Leap-Forward Development and Sustainability: Measurement and Analysis of Chinese Modernization from the Perspective of Multiple Factors

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Abstract

This paper conducts multi-index analysis for Chinese modernization, and selects multi-dimensional indicators such as economy, population and social development and environment for measurement. In terms of the index construction and measurement, this paper fully considers the authority, objectivity and reliability of the index, and adopts various methods such as correlation analysis, factor analysis and trend analysis for verification. This paper combines the results of various evaluation, analyzes the overall situation of Chinese modernization, and discusses the regional differences of Chinese modernization. Finally, this paper summarizes the main findings and discusses the development direction and trend of Chinese modernization in the future. Through the study of this paper, we have a deeper understanding of the multi-dimensional development of Chinese modernization, which provides a certain reference for the future research.

Keywords

Modernization; Economy; Population And Social Development; Environment.

1. Introduction

Since the late 1970s, China has begun a historic transformation called "reform and opening up", a process that has led China to its modernization and become one of the most rapid and successful modern countries in the world. However, with the rapid development of China's economy and the profound change of social structure, the population problems faced by the modernization process have gradually become the focus of attention. In addition, the social and economic problems brought about by the modernization process have also gradually surfaced, causing people's concern and reflection. Therefore, the analysis of the measurement and influencing factors of Chinese modernization has important theoretical and practical significance for exploring the development trend of the modernization process, finding problems and making policies.

This paper aims to make a comprehensive study of China's modernization process through the empirical analysis of the index measurement and influencing factors of Chinese modernization. Specifically, this paper will study from the following three aspects: first, to comprehensively and objectively describe the modernization process of China by constructing and measuring the modernization index; second, to discuss the influencing factors of the modernization process based on the constructed modernization index, so as to deeply analyze the modernization process of China and verify the reliability of the construction of the modernization index; third, to put forward the corresponding policy suggestions to promote the sustainable development of Chinese modernization.

The main contributions of this paper are: on the one hand, through the construction and measurement of modernization indicators, it provides reliable basic data and theoretical support for further research; on the other hand, it discusses the influencing factors of the

modernization process, and provides to study the modernization process in China; finally, this paper puts forward corresponding policy suggestions to promote the sustainable development of Chinese modernization.

2. Theoretical analysis

For modern definitions and measurement methods, the existing literature uses a variety of indicators and methods for analysis. Economic indicators are one of the main considerations, such as GDP, per capita income, and wealth distribution. In addition to economic indicators, social factors, institutional and cultural indicators also need to be taken into consideration, such as education and health level, urbanization and infrastructure construction, political systems, cultural values, etc. These indicators help to measure the degree of modernization or modernization and provide the basis for comparison and comparison.

Based on China's national conditions, scholars adopt different measures to carry out the analysis, and gradually form a more perfect system. Ma(2003)[1]select a series of indicators reflecting the modernization process and comprehensively measured by the weighted average method; Li et al. (2003)[2]combining the representative indicators of economy, society, environment and science and technology, the quantitative research and qualitative analysis of multiple indicators are used for specific analysis. Liu (2008)[3]on the basis of constructing the evaluation index system and signal index system, the fuzzy clustering method and analyzes the modernization process with the signal index; Lin(2015)[4] comprehensive evaluation index system of modernization process is constructed from the four aspects of modern economy, living standard and environment, and the improved efficiency coefficient method and synthesis method are used to select the weighted arithmetic average method for comprehensive analysis. Further, some scholars specifically learn from agricultural modernization (Xie et al.,2023)[5], industrial chain modernization (Mao, 2022)[6]and modernization of animal husbandry (Xiong et al., 2023)[7],from the perspective of China's modernization is analyzed by selecting different indicators and constructing different computing systems.

Chinese-style modernization highlights the characteristics of "state-led, Chinese characteristics, integration of tradition and modernity, and innovation-driven", marking that China is promoting the process of globalization, in which it presents the characteristics of diversification and innovation. However, the development of Chinese-style modernization faces many practical challenges, such as slowing economic growth, social class differentiation, resource and environment pressure, and the protection of cultural heritage. At the same time, modernization is a comprehensive process, involving economic, social, environmental and other aspects. Therefore, the evaluation and measurement of modernization should have a comprehensive and multi-dimensional characteristics. The three dimensions of economy, population and social development and environment are very important aspects in the process of modernization, and they are also interrelated.

First of all, the economy is the most basic aspect of the process of modernization, which is related to the country's economic strength and development level (Liu and Li,2023)[8]. The stability and sustainability of economic development is an important foundation for the modernization process (Liu,2023)[9], Therefore, economic indicators are an indispensable part of the modernization measures. For example, indicators such as GDP, import and export volume and total railway mileage can reflect the overall economic situation and level of development of a country or region.

Secondly, population and social development are also important aspects in the process of modernization, and their influence on the modernization process is reflected in many aspects. Changes in the quantity and quality of the population are of great significance to the modernization process (Hao et al., 2019)[10]In addition, the improvement of social

development level can promote economic development and social progress, so the social indicators are also an essential part of the modernization measure. For example, the unemployment rate and the aging index are both important indicators that reflect the level of social development of a country or region.

Finally, the environmental indicators are also an integral part of the modernization measures. The environmental quality of a country or region is not only related to the quality of people's life, but also related to the sustainable development of the economy. Therefore, environmental indicators such as carbon dioxide emissions are also important indicators to reflect the environmental governance level of a country or region in the process of modernization (Deng and Chen, 2014)[11].

In short, the three dimensions of economic, population and social development and environment are an essential part of the modernization measure. These three aspects are interrelated and interrelated, and one is indispensable. Through the comprehensive measurement and evaluation of these indicators, the modernization level and development trend of a country or region can be reflected more comprehensively and objectively.

3. Index construction and measurement

3.1. Construction of indicators

We expect to select three indicators from economic, environmental, population and social development, and comprehensively analyze the data of 2000-2019 from China and its provinces (municipalities directly under the Central Government) as a research sample, so as to establish a Chinese-style modernization index system .

In economics, GDP is the most common indicator of a country's economic development. At the same time, imports and exports and total railway mileage are important indicators of economic modernization, which can reflect the level of trade and transportation modernization of a country; environmentally, carbon dioxide emission is an important environmental indicator. This index can reflect the environmental pressure in the process of industrialization and urbanization, and is closely related to global climate change, in population and social development. For example, the number of people under 14 and over 65 can reflect the population age structure of a country. The number of unemployed people can reflect a country's level of employment modernization.

The relevant index data are all from the China Statistical Yearbook, and the specific secondary indicators and the nature of the indicators are shown in Table 1.

3.2. Index Weight

3.2.1. Standardized treatment

In order to eliminate the influence of unit and magnitude differences on the comprehensive evaluation, the extreme value method was used to standardize the original data in the indicators one by one to alleviate the impact of the index magnitude differences on comparability and comprehensive evaluation.

$$X_{ij}^* = (X_{ij} - 〖X〗_{min})/(X_{ij} - X_{max}) \tag{1}$$

X_{ij} is the original data of item j in province i, X_{max} is the maximum value of item j, X_{min} is the minimum value of item j, X_{ij}^* is the standardized value of the index data.

3.2.2. Index weight

$$\text{Weight}_{X_j} = \frac{X_{j_{mean}}}{\sum X_{j_{mean}}} \qquad (2)$$

$X_{j_{mean}}$ is the mean of the standardized value of item j in each province, Weight_{X_j} is the weight after the standardized value of item j. The specific weight of each index is shown in Table 1.

Table 1: Evaluation index system of Chinese modernization level

First level indicators	Second level indicators	property	weight
economy	per capita GDP	+	0.2946784
	amount of imports	+	0.0563285
	amount of exports	+	0.0572783
	Total railway mileage	+	0.0663630
Population and social development	Population under 14 years old	+	0.0107220
	Population over 65 years	+	0.0077403
	Per capita disposable	-	0.0663630
	income of urban residents	+	0.3268271
environment	CO_2 discharge	-	0.0710430

4. Chinese-style modernization index measurement

4.1. Changing trend of China's modernization process

The weight results of each index calculated by the maximum-minimum method are shown in Table 1. The weight of the per capita GDP is 0.2946784, indicating that economic factors play an important role in the comprehensive development level of a country. The weights of import volume and export volume are 0.0563285 and 0.0572783, respectively, indicating that trade also has a certain impact on the development level of a country. The weight of the total railway mileage is 0.0663630, indicating that the transportation infrastructure also has a certain influence on the development of the country. The weights of the population under 14 years old and the population over 65 years old are 0.0107220 and 0.0077403, respectively, indicating that the population structure has little influence on the comprehensive development level of the country. The weight of the unemployed is-0.0663630, indicating that unemployment has a negative impact on the country's level of development. The weight of per capita disposable income of urban residents is 0.3268271, indicating that people's income level plays an important role in the development of the country. CO2 The weight of emissions is-0.0710430, indicating that environmental protection also has a certain influence on the comprehensive development level of the country. After obtaining the weight of each index, it is multiplied by the standardized value of each index to calculate the modernization process of the national and the provinces (municipalities directly under the Central Government). The specific results are shown in Table 2.

As can be seen from Table 2 and Figure 1, from 2000 to 2019, China's modernization indicators showed a growing trend. Among them, the modernization index in 2000 was 0.0156309, but by 2019, it had reached 0.346263, showing a huge space for growth. In the past 20 years, the growth rate of modernization indicators has gradually accelerated. Growth was relatively stable in the first 10 years and accelerated in the next decade. In particular, since 2010, the growth rate has been relatively fast, which shows that China has accelerated the pace of modernization in the past decade.
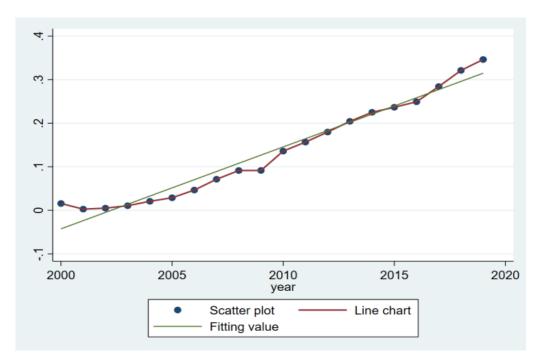
Figure 1: The Trend of China's modernization process

Further analysis from the year found that the modernization index grew relatively slowly between 2000 and 2005, but the growth rate accelerated significantly between 2006 and 2019, which shows that China has made more efforts in the modernization drive in recent years and achieved more remarkable results. In general, the modernization index is a comprehensive index, involving many aspects, including economy, education, culture, science and technology and other fields. Therefore, the growth of modernization indicators reflects the significant progress China has made in various fields, which also shows that China is moving towards a more modern, open and innovative direction.

Can be seen from the data of table 2, China's modernization level distribution has obvious regional and zonal differences, such as Beijing, Shanghai, Tianjin and other areas are widespread the phenomenon of high degree of modernization, and the remote areas such as Xinjiang, Gansu in China's modernization process of the lower level, combined with relevant data is not hard to find, high modernization level of modernization in the second tier, and the western region modernization level in the domestic low level.

Table 2: Index measures of Chinese-style modernization

Province	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anhui	0.006	0.008	0.011	0.015	0.021	0.027	0.036	0.047	0.059	0.067
Beijing	0.067	0.078	0.089	0.103	0.123	0.141	0.161	0.190	0.213	0.226
Fujian	0.029	0.034	0.040	0.046	0.056	0.065	0.077	0.093	0.113	0.127
Gansu	0.004	0.006	0.010	0.014	0.019	0.024	0.031	0.039	0.047	0.053
Guangdong	0.044	0.049	0.056	0.068	0.081	0.094	0.109	0.129	0.147	0.157
Guangxi	0.009	0.013	0.017	0.021	0.027	0.032	0.038	0.052	0.066	0.075
Guizhou	0.002	0.003	0.006	0.010	0.014	0.020	0.025	0.036	0.045	0.052
Hainan	0.010	0.013	0.019	0.022	0.027	0.031	0.040	0.052	0.064	0.073
Hebei	0.013	0.015	0.020	0.024	0.031	0.040	0.050	0.061	0.075	0.084
Henan	0.005	0.007	0.013	0.018	0.024	0.032	0.041	0.053	0.067	0.075

Heilongjiang	0.011	0.014	0.018	0.023	0.030	0.038	0.045	0.054	0.067	0.072
Hubei	0.009	0.011	0.016	0.020	0.026	0.032	0.040	0.054	0.068	0.079
Hunan	0.012	0.015	0.017	0.021	0.028	0.034	0.042	0.055	0.069	0.079
Jilin	0.009	0.012	0.018	0.023	0.030	0.037	0.046	0.061	0.076	0.087
Jiangsu	0.025	0.029	0.036	0.046	0.059	0.077	0.094	0.116	0.139	0.154
Jiangxi	0.006	0.008	0.013	0.017	0.022	0.030	0.036	0.050	0.062	0.070
Liaoning	0.016	0.019	0.023	0.029	0.036	0.047	0.058	0.076	0.097	0.109
Nei Monggol	0.010	0.013	0.017	0.025	0.035	0.046	0.058	0.079	0.104	0.120
Ningxia	0.006	0.010	0.014	0.017	0.023	0.029	0.037	0.051	0.069	0.078
Qinghai	0.007	0.011	0.014	0.018	0.023	0.029	0.037	0.048	0.062	0.068
Shandong	0.019	0.023	0.027	0.034	0.045	0.057	0.070	0.088	0.107	0.119
Shanxi	0.005	0.008	0.013	0.020	0.028	0.035	0.043	0.057	0.071	0.075
Shaanxi	0.006	0.009	0.014	0.017	0.023	0.029	0.037	0.051	0.067	0.078
Shanghai	0.082	0.091	0.099	0.114	0.137	0.157	0.178	0.202	0.226	0.239
Sichuan	0.009	0.011	0.013	0.016	0.022	0.027	0.034	0.047	0.059	0.068
Tianjin	0.042	0.050	0.055	0.068	0.083	0.098	0.115	0.138	0.172	0.188
Xinjiang	0.013	0.017	0.021	0.025	0.029	0.034	0.041	0.052	0.063	0.067
Yunnan	0.012	0.014	0.017	0.019	0.027	0.030	0.036	0.046	0.057	0.065
Zhejiang	0.040	0.048	0.058	0.071	0.085	0.100	0.117	0.138	0.157	0.170
Chongqing	0.012	0.015	0.019	0.025	0.033	0.040	0.049	0.062	0.077	0.088
China	0.016	0.003	0.005	0.011	0.021	0.029	0.046	0.071	0.091	0.091

Continuation table:

Province	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Anhui	0.085	0.106	0.123	0.139	0.152	0.165	0.182	0.201	0.222	0.257
Beijing	0.252	0.287	0.315	0.347	0.395	0.425	0.466	0.511	0.560	0.632
Fujian	0.150	0.179	0.204	0.227	0.237	0.257	0.282	0.311	0.355	0.387
Gansu	0.064	0.079	0.093	0.107	0.124	0.133	0.145	0.156	0.172	0.186
Guangdong	0.183	0.210	0.233	0.258	0.262	0.280	0.305	0.334	0.362	0.393
Guangxi	0.091	0.108	0.124	0.139	0.150	0.163	0.177	0.188	0.203	0.217
Guizhou	0.063	0.079	0.096	0.111	0.126	0.142	0.159	0.179	0.197	0.219
Hainan	0.090	0.112	0.131	0.146	0.160	0.172	0.188	0.207	0.225	0.246
Hebei	0.099	0.118	0.133	0.147	0.157	0.167	0.182	0.197	0.213	0.224
Henan	0.090	0.108	0.125	0.139	0.150	0.163	0.178	0.196	0.213	0.236
Heilongjiang	0.087	0.106	0.121	0.133	0.150	0.158	0.167	0.178	0.189	0.185
Hubei	0.097	0.119	0.139	0.157	0.175	0.192	0.212	0.232	0.256	0.291
Hunan	0.095	0.114	0.132	0.149	0.170	0.185	0.204	0.222	0.242	0.266
Jilin	0.103	0.126	0.147	0.164	0.174	0.184	0.196	0.207	0.217	0.205
Jiangsu	0.184	0.218	0.245	0.272	0.293	0.317	0.346	0.383	0.416	0.449
Jiangxi	0.084	0.102	0.119	0.134	0.151	0.165	0.182	0.199	0.219	0.243
Liaoning	0.132	0.160	0.184	0.205	0.228	0.237	0.219	0.234	0.254	0.263
Nei Monggol	0.142	0.174	0.197	0.216	0.235	0.247	0.260	0.257	0.278	0.288
Ningxia	0.094	0.115	0.132	0.147	0.158	0.171	0.186	0.204	0.221	0.233
Qinghai	0.083	0.101	0.117	0.132	0.151	0.164	0.179	0.191	0.209	0.223
Shandong	0.141	0.166	0.188	0.210	0.221	0.237	0.256	0.278	0.298	0.301
Shanxi	0.092	0.112	0.127	0.139	0.147	0.155	0.163	0.183	0.198	0.209
Shaanxi	0.096	0.119	0.140	0.158	0.172	0.183	0.199	0.222	0.245	0.264

Shanghai	0.268	0.302	0.326	0.354	0.390	0.421	0.466	0.509	0.551	0.618
Sichuan	0.084	0.104	0.121	0.136	0.149	0.162	0.178	0.198	0.218	0.245
Tianjin	0.221	0.256	0.284	0.309	0.315	0.332	0.359	0.381	0.397	0.356
Xinjiang	0.083	0.101	0.119	0.135	0.156	0.170	0.181	0.200	0.217	0.235
Yunnan	0.077	0.095	0.112	0.128	0.137	0.149	0.164	0.181	0.199	0.231
Zhejiang	0.199	0.231	0.255	0.281	0.302	0.326	0.355	0.388	0.422	0.461
Chongqing	0.106	0.131	0.152	0.172	0.180	0.198	0.220	0.241	0.259	0.292
China	0.136	0.157	0.180	0.204	0.225	0.237	0.249	0.284	0.321	0.346

4.2. Dynamic change trend of provincial modernization proces

According to the analysis of Tabel 2, the modernization process of all provinces and municipalities in China has shown a gradual upward trend since the new century. Among them, Shanghai, Beijing, Tianjin and other municipalities directly under the Central Government, as well as Jiangsu, Guangdong, Zhejiang, Fujian and other provinces, grew faster in the modernization process. These regions have a relatively developed economic foundation and advanced science and technology, education and other resources, but also attracted a large number of domestic and foreign investment and talents, accelerating the modernization process.

However, some provinces, such as Gansu, Qinghai, Xinjiang, Guangxi and Guizhou, have seen slow modernization progress. The natural conditions in these areas are relatively harsh, with a weak economic foundation and a relatively low level of development. At the same time, due to the differences and unbalanced development between regions, the modernization process of these regions is also greatly challenged.

In general, the modernization process of various regions in China shows a trend of differentiation and differentiation. With the continuous development of the national economy and the continuous improvement of policies, the future development of these regions will also face new opportunities and challenges.

4.3. Reliability analysis of modern indicators measurement

4.3.1. Correlation analysis

Shaoand Yang (2023)[12]In the process of studying the influence of the national social capacity and technological differences on the national modernization process, the GDP of a country is taken as the development index of the national modernization process. Based on this, we use Pearson (Pearson) and Spearman (Spearman) correlation coefficient to analyze the correlation between the modernization process (Moderate) and GDP to verify the reliability of our Chinese modernization index measure.

The correlation analysis showed that the Pearson correlation coefficient between Moderate and GDP was 0.979, significant at the 1% level, and Spearman's correlation was 0.983, significant at the 1% level; further, we lagged GDP in one phase, and the correlation coefficient between Moderate and GDP remained above 0.700 and was significant at the 1% level. In conclusion, the correlation coefficient analysis shows that the paper has the reliability of the modernization process index.

4.3.2. Analysis of influencing factors

The added value of the tertiary industry is an important part of the modernization process. According to the literature research, the tertiary industry plays an important role in the process of modernization. Li (2005)[13]The research shows that the added value of China's tertiary industry makes a great contribution to the modernization process, especially under the background of the current economic structural adjustment.

Education investment is one of the indispensable factors in the modernization process. Education investment has a positive impact on improving the quality of the population, cultivating innovative talents and promoting economic development. Fan (2023)[14]Research shows that education investment is one of the key factors driving the modernization process, and education investment has a driving role in the economies of different regions and different levels of development.

Investment in pollution control is necessary link in the modernization process. Environmental protection and governance is one of the key areas in the modernization process, and investment in pollution control can promote the balance between economic development and environmental protection. Li et al. (2021)[15]Research shows that investment in pollution control has played a positive role in promoting China's modernization process, especially in environmental governance.

Therefore, We analyzed the reliability of Moderate based on the above factors influencing the modernization process, The regression results are shown in column (2) of Table 3, The added value of the tertiary industry (EcoAdd Val TerInd) was significantly and positively correlated with Moderate; The regression coefficient for educational investment (EducationFunds) is- 2.933, Significantly, at the 1% level, It indicates that the education investment in China may be negatively associated with the modernization process; The available research states that, In the developing countries, The contribution of education investment to economic development is negatively related, Increasing investment in education has a negative impact on economic development, This may be due to the inefficient use of educational investments (Liu and Chen, 2021)[16]However, this does not mean that there is no positive correlation between education investment and the modernization process or that education investment does not contribute to the modernization process; the pollution control investment (Invest Plt Source) regression coefficient is 0.175, significant at the 10% level, and the population (Population) regression coefficient is 0.182, significant at the 1% level.

Therefore, according to the data measurement index analysis of the modernization process in this paper, our index Moderate further verifies that the added value of the tertiary industry, education investment, pollution control investment, population and other factors will significantly affect the process of national modernization. Thus, further demonstrating the reliability of the Moderate in this paper.

Table 3: Analysis of the influencing factors of the modernization process

Numble	（1）	（2）
	Modernize	Modernize
EcoAddValTerInd	3.223***	2.500***
	(2.95)	(5.00)
EducationFunds	-3.342***	-2.933***
	(-3.16)	(-5.93)
InvestPltSource	0.102	0.175*
	(0.65)	(1.91)
Population	7.792***	5.730***
	(3.63)	(5.86)
Province	Contorlled	Contorlled
Year	No	Contorlled
Constant	0.187***	0.182***
	(4.47)	(7.95)
N	500	500
adj. R2	0.418	0.958

4.3.3. Trend analysis

By figure1 of China and its provinces (municipalities directly under the central government) modernization index annual trend of figure (scatter), China and its provinces (municipalities directly under the central government) modernization on the time, at the same time, Beijing, Shanghai and other municipalities directly under the central government and coastal provinces modernization growth rate is significantly higher than other regions, but after 2010 modernization, it fully embodies the first rich drive rich, finally realize the concept of common prosperity.

So far, this paper verifies the reliability of Moderate construction based on correlation coefficient analysis, influence factor analysis and trend analysis respectively. The above analysis shows that Moderate has high reliability and accuracy in measuring the Chinese-style modernization process.

5. Conclusion

This paper aims to make a quantitative analysis of Chinese modernization and comprehensively evaluate the overall situation of Chinese modernization through weighted calculation method. Economy, population and social development, environment and other aspects were selected as quantitative indicators to verify the reliability of the indicators from the perspectives of relevant analysis, factor analysis and trend analysis. This paper holds that the multi-index weighted calculation method can comprehensively evaluate the overall situation of Chinese modernization, and provide quantitative evaluation and guidance for the problems in the process of Chinese modernization.

Economic indicators are one of the key indicators to evaluate Chinese-style modernization, and GDP and import and export volume are important parts of the quantitative indicators of economic aspects. This paper found that the growth rate of GDP showed a downward trend, and the proportion of import and export volume to GDP also decreased. This shows that the Chinese modern economic growth model is changing, gradually shifting from the pure pursuit of speed to focusing on quality, efficiency and sustainability. On the other hand, the increase in the total railway mileage shows that China is still making continuous efforts in the infrastructure construction.

Population and social development indicators are also an important part of assessing Chinese modernization. This paper selects the number of people under 14, people over 65 and unemployed people. The data show that the number of people under 14 is gradually declining, the number of people over 65 is rising, and the number of unemployed is declining but still high. This shows that there are still many population and social development problems to be solved in the process of Chinese modernization.

Environmental indicators are also an important part of the evaluation of Chinese modernization. This paper selects carbon dioxide emissions as environmental indicators. The results suggest that although carbon dioxide emissions have been on the rise, they have slowed over the past few years. This shows that China has taken positive measures to tackle climate change, but it still has a long way to go in environmental protection.

Through a comprehensive evaluation of multiple indicators, this paper finds that Chinese modernization has made remarkable progress in economy, but still faces challenges in population and social development and environment. At the same time, we also realize that the simple development model of pursuing economic growth and modernization will inevitably bring about many problems and challenges in population, society and the environment. Therefore, the future development of Chinese modernization needs in three aspects of economy,

society and environment to achieve balanced and coordinated development, people-oriented, the concept of sustainable development as a guide, realize the high quality of economic development, improve people's living standards, strengthen social fairness and justice and the construction of ecological civilization, for the construction of prosperous democratic civilization and harmonious beautiful socialist modernization power to make greater contributions.

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