Research on China's Green GDP Based on VAR Model

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Abstract. This paper aims to address the traditional GDP's inability to reflect environmental protection and sustainable development concerns. A new GGDP evaluation system is constructed, which complements and modifies the traditional GDP. The entropy weight method is utilized in constructing the climate composite index, and the vector autoregressive model is developed using GGDP. The dynamic relationship between GGDP and the climate composite index is explored, and impulse response analysis is employed to probe the impact of GGDP on the climate composite index. Finally, China is taken as an example to compare the impact of GGDP and GDP on climate. The findings demonstrate that GGDP, which considers the effects of natural environment, can reduce greenhouse gas and wastewater emissions. Nonetheless, it does not benefit forestry construction.

Keywords: Green GDP, Entropy weight method, VAR model, Linear regression model

1 Introduction

The use of GDP as a measure of economic health has been widespread since 1944. However, in recent years, limitations of GDP have been identified, particularly its failure to account for the environmental impact of resource depletion [1]. As environmental concerns grow, countries recognize the need to balance economic growth and environmental protection. This has led to the emergence of G(green)GDP, which considers the environmental friendliness of economic development as an indicator of economic health [2]. Going forward, it is crucial to incorporate environmental factors in measuring economic growth to ensure sustainability. Adopting GGDP as a primary indicator of economic health may encounter some challenges [3]. This study aims to examine the impact of this change, evaluate its feasibility, and determine if it is worthwhile.

Firstly, this paper conducts a comparison of several existing methods of calculating GGDP and combines correction methods for GDP. It comprehensively considers the depletion of natural resources, environmental pollution, and environmental improvement income and constructs first-level and second-level indicators, providing a formula for calculating the GGDP index.

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Secondly, to investigate whether the shift from GDP to GGDP as a measurement model has a positive effect on environmental protection, an environmental index is constructed, and regression is performed based on the newly established GDP and GGDP. Results indicate that adopting GGDP is indeed beneficial. This paper selects three representative climate indicators - carbon dioxide, rainfall, main pollutant emissions of wastewater, and forest coverage - and uses the entropy weight method to calculate the climate composite index. The vector autoregressive model is utilized to explore the impact of GGDP on the composite index.

Finally, taking China as an example, the paper analyzes the impact of GGDP on the economy as compared to using GDP. The analysis suggests that the implementation of GGDP will have a positive impact on China's economy. By evaluating these changes, this study concludes that shifting from GDP to GGDP as a fundamental indicator of economic health is advantageous in addressing environmental concerns.

2 GGDP Evaluation System

2.1 Conventional Approach of Calculating GGDP

The conventional approach to GDP calculation overlooks resource use and its environmental impact, leading to an inaccurate reflection of economic health. This has prompted the development of GGDP, a quantitative measure of a country's progress towards sustainable development [4]. By modifying the conventional GDP calculation, GGDP incorporates the depreciation of natural resources, economic losses from environmental pollution, and production benefits through a comprehensive index system. GGDP provides a more comprehensive assessment of a country's economic performance, considering economic growth, resource preservation, and environmental quality [5].

Scholars have explored environmentally friendly development through frameworks such as sustainable development, ecological economy, circular economy, low-carbon economy, and green economy [6]. To assess GGDP development, researchers have defined eco-friendly development as a dynamic process, creating mathematical models and index systems to evaluate it at national and regional levels, with cities as the focus. Eco-friendly development represents the ultimate goal of social progress, characterized by a low energy consumption economic model enabling ecological and sustainable growth within existing resources [7]. However, there are variations in the definition and expression of GGDP, lacking a unified or standardized definition. Ambiguous definitions may impact calculation system accuracy, while vague or unclear measurements can hinder comprehension [8].

Various definitions of GGDP may result in different calculation processes and formulas, producing divergent outcomes. A current issue in current research is the fluctuating proportion of GDP that GGDP represents. The instability and lack of uniformity in GGDP accounting have triggered debates regarding its purpose and motivation [9].

2.2 Construction of GGDP Evaluation System Index

In consideration of a comprehensive approach, the preferred method to account for resource and environmental value loss, along with ecological environment improvement benefits, is to calculate the GGDP according to the following model: GGDP = Traditional GDP - Value of Resource Consumption - Value of Environmental Pollution + Benefits of Ecological Environment Improvement. The indicator system shown in Table 1:

Table 1. Construction of green GDP indicators

Accounting subaccount	Level indicators	Secondary indicators
Gross GDP account (+)	Total regional GDP	Total regional GDP
Natural resource depletion account (-)	Energy consumption value	Cost reduction of fossil fuel consumption
		Water depletion costs
Environmental pollution loss account (-)	Pollution control cost	Actual governance cost
		Virtual governance cost
	Environmental degradation value	Loss in capital depreciation
Environmental improvement income account (+)	Resource and environmental improvement benefits	Value of afforestation area

2.3 Natural Resource Depletion Value Accounting

Considering the unique characteristics of China's natural resources, particularly in relation to recent consumption during economic and social development, this study selects water and energy resource consumption losses for accounting purposes [10].

Cost reduction of energy resources: the cost reduction of energy resources is determined by multiplying the converted energy resource consumption reduction into standard coal by the current year's standard coal price: Cost reduction of energy resources =∑Annual consumption reduction of different energy sources x Unit resource restoration cost. In previous research, unit recovery cost per mineral resource was classified into theoretical and actual values, and their average was used in the calculation. For coal, the theoretical and actual recovery costs are 73.12 yuan/t and 57.20 yuan/t, respectively, with an average of 65.16 yuan/t. For oil, the theoretical and actual recovery costs are 461.03 yuan/t and 589.34 yuan/t, respectively, with an average of 525.19 yuan/t. The theoretical and actual recovery costs for natural gas are 2172.89 yuan/10^4 m^3 and 2777.61 yuan/10^4 m^3, respectively, with an average of 2475.25 yuan/10^4 m^3.

Water depletion costs: the cost reduction of water resources is obtained by multiplying the water consumption reduction by the current water price: Water resource reduction cost = Water resource reduction x Compensation cost per unit. Due to a lack of research on the compensation cost of water resources, many relevant studies have adopted the research results of Paul Turner. This study will also adopt his results, which indicate an actual compensation cost of 0.13 yuan/m^3 and a theoretical cost of 0.14 yuan/m^3. The average of these two values is 0.135 yuan/m^3 for this study's purposes.

2.4 Environmental Pollution Loss Value Accounting

Environmental pollution loss is separated into two parts: pollution control costs and environmental degradation values. Pollution control costs encompass actual and virtual expenses spent on avoiding environmental pollution. Environmental degradation value, on the other hand, refers to the harm caused by said pollution. This study only considers the depreciation expense of fixed assets caused by environmental pollution.

Pollution control costs: The cost of pollution control is made up of two components: actual control cost and virtual control cost. Actual control costs are determined using data from urban environmental infrastructure construction. Virtual control costs for this study include the total cost of treating industrial wastewater, SO2 emissions, smoke (powder) dust, domestic garbage, and domestic wastewater. The calculation formula for this cost is:

$$V = \sum_{i=1}^{m} M_i X_i$$

where V is the virtual governance cost, M_i is the ith pollutant emissions, X_i represents the unit governance cost of the ith pollutant, n means there are n kinds of pollutants in total.

The accounting objects include sulfur dioxide, nitrogen oxide, soot, and industrial dust in waste gas, chemical oxygen demand and ammonia nitrogen in wastewater, and solid waste from household and general industrial sources. The amount of industrial solid waste is calculated using the "production-comprehensive utilization" approach while household garbage is calculated using the "clearing volume - harmless disposal volume" approach. To calculate the unit treatment cost of each pollutant, this research uses the current year parameter as the base price, which is adjusted annually based on the consumer price index (CPI). Waste gas and wastewater use 2006 parameters, which is 2 times the current sewage fee collection rate. Solid waste uses 2004 national unified standard parameters, where industrial solid waste incurs a disposal cost of 20 yuan per ton. Household waste uses a simple treatment cost of 12 yuan per ton. Table 2 shows the benchmark price of each pollutant. The unit virtual treatment cost has been revised and adjusted based on the current pollutant discharge fee, since the statistics of pollutants are not comprehensive.

Table 2. Value of unit pollutant treatment cost

Pollutant classes	Pollutant	Unit governance cost base year	Unit management cost base price/(yuan)
Air pollution	Sulfur dioxide	2006	1264[11]
	Nitrogen oxide	2006	1264[11]
	soot	2006	550[11]
	Industrial dust	2006	300[11]
Water pollution	Chemical oxygen demand	2006	1400[11]
	Ammonia nitrogen	2006	1750[11]
Solid waste	General industrial solid waste[a]	2004	20[12]
	Household garbage[b]	2004	12[12]

a According to "yield - comprehensive utilization", b According to "clearance volume - harmless handling capacity".

Value of environmental degradation: the accounting of environmental degradation value mainly focuses on the accelerated depreciation loss of assets resulting from environmental degradation. As obtaining the environmental protection accelerated depreciation rate is challenging, this research calculates the environmental protection maintenance cost caused by the environmental degradation of fixed assets accelerated depreciation using the maintenance cost[12]. According to this method, the environmental maintenance expenditure is 5.2% of the total maintenance expenditure, while the total maintenance expenditure is 5.5% of the total industrial output value. Thus, we can obtain the calculation using this formula: "total industrial output value x total maintenance expenditure in total industrial output value 0.055 x environmental maintenance expenditure in total maintenance expenditure 0.052".

2.5 Environmental Pollution Loss Value Accounting

The calculation index for the benefit of resource and environment improvement is the amount of new afforestation area in the country. The specific formula to calculate this benefit value is: afforestation area in each year x price of forest tree per unit. The value of the benefit of resource and environment improvement is measured using the literature method. However, without a uniform price for the price of new afforestation, this research uses an average unit price of 1913.15 yuan/hm2 for shelterbelt, timber, and economic forests to ensure the accuracy of the measurement results.

2.6 Application of GGDP Evaluation System in China

The research data were collected from various sources, including China Statistical Yearbook, China statistical yearbook on environment, China land and resources statistical yearbook, and relevant statistical yearbooks of provinces from 2004 to 2022. The study area includes 31 provinces in mainland China, excluding Hong Kong, Macao, and Taiwan. This paper calculates and analyzes the value of resource depletion, environmental loss, and GGDP in China from 2004 to 2020, examining their spatiotemporal variation differences.

Regarding variables, several points need clarification. Firstly, there is no statistical data available on the harmless disposal volume of domestic garbage in China, and thus it is not included in the calculation due to its negligible quantity. Secondly, the amount of investment in environmental pollution control was estimated using the trend extrapolation method, as data for 2013 was unavailable. Thirdly, starting from 2011, the statistical yearbook combined soot and industrial dust into the total emission amount of smoke (powder) dust. Considering that the ratio of soot to industrial dust emissions in previous years was approximately 1.5:1, the virtual treatment cost was calculated after allocating this ratio.

2.7 Analysis of China's GGDP from 2003 to 2020

Using the calculated data, we obtained GGDP value and GGDP index for China from 2003 to 2020. Table 3 shows that GGDP and traditional GDP exhibit synchronized upward trends, with similar changing growth rates and gradually converging sizes. However, the difference between GGDP and traditional GDP increases annually, from 2788.8 billion yuan in 2003 to 11446.6 billion yuan in 2020[Figure 1]. This is also reflected in the fluctuating rise of GGDP index, which increased from 79.58 in 2003 to 88.836 in 2020. Overall, both GGDP value and GGDP index are rising as China emphasizes resource conservation and environmental protection. This indicates a weakening of the negative effects of economic growth on resources and the environment, and a somewhat optimized economic development model, reflecting structural benefits.

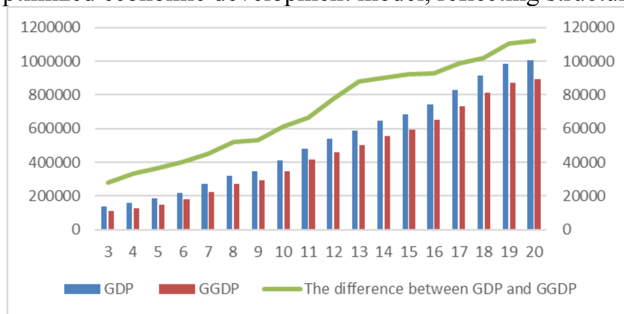

Fig. 1. Difference between GGDP and GDP in China from 2003 to 2020

Table 3. Ratio of GGDP accounts to traditional GDP (%)

Year	Proportion of loss value of natural resources	Proportion of environmental pollution loss value	Proportion of positive benefits of resources and environment	Green GDP index
2003	15.73	4.76	0.069	79.58
2004	16.12	4.6	0.063	79.343
2005	15.42	4.27	0.059	80.364
2006	14.49	3.98	0.036	81.565
2007	13.1	3.64	0.031	83.288
2008	12.5	3.74	0.038	83.79
2009	11.86	3.48	0.041	84.698

Year	Proportion of loss value of natural resources	Proportion of environmental pollution loss value	Proportion of positive benefits of resources and environment	Green GDP index
2010	11.28	3.67	0.034	85.088
2011	46.88	4.14	0.031	86.251
2012	10.67	3.86	0.026	85.501
2013	11.44	3.58	0.027	85.003
2014	10.67	3.33	0.023	86.023
2015	10.26	3.24	0.03	86.526
2016	9.6	2.95	0.027	87.483
2017	8.99	2.92	0.026	88.121
2018	8.31	2.87	0.023	88.836
2019	8.35	2.88	0.022	88.785
2020	8.39	2.79	0.021	88.833

3 The Impact of GGDP on Climate

3.1 The index Construction of Climate Composite Index

In the "State of the Global Climate 2021" report released by the World Meteorological Organization (WMO) on May 18, 2022, greenhouse gas concentration, rainfall, discharge of major pollutants in wastewater and forest coverage were identified as crucial factors affecting climate. As such, this study aims to create a climate composite index by obtaining data on these key indicators from the China Statistical Year-book. By developing this index, we can gain a comprehensive understanding of China's climate status and identify potential areas of concern for policymakers and stakeholders. This paper seeks to contribute to a better understanding of climate change and support effective decision-making efforts to tackle this global issue.

Carbon dioxide: Greenhouse gases are atmospheric gases that have the ability to absorb and reemit long-wave radiation. The level of carbon dioxide is a critical factor for measuring and understanding climate change, as it has a considerable impact on the planet's temperature and overall climate patterns.

Rainfall: Annual average rainfall is a critical indicator for assessing local and regional climates. Rainfall is a direct reflection of climate change and patterns and has a significant impact on measuring and understanding climate. Therefore, accurate measurement and monitoring of rainfall are essential for developing effective climate change policies and strategies.

Discharge of main pollutants in wastewater: Water is the main medium through which we feel the impact of climate change. United Nations data show that the comprehensive carbon emissions of the water sector account for about 10% of global greenhouse gas emissions. The main chemical substance in wastewater is ammonia nitrogen, so the content of ammonia nitrogen can effectively reflect the pollution degree of wastewater, thus affecting the climate.

Percentage of forest cover: As we all know, plants have a direct impact on the environment, and forests have a strong carbon sink function that can effectively affect the climate. Forests partially affect precipitation, so forest destruction not only reduces the absorption of solar radiation but also affects the water cycle. Large-scale forest changes may even affect the global heat balance and water balance. As one of the components of the global climate system, forests stabilize the regional climate and thus play a stabilizing role in the global climate.

3.2 Calculation of Climate Composite Index Based on Entropy Weight Method

Index weight is a crucial consideration when assessing the relationship between different indicators under the same overarching goal. Currently, two main approaches exist: subjective and objective methods. To avoid the subjectivity inherent in the former approach, this paper uses an objective entropy weight method to determine the weight of each index [13].

3.3 Calculation of Climate Composite Index

According to the above method to determine the index weight, calculate the weight of each index to measure the climate composite index. The comprehensive evaluation function of the climate composite index is set as:

$$Y_i = \sum_{j=1}^{n} \omega_j x_{ij}, (i = 1,2,\cdots,m)$$

where m denotes evaluation objects, n denotes evaluation indexes in the climate system.

Using the above formula, the climate composite index of different countries in different periods can be obtained.

3.4 The Impact of GGDP on Climate Composite Index Based on Vector Autoregression

Before using time series data for analysis, it is necessary to first test whether the variables are stable. In this paper, the most commonly used ADF test method is used to test the stability of the sequence.

The VAR model is a new model proposed by Sims in 1980. It is mainly used to predict multiple related time series variables and analyze the impact of random disturbance terms on each system as a whole [14]. To construct the VAR model, we must first determine the number of variables contained in the model and the lag period of the variables.

The general form of p-order VAR model is:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + Bx_t + \varepsilon_t$$

Among them,$t = 1,2,\cdots,T$,in this equation,y_t represent k-dimensional endogenous variables,$x_t$represent d-dimensional endogenous variables, p represents the lag period, T denotes the sample size. $A_1, A_2, \cdots, A_p, B$ denotes the coefficient matrix to be estimated. ε_t denotes the k-dimensional perturbed column vector. They are all white noise, that is, no autocorrelation, but allow the existence of simultaneous correlation [15]. The VAR model can be represented as:

$$\begin{pmatrix} y_{1t} \\ y_{2t} \\ \vdots \\ y_{kt} \end{pmatrix} = A_1 \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \\ \vdots \\ y_{kt-1} \end{pmatrix} + A_2 \begin{pmatrix} y_{1t-2} \\ y_{2t-2} \\ \vdots \\ y_{kt-2} \end{pmatrix} + \cdots + B \begin{pmatrix} x_{1t} \\ x_{2t} \\ \vdots \\ x_{kt} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \vdots \\ \varepsilon_{kt} \end{pmatrix}, t = 1,2,\cdots,T$$

If the VAR model does not contain exogenous variables, it is called an unrestricted VAR model, and its expression can be simplified to:

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + \varepsilon_t$$

In the establishment of a VAR model, the appropriate lag period must first be determined. The optimal lag period can be obtained according to the principle of minimum, using the five criteria of LR, FPE, and AIC.

While the coefficient of the VAR model can reflect the local connection between variables, it cannot fully display the dynamic change relationship between variables. Explaining each coefficient individually may not achieve the desired effect of the study. Therefore, when analyzing a VAR model, the impact of one factor on other factors is typically not considered. Instead, the focus is on understanding the dynamic impact of a random disturbance term on the entire system. This process is known as impulse response analysis.

Taking the VAR(1) model with two variables as an example:

$$\begin{cases} y_{1,t} = a_{11} y_{1,t-1} + a_{12} y_{2,t-1} + \varepsilon_{1t} \\ y_{2,t} = a_{21} y_{1,t-1} + a_{22} y_{2,t-1} + \varepsilon_{2t} \end{cases}$$

We could know if ε_{1t} is distributed, it will affect the next value of $y_{1,t}$. Because of the lag period, the change of $y_{2,t}$will also lead to the change of $y_{1,t}$ in the next period. This means that the initial disturbance will eventually affect the whole model.

After constructing the VAR model, the variance decomposition method can be used to further study the characteristics of the model. According to the time change, the different response degrees of each variable after the impacts are studied.

3.5 Application in China

Take the data of China from 2003 to 2020, combined with the above methods and using Matlab programming, the weights of each weight of Climate composite index are shown in following Table 4:

Table 4. The weight of each index of climate comprehensive index

	CO2	percentage of forest cover	Total waste water discharge (ammonia nitrogen)	rain fall
weight	0.4378	0.1073	0.2854	0.1695

Next, we do the unit root test on the climate composite index Y_i and GGDP, and the results are shown in following Table 5:

Table 5. ADF test results of variables in China from 2003 to 2020

Factors	The form of test(C, T, K)	ADF test values	1% critical value	5% critical value	10% critical value	conclusion
LNY	(C, 0,0)	-6.587	-3.887	-3.052	-2.667	stationary
LNGGDP	(C, 0,0)	-4.701	-4.004	-3.099	-2.690	stationary

Table 5 indicates that the original sequence of LNY and LNGGDP is stable, indicating that further analysis can proceed to establish a VAR model. Using information criteria, the lag order of the model can be selected. These results reveal that setting the maximum lag as the first phase is most appropriate, resulting in the construction of a VAR (1) model. The results are shown in Table 6.

Figure 2 presents the stability test results of the model. It is evident that all characteristic roots are located within the unit circle, indicating that the VAR (1) model is stable, and any analysis based on this model has significance and relevance.

Table 6. VAR model lag order selection results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	14.635	NA	0.001	-1.685	-1.590	-1.686
1	68.271	85.818*	8.59e-07*	-8.303*	-8.020*	-8.306*
2	69.875	2.139	1.23e-06	-7.983	-7.511	-7.988
3	73.489	3.854	1.44e-06	-7.932	-7.271	-7.939

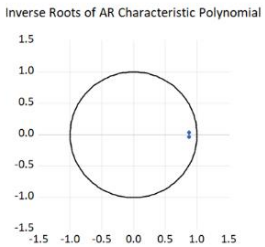

Fig. 2. VAR model characteristic root test results

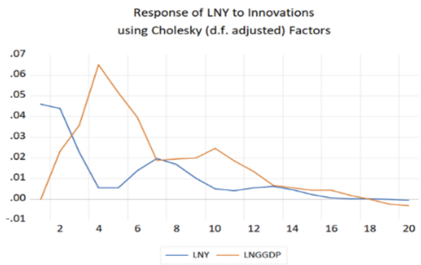

Fig. 3. Climate composite index impulse response curve

Next, we make the impulse response curve of China 's climate composite index to GGDP. The results are shown in Figure 3.

Figure 3 reveals that, following a positive impact on GGDP, no immediate effect is observed on the climate composite index in the current period. However, from the second to the fourth periods, there is a steady increase in the index. Subsequently, the influence begins to weaken, with faster convergence in the early stage and slower convergence in the later stage. The index approaches 0 around the 16th stage. This observation suggests that GGDP requires energy consumption to support economic growth in the short term, thereby causing environmental pollution and leading to an increase in the climate composite index.

However, in the long term, developments such as an improvement in people's environmental requirements, increased energy utilization, and the development of low-carbon technologies have enabled economic growth (GGDP) to contribute to reducing the climate composite index. As the climate composite index is a comprehensive measure of CO_2, forest coverage, total wastewater discharge, and rainfall, these findings suggest that using GGDP as a primary indicator of a country's economic health status can contribute to reducing the climate composite index and improving the environmental climate. These results have important implications for countries around the world.

4 The Impact of GGDP on Climate

4.1 Impact of GDP and GGDP on Climate Indicators

To measure the impact of GDP and GGDP on the four climate indicators, we need to establish four linear regression models, namely:

$$Y_i = a_i GDP + b_i, i = 1,2,3$$

Among them, Y_i represents CO_2, forest coverage, total wastewater discharge (ammonia nitrogen) and rainfall, and summarizes the parameter estimation results of the four regression models, as shown in Tables 7 and 8.

Table 7. Analysis results with GDP as independent variable

	CO2	percentage of forest cover	Total waste water discharge (ammonia nitrogen)	rain fall
coefficient	0.906423	0.952512	0.564195	0.55471
R2	0.821602	0.907278	0.318316	0.307703

Table 8. Analysis results with GGDP as independent variable

	CO2	percentage of forest cover	Total waste water discharge (ammonia nitrogen)	rain fall
coefficient	0.802424	0.750484	0.364193	0.555433
R2	0.814369	0.903419	0.318313	0.308506

4.2 Comparative Analysis

Tables 7 and 8 reveal several common results, including the positive impact of GDP/GGDP on all four climate indicators. However, a comparison of the coefficient results from these tables shows that GGDP, compared to GDP, has a weaker positive impact on CO_2, total wastewater discharge (ammonia nitrogen), and rainfall. These findings indicate that the use of new GGDP index proposed in this paper has alleviated China's climate pollution.

Moreover, as the national economy grows, there is an increasing focus on protecting and constructing forestry resources. As a result, forest coverage is on the rise. However, the GGDP indicator appears to underperform in this regard. Ideally, GGDP should have a stronger positive impact on forest coverage, considering its focus on the green environment. Nevertheless, the results in the table indicate that GDP has a stronger impact on forest coverage. Therefore, using GGDP as a replacement for GDP can result in both favorable and adverse effects.

The positive impact of GGDP can be seen from its definition. While GDP is a simple concept of economic growth, GGDP deducts the value of environmental pollution loss and resource depletion caused by economic growth. This approach takes into account the impact of a green environment, environmental protection, and sustainable development on the country, reflecting the degree of harmony between economic growth and the natural environment. Therefore, GGDP not only reflects the level of economic growth but also the sustainability of economic growth and the net welfare of national life.

However, certain adverse effects should be considered. Firstly, GGDP is not comprehensive and does not account for the interaction between the economy, society, and the environment. Secondly, the accounting method for GGDP is not yet mature, and there is a need to continue exploring the valuation of resource depletion costs and the cost of environmental damage. Finally, after GGDP accounting is established, GDP cannot be directly abandoned. GDP remains an important macroeconomic indicator and the basis of GGDP, which enables the cost of resource depletion and environmental loss to be compared to GDP.

In conclusion, while GGDP has several positive impacts, there are adverse effects that have to be considered. GGDP should, therefore, be used alongside other indicators to reflect sustainable development comprehensively.

5 Conclusion

In summary, this study has constructed a GGDP accounting system based on resources and the environment and conducted macro-level empirical accounting and analysis of 31 provinces, municipalities, and autonomous regions in China from 2003 to 2020. Our analysis reveals that China has experienced significant resource and environmental losses from 2003 to 2020, indicating economic development dependency on natural resources, especially energy resources. The GGDP index shows that it fluctuates between 79.343% and 88.836%, with a significant effect on resource conservation and a need to strengthen environmental pollution control.

Overall, the negative externalities of China's economic development on resources and the environment have been weakened, the economic development model has been optimized, and structural benefits have been reflected. This study reveals that traditional GDP accounting values exaggerate economic growth and cannot reflect the real level of economic development, especially in areas that are overly dependent on natural resources. Moreover, ignoring resources and the environment can lead to a one-sided view of economic development and undermine efforts to protect the environment and save resources, thus impacting the sustainable development of the economy and society.

This paper aims to supplement and correct traditional GDP accounting by including various resource and environmental factors in the accounting system. However, since a complete and general GGDP accounting system is yet to exist, the conclusion of this paper inevitably has its shortcomings. Nevertheless, GGDP calculation method used is consistent with the current leading method, making this study a useful attempt for future research in this area.

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