Green GDP Accounting Analysis Based on Sustainable Development Concept

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Abstract. Adhering to the concept of sustainable development, this paper boldly abandons the traditional single accounting method of GDP, selects a large number of dominant and authoritative data for accounting, makes the data oriented green and comprehensive, and reflects quantitatively and truly the actual output value of China's economy and the resource loss and environmental pollution loss caused by the process of economic development. Then, the future development of GGDP is forecasted under the grey prediction model and corresponding suggestions and measures are put forward.

Keywords: GGDP, GDP, sustainable development, grey prediction

1 Introduction

1.1 Problem Background

Gross Domestic product (GDP) is one of the commonly used indicators of a country's economic health. It is commonly used to determine a country's purchasing power and access to credit, providing an incentive for countries to propose policies and related economic projects that increase GDP. GDP "measures the monetary value of final goods and services produced by a country over a given period of time; It counts all the output produced within a country. This method of calculating such an important and oft-cited indicator favors production today without thinking about saving resources for tomorrow. For example, a country with rich forests can boost its current GDP by cutting down trees and producing lots of wooden furniture. The country can do so with impunity, despite the loss of biodiversity and other negative environmental consequences. Similarly, a country can boost its GDP by catching more fish now without being penalized for potentially irreversible damage to fish stocks. Since GDP does not account for natural resources, it may not be a good measure of a country's true economic health, and may even become a tool for assessing political performance. Therefore, Green GDP (GGDP) accounting based on the concept of sustainable development came into being. Can we construct a suitable indicator GGDP as a new indicator to measure the health of the national economy?

1.2 Restatement of the Problem

Most countries in the world take gross domestic product (GDP) as a measure of economic strength or not. Under the principle of macroeconomics, traditional GDP accounting methods mainly include production method, income method and expenditure method, and the traditional GDP accounting method described in this paper is expenditure method. As we know, GDP is

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regarded as the most general macroeconomic indicator, which closely revolves around the value created by production and effectively measures the development of the overall economy. However, because its accounting method is simple and can not take into account the comprehensiveness, it can not really calculate the cost of natural resources loss and ecological environment damage accompanied by production activities. It can be seen that using GDP as an indicator generally overestimates real economic output, to some extent encouraging and promoting near-term economic growth at the cost of resources and the environment. The situation is that for a long time, the value of resource depletion costs and ecological damage costs cannot be monetized. It can be predicted that the proposal of green GDP accounting has strong practical and guiding significance. On the one hand, it overcomes the shortcomings of traditional accounting methods and reflects the current economic situation more comprehensively. On the other hand, it is helpful for the state and the government to make effective macro-control decisions according to the situation, promote the change of economic behavior in production activities, and achieve long-term sustainable economic development.

1.3 Our Work

As shown in Figure 1, the Flow Chart nicely describes my ideas.

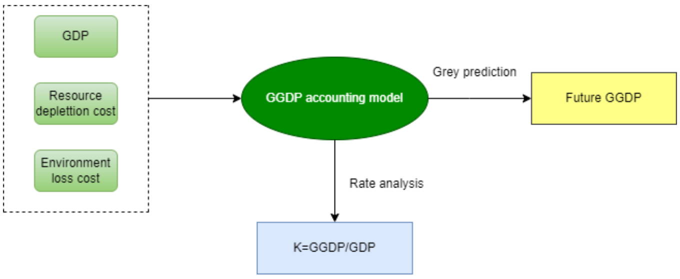

Figure 1. Flow Chart

2 Materials and Methods

2.1 Theoretical Methods and Models of Green Accounting

The new GDP (GGDP) requires that natural resources are continuous, that there is complete substitution between man-made and natural capital, and that the goal is to monetize all factors that cause GDP growth or decline[1] , and that all social and natural resources are measured in monetary form. GGDP corrects traditional GDP with the monetary value of natural resource depletion cost and ecological environment destruction cost, and greenizes its economic value. At present, most countries in the world are experiencing resource depletion and environmental degradation, so the output value estimated by the GGDP is generally lower than the traditional GDP. Foreign scholars have studied and tested the sustainability of economic development of more than 20 countries, and found that the long-term sustainability of development of most countries is not optimistic after considering the value of resource and environment loss[2] [3]. Therefore, we can preliminarily judge that the value of ecological resources plays an important role in making an objective assessment of economic development. We take China as an example to select resource and environmental factors that reasonably affect GGDP accounting. The simple calculation methods and ideas of the GGDP model constructed in this paper are as follows:

$$GGDP=GDP-R_i-E_i$$

Among them, *GGDP* is green GDP; *GDP* is gross domestic product (expenditure method); R_i is the cost of resource depletion; E_i is the cost of ecological damage; K is the development rate of GGDP;

2.2 Selection and Calculation of Loss Factors

1. Selection of factors for resource loss and ecological destruction

Obviously, there are many kinds and ways of accounting for green resources, and in the actual data processing, we find that some data is difficult to monetize. Therefore, we choose the factors that are dominant in the cost of resources and environment. In this paper, mineral resources, forestry resources, grassland resources and cultivated land resources are selected as the main resource loss factors. Waste water, waste gas and solid waste are the main environmental damage factors. Most of the calculated data in this paper come from China Statistical Yearbook, China Economic Yearbook, and the State Environmental Protection Administration.

2. Calculation of resource loss cost

First, we divide the total cost of resources and environment into two parts: the cost of resource depletion and the cost of environmental damage. The cost of resource loss includes energy resource loss, forestry resource loss, cultivated land resource loss and grassland resource loss. The cost of ecological damage includes the discharge of three wastes (wastewater, waste gas, solid waste) in China's large and medium cities, as well as environmental protection expenditures.

In Table 1 below, it is found that the total value of resource loss is mainly caused by the loss of mineral resources in the calculation of actual data. It should be that under the rapid development of industry, the exploitation of mineral resources increases the cost of resource loss. Urbanization reform and environmental pollution have reduced the available arable land, and it should be pointed out that the policy of returning farmland to forest is also an important factor. When calculating the loss value of grassland, we took 264.5301 million hectares of grassland in the third National Land Survey as the final available grassland area, and learned that the grassland area has been degraded at an annual rate of 1.33 million mu since 2013. The calculation of resource loss is as follows:

Cost of cultivated land resource depletion = (gross agricultural product * net reduction of cultivated land area)/actual cultivated land area

Grassland resource loss cost = (gross livestock production * rate of grassland area degradation)/available grassland area

Energy consumption cost = total revenue from main operations of mining industry (mainly accounted for by coal, oil and natural gas)

Forestry loss cost = Net import of forestry materials (timber and related wood products) x current exchange rate

Table 1. Resource depletion cost

YEAR	Net loss of cultivate land	Arable land loss	Rate of grassland degradation	Grassland loss	Reduction of mineral resources	Net forestry import	Current exchange rate	Forestery wastage	Total resource depletion
2013	8.02	28.99	133	138.63	64152.1	103.20	6.19	638.81	64958.53
2014	10.61	45.17	133	145.81	61437.2	107.30	6.14	658.82	62287.00
2015	6.60	26.50	133	144.04	53406.2	110.60	6.22	687.93	54264.67
2016	4.35	17.96	133	153.15	49646.7	107.20	6.64	711.81	50529.62
2017	6.09	26.24	133	147.62	53154.5	102.70	6.75	693.23	54021.58
2018	12.47	53.52	133	144.28	43211.9	114.30	6.61	755.52	44165.23
2019	10.19	52.68	133	166.24	46162.2	34.62	6.89	238.53	46619.65
2020	7.34	41.16	133	202.45	38812.3	43.93	6.89	302.68	39358.59
Units	ten thousand hectares	one hundred million yuan	million mu per year	one hundred million yuan	one hundred million yuan	one hundred million dollars	$:¥	one hundred million yuan	one hundred million yuan

3. Calculation of ecological damage cost

The detailed accounting of ecological damage costs is shown in Table 2 below. Before examining the data in the table below, we first introduce a value accounting method. Value accounting is to estimate the value of environmental degradation caused by various environmental pollution or the cost of controlling environmental pollution on the basis of physical quantity accounting[4]. Under The System of Environmental Economic Accounting (SEEA), the cost method of water pollution treatment is a common cost based valuation method. It calculates the cost of avoiding environmental pollution from the perspective of "protection" [5]. Its calculation idea is also very simple, that is, if all pollutants are treated, the damage caused by water pollution will not occur, so the economic value of the damage already caused can be replaced by the marginal cost of pollutant treatment[6]**.** Therefore, inspired by this idea, we apply this method as a whole to the accounting cost of "three wastes" emissions, and the accounting formula is as follows:

$$CTW=\sum^{n}_{i=1}P_i*GC_i$$

Among them, *CTW* (cost of three wastes) represents the actual treatment cost of three wastes. *Pi* represents the removal amount of the i pollutant; *GCi* (governance cost) indicates the unit governance cost of pollutant i.

Table 2. Ecological damage cost

YEAR	Wastewater discharge	Marginal cost	Exhaust emission	Marginal cost	Solid waste discharge	Marginal cost	Environmental protection expenditure	Environmental degradation
2013	684.3	1.2	14.3	1000	23.8	200	2648	22529.16
2014	670.8	1.15	14	900	19.2	220	2794	20389.42
2015	656.8	1.1	13.8	950	19.1	200	3050	20702.48
2016	643.4	1.05	13.5	1000	14.8	180	3322	20161.57
2017	630.7	1.03	13.4	950	13.1	190	3571	19439.62
2018	618.7	1	13.3	900	15.5	200	3850	19538.7
2019	606.4	1.01	13.2	850	13.8	180	4190	18506.46
2020	595.3	1.02	13.1	800	13.8	170	4450	17883.21
Units	one hundred million tons	Yuan per ton	one hundred million tons	Yuan per ton	one hundre-d million tons	Yuan per ton	one hundred million yuan	one hundred million yuan

2.3 Grey predictive analysis

1. Algorithm configuration:

algorithm: Grey prediction model GM(1,1)

variable Time series variable :{GGDP}； time term:{YEAR}

parameter:Backward prediction unit :{5}

2. Analytical procedure

(1)Before the grey prediction model [7] GM(1,1) is established, the time series is tested by level ratio. If it passes the stage ratio test, it indicates that the sequence is suitable for constructing the grey model; if it does not pass the stage ratio test, the sequence is "translated" so that the new sequence meets the stage ratio test.

(2)Only the model that passes the test can be used for prediction. The system mainly tests the grey prediction model through the posterior difference ratio C value.

3.Code analysis

```
import pandas

from spsspro.algorithm import no_parameter_test

data = pandas.Series([1, 2, 3, 4, 5], name="A")

index = pandas.Series(["1", "2", "3", "4", "%"], name="B")

print(no_parameter_test.grey_forecasting_analysis(data, index))

end.
```

3 Results & Discussion

Through the calculation of the above resource loss cost and ecological damage cost, the author combined with the model proposed in the paper, gave the following data summary table 3 and the green accounting data of the mixed Figure 2. As shown in Table 3 and Figure 2,based on the data of GDP and GGDP in the chart, it can be concluded that since 2013, China's economic development[8] has been in a good momentum, with resource depletion and ecological destruction showing a downward trend, and the development rate k value of GGDP showing an overall upward trend. However, it should be pointed out that the monetization factors selected in this paper are limited. If the comprehensiveness and accuracy of the assessment range are increased, GGDP will inevitably decline further.

Table 3. GGDP GDP&GGDP units:Trillion yuan

YEAR	GDP	R_i	E_i	GGDP	K
2013	58.81	6.50	2.25	50.06	85.12%
2014	64.44	6.22	2.04	56.18	87.18%
2015	68.56	5.43	2.07	61.06	89.06%
2016	74.27	5.05	2.02	67.20	90.48%

2017	83.09	5.40	1.94	75.75	91.17%
2018	91.52	4.42	1.95	85.15	93.04%
2019	98.38	4.66	1.85	91.87	93.38%
2020	100.88	3.94	1.79	95.15	94.32%

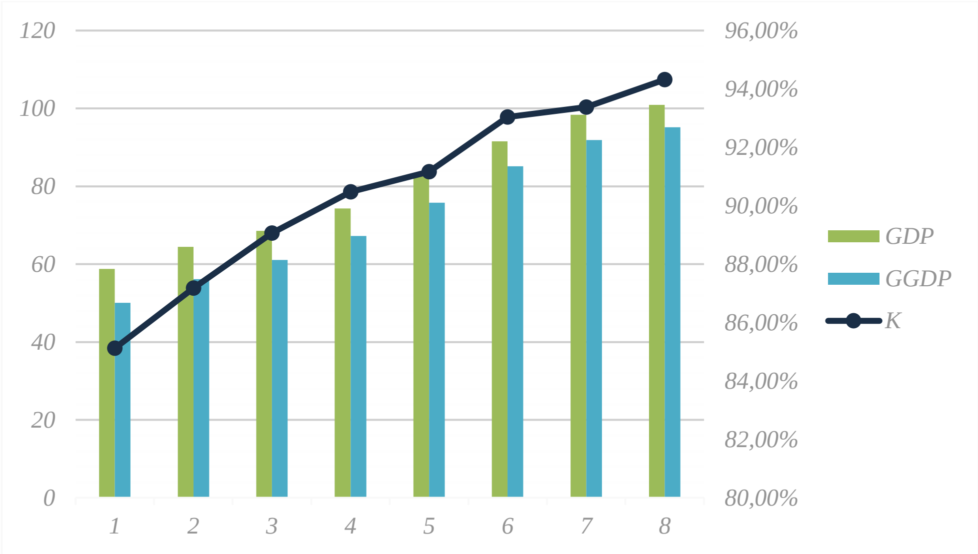

Figure 2. Visualization of processed data

Table 4. Grade ratio test result table

Index entry	Original value	Stage ratio
2013	50.06	-
2014	56.18	0.891
2015	61.06	0.92
2016	67.2	0.909
2017	75.75	0.887
2018	85.15	0.89
2019	91.87	0.927
2020	95.15	0.966

Diagram key:

The Table 4 above shows sequence values and stage ratios. If all the stage ratios are in the interval (e^(-2/(n+1)), e^(2/n+1)), the data is suitable for model construction. If the sequence does not pass the level ratio test, the "translation transformation" is performed on the sequence, so that the sequence meets the level ratio test after the translation transformation.

Chart analysis:

It can be seen from the above table that all the stage ratios of the original sequence are within the interval (0.801, 1.249), indicating that the original sequence is suitable for building the gray prediction model.

Table 5. Grey model construction

Development coefficient a	Grey action b	Posterior difference C
-0.091	49.696	0.015

Diagram key:

The Table 5 above shows the development coefficient, grey action, and posterior difference ratio. The grey prediction model can be constructed from the development coefficient and grey action.

● The development coefficient represents the development law and trend of the series, and the gray action reflects the change relationship of the series.

● The posterior difference ratio can verify the accuracy of gray prediction, and the smaller the posterior difference ratio, the higher the accuracy of gray prediction.

● The general posterior difference ratio C value is less than 0.35, the model accuracy is high, the C value is less than 0.5, the model accuracy is qualified, the C value is less than 0.65, the model accuracy is basically qualified, if the C value is greater than 0.65, the model accuracy is unqualified.

Chart analysis:

It can be seen from the above table that the posterior difference ratio is 0.015, indicating a high precision of the model.

Table 6. Model fitting effect

Index entry	Original value	Predicted value	Residual error	Relative error(%)
2013	50.06	50.06	0	0
2014	56.18	56.834	-0.654	1.164
2015	61.06	62.277	-1.217	1.993
2016	67.2	68.241	-1.041	1.549
2017	75.75	74.776	0.974	1.285
2018	85.15	81.938	3.212	3.773
2019	91.87	89.785	2.085	2.27
2020	95.15	98.383	-3.233	3.398

Diagram key:

The above Table 6 shows the fitting result table of the grey prediction model. The smaller the relative error value, the better. Generally, less than 20% means that the fit is good.

Model analysis:

The average relative error of the model is 1.929%, which means that the model fits well.

Model fitting prediction graph

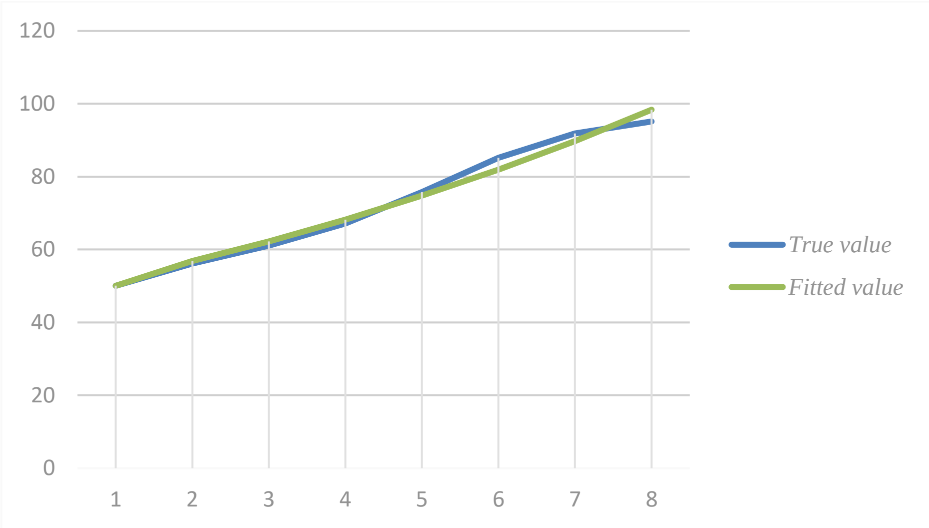

Figure 3. Comparison between initial and predicted values

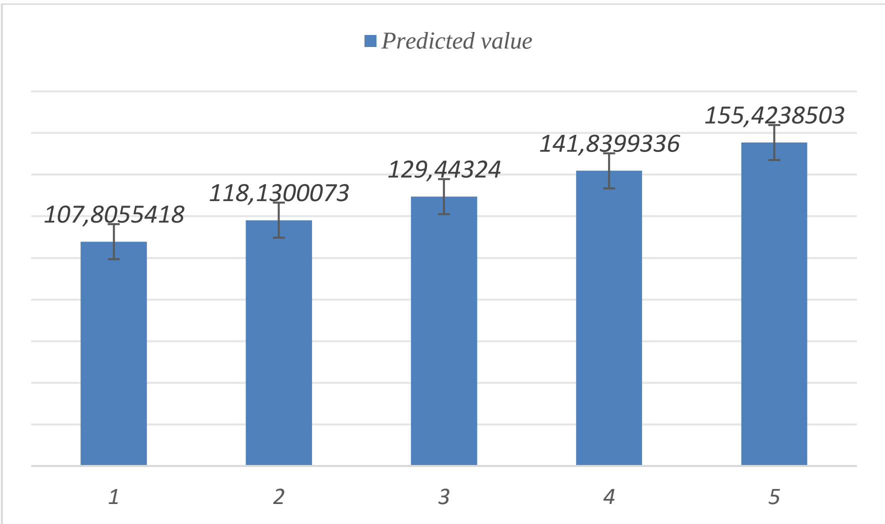

Figure 4. Grey model Prediction Results

Diagram key:

The Figure 3 and Figure 4 above shows the fitted prediction graph of the grey prediction model.

Analysis result:

The grey prediction model GM(1,1) is based on the data of the historical period to predict the data of the future period: the average relative error of the model is 1.929%, which means that the model has a good fitting effect. The forecast results of the next five periods are 107.806, 118.13, 129.443, 141.84 and 155.424 respectively.

4 Conclusions

The GGDP envisaged by us and its gray prediction not only improve the current accounting practices, overcome the shortcomings of traditional accounting methods, objectively reflect the real development of the national economy, but also forecast the future development of GGDDP. At the same time, it warns people that deforestation, ozone depletion, and the exploitation of mineral resources lead to the accelerated degradation of Marine ecosystems and many fields. We should fundamentally change the mode of production, improve the development of productivity, and abandon the idea of pollution first and treatment later, which is bred by the pursuit of a single economic growth[9][10].

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