building a modern socialist country is expounded, and a grand blueprint for achieving this goal is outlined. As an overall and systematic project, Chinese modernization is prominently characterized by its comprehensiveness in all domains, among which the link of coordinated regional development is particularly crucial. Against the backdrop of the current era, in-depth analysis of the inherent logical connection between Chinese modernization and coordinated regional development, scientific measurement of the development level of various regions, in-depth examination of the differences and obstacles existing in the process of coordinated regional development, and further exploration of innovative paths to promote coordinated regional development not only possess profound theoretical value but also hold significant practical guiding significance [2].

Therefore, in response to the problems China faces on the path of realizing Chinese modernization, how to more effectively advance the modernization drive and promote coordinated development among regions has become an important issue that urgently needs in-depth discussion and solution at present.

Related Concepts and Theoretical Foundations

A. The Connotation of Chinese Modernization

Chinese modernization is a distinctive model of socialist modernization. It not only draws on the valuable experience accumulated in the global modernization process but also deeply integrates China's unique national conditions to conduct innovative practical explorations, demonstrating its rich, diverse and far-reaching connotation. When discussing the characteristics of Chinese modernization, the most prominent one is its huge population scale. This striking feature not only reflects China's unique status as a major country but also reveals the complexity and diversity in its modernization drive. Secondly, it is a modernization aimed at common prosperity for all people, emphasizing the realization of shared prosperity on the basis of economic development. Thirdly, Chinese modernization focuses on the coordinated development of material civilization and spiritual civilization, pursuing comprehensive and sustainable progress. In addition, it emphasizes the harmonious coexistence of humans and nature; by promoting the formation of green development models and lifestyles, it achieves a positive cycle between humans and nature. Finally, Chinese modernization unswervingly takes the path of peaceful development. We are committed to building a global development community characterized by harmonious coexistence, joint discussion and joint construction, contributing Chinese wisdom and Chinese momentum to global peace and prosperity.

In summary, the Chinese modernization model embodies a unique socialist path and Chinese characteristics. It originates from the fine traditional Chinese culture and endows Chinese civilization with modern vitality. At the same time, it also reflects the Communist Party of China's profound understanding and grasp of the laws governing the construction of socialist modernization, providing strong support for the great rejuvenation of the Chinese nation [18].

B. The Theoretical Basis of Chinese-Style Modernization

The formation of the theory of Chinese-Style Modernization has undergone the test of long history and the tempering of practice. Rooted in the profound soil of fine traditional Chinese culture, it not only embodies the essence of scientific socialism but also extensively absorbs the outstanding achievements of human civilization. The birth of this theory stems from the unswerving pursuit of the Communist Party of China to seek well-being for the Chinese people and realize the great rejuvenation of the Chinese nation.

Closely integrated with China's national conditions and the characteristics of the times, the theory of Chinese-Style Modernization has constructed a socialist modernization theoretical system and practical path that not only follows the universal laws of modernization but also possesses distinct Chinese characteristics. This theory not only provides a solid institutional foundation, builds a stable economic support, and injects a strong spiritual impetus for China's journey toward modernization, thereby offering comprehensive and powerful guarantees for China to achieve its modernization goals. Meanwhile, it has also opened up a new path quite different from the Western modernization model, presenting a brand-new form of human civilization and contributing Chinese wisdom and Chinese solutions to the global modernization process [19].

When we conduct in-depth research on the theoretical system of Chinese-Style Modernization, it is not difficult to find that it contains a series of iconic categories. These categories not only profoundly reveal the core connotation, unique characteristics, and fundamental nature of Chinese-Style Modernization but also make the construction of this theoretical system more clear, systematic, and scientific, endowing it with great practical guiding

significance [20]. These iconic categories of the theory of Chinese-Style Modernization not only provide a solid cornerstone for the construction of its theoretical system but also play a key role in refining its basic principles and enhancing its persuasiveness and influence. Through in-depth analysis and definition of this series of core categories, we have laid a solid foundation for the systematic and theoretical construction of the theory of Chinese-Style Modernization and further consolidated its prominent position in academia and practice. Therefore, refining and accurately interpreting these iconic categories is a fundamental and indispensable key task for constructing a logically rigorous and theoretically profound theoretical system of Chinese-Style Modernization.

The Construction of the Evaluation Index System and the Introduction of Evaluation Methods

A. Construction of the Evaluation Index System

Based on the above analysis of the theory of Chinese-style modernization and sustainability, as well as the principles for establishing an indicator system, this study constructs an evaluation index system for the sustainable development level of Chinese-style modernization from five fundamental dimensions. This system comprises five first-level indicators and seventeen second-level indicators, aiming to reflect the sustainability of China's modernization drive.

1. Modernization with a Massive Population Scale

When establishing the evaluation index system for the modernization process with a massive population scale, the following considerations apply: Employment level is the cornerstone of people's livelihoods, directly reflecting the economic development level and social stability of a country or region. Social security level represents a crucial safeguard in modern society, where a sound social security system helps improve people's quality of life and promote social harmony and stability. Social service level is a direct manifestation of the ability and efficiency of governments and social organizations to provide public services; high-quality social services can enhance people's quality of life and sense of well-being. Educational level, as the foundation of national development, is vital for improving the overall quality of the population and the skill level of the labor force-higher educational levels enable a country to cultivate more talents, thereby driving scientific and technological progress and economic development. Based on these considerations, this study selects four indicators-employment level, social security level, social service level, and educational level-for analysis.

2. Modernization for Common Prosperity of All People

In constructing the evaluation index system for modernization oriented toward common prosperity of all people, this study identifies four core indicators: coordinated regional economic development level, coordinated urban-rural economic development level, urbanization level, and residents' consumption level. First, the coordinated development of regional economies is essential for achieving common prosperity for all people, as it involves the closeness of economic ties between different regions and the optimal allocation of resources. Second, the coordination of urban and rural economies is a key pathway to narrowing the urban-rural gap and realizing common prosperity; by assessing disparities in urban-rural economic development and the status of economic interaction, more targeted policies can be formulated to promote the integration of urban and rural economies. Third, urbanization level, as an important metric for measuring the progress of modernization, helps grasp the development trend of urbanization and drives socioeconomic advancement in rural areas. Finally, residents' consumption level directly reflects people's quality of life and serves as a critical indicator of common prosperity.

3. Modernization with Coordinated Material and Spiritual Civilizations

In establishing the evaluation index system for modernization featuring coordinated material and spiritual civilizations, the selection of three indicators-innovation development level, industrial structure level, and knowledge power level-is based on a comprehensive and in-depth consideration of the modernization process. First, evaluating the innovation development level provides insights into a country's achievements and potential in scientific and technological innovation, management innovation, and institutional innovation. Second, the industrial structure level is a significant symbol of a country's material civilization development; assessing this indicator helps understand the distribution and development status of a country's agriculture, industry, service industry, and other sectors. Finally, the knowledge power level is a key measure of a country's spiritual civilization development; evaluating this indicator sheds light on a country's investment and achievements in scientific research and development, talent cultivation, and cultural inheritance.

4. Modernization with Harmonious Coexistence Between Humans and Nature

In constructing the evaluation index system for modernization characterized by harmonious

coexistence between humans and nature, three indicators are selected: low-carbon development level, natural greening level, and environmental governance level. First, amid the growing severity of global climate change and environmental issues, low-carbon development has become an indispensable path to achieving sustainable development. Second, the natural greening level reflects a region's investment and achievements in afforestation, green space construction, and ecological protection, serving as an important criterion for measuring ecological environment quality. Finally, environmental pollution and ecological damage are among the major obstacles to the harmonious coexistence of humans and nature; the environmental governance level can reflect a region's capabilities and effectiveness in preventing and controlling environmental pollution, restoring ecosystems, and promoting resource recycling [24].

5. Modernization on the Path of Peaceful Development

In establishing the evaluation index system for modernization pursuing a path of peaceful development, three indicators are chosen: economic development level, export trade level, and foreign investment level. First, economic development level is the foundation for measuring a country's comprehensive strength and international status; a country pursuing peaceful development must have a solid economic foundation to provide strong support for social stability and people's well-being. Second, the path of peaceful development emphasizes international cooperation and mutual benefit; evaluating the export trade level helps understand a country's competitiveness and status in the international market. Finally, the path of peaceful development requires the flow and cooperation of factors such as capital, technology, and management; assessing the foreign investment level provides insights into a country's global capital layout and influence.

In summary, the evaluation index system for the sustainable development level of Chinese-style modernization selected in this study is presented in Table 1 below.

Table 1 Evaluation Index System for the Sustainable Development Level of Chinese-Style Modernization

Target Layer	Basic Dimension	First-Level Index Layer	Second-Level Index Layer	Assignment Calculation Method	Index Direction
Sustainable Development Level of Chinese-Style Modernization	Modernization with a Huge Population Scale	Livelihood Construction	Employment	Urban Registered Unemployment Rate (%)	Negative
			Social Security	Social Security and Employment Expenditure / Total Fiscal Expenditure (%)	Positive
			Social Services	Number of Social Organization Entities (unit)	Positive
			Education	Average Number of Higher Education Enrollees per 100,000 People (person)	Positive
	Modernization for Common Prosperity of All People	Common Prosperity	Regional Economic Coordination	Per Capita GDP of the Province (Prefecture/City/District/County) with the Highest Value / Per Capita GDP of the Province (Prefecture/City/District/County) with the Lowest Value	Negative
			Urban-Rural Economic Coordination	Per Capita Disposable Income of Urban Residents / Per Capita Disposable Income of Rural Residents	Negative
			Urbanization	Urban Population / Total Population (Permanent Population) (%)	Positive
			Resident Consumption	Total Resident Consumption / Total Population (RMB/person)	Positive
	Modernization with Coordinated	Construction of Material Civilization	Innovative Development	Annual R&D Expenditure / Annual GDP (%)	Positive
			Industrial	Proportion of the Tertiary	Positive

	Material Civilization and Spiritual Civilization	and Spiritual Civilization	Structure	Industry (%)	
			Knowledge Power Construction	Number of Patent Authorizations (unit)	Positive
	Modernization with Harmonious Coexistence between Humans and Nature	Ecological Civilization Construction	Low-Carbon Development	Carbon Emissions (10,000 tons)	Negative
			Natural Greening	Forest Coverage Rate (hectare)	Positive
			Environmental Governance	Comprehensive Utilization Rate of Industrial Solid Waste (%)	Positive
	Modernization Taking the Path of Peaceful Development	Peaceful Development	Economic Development	Per Capita GDP (RMB)	Positive
			Export Trade	Total Export Trade Volume (100 million USD)	Positive
			Foreign Investment	Outward Direct Non-Financial Investment Flow (100 million USD)	Positive

B. Introduction to the Entropy Weight-TOPSIS Method

As a comprehensive evaluation method, the TOPSIS method is notably characterized by its ability to make full use of raw data information and effectively quantify the differences between different evaluation objects. This method consists of two main steps: first, it requires standardizing the raw data matrix to identify the optimal solution and the worst solution among all alternatives; second, it calculates the distance between each evaluation object and these two solutions to measure how close each object is to the optimal solution, which is then used as a key basis for assessing the quality of the evaluation objects.

The Entropy Weight Method mainly determines the weight of each indicator based on information entropy. Entropy is used to measure the degree of uncertainty of each indicator: if an indicator has a higher entropy value, it indicates a higher degree of uncertainty, and its corresponding weight should be reduced; conversely, if the entropy value is lower, the weight should be increased. This method effectively avoids the subjective influence of artificially setting weights, ensuring the objectivity and rationality of the results.

The Entropy Weight-TOPSIS Method combines these two methods. It first uses the Entropy Weight Method to determine the weight of each indicator, then applies the TOPSIS Method to calculate the distance between each evaluation object and the optimal solution as well as the worst solution, and finally ranks each evaluation object according to the relative closeness degree. This method has good applicability in scenarios with high requirements for data standardization and can evaluate the advantages and disadvantages of various alternatives or objects more objectively.

C. Introduction to the Dagum Gini Coefficient Decomposition Method

The Dagum Gini Coefficient Decomposition Method is an analytical approach widely used in economics, aiming to conduct in-depth analysis and understanding of the inequality in income or consumption levels between regions or groups. By ingeniously introducing a parameter, this method optimizes the calculation process of the Gini coefficient, thereby significantly enhancing its adaptability and accuracy, and ensuring more precise and flexible evaluation results.

The Dagum Gini Coefficient can be decomposed into three components: the intra-group coefficient (G_w), the inter-group coefficient (G_{nb}), and the transvariation density coefficient (G_t). The intra-group coefficient mainly reflects the disparity in levels within each region or group, the degree of inequality among individuals within the same region or group; the inter-group coefficient reflects the disparity in levels between different regions or groups, the overall degree of inequality between different regions or groups; the transvariation density coefficient represents the cross-overlap phenomenon between regions or groups, it reflects the situation of relative disparity.

Specifically, the Dagum Gini Coefficient Decomposition Method enables us to better understand the sources and composition of inequality between regions or groups. For example, in the analysis of regional disparities, by comparing the magnitudes of the intra-group coefficient and the inter-group coefficient, we can determine the extent to which intra-regional inequality and inter-regional inequality contribute to the overall inequality.

Meanwhile, the introduction of the transvariation density coefficient also allows us to more accurately identify the impact of cross-overlap phenomena between regions on inequality [25].

Measurement of the Sustainability of Chinese-Style Modernization

A. Data Source

In the process of measuring the sustainability of Chinese-style modernization, this study selects time-series data at the national and provincial levels from 2015 to 2022 as the research sample. For individual missing values at the provincial level, data from adjacent years are used for supplementation, and the extreme value method is uniformly adopted for dimensionless processing. The relevant data are sourced from the China Statistical Yearbook, China Environmental Statistical Yearbook, China Carbon Accounting Database, and Statistical Bulletin of China's Outward Foreign Direct Investment over the years.

B. Measurement Process of the Entropy Weight-TOPSIS Method

1) Construct the original data matrix

Assume that the sample data represents the development of m evaluation indicators for Chinese-style modernization over n years; the resulting original indicator data matrix A is as follows:

$$A=\begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ X_{m1} & X_{m2} & \cdots & X_{mn} \end{bmatrix}$$

X_{ij} represents the original data of the j-th indicator in the i-th year, $X=\{X_{ij}\}m\times n$, $X_{ij}\geq 0$, $0\leq i\leq m$, $0\leq j\leq n$.

2) Data Standardization

For positive indicators-i.e., indicators where a larger value indicates better performance-the Min-Max standardization method is adopted:

$$X^{*}=\frac{X_{ij}-\min\{X_{ij}\}}{\max\{X_{ij}\}-\min\{X_{ij}\}}$$

For reverse indicators-i.e., indicators where a smaller value indicates better performance-the Max-Min standardization method is adopted:

$$X^{*}=\frac{\max\{X_{ij}\}-X_{ij}}{\max\{X_{ij}\}-\min\{X_{ij}\}}$$

Then standardize the indicators, which means dividing each element by the square root of the sum of the squares of the elements in its corresponding column:

$$z_{ij}=\frac{x_{ij}}{\sqrt{\sum_{i=1}^{n}x_{ij}^{2}}}$$

Calculate the standardized matrix Z, where each element is denoted as z_{ij}:

$$Z=\left(z_{ij}\right)_{m\times n}=\begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ z_{m1} & z_{m2} & \cdots & z_{mn} \end{bmatrix}$$

3) Calculate the indicator weights

At this point, the proportion of the indicator value in the i-th year under the j-th indicator is:

$$r_{ij}=\frac{X_{ij}^{*}}{\sum_{i=1}^{n}X_{ij}^{*}}$$

The entropy value of the j-th indicator is:

$$e_j = -k\sum_{i=1}^{n} r_{ij} \ln r_{ij} (k = \frac{1}{\ln n}, 0 < e_j < 1)$$

The coefficient of variation for the j-th indicator $d_j = 1 - e_j$

The weight of each evaluation indicator is:

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

4) Construct the weighted standardized matrix P

Multiply the standardized data matrix Z by the weight vector W_j to obtain the weighted standardized matrix:

$$P = \begin{bmatrix} P_{11} & P_{12} & \cdots & P_{1n} \\ P_{21} & P_{22} & \cdots & P_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ P_{m1} & P_{m2} & \cdots & P_{mn} \end{bmatrix}$$

$$= \begin{bmatrix} W_1 Z_{11} & W_1 Z_{12} & \cdots & W_1 Z_{1n} \\ W_2 Z_{21} & W_2 Z_{22} & \cdots & W_2 Z_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ W_m Z_{m1} & W_m Z_{m2} & \cdots & W_m Z_{mn} \end{bmatrix}$$

5) Apply the weighted standardized matrix P

Combine the maximum value of each column into a new vector; this vector is the positive ideal solution P^+, which represents an ideal state that achieves the optimal level across all evaluation indicators. Combine the minimum value of each column into another new vector; this vector is the negative ideal solution P^-, which represents a non-ideal state that reaches the worst level across all evaluation indicators.

Calculate the distances between the object's indicator values and the positive ideal solution as well as the negative ideal solution; the formulas are as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} (P_{ij} - P_j^+)^2} (i = 1, 2, \cdots, n)$$

$$D_i^- = \sqrt{\sum_{j=1}^{m} (P_{ij} - P_j^-)^2} (i = 1, 2, \cdots, n)$$

Calculate the relative closeness degree between the indicator values of each evaluation object and the positive ideal solution as well as the negative ideal solution:

$$C_i = \frac{D_i^-}{D_i^+ D_i^-} (i = 1, 2, \cdots, n)$$

In the formula, the value of C_i ranges from 0 to 1 (denoted as [0,1]). The closer the value of C_i is to 1, the closer the evaluation object is to the positive ideal solution, indicating a better scheme; the closer the value of C_i is to 0, the closer the evaluation object is to the negative ideal solution, indicating a worse scheme [26].

C. Analysis of the Results on the Sustainability of Chinese-Style Modernization

1. Analysis of the Overall Level of Modernized Sustainable Development

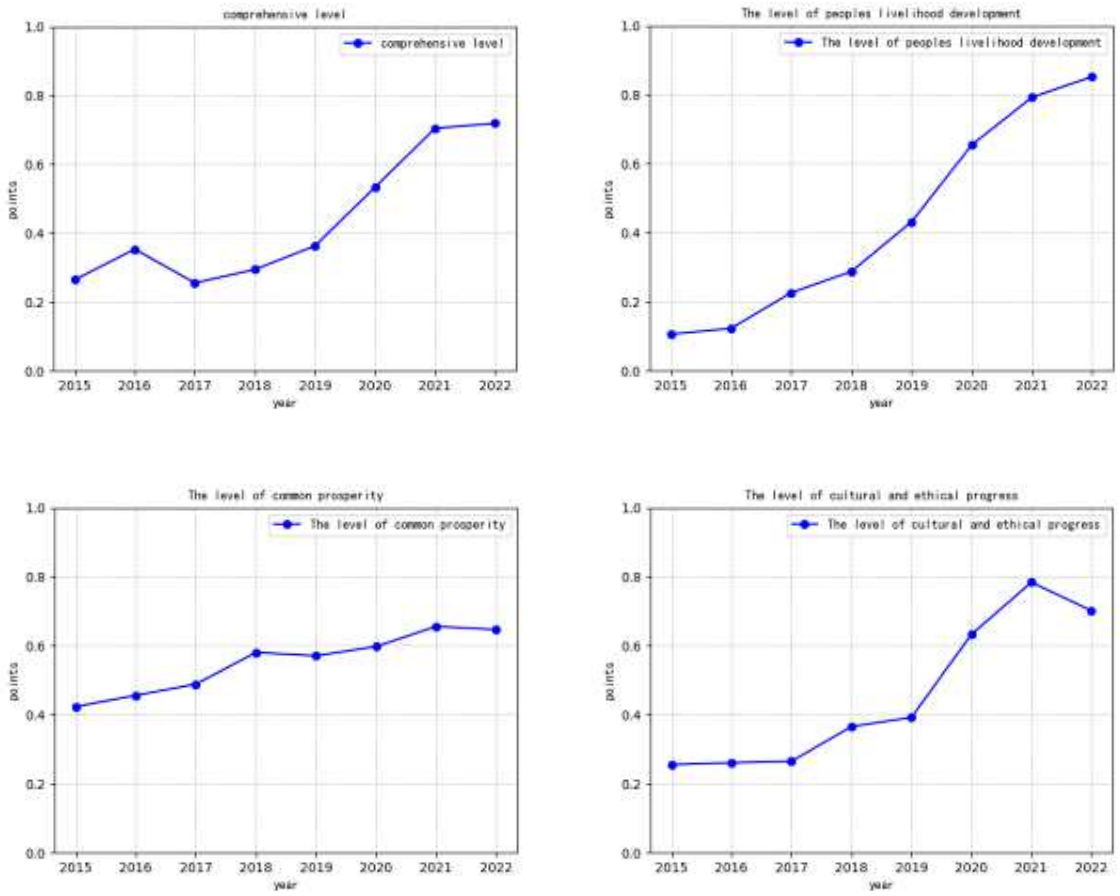
When evaluating the sustainable development level of Chinese-style modernization, the entropy weight method was adopted to conduct a quantitative analysis of each evaluation indicator, and the corresponding weight distribution was obtained. The specific values are detailed in the table below. The weight proportions in descending order are as follows: the level of ecological civilization construction accounts for 21.12%, the level

of common prosperity accounts for 20.15%, the level of cultural and ethical progress (spiritual civilization construction) accounts for 19.73%, the level of people's livelihood development accounts for 19.69%, and the level of peaceful development accounts for 19.32%.

Table 2 Weight of Each Evaluation Indicator for the Sustainable Development Level

First-Level Indicator	Indicator Weight $^{W}_{j}$	Second-Level Indicator	Entropy Value $^{e}_{j}$	Indicator Weight $^{w}_{j}$
People's Livelihood Development	19.69%	Employment	0.9315	2.44%
		Social Security	0.8967	3.67%
		Social Services	0.8855	4.07%
		Education	0.7326	9.51%
Common Prosperity	20.15%	Regional Economic Coordination	0.9188	2.89%
		Urban-Rural Economic Coordination	0.7551	8.70%
		Urbanization	0.8861	4.05%
		Residents' Consumption	0.8731	4.51%
Cultural and Ethical Progress	19.73%	Innovative Development	0.7830	7.71%
		Industrial Structure	0.9156	3.00%
		Knowledge-Powered Nation	0.7463	9.02%
Ecological Civilization Construction	21.12%	Low Carbon	0.8004	7.10%
		Natural Greening	0.7547	8.72%
		Environmental Governance	0.8508	5.30%
Peaceful Development	19.32%	Economic Development	0.8611	4.94%
		Export Trade	0.8014	7.06%
		Overseas Investment	0.7941	7.32%

The TOPSIS method was used to calculate the indicator scores for different years. The results were categorized according to the first-level indicators, and the measured results are shown in Figure 1 below:



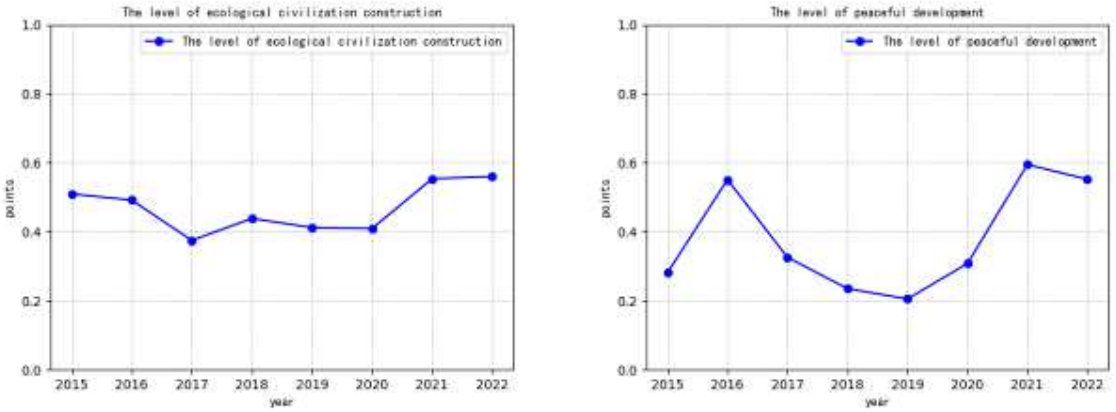


Figure 1 The Sustainable Development Level of Chinese-Style Modernization

It can be seen that the comprehensive score of the sustainable development level of Chinese-style modernization has increased from 0.264 in 2015 to 0.719 in 2022. This fully indicates that under the strong leadership of the Communist Party of China and with the unremitting joint efforts and struggles of the people of all ethnic groups across the country, the sustainable development of Chinese-style modernization has achieved considerable progress and remarkable results.

In addition, in terms of cultural and ethical progress, the level of its sustainable development has shown a strong growth momentum, rising significantly from 0.255 in 2015 to 0.702 in 2022. This significant growth highlights that China has fully leveraged the political advantages of cultural and ethical progress, effectively improved the practical effectiveness of ideological and political work, and integrated cultural and ethical progress into all aspects of the cause of socialism with Chinese characteristics for the new era.

Although China has made progress in the global ranking of sustainable development levels, the sustainability of ecological civilization construction is still insufficient, and its growth momentum is relatively slow. From a data perspective, it has steadily increased from 0.510 in 2015 to 0.560 in 2022, and this trend is positive. However, against the backdrop of the rapid development of the economy and society, the challenges facing the ecological environment remain severe. In particular, environmental issues such as water pollution, air pollution, and land degradation have become key factors restricting the process of China's sustainable development, indicating that ecological civilization is still a weak link that urgently needs to be strengthened in the comprehensive sustainable development strategy.

2. Analysis of the Modernized Sustainable Development Level of Each Province

The scores of the comprehensive sustainable development level of each province in 2015 and 2022, calculated by the entropy weight-TOPSIS method, are shown in the figure below:

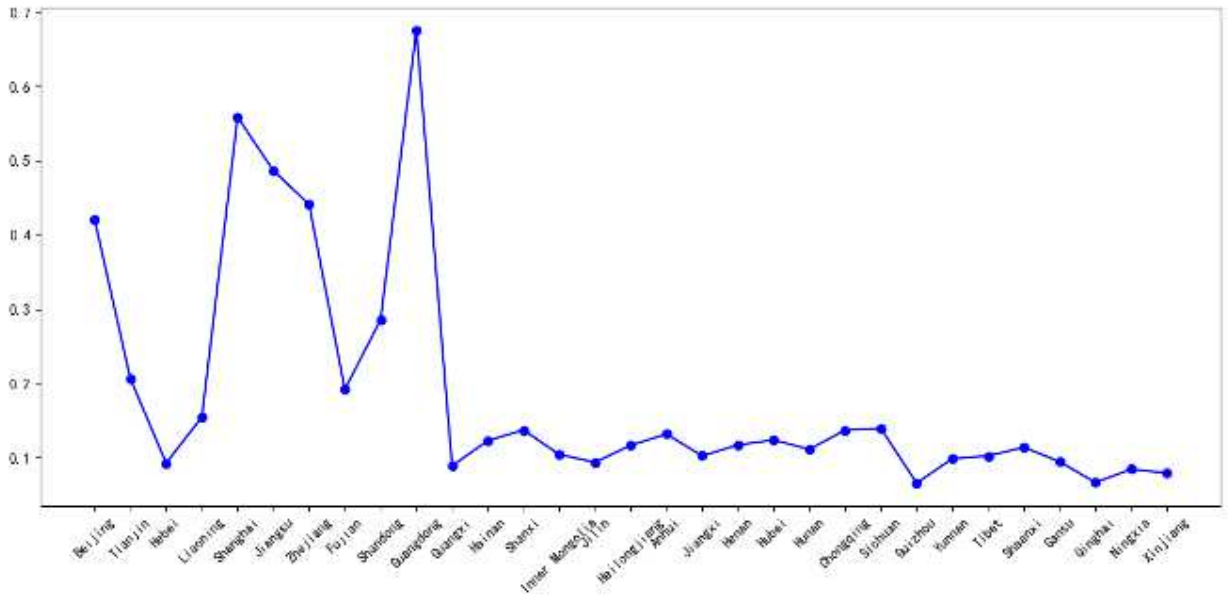


Figure 2 Level of Sustainable Development of Chinese-Style Modernization in Each Province in 2015

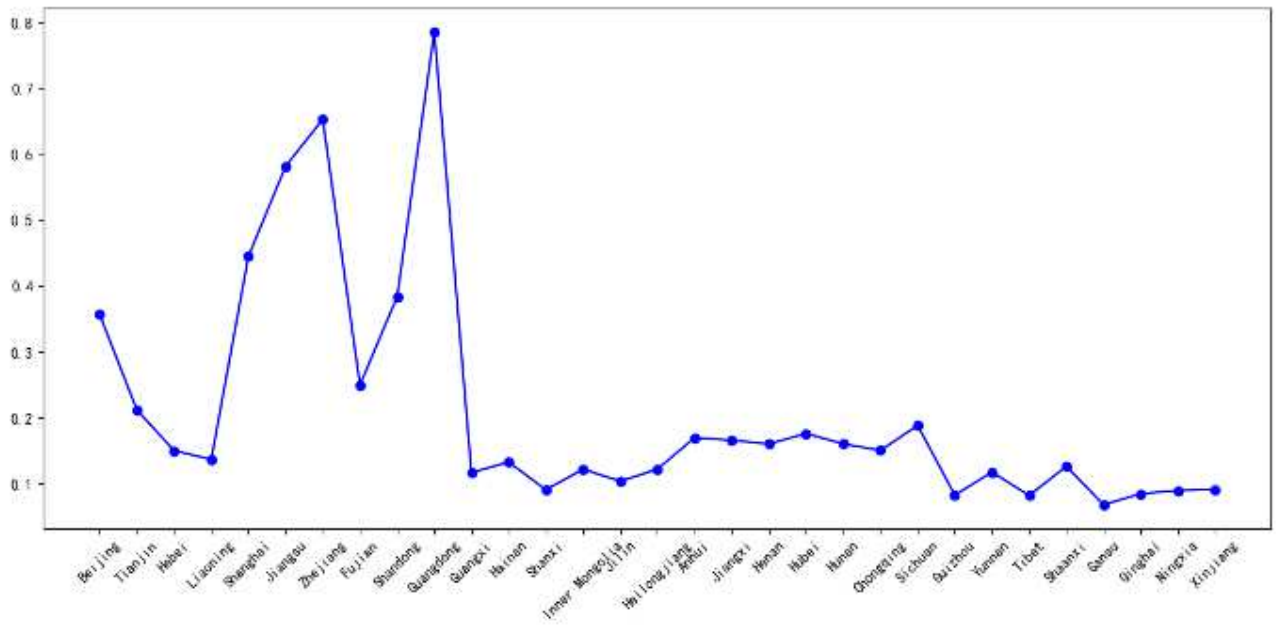


Figure 3 Level of Sustainable Development of Chinese-Style Modernization in Each Province in 2022

By observing the figure above, it is not difficult to find that the provinces with top comprehensive rankings are mainly concentrated in the eastern region, specifically including seven regions: Beijing, Guangdong, Shanghai, Jiangsu, Zhejiang, Tianjin, and Shandong. Among the provinces ranked in the bottom ten, the western region accounts for five seats, the central region for four seats, and the eastern region for only one seat. This distribution reveals significant differences in the modernization level between regions and among provinces within a region, forming a spatial distribution pattern where the eastern region takes the lead and the western region lags relatively behind.

From 2015 to 2022, the average growth rate of the national modernized sustainable development level reached 3.1%, showing a stable and continuous growth trend. Through further analysis, the central and western regions have shown more outstanding performance in terms of growth rate, with the overall growth rate presenting a pattern where the central region grows faster than the western region, and the western region in turn leads the eastern region. This phenomenon indicates that although the provinces in the eastern region have a relatively high level of modernization, the provinces in the central and western regions have shown a strong momentum in terms of growth rate, forming a "catch-up" development model. This trend conforms to the inherent laws of modernization development and also proves that the relevant policies implemented by the country have played a positive role in promoting the improvement of the sustainable development level of Chinese-style modernization.

Analysis of Regional Disparities in the Sustainability of Chinese-Style Modernization

A. Analysis Process of the Dagum Gini Coefficient Decomposition Method

As a tool for measuring income inequality, the Gini coefficient is of self-evident importance. The decomposition method of the Gini coefficient proposed by Dagum provides us with a new perspective to deeply understand its internal structure. The overall Gini coefficient G can be decomposed into three parts according to spatial sources: the contribution of intra-regional differences G_w, the contribution of inter-regional differences G_{nb}, and the contribution of hypervariable density G_t. The specific calculation formulas are as follows:

1) Overall Gini coefficient:

$$G_{jj} = \frac{\sum_{i=1}^{n_j}\sum_{r=1}^{n_k}\left|y_{ji} - y_{jr}\right|}{2n_j n_h(\overline{Y_j} + \overline{Y_h})}$$

$$\overline{Y_1} \le \overline{Y_h} \le \cdots \overline{Y_j} \le \cdots \le \overline{Y_k}$$

It reflects the relative differences in modernization sustainability among all provinces.

2) Intra-regional Gini coefficient of Region j is:

$$G_{jj} = \frac{\sum_{i=1}^{n_j}\sum_{r=1}^{n_k}\left|y_{ji} - y_{jr}\right|}{2n_j^{\,2}\overline{Y_j}}$$

3) The inter-regional Gini coefficient between Region j and Region h is:

$$G_{jh} = \frac{\sum_{i=1}^{n_j}\sum_{r=1}^{n_k}\left|y_{ji} - y_{jr}\right|}{2n_j n_h(\overline{Y_j} + \overline{Y_h})}$$

4) Intra-regional differences:

$$G_w = \sum_{j=1}^{k} G_{jj} p_j s_j$$

5) Inter-regional net value differences:

$$G_{nb} = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j) D_{jh}$$

6) Hypervariable Density:

$$G_t = \sum_{j=2}^{k}\sum_{h=1}^{j-1} G_{jh}(p_j s_h + p_h s_j)(1 - D_{jh})$$

D_{jh} represents the relative impact of the development of Chinese modernization level between Region j and Region h. It is the difference in the modernization level development indicators between Region j and Region h, and also the mathematical expectation of the sum of all $y_{ji} - y_{hr} > 0$ sample values within the j-th region and the h-th region, which is used to measure the degree of mutual influence between regions; P_{jh} denotes the mathematical expectation [27].

B. Analysis of Regional Difference Results in the Sustainability of Chinese Modernization

To conduct an in-depth exploration of the regional disparities in the level of modernized sustainable development and their sources, this study divides China's 31 provinces into three major regions: the Eastern, Central, and Western regions. Subsequently, the Dagum Gini coefficient decomposition method is employed to quantitatively measure the overall disparities in the level of modernized sustainable development across the entire country and the three major regions at two key time points, namely 2015 and 2022. Additionally, attention is paid to the disparities in sustainable development levels within each of the Eastern, Central, and Western regions (i.e., within subgroups) as well as between these regions (i.e., between subgroups), with a detailed analysis of the main sources of these disparities. This method not only helps us more accurately grasp the distribution pattern of the national-level modernized sustainable development but also provides strong support for formulating more targeted policies [28].

1. The Overall Differences in the Level of Modernization and Sustainable Development

Based on the results of the Dagum Gini coefficient, we can observe that the overall Gini coefficient (G) has slightly decreased from 0.276 in 2015 to 0.274 in 2022. This change indicates that against the backdrop of the steady improvement in the level of modernization and sustainable development, the overall differences in modernization and sustainable development have not shown a positive narrowing trend. The Party and the country attach great importance to the issue of "balanced regional development" and have made important statements on this matter on many occasions, pointing out that it is necessary to focus on promoting high-quality and coordinated development strategies for regions and urban agglomerations in the new era, such as the integrated development of the Beijing-Tianjin-Hebei region and the construction of the Chengdu-Chongqing economic circle. These policy guidelines clearly point to "deepening the implementation of the balanced regional development strategy" and "promoting balanced regional development to a higher level". China still needs to make continuous efforts in balanced regional development to ensure that the overall differences in the level of sustainable development show a positive and improving trend.

2. Intra-group Differences in the Level of Modernization and Sustainable Development

As shown in the figure, the intra-group differences in the modernization and sustainable development level among China's Eastern, Central, and Western regions have each exhibited distinct evolutionary trajectories. Generally speaking, the intra-group differences in the Central and Western regions have shown a narrowing trend. Specifically, the intra-group difference in the Central region dropped significantly from 0.071 in 2015 to 0.022 in 2022, presenting a marked narrowing momentum; while that in the Western region also decreased, the decline was relatively small, falling from 0.121 to 0.101. In contrast, the internal difference in the Eastern region showed a slight upward trend, increasing marginally from 0.2636 in 2015 to 0.2637 in 2022. These changing trends of differences reflect the diverse challenges and opportunities faced by various regions in China during the process of advancing balanced regional development.

From the perspective of the specific level of intra-group differences, the difference in the Eastern region is significantly higher than that in the Central and Western regions, which highlights the obvious differentiation in the level of modernization and sustainable development among provinces in the Eastern region. The prominent intra-group difference in the Eastern region is mainly due to the substantial disparity in scores among its provinces. Specifically, the average value of the standard deviation of the comprehensive index in the Eastern region is as high as 0.096, which profoundly reveals the unbalanced state of sustainable development performance among provinces in the Eastern region. Taking Guangdong, a leading province in development, and Hebei, a province with a relatively lower score, as examples, there is a significant gap between the two, which further confirms the imbalance in sustainable development among provinces in the Eastern region.

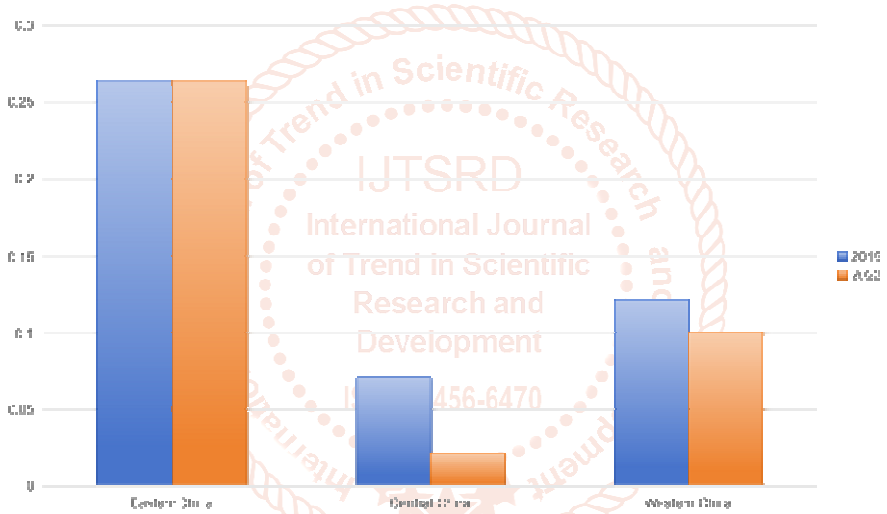


Figure 4 Intra-group Gini Coefficient

3. 3. Inter-group Differences in the Level of Modernization and Sustainable Development

The changes in inter-group differences among the Eastern, Central, and Western regions are shown in the figure below:

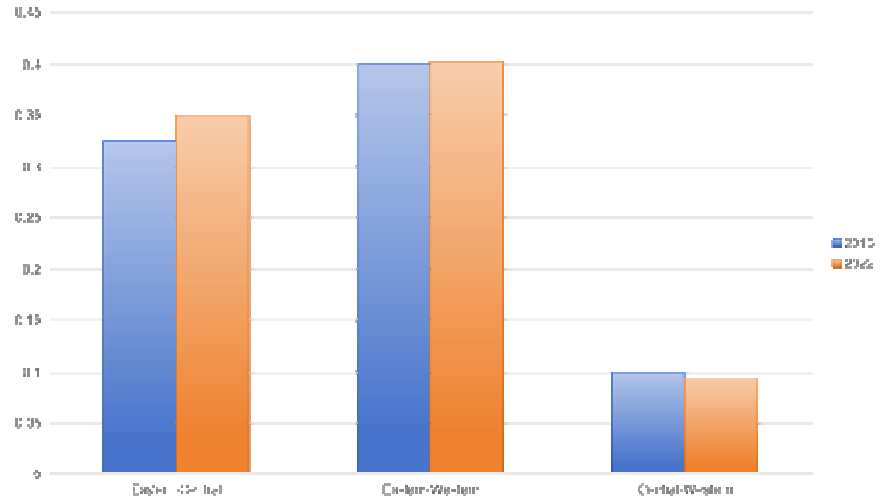


Figure 5 Inter-group Gini Coefficient

It can be observed that the inter-group Gini coefficients between the Eastern-Central regions and the Eastern-Western regions show an upward trend, and their inter-group differences have always been greater than the inter-group difference between the Central-Western regions. Thus, it is evident that despite long-term and unremitting efforts, significant progress has been generally achieved in modernization and sustainable development, and the overall differences have shown a positive narrowing trend. However, we must clearly recognize that in the current process, there still exist obvious unbalanced characteristics among regions. In particular, the inter-group differences in the level of sustainable development between the Eastern region and the Central-Western regions remain significant. This highlights the unbalanced development issues faced by the Central-Western regions due to multiple factors such as geographical location, natural resource endowments, socio-economic foundation, and ecological environment. Especially for those border provinces, the development gap between them and the developed provinces in the Eastern region is still obvious, which requires our continuous attention and the adoption of corresponding measures to address.

4. Sources of Differences and Their Contributions to the Level of Sustainable Development

To conduct an in-depth analysis of the root causes of differences in the level of modernization and sustainable development, this study further conducts a quantitative analysis of the contribution rates of intra-group differences, inter-group differences, and hypervariable density to the overall differences. The results show that the average values of these three factors are 25%, 71.28%, and 3.72% respectively, and their dynamic evolution trends are shown in the figure. Obviously, inter-group differences have become the main driving force behind the differences in modernization and sustainable development. In contrast, the combined contribution rate of hypervariable density and intra-group differences is only 28.72%. Therefore, against the grand backdrop of sustainable development in the new era, and in the face of this complex and large-scale systematic project, ensuring balanced and coordinated development among regions is undoubtedly one of the key tasks that we urgently need to address.

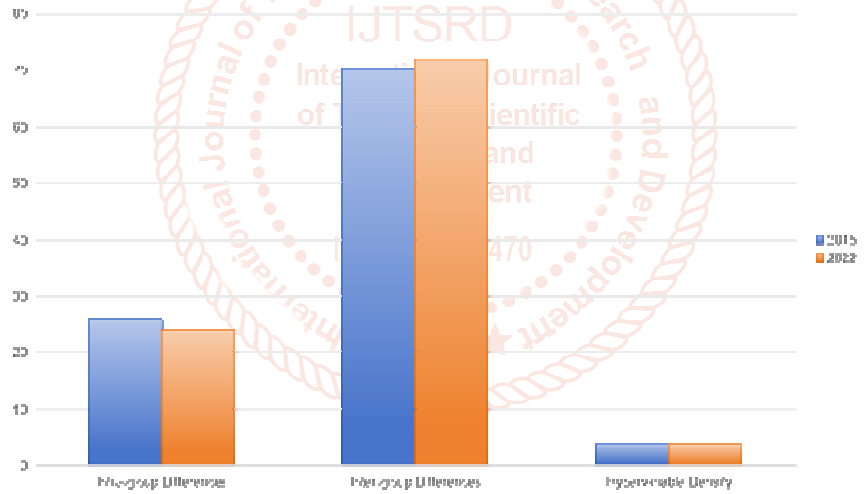


Figure 6 Sources of Differences

Summary and Recommendations

A. Summary

Starting from the connotation of Chinese-style modernization development, this study constructs a comprehensive evaluation system for the sustainability of Chinese-style modernization, collects data on various indicators of China and its 31 provinces, and then uses the entropy weight-TOPSIS method and Dagum Gini coefficient decomposition method to measure the sustainable development level of Chinese-style modernization and regional disparities, as well as analyze the influence of various factors. The research results show that:

1. Among the many factors affecting the sustainable development of modernization, factors such as education level, urban-rural coordination level, and natural greening level play a particularly critical driving role. These three factors not only reflect the core strategies adopted by China in advancing the process of socialism with Chinese characteristics modernization-the new-type urbanization strategy, the innovation-driven development strategy, and the agricultural modernization strategy-but also serve as the core driving forces for the continuous improvement of the sustainable development level of Chinese-style modernization.
2. Although China has achieved remarkable achievements in promoting the sustainable development of Chinese-style modernization,

there are still significant disparities in the level of sustainable development among different provinces. Specifically, the Eastern region generally shows a relatively high level of modernized sustainable development, while the Central and Western regions are relatively backward, forming a regional pattern of "high in the east and low in the west". From the perspective of modernization levels, the number of provinces that have achieved strong modernization or high-level modernization is relatively small, while regions with moderate or low-level modernization account for the majority. This further highlights the regional imbalance in the sustainable development level of Chinese-style modernization. It is worth noting that economically prosperous urban agglomerations such as the Yangtze River Delta, the Pearl River Delta, and the Beijing-Tianjin-Hebei region have particularly prominent sustainable development levels, and their development achievements have become models of China's economic development.

B. Recommendations

Based on the above conclusions, this study argues that:

1. It is essential to deeply understand the core essence and standards of Chinese-style modernization, follow the two-step strategy, and fully advance the building of a great modern socialist country. Through multi-dimensional and multi-perspective analysis, we find that the imbalance in the weights of specific indicators requires the adoption of targeted strategies in governance. For instance, we should intensify efforts in forest greening and adhere to the concept that "green development is sustainable development"; actively expand foreign economic exchanges and cooperation to integrate into the tide of global development; and create a high-quality technological innovation environment, guided by the innovation-driven development strategy.
2. We must face up to and commit to resolving the inter-regional imbalance in the process of China's modernized sustainable development. In this process, the Eastern region should fully leverage its advantages to actively lead and promote the coordinated development of the Central and Western regions. Both developed regions and relatively underdeveloped regions should focus on their own weak links, rise to challenges, and pursue more advanced modernization goals. At the same time, we should pay close attention to the development gaps within the Eastern region to prevent further widening; the Western region needs to align with its own characteristics to build a regionally distinctive modernization development pattern, strengthen cooperation with advantageous regions, advance the in-depth implementation of the Western Development Strategy, and foster a more balanced development layout; regarding the polarization phenomenon emerging in the Central region, we need to conduct in-depth analysis of its causes and formulate targeted and effective policies to narrow the development gaps between regions.
3. We should adhere to the integrated urban-rural development and vitalize the rural economy. Studies show that urbanization and technological innovation are important drivers of Chinese-style modernization. We should deepen the urban-rural integration strategy, with accelerating rural revitalization as the top priority. The government should further strengthen the linkage mechanism between urban and rural areas, commit to improving the quality of rural infrastructure and the level of public services such as education and medical care, so as to promote balanced development and in-depth integration between urban and rural areas. Meanwhile, we must advance the modernization of agriculture and rural areas in parallel, increase investment in technological innovation, enhance independent R&D and innovation capabilities, and build a technological innovation system with international competitive advantages. With the power of innovation-driven development, we will inject sustained vitality into rural development, advance people-centered urbanization, guide population mobility in a rational manner, and steadily promote the citizenization of the agricultural migrant population.

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