Study on the Impact of GGDP Method Based on SEEA Accounting System on Climate Mitigation

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Abstract. GDP is one of the best-known measures of socioeconomic well-being, but because it does not consider natural resources, it may not be a good measure of a country's economic health. Therefore, considering that the world recognizes GGDP as the primary criterion for measuring a country's financial health, this paper studies the changes and the impact of these changes on the environment. A technique under the SEEA accounting system was choosed to account for GGDP and, based on this, to explore the impact of GGDP on climate mitigation. Then, Pearson Relation Coefficient is used to evaluate the expected global impact of GGDP on climate mitigation. According to the Grey Relation Model, the correlation between GGDP and climate mitigation is more significant than GDP. It suggests that this shift is worthwhile globally while comparing the potential advantages of climate mitigation impacts with the possible disadvantages of efforts needed to replace the status quo. Taking China as the research object and make a more in-depth analysis of the impact of the transformation of measurement indicators. Recommended measures in the use of natural resources and analyzed the effects of actions on the economy and the ability to support future generations using the BP neural network, which concludes that the changes resulting from the measures will benefit China to some extent.

Keywords: GGDP, country's economic health, Climate mitigation, Pearson Relation Coefficient, BP neural network.

1. Introduction

GDP is one of the best indicators for measuring social and economic welfare [1], and it is an essential comprehensive indicator of the system of national accounts (SNA). It measures both the total income of the economy and the total expenditure of the economy on goods and services. Nevertheless, it is not a perfect indicator of welfare. As Robert Kennedy said: GDP measures everything in short, except that which makes life worthwhile. Similarly, GDP reflects the production of factories but does not reflect its damage to the environment [2]. Suppose enterprises only blindly produce goods and services without considering the harm of this behavior to the environment. In that case, the total GDP may increase, but the deterioration of air and water quality is far more significant than the welfare benefits brought by production [3].

In order to solve the problem that traditional GDP does not reflect these adverse effects of economic development on resources and the environment, establish green national economic accounting, natural resources account, and pollution account. The United Nations Statistics Division (UNSD) proposed the concept of the System of Integrated Environmental and Economic Accounting (SEEA)t [3]. Compared with the SNA natural resource accounting account, SEEA increases the accounting of 'external' environmental costs and benefits and expands and improves the SNA system from two aspects: the use of natural resources by-product production and final demand, and the impact of factors such as pollution on environmental quality. Green GDP is the core index in the comprehensive environmental and economic accounting system [5, 6]. The implementation of GGDP is to pay attention to economic development while protecting the natural environment, making up for the calculation method of GDP simply focusing on economic growth. This method may also contribute to alleviating the climate crisis.

The technical roadmap of this article is as Fig 1:

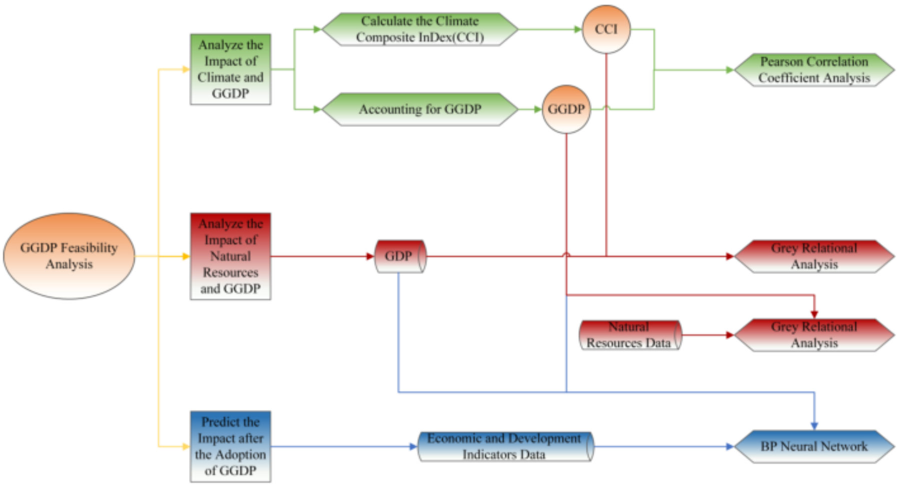


Figure 1. Technology Roadmap

In addition, the following work will be carried out:

(1) Establish the accounting model of green GDP which is based on SEEA.

(2) Use the entropy weight-comprehensive index method to calculate the comprehensive index of climate, and analyze the correlation between GGDP and its correlation according to the correlation coefficient.

(3) Change the model to discuss the difference relationship between GGDP or GDP and CCI. And taking a country as an example to discuss whether GGDP can replace GDP.

2. GGDP Accounting Analysis Model Based on Climate Composite Index

2.1. GGDP Accounting Model Based on SEEA

Whether in China or abroad, the current green GDP accounting methods generally use the SEEA as the framework [7]:

$$GGDP = GDP - C - E \tag{1}$$

In the formula (1), C represents the cumulative loss of natural resources, and E represents the accumulation of environmental degradation costs. In order to simplify the calculation, the loss of natural resources in this paper only considers the consumption value of water resources and fossil energy, the consumption value of water resources (Depletion value = Water resources price × Total water consumption) and energy consumption value (Value = Total Energy Consumption × Fossil Energy Percentage × International Average Fossil Energy Price), environmental degradation cost calculation method is more, this article mainly from the forest loss, particle loss and other aspects of accounting. There is a more intuitive calculation method that green GDP is the net output value after deducting environmental pollution and waste of resources, which is expressed as GGDP =Gold GDP - Black GDP, where 'Black GDP' refers to the GDP obtained at the expense of the ecological environment.

The indicators involved in the calculation method of GGDP are mainly from the International Statistical Y earbook, China Statistical Y earbook, the World Bank and OECD. The time span of the data is from 1990 to 2020. Since some countries have missing years, we use SPSS for multiple interpolation to fill in missing values [8, 9].

2.2. Climate Comprehensive Evaluation Model

2.2.1 Pearson Correlation Coefficient

The correlation coefficient method is a statistical method used to measure the correlation between two indicators. Pearson correlation coefficient is the most commonly used index to measure the linear correlation between two variables. The value range is from −1 to +1, where 0 represents no correlation, the negative value represents a negative correlation, and the positive value represents a positive correlation.

2.2.2 Entropy Weight Method

Entropy represents an uncertain measure. The entropy weight method is an objective assignment method. According to the information provided by the evaluation index, depending on the discreteness of the data itself, a more objective weight can be obtained, and then the entropy weight is used to correct each index [10]. Get the final weight calculation result. The smaller the entropy weight, the less the information reflected, indicating that the index is less important, and vice versa.

2.2.3 Comprehensive Index Method

The comprehensive index method is widely used in regional ecological environment impact assessment. It first standardizes the evaluation indexes of different properties or units, then synthesizes them according to multiplying similar indexes and adding different indexes, and finally compares them [11].

2.2.4 GGDP and Climate Mitigation Relationship Analysis Model

(1) Calculate the climate composite index CCI in the weight-comprehensive index method.

1) Construction of standard matrix

Assuming that there are m years and n climate indicators in each year, the original evaluation matrix is first constructed:

$$A = (a_{ij})_{m\times n} \tag{2}$$

In the formula, aij represents the corresponding value of the jth climate index in i year. Climate indicators have positive and negative points, positive indicators have maximum value attributes, negative indicators have minimum value attributes, and indicators should be standardized. The positive indicators are processed as follows:

$$r_{ij} = \frac{a_{ij} - \min\limits_{1\le i\le m} a_{ij}}{\max\limits_{1\le i\le m} a_{ij} - \min\limits_{1\le i\le m} a_{ij}} \tag{3}$$

The negative indicators are processed as follows:

$$r_{ij} = \frac{\min\limits_{1\le i\le m} a_{ij} - a_{ij}}{\max\limits_{1\le i\le m} a_{ij} - \min\limits_{1\le i\le m} a_{ij}} \tag{4}$$

The standardized evaluation matrix is obtained:

$$R = (r_{ij})_{m\times n} \tag{5}$$

In the formula, r_{ij} is the normalized data of a_{ij}, and the value is [0, 1].

2) Calculate the weight of climate indicators in entropy weight method

Because the entropy weight method is used to calculate the index weight, the index value r_{ij} of the *j*th index in the nth year is required to be logarithmic, that is, the proportion is required to be greater than zero, so the index value r_{ij} of the *j*th index in the *i* year is calculated as follows:

$$f_{ij} = \frac{1 + r_{ij}}{\sum_{j=1}^{m}(1 + r_{ij})} \tag{6}$$

Then the entropy of the jth index:

$$e_j = -k\sum_{i=1}^{m} f_{ij} Lnf_{ij} \tag{7}$$

Then we calculate the entropy weight w_j of the *j*th index, the weight diagram of each climate index by entropy weight method in this paper is shown in Fig. 2:

$$w_j = \frac{1 - e_j}{\sum_{j=1}^{n}(1 - e_j)} \tag{8}$$

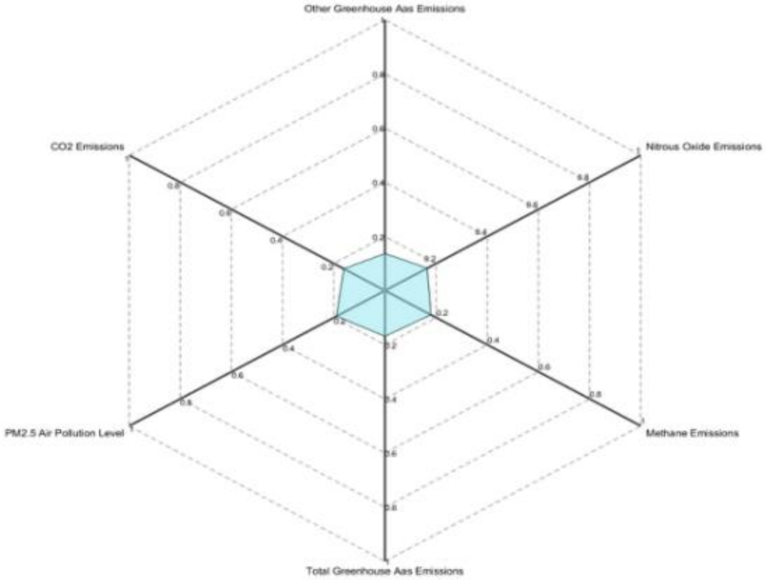


Figure 2. Weight Diagram of each Climate Index

3) Calculate the climate composite index in comprehensive index method

By calculating the weight of the climate index and climate index data, the formula is as follows:

$$CCI = \sum_{j=1}^{n} W_k \times r_{ij} \tag{9}$$

In the formula, CCI is the climate composite index, W_k is the weight of the kth climate index, and r_{ij} is the standardized value of the *j*th climate index in *i* year. n is the number of climate indicators. In this paper, the climate index n = 6.

(2) Calculate correlation coefficients between GGDP and CCI by Pearson Correlation Analysis. For $X = [x_1, x_2, \ldots, x_n]^T$ and $Y = [y_1, y_2, \ldots, y_n]^T$, the calculation formula of Pearson correlation coefficient is as follows:

$$r = \frac{\sum_{i=1}^{n}(x_i - \overline{x})(y_i - \overline{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \overline{x})^2 \sum_{i=1}^{n}(y_i - \overline{y})^2}} \tag{10}$$

Among them, xi represents the i-year climate composite index, yi represents the i-year GGDP. x and y are the average of n data, $|r| \leq 1$. When $|r|$ is closer to 1, it shows that the higher the degree of correlation between CCI and GGDP in a country. Generally, $|r| \geq 0.8$ can be regarded as highly correlated; $0.5 \le |r| < 0.8$ can be regarded as moderate correlation; $0.3 \le |r| < 0.5$ can be regarded as low correlation; When $|r| < 0.3$, it shows that the linear correlation between the two variables is very weak and can be regarded as nonlinear correlation.

(3) The significance test of Pearson correlation coefficient.

The significance test usually uses the t distribution test, and the calculation formula is as follows:

$$t = |r|\sqrt{\frac{n-2}{1-r^2}} \sim t(n-2) \tag{11}$$

According to the given significance level α and degree of freedom $d = n-2$, Using the t distribution table to find the critical value $t_{\alpha/2}(n-2)$. If $|t| > t_{\alpha/2}$, it shows that there is a significant linear relationship between the two variables.

3. Results and discussion

3.1. Pearson correlation coefficient analysis

We selected carbon dioxide emissions, PM2.5 air pollution, total greenhouse gas emissions, methane emissions, nitrous oxide emissions, other greenhouse gas emissions six indicators as climate indicators, and the entropy weight-comprehensive index method is used to calculate the climate composite index. This problem is solved by observing the relationship between the climate composite index and GGDP.

In this paper, we select 24 countries as observation samples to calculate. These countries are distributed on five continents, including developed and developing countries, and the sample is diverse. According to Fig. 3, we found that the GGDP situation of these sample countries has changed over the past 30 years, in which the blue represents the GGDP value is more extensive, and the green represents the GGDP value is smaller. For example, China’s GGDP increased significantly from 1990 to 2020, which proves that it pays more and more attention to the protection of environmental resources in the process of development. However, on the whole, the average GGDP of countries in the world is not high, indicating that most countries will consume natural resources or increase GDP at the expense of the environment in the process of economic development.

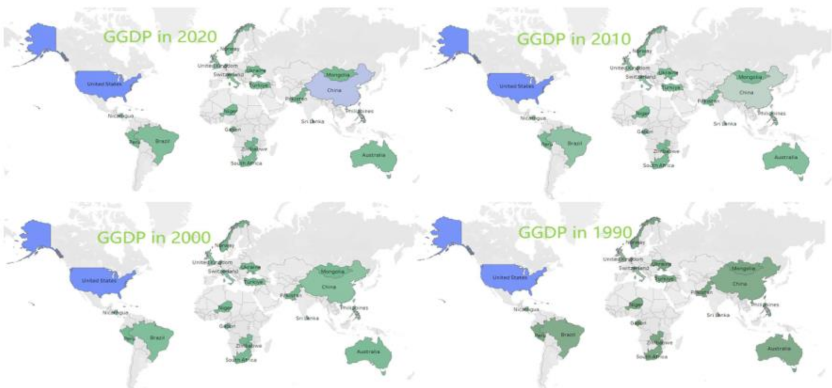


Figure 3. The GGDP situation of the selected countries in some years

Then we first analyze the changes in CCI and GGDP. In Figure 5, the red line represents the trend change of CCI, and the blue dot represents the GGDP value of 24 countries from 1990 to 2020.

We can find that almost all the blue dots are distributed near the red line, indicating a correlation between GGDP and CCI, and it can be almost considered linear. We use the Pearson correlation coefficient method to further explore the correlation between CCI and GGDP. It can be seen from the heat map (Fig. 4) that when the color block is closer to blue, there is a positive correlation between the two indicators. When the color block is closer to green, there is a negative correlation between the two indicators; the more profound the color block, the stronger the correlation. The color blocks of each country are dark blue, and the Pearson coefficient is almost between 0.75 and 0.9, so we can consider that there is a positive linear correlation between GGDP and climate mitigation. At the same time, after the significance test, we found that all the p-values were less than 0.01. That is, the sample had a linear correlation, and it was very significant.

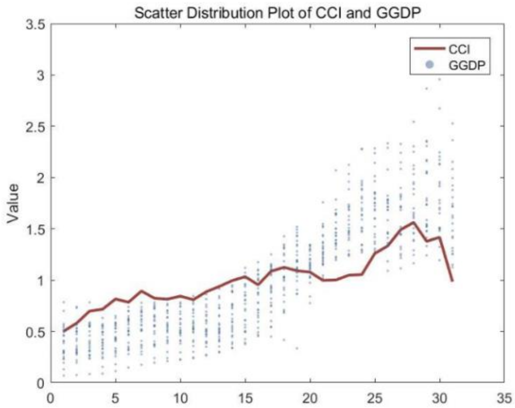
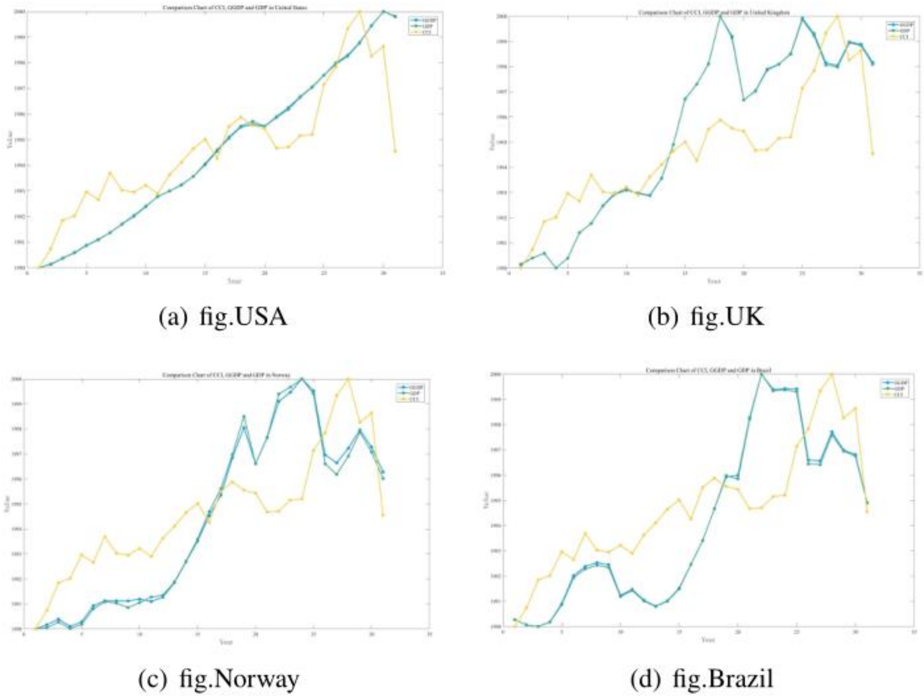


Figure 4. Scatter Distribution Plot of CCI and GGDP

3.2. Grey Relation Analysis of GDP, GGDP and CCI

First, we selected Brazil, the United States, Norway, and the United Kingdom to compare the trend of the climate composite index calculated by the entropy weight method-the composite index method with the GGDP and GDP. According to the trend map, GGDP and GDP are related to the trend of CCI, which is generally positively correlated. However, according to the trend chart Fig. 5(a) – Fig. 5(d), it is impossible to identify which index has a more excellent correlation with CCI intuitively, so the grey relation analysis is used for comparison.



(a) fig.USA (b) fig.UK

(c) fig.Norway (d) fig.Brazil

Figure 5. The composite index method with the GGDP and GDP

Here we still use 24 countries as samples to calculate and compare the correlation between GGDP and GDP and the comprehensive climate index. The calculation results are shown in the following table. According to Fig. 6, it is found that the correlation between the two and CCI is not much different, but the correlation between GGDP and CCI in most countries is slightly higher. It shows that using the existing calculation method to calculate GGDP, the correlation between green GDP and climate composite index is higher, which is more likely to reflect the impact of global climate change.

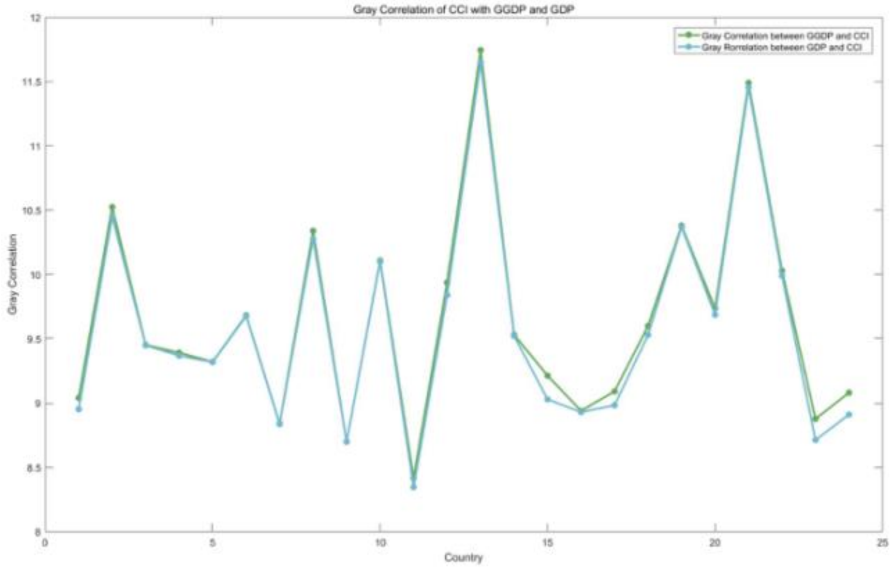


Figure 6. Gray Correlation of CCI with GGDP and GDP

4. Conclusion

According to the previous calculation method, the global impact of GGDP on climate mitigation is more significant than the traditional GDP indicator. This proves that implementing green GDP has a positive significance for the world. First of all, because green GDP combines economic growth with natural resources, it makes up for the shortcomings of traditional GDP accounting, which reflects economic development and the sustainable development of people and society. The implementation of green GDP is conducive to protecting the environment and resources. The calculation of green GDP subtracts the impact of increased natural resource consumption and environmental degradation costs, making the calculation results more effective.

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