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Research Article

Research on Financial Accounting of GDP Index Based on Numerical Simulation

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Because the traditional GDP accounting method was difficult to meet the actual needs of governments for economic and social development, aiming at the problems of unclear data sources related to GDP and inconsistent GDP accounting results in the national economic accounting system, a GDP index financial accounting method based on numerical simulation was proposed. Firstly, it summarized the traditional GDP thought and its related accounting methods and analyzed the common problems existing in the traditional GDP accounting. Secondly, it expounded the concept of green GDP and its accounting scope and theoretical model and pointed out the key problems to be solved in green GDP accounting, such as ecological resource consumption and environmental pollution cost calculation. Finally, by analyzing the relationship between green GDP and main supporting indicators, the accounting method of GDP indicators based on numerical simulation was proposed, and the accounting result detection model based on the econometric model was given. Through empirical analysis, it showed that the GDP accounting method proposed in this paper has good feasibility and effectiveness and can effectively reflect the development of the economic operation. The accounting method proposed in this paper can also provide a reference basis for the construction of a green GDP system.

1. Introduction

Gross domestic product (GDP) usually refers to the value of products or services obtained by a country or region through economic operation over a period. It is not only used to measure the trend of economic development but also reflects the economic operation and the level of comprehensive national strength. As an important indicator reflecting the economic development of a country or region, GDP can provide information consultation and decision-making services for economic analysis and management. GDP is not only the main part of the national economic accounting system but also an important part of the total macroeconomic volume of a country or region [1]. Most countries use GDP to compare the level of economic development between countries or regions, and it is also commonly used to compare the economic operation of countries or regions in different periods.

At present, most of the relevant GDP accounting do not consider the utilization and consumption of natural environmental resources and the degradation of environmental pollution in the process of economic operation. The consumption of natural resources and the cost of environmental pollution are ignored in GDP accounting, and the accounting results do not truthfully reflect the rules of economic operation. Due to the neglect of the consumption of natural resources and the ecological environment in the process of production and operation activities, it is difficult for the economy to achieve sustainable development [2, 3]. Therefore, improving the original GDP accounting method has become one of the hot issues widely studied by scholars at home and abroad. With the rapid economic development of countries and regions around the world, the natural ecological environment and resources are also seriously affected. In the process of actual economic operation, the continuous consumption of resources and the environment

is one of the main factors hindering economic development. At present, the biggest challenge for all countries is how to achieve sustainable development under the condition of deteriorating ecological resources and the environment.

In view of the relationship between natural environmental protection and sustainable utilization of resources, economic development, and resource and environmental consumption, scholars at home and abroad have begun to incorporate ecological environment consumption and natural resource consumption into the national economic accounting system and put forward the concept of green GDP [4]. The accounting of green GDP not only can effectively reflect the relationship between economic development and the utilization of natural resources and environment but also can truly reflect the level of economic development. Since the data required in the accounting process mainly come from the mathematical statistical results of various industries, the accounting results of GDP may vary greatly due to different accounting methods, which will affect the function of GDP to provide effective services for economic operation and decision-making consultation. Therefore, this paper puts forward the accounting method of GDP index based on numerical simulation, in order to provide a reference for the accounting of GDP, in order to provide a reference for green GDP accounting and its system construction.

2. Related Works

Since the macrocontrol of the economy of all countries in the world is largely based on the development of GDP, GDP accounting is an important topic and challenge faced by the government. Domestic and foreign scholars' research on GDP accounting has been deepening and made some progress. Affected by the traditional GDP accounting problems, various countries have gradually incorporated the ecological environment and resource consumption into the national economic accounting system, to obtain a GDP that accurately reflects the level of economic development. For example, some scholars believe that it is necessary to deduct the costs of resource consumption and environmental pollution in the process of production and economic operation from the existing GDP accounting results and calculate the comprehensive accounting indicators that truly reflect the actual level of economic operation and development [5]. Due to a large amount of data and many model parameters required by the traditional input-output method, it is necessary to obtain the input cost of different pollutants in various industries, and the actual accounting process and application are difficult. From the perspective of input-output accounting, some scholars have explored the problem of green national economic accounting based on the marginal cost theory and put forward the method of green input-output accounting.

With the proposal of the concept of green GDP, attention has been paid to environmental protection and resource utilization in GDP accounting. Due to the continuous increase of environmental protection and governance costs, the ecological environment has been significantly improved [6]. Therefore, governments of various countries propose that addition should be made in GDP accounting. Therefore, according to the theory of welfare economics, some scholars believe that not only environmental costs but also environmental benefits should be considered in the calculation of green GDP and put forward the accounting theory of green GDP. In the existing GDP accounting, the total economic production is mostly used to deduct the expenditure of resource consumption and environmental pollution [7]. Due to the use of static pricing, it cannot reflect the input-output relationship of social reproduction, nor can it really reflect the guidance of environmental policies, which makes the accounting results of green GDP differ greatly from the actual situation. The higher the accounting value of green GDP, the lower the quality of the ecological environment may appear.

In addition, in the existing GDP accounting, the principle of input-output consistency is not strictly followed, and the input to improve environmental benefits is not considered in the framework of national economic accounting. Moreover, as the input of supporting the economic operation, the corresponding output of ecological and environmental protection cost has not been accounted for by effective methods [8, 9]. Therefore, by constructing a GDP accounting system including various losses, the researchers use the calculated green development index to adjust GDP in order to obtain the results of green GDP accounting. For example, when calculating GDP, some scholars do not distinguish between resource consumption and environmental pollution and obtain an adjustment coefficient by subdividing and weighting ecological resources, environment, and economic operation at different levels [10]. At present, there is no unified green GDP accounting method for reference in the world, and the green GDP data published in the name of the government have not been reported. Therefore, relevant scholars have carried out a lot of relevant research based on existing GDP accounting and made some progress. Although some countries have conducted relevant case studies, they are only partial or phased results. Therefore, how to conduct in-depth research on GDP accounting based on existing research methods has become a widespread concern of relevant scholars all over the world.

3. Theoretical Basis of GDP Accounting

3.1. Definition and Accounting Scope of GDP. The system of national accounts (93SNA) published by the United Nations in 1993 is a widely used data accounting system [11]. Based on the economic accounting framework, a comprehensive environmental economic accounting system can be established by using resources and environmental factors. Gross domestic product (GDP) is an important part of the national economic accounting system, which reflects the results of all production activities of a country or region in a certain period in the form of currency. GDP can fully reflect the overall scale, growth rate, and composition of a country's national economy. GDP accounting mainly includes the production of all materials and various services provided.

The content of GDP is mainly reflected in three aspects. The first aspect is embodied in the form of value. The value is

mainly the product value formed by the product value produced by the production department or industry minus the production input other than fixed assets. The second aspect is reflected in the form of income. This income refers to the return on all elements invested in production activities. The income not only includes the return of labor factors after production reflected in the form of labor remuneration, the return of fixed assets after production reflected in the form of depreciation of fixed assets, and the return of other factors after production reflected in the form of operating surplus but also includes the taxes and subsidies paid for engaging in production activities reflected in the form of production tax and production subsidy. The third aspect is reflected in the form of products. This product mainly includes investment goods, consumer goods, as well as import and export products, which are usually represented by investment demand, consumption demand, as well as import and export demand.

3.2. Common GDP Accounting Methods. Generally, the GDP reflected in three different forms of value, income, and product can be accounted for by the production method, income method, and expenditure method in turn.

3.2.1. Production Method. Using the production method to calculate GDP, we must first calculate the value of all products created by various industries in a certain period (called total output), then calculate the product value invested in the production of these products (called intermediate input), and finally, subtract the intermediate input from the total output to obtain the product added value of various industries. By accumulating the added value of products in various industries, the corresponding GDP can be calculated [12]. The calculation formula is as follows:

$$GDP = \sum\left(\mathrm{OUT}_{\mathrm{total}} - \mathrm{IN}_{\mathrm{inter}}\right), \quad (1)$$

where $\mathrm{OUT}_{\mathrm{total}}$ indicates total output and $\mathrm{IN}_{\mathrm{inter}}$ represents intermediate input.

The total output refers to the value of all products and services produced in a certain period of time, and the intermediate input refers to the value of nonfixed asset goods and services consumed and used in the production of these materials and the provision of services.

3.2.2. Income Method. To calculate GDP with the income method, it is necessary to calculate the returns of various factors invested in production activities of various industries, including net production tax, labor remuneration, operating surplus, and depreciation of fixed assets, and then take the sum of these income returns as the income added value of various industries. Finally, the corresponding GDP is obtained by accumulating the income added value of all industries [13]. The calculation formula is as follows:

$$GDP = \sum\left(REM_{\mathrm{wor}} + \mathrm{TAX}_{\mathrm{netp}} + \mathrm{ASSET}_{\mathrm{df}} + SURP_{\mathrm{op}}\right), \quad (2)$$

where REM_{wor} is the remuneration of workers, $\mathrm{TAX}_{\mathrm{netp}}$ indicates net production tax, $\mathrm{ASSET}_{\mathrm{df}}$ represents a depreciation of fixed assets, and $SURP_{\mathrm{op}}$ shows an operating surplus.

The remuneration of workers refers to the remuneration obtained by workers after engaging in relevant production activities. In addition to various wages, allowances, and bonuses, it also includes public medical treatment, transportation subsidies, housing accumulation fund, social insurance premiums, and health expenses that employees should enjoy. There are both monetary and physical forms of remuneration. Net production tax refers to the difference obtained by subtracting production tax from production subsidies. Among them, production tax refers to various taxes that the production department needs to pay to complete production, sales, operation, and other activities, as well as the use of fixed assets, land, labor, and other production factors. Production subsidies refer to the policy subsidies and price subsidies obtained by the production department from government agencies for the completion of production, sales, operation, and other activities, as well as the use of relevant production factors. Depreciation of fixed assets is used to reflect the loss and transfer value of fixed assets in the production process. It refers to the depreciation of fixed assets calculated according to a certain depreciation rate in order to make up for the loss of fixed assets. Operating surplus is used to indicate the profits obtained by the production unit from production, operation, and other activities. It is the balance obtained by subtracting the labor remuneration, net production tax, and depreciation of fixed assets from the added value created by the enterprise.

3.2.3. Expenditure Method. To calculate GDP by expenditure method, we need to calculate the three demand values of investment demand, consumption demand, and net export demand in turn and then accumulate the three demand values to obtain the corresponding GDP. Investment demand mainly refers to total fixed capital formation and inventory increase, which is also called total capital formation. Consumption demand mainly refers to residents' consumption expenditure and government consumption expenditure, which is also called final consumption expenditure. Net export demand refers to the difference between the export value of goods and services minus the import value of goods and services [12]. It is also called the net export of goods and services. The calculation formula is as follows:

$$GDP = EXP_{\mathrm{rc}} + EXP_{\mathrm{gc}} + \mathrm{CAP}_{\mathrm{tf}} + INV_{\mathrm{in}} + NETEX_{\mathrm{gs}}, \quad (3)$$

where EXP_{rc} is resident consumption expenditure, EXP_{gc} indicates government consumption expenditure, $\mathrm{CAP}_{\mathrm{tf}}$ represents total fixed capital formation, INV_{in} is inventory increase, and $NETEX_{\mathrm{gs}}$ shows net exports of goods and services.

Resident consumption expenditure refers to the total consumption expenditure of residents on transportation, education, food, medical treatment, and other goods or services within a certain period of time. Household

consumption expenditure includes not only the expenditure on goods and services obtained in monetary form but also the expenditure on goods and services obtained in other ways. Government consumption expenditure refers to the expenditure of public services such as public security services, administrative services, education services, national defense services, and science and technology services provided by government agencies. It is the financial expenditure provided by government departments for social members. Total fixed capital formation refers to the total value of the fixed assets obtained by relevant units after deducting the fixed assets disposed of. Among them, fixed assets, excluding land and other natural resources, are assets obtained through the production sector. Total fixed capital formation is mainly composed of tangible fixed capital and intangible fixed capital. Inventory increase refers to the value formed by the change of the physical quantity of inventory in relevant units in a certain period, that is, the difference obtained by subtracting the opening value from the closing value and then by subtracting the income or loss caused by the price change. If the inventory increase is positive, it indicates that the inventory value has increased, while if it is negative, it indicates that the inventory value has decreased. The increase in inventories includes not only the added value of inventories of agricultural products, means of agricultural production, raw materials, finished products, and products in process but also the added value of construction materials and circulating inventories. Net exports of goods and services refer to the difference between exports of goods or services minus imports of goods or services. Among them, exports include the value of goods or services transferred by resident enterprises to nonresident enterprises, while imports include the value of goods or services obtained by resident enterprises from nonresident enterprises.

Although the above accounting methods calculate GDP from different angles, theoretically, the final calculation results should be equal. However, in the actual calculation process, there may be some deviation in the calculation results due to different data sources, which are allowed to exist to a certain extent.

3.3. Existing Problems in GDP Accounting. Although the existing GDP can reflect the total economic output or national income level of a country or region, there are still some defects. Due to the interaction between economic development and resources and the environment, the existing GDP accounting methods only consider economic development and ignore the consumption of resources and the environment, resulting in an overestimation of economic development. The traditional GDP accounting results only reflect the economic growth or the total national economic income but cannot reflect the environmental pollution and ecological damage. The shortcomings of traditional GDP accounting mainly include the following aspects:

(1) GDP accounting does not include the cost of natural resources. In the process of GDP accounting, only the development cost of natural resources in the production process is considered, but the cost of natural resources itself is not considered, which may lead to the high final GDP accounting result. The goods or services included in the existing GDP accounting are calculated by the monetary value of market transactions. GDP accounting mainly reflects the degree of economic growth based on market-oriented output but ignores the cost of natural resources that do not participate in market transactions. In the process of production activities, the consumption of nonrenewable resources has led to the continuous reduction of assets, while the consumption of reusable resources such as land has not reduced the number of such resources, but the production potential of such natural resources has decreased.

(2) GDP accounting does not include economic losses caused by ecological environment deterioration. The existing GDP accounting can only reflect the positive effect of production activities but does not consider the negative effect of deteriorating ecological environment caused by the production. From a long-term perspective, the economic development of a country or region is based on ecologically sustainable development. When the economy develops to a certain extent, it may affect the bearing capacity of the ecological environment, lead to ecological imbalance due to environmental deterioration, result in direct or indirect economic losses, and have an adverse impact on the ecological balance and human sustainable development. Therefore, the existing GDP accounting is not in line with the sustainable development strategy.

(3) GDP accounting does not consider the economic value of ecological resources and the expenditure of environmental protection fees. Because the production process is inseparable from a good ecological resource environment, ecological resources not only have physical value but also can provide a good climate environment for production and life, prevent soil erosion, provide recreation, and other ecological functions. Therefore, it can be seen that ecological resources have multifaceted economic value. However, the national economic accounting system ignores the economic value of ecological resources and may destroy these ecological resources due to production and life. Since the existing GDP accounting not only does not take environmental pollution as the production input cost but also takes the expenses required for pollution control as the output of production activities to calculate GDP, the more serious the environmental pollution is, the more the expenses for pollution control will be, resulting in the greater the GDP accounting result.

In addition, the existing GDP accounting does not strictly distinguish between constructive and destructive production activities. The traditional GDP accounting

includes the added value of all trading activities. For example, because funds need to be invested to treat patients and repair losses, diseases, traffic accidents, and natural disasters will be regarded as factors to increase GDP by using traditional GDP accounting methods. At this time, although the actual living standard of residents is declining, GDP is rising.

4. Green GDP Accounting System

4.1. The Concept of Green GDP and Its Accounting Scope. With the decrease of ecological resources and the decline of environmental quality, GDP, as an important indicator of national economic accounting, fails to fully consider the input of ecological resources and the decline of environmental quality in the accounting process, resulting in the accounting results not only unable to adapt to the changes of environmental conditions corresponding to economic growth but also unable to meet the strategic requirements of socially sustainable development, That is, GDP cannot effectively predict and evaluate the sustainable development of society.

In the past GDP accounting, it was considered that the ecological resources and environmental factors remained unchanged, but in fact, the factors such as ecological resources and environmental quality related to production have changed to a certain extent. Therefore, the accounting scope of GDP needs to be appropriately modified in order to obtain the real total economic volume. Green GDP refers to recalculating the new GDP result by bringing the factors such as ecological environment and resources into the accounting scope on the basis of the original GDP [14].

As an integral part of national economic accounting, environmental economic accounting can expand its accounting scope on the basis of the SNA accounting framework and expand the scope of GDP accounting to the ecological resources and environment sector. Therefore, the scope of green GDP accounting includes the whole economic ecosystem and is no longer limited to the economic system.

The environment and economy interact and are interrelated. Obtaining economic products through production can effectively improve the environmental situation, while more products can be produced through environmental utilization processes such as consuming ecological resources and containing production waste. Therefore, the accounting for environmental economy mainly includes environmental protection accounting and environmental cost accounting. Among them, environmental protection accounting mainly improves environmental benefits through product input, while environmental cost accounting mainly obtains negative output through resource input and environmental pollution. Environmental economic accounting is based on national economic accounting, by calculating the input of resource consumption reduction and environmental protection, the output of environmental improvement benefits, and the negative output of environment and bringing the net output of resources and environment into the accounting of GDP.

In short, green GDP is derived from the calculation scope of input and output to all production and environmental activities of ecological environment and resources based on traditional GDP accounting. In the accounting of green GDP, the environmental output needs to be considered in the output part, while resource input and environmental protection input need to be considered in the input part. By calculating the difference between input and output, the comprehensive results of economy and environment can be obtained [15].

According to the above definition of green GDP, the accounting theoretical formula of GDP can be adjusted as follows:

$$GDP_{\text{green}} = GDP + \text{OUT}_{\text{re}} + \text{IN}_{\text{re}}, \tag{4}$$

where GDP_{green} denotes green GDP, OUT_{re} indicates the output of ecological resources and environment unit, and IN_{re} represents the input of ecological resources and environment unit.

The output of ecological resources and environment unit is the benefit and negative output of environmental improvement, while the input of ecological resources and environment unit is the input of ecological resources consumption and public environmental protection [16]. If the net output of ecological resources and environment unit is subdivided into input and output, the accounting theoretical formula of GDP is as follows:

$$GDP_{\text{green}} = GDP + \text{NETOUT}_{re}, \tag{5}$$

where NETOUT_{re} denotes the net output of ecological resources and environment unit.

If the net output of ecological resources and environment unit is substituted into the GDP calculation formula, the green GDP calculated by production method, income method, and expenditure method can be obtained.

Supplement the input and output of ecological resources and environment on the basis of existing GDP accounting. It is advisable to take the cost of ecological resource consumption reduction and environmental protection expenditure as inputs, take the environmental pollution caused by improving the environment as negative output, and take the output of ecological resources as positive output [17]. Therefore, the green GDP accounting framework can be obtained, as shown in Figure 1.

4.2. Green GDP Accounting Model. Similar to the accounting theory of GDP, green GDP can be accounted for from different angles after supplementing the input and output of ecological resources and the environment. Green GDP accounting can generally adopt direct accounting methods and indirect accounting methods.

4.2.1. Direct Accounting Methods. Direct accounting methods mainly include production and distribution methods. The theory of using the production method to calculate green GDP is similar to the existing GDP accounting. It supplements the natural resources factor on the

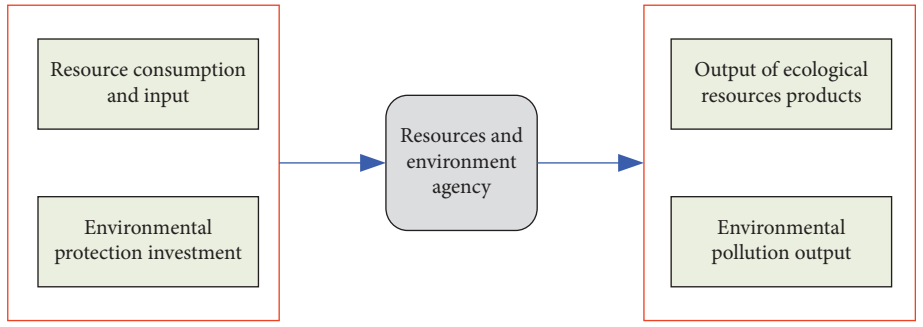

Figure 1: Schematic diagram of the relationship between input and output of resources and environment department.

basis of the original accounting theory. Among them, the intermediate input refers to the economic and natural resources consumed due to production [14]. The calculation formula is as follows:

$$GDP_{\text{green}} = \sum(\text{OUT}_{\text{ins}} - INVA_{\text{ins}} - INVA_{\text{inas}}), \quad (6)$$

where OUT_{ins} denotes the total output of an industrial sector, $INVA_{\text{ins}}$ indicates the investment in economic assets of an industrial sector, and $INVA_{\text{inas}}$ represents the investment in natural assets of an industrial sector.

Using the distribution method to calculate green GDP is mainly considered from the perspective of the final use direction of green GDP. Among them, the closed economy mainly includes two factors: consumption and accumulation, while the open economy needs to supplement the factor of net export [13]. The calculation formula is as follows:

$$GDP_{\text{green}} = CONS_{fi} + ACCU_{ea} + \text{NET}_{\text{ex}} + DEP_{na}, \quad (7)$$

where $CONS_{fi}$ denotes final consumption, $ACCU_{ea}$ indicates economic asset accumulation, DEP_{na} is net export, and DEP_{na} represents depletion of natural assets.

4.2.2. Indirect Accounting Methods. When using the indirect accounting method, because the impact of comprehensive factors such as economy, resources, and environment on GDP should be considered, the relevant indicators need to be adjusted appropriately in the original GDP accounting in order to obtain accurate green GDP [12]. Due to the different purposes and angles of accounting, there are some differences in the relevant elements involved in the accounting of green GDP. The calculation formula of the indirect accounting method is as follows:

$$GDP_{\text{green}} = GDP - \text{VALUE}_{es} + \text{OUTPUT}_{epd}, \quad (8)$$

where VALUE_{es} denotes ecosystem service value and OUTPUT_{epd} indicates the output value of environmental protection department.

Ecological resource service refers to the natural ecological environment conditions generated by ecological resources that can provide human survival. It mainly includes ecological resource products and ecosystem services that have an impact on human production and life. Ecosystem service refers to the function of ecological resources to provide products for human production and life and ensure the quality of production and life.

Considering that the accounting cost of some elements of green GDP is large, the effectiveness of accounting methods should be considered according to the actual situation when implementing specific accounting. Therefore, the accounting of green GDP can first choose a simple accounting method and then gradually expand the accounting scope with the improvement of relevant data and information systems.

Through the preliminary calculation of relevant environmental pollution index, ecological resource consumption index, and its shadow price, then calculate the resource consumption input and negative output of environmental pollution and then obtain the public environmental protection input data according to relevant data and information [17]. Finally, green GDP can be calculated. The specific accounting model is shown in Figure 2.

4.3. Key Issues of Green GDP Accounting. In the accounting of green GDP, the key is to reasonably evaluate the value of natural resources consumed due to production. In the process of economic activities, most natural resources have a certain market price. Therefore, the value of natural resources can be measured according to the market price. Because the actual price of natural resources may be different from the market equilibrium price, its value is often underestimated, and the market price may be lower than the cost.

When evaluating the value of natural resources, it is necessary to classify the value of natural resources first. On this basis, the corresponding value evaluation methods are selected according to different value types of natural resources. The value of natural resources can be classified by half of the value of resources and the environment. The total value of natural resources is divided into two parts: use value and nonuse value. Among them, use value is divided into direct use value, indirect use value, and choice value, while nonuse value is divided into existence value and genetic value [18]. The classification of natural resource value is shown in Table 1.

Due to the different ways in which natural resources and the environment provide services for economic activities, there are also some differences in the value evaluation methods of resources and the environment. Natural

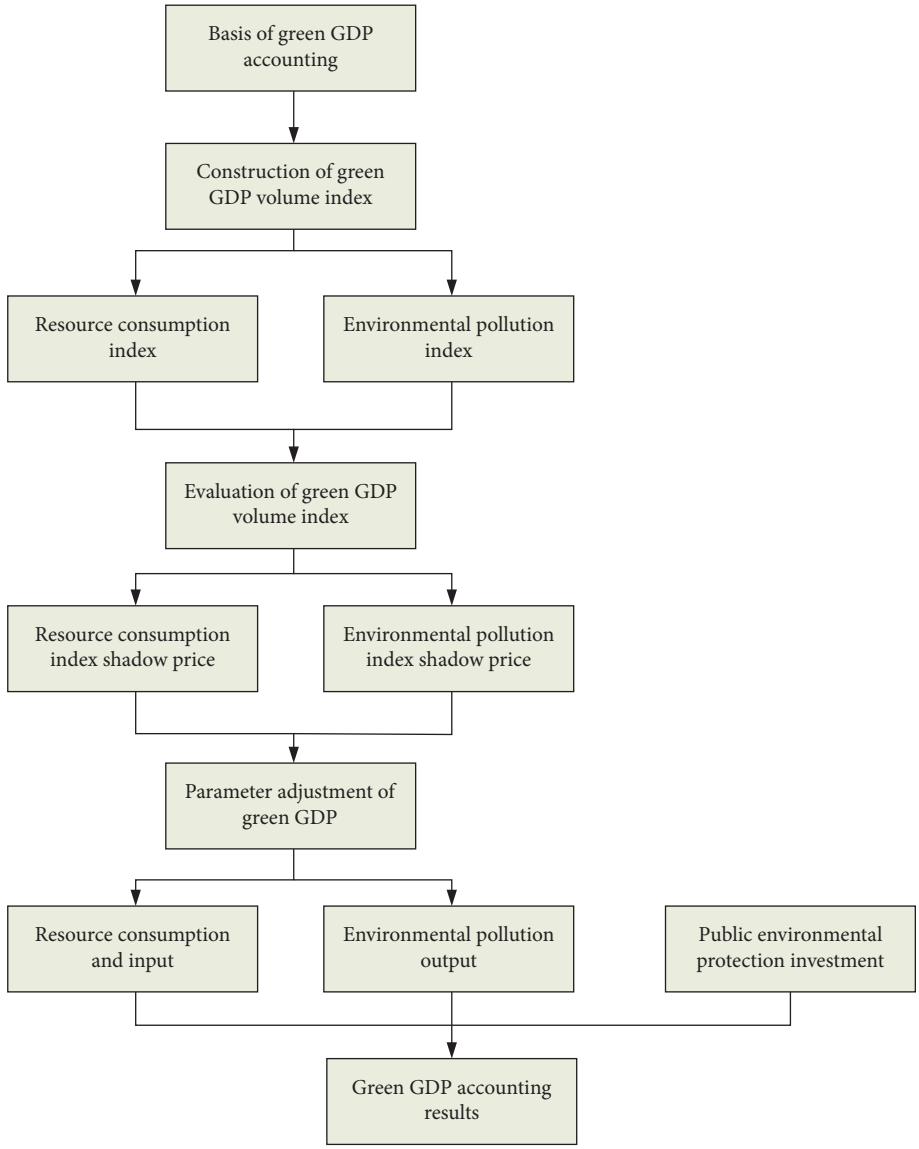

Figure 2: Green GDP accounting system model.

Table 1: Classification method of resource and environmental value.

Total value of resources and the environment	Use value	Direct use value	Direct consumption Physical and biomass
		Indirect use value	Functional benefits Storm protection
		Choice value	Potential use value Biodiversity
	Nonuse value	Genetic value	Value for future generations Living habitat
		Existence value	Continued use value Endangered species

resources refer to the tangible asset investment in economic activities, which has obvious monetization characteristics. The environment provides intangible external conditions for economic activities, and the market price cannot be determined in the form of monetization. Therefore, the evaluation of resource and environmental value is generally divided into resource value evaluation method and environmental value evaluation method.

In the natural resource valuation method, in addition to the market method, the income reduction method, the rent method, and the shadow price method, the net price method can also be used. The net price method is to subtract the

market price of natural resource products from the development cost of natural resources and finally obtain the price of natural resources [15]. The calculation formula is as follows:

$$\mathrm{VALUE}_t = \left(PA_t - \mathrm{COST}_t\right) \sum_{i=0}^{t} \mathrm{VOL}_i, \tag{9}$$

where VALUE_t is the assessed value of natural resources in the accounting period, t refers to the accounting period, PA_t is the average market price of unit natural resources, COST_t is the average mining cost of unit natural resources, and COST_t is the annual consumption of natural resources in the service period.

5. GDP Accounting Method Based on Numerical Simulation

GDP not only can reflect the comprehensive strength of a region's economic and social development but also can provide an important reference and basis for regional development. Although the statistics and accounting of GDP are complex, the changes of industrial development, structure, and investment in a region are relatively gentle in a certain period of time. Therefore, there is a significant functional relationship between GDP and relevant accounting indicators in a period of time.

5.1. Constant Price and Present Value in GDP and Its Numerical Simulation. Constant price GDP accounting uses a set of price or volume indexes to calculate the actual GDP or growth rate of a country or region, so as to accurately reflect the actual economic growth and its structural changes. Present value refers to evaluating the value of a payment or payment flow made in the future or in the past from the current perspective. As an important parameter in GDP accounting, the constant price not only can eliminate the influence of product price changing with time in the process of economic activities but also can truly reflect the situation of economic growth, and the present value plays an important role in financial decision-making and analysis. Although the constant price remains unchanged for a certain period of time, with the change of the price of various materials or service products, it is necessary to redefine the new constant price every other period of time.

Affected by the compilation of constant price values in different periods, the constant price of each year is mainly calculated according to the average price of similar products and services in the current year. Some uncertain factors or unpredictable risks may lead to data deviation, which may have a certain impact on GDP accounting. In the calculation of constant price GDP, the production method can be used to calculate the constant price added value of all industries of the national economy, and the expenditure method can also be used to calculate the sum of constant price household consumption, total fixed capital formation, government consumption, and net exports of products and services.

Constant price refers to taking the fixed price of a year as the price of the base period. Its calculation method can either directly specify the constant price or take the current price of the base period. For example, take a group of representative commodity prices or current prices in the base period as constant prices [19]. Affected by the continuous upgrading of industries and the continuous renewal of products, in order to better compare the GDP between different years, it is necessary to constantly change the new base year in order to form a new constant price. The calculation formula of present value VALUE_p is as follows:

$$\mathrm{VALUE}_p = \frac{1}{(1+k)^T} \times \mathrm{VALUE}_f, \tag{10}$$

where VALUE_f is the final value, k is the discount rate, and T is the service life. Formula (10) shows the relationship between present value and future product price. The calculation formula of the present value of cash flow is as follows:

$$\mathrm{VALUE}_p = \sum_{k=1}^{T} \frac{NETCF_t}{(1+k)^T}, \tag{11}$$

where $NETCF_t$ is the net cash flow in year t.

5.2. Construction of Relationship Model between GDP and Relevant Accounting Indicators. Affected by the complexity of the statistical process, the final results obtained by different GDP accounting methods may be different, so it is difficult to effectively provide information consultation or decision-making services for relevant departments. Because the industrial development and economic structure of a region are relatively stable for a period of time, we can build relevant models to reflect the correlation between GDP and accounting indicators.

According to the statistical results of GDP over the years and the change relationship between GDP and relevant accounting indicators, the relationship between GDP and main supporting indicators in that year can be regressed, and the relationship model between GDP and different indicators can be established. According to the existing research, among the main supporting indicators affecting GDP accounting, the change of GDP has a significant relationship with commodity prices and price indexes to a certain extent.

Therefore, the linear regression equation can be used to describe the relationship between GDP and relevant supporting indicators, and its calculation model is as follows:

$$GDP_{\mathrm{green}} = a \times PAR_1 + b \times PAR_2 + c, \tag{12}$$

where PAR_1 and PAR_2 are the supporting indicators and a, b and c are accounting coefficients.

5.3. GDP Accounting Quality Assessment. In order to evaluate the quality of GDP accounting, the econometric model can be used to analyze the results of GDP accounting [20].

5.3.1. Reliability Analysis of Accounting Indicators Based on Econometric Model. Based on the economic theory or the change law of time series data, the econometric model of the evaluation index G is proposed to be combined as the accounting parameter, and its fitting function is as follows:

$$G_t = f(P_t, t, \lambda) + v_t, \quad t = 1, 2, \cdots, N, \tag{13}$$

where λ is the reference indicator set of model accounting parameters and λ is the parameter set of the model. A new model fitting result can be obtained through parameter estimation and test, and its fitting function is as follows:

$$\widehat{G}_t = f\left(P_t, t, \widehat{\lambda}\right), \quad t = 1, 2, \cdots, N. \tag{14}$$

When analyzing the rationality of parameter results, the parameter in formula (13) is λ. When the actual estimated value $\widehat{\lambda}$ is not in the reasonable value range $(\lambda, \overline{\lambda})$ scope, its relationship is as follows:

$$\widehat{\lambda} > \overline{\lambda}, \widehat{\lambda} < \lambda. \tag{15}$$

Without considering the interference of other factors, it is known from formula (15) that the simulation result of G has obvious statistical error.

In terms of cross-regional attribute analysis of parameter results, it may be assumed that the model parameter is $\widehat{\lambda}$. When the difference between the estimated values of model parameters is not within a reasonable range, the relationship is as follows:

$$\left|\widehat{\lambda} - \widehat{\lambda}^{'}\right| > \zeta. \tag{16}$$

From the above relationship, it can be seen that there is a large deviation between the index to be evaluated and the reference index, indicating that the quality of the simulation results is poor.

In terms of cross-period attribute analysis of parameter results, the model fitting results of different periods are compared. If the estimated values of parameters in adjacent periods are greatly different, they are expressed as follows:

$$\left|\widehat{\lambda}_2 - \widehat{\lambda}_1^{'}\right| > \zeta. \tag{17}$$

Because the fitting results of the two adjacent periods are quite different, it shows that the quality of the simulation results is poor.

5.3.2. Abnormal Parameter Detection Based on Econometric Model. If the fitting value $\widehat{G}_t$ of formula (14) is assumed to be the actual value of index G_t to be evaluated, the following relationship can be used to detect the quality of index G to be evaluated [18].

The relative fitting error is used for detection. The detection is carried out by calculating the relative error between the actual statistical results and the model fitting results, as follows:

$$F_t = \frac{G_t - \widehat{G}_t}{G_t} = \frac{v_t}{G_t}, \quad t = 1, 2, \cdots, N. \tag{18}$$

According to the calculation results, we can judge whether the relative error is within the set error limit. If it is not within the error range, it indicates that there are abnormal parameters in the model.

Diagnostic statistics are used for detection [20]. Through data statistical diagnosis analysis, the diagnosis statistics of relevant parameters are calculated as follows:

$$R_t = \frac{\widehat{v}_t}{m\sqrt{1 - p_t}}, T_t = \frac{\widehat{v}_t}{m(t)\sqrt{1 - p_t}}, \tag{19}$$

where $\widehat{v}_t$ is the model fitting residual, m is the standard error of the model, $m(t)$ is the standard error of the fitting model obtained after deleting the t-th data point, and p_t represents the t-th diagonal element.

6. Empirical Analysis

6.1. Basic Overview of the Study Area. Using the GDP accounting method proposed in this paper, this paper takes a county in southern China as an example for empirical analysis. The county has a land area of 2,315 square kilometers and a total population of about 490,000. In 2020, the regional GDP was 3.015 billion US dollars, an increase of 4.4% over the previous year. The total fiscal revenue was 427 million US dollars, an increase of 2.4% over the previous year. The added value of industries above the designated size increased by 4.6%, and the main business income was 8.2 billion US dollars, an increase of 7.8% over the previous year. Among them, the added value of the primary industry was 927 million US dollars, an increase of 4.8% over the previous year; the added value of the secondary industry was 1.136 billion US dollars, an increase of 14% over the previous year; and the added value of the tertiary industry was 952 million US dollars, an increase of 11% over the previous year. The per capita GDP was 2,638.15 US dollars, an increase of 8.5% over the previous year. The GDP and structure of the county are shown in Table 2.

The price index in the region remained basically stable. The overall level of consumer prices rose by 1.2% over the previous year, including about 1.2% in both urban and rural areas. Product price changes and structural characteristics are relatively significant. Housing and food prices rose by a large margin, with increases of 4.3% and 3.7%, respectively. These two indicators are also the main factors contributing to the rise of consumer prices. The ex-factory price of industrial products rose by 1.2%, and the purchase price of raw materials and fuels rose by 4.3%, down 1.5 and 2.3 percentage points, respectively, over the previous year. The production price of agricultural products rose by 0.6%.

According to the GDP accounting method in this paper, we can get that the green GDP after the adjustment of resources and the environment was 2.74365 billion US dollars, and the green GDP index was 0.91. The accounting results of green GDP are shown in Table 3.

6.2. Accounting Results and Analysis of Green GDP. In order to verify the effectiveness of this GDP accounting method for different periods, in the simulation experiment, it is assumed

Table 2: GDP structure of the region in 2020.

Item	Primary industry	Secondary industry			Tertiary industry	Regional GDP (USD)	Per capita GDP (USD)
		Industry	Construction	Mining			
2020	927 million	527 million	458 million	151 million	952 million	3,015 million	2,638.15

Table 3: Accounting results of green GDP in 2020.

Item	Regional GDP (USD)	Loss of natural resources	Environmental degradation cost	Ecological environment cost	Green GDP (USD)	Green GDP index
2020	3,015 million	149.6 million	97.4 million	24.35 million	2,743.65 million	0.91

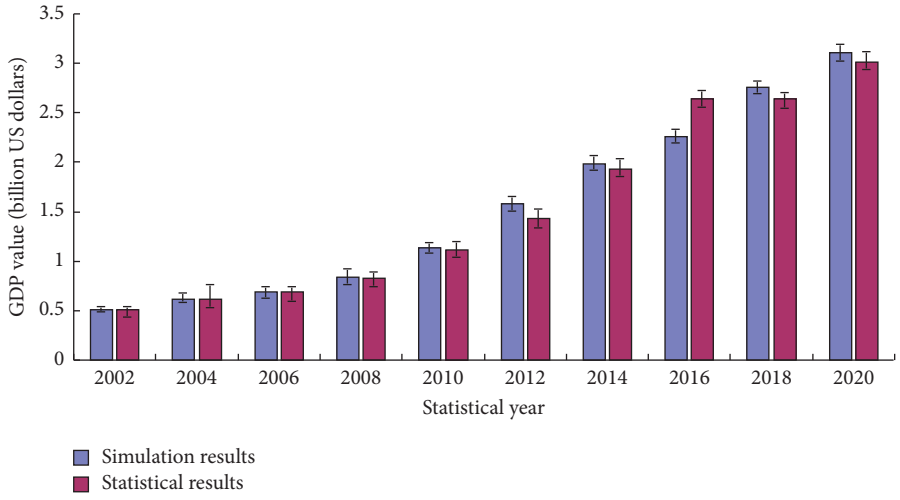

Figure 3: Comparison results of simulated and statistical values of GDP model.

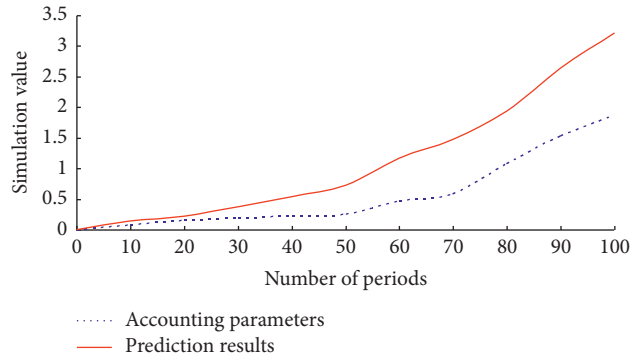

Figure 4: Dynamic changes of accounting parameters and prediction objectives with different periods.

that the duration of the statistical sample is 100 periods, and the simulation is repeated 1,000 times for different accounting parameters. As shown in Figure 3, it reflects the comparison results between simulated and statistical values of GDP models in different years.

In order to verify the final results obtained by using the GDP accounting method in this paper, the econometric model can be used to analyze the reliability of relevant accounting indicators. As shown in Figure 4, the dynamic change trend of evaluation indicators and accounting parameters with different periods is described. It can be seen from the figure that the model evaluation index and accounting parameters have good consistency with the change of time series, indicating that the model can reflect the change law of macroeconomic indicators. Therefore, the model can be used to simulate relevant indicators. This shows that the GDP index accounting method based on numerical simulation proposed in this paper can effectively reflect the relationship between GDP accounting results and relevant supporting indicators.

By regression fitting the sample data of accounting indicators, the model residual sequence can be calculated, as shown in Figure 5. At the same time, the relative error rate sequence of the model can also be obtained, as shown in

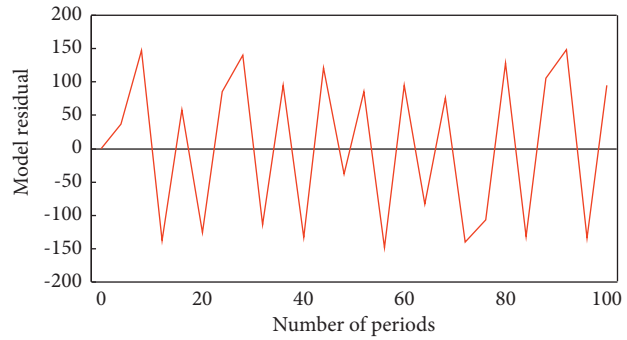

Figure 5: Dynamic variation of model residuals with different periods.

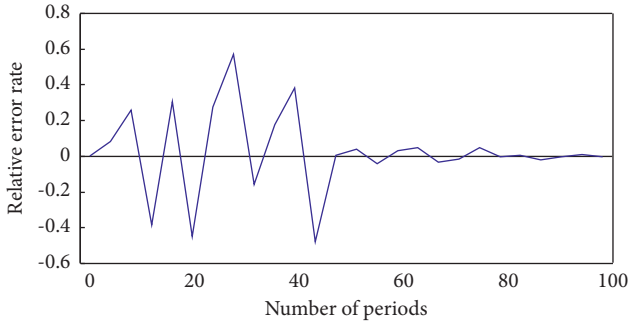

Figure 6: Dynamic variation of relative error rate with different periods.

Figure 6. According to the variation law of model residuals in different periods, although the random interference term of the model can basically meet the same variance condition, the relative error rate will decrease with the increase of the prediction target value of the model. The relative error rate of the model prediction is large in the early stage but small in the later stage.

7. Conclusion

With the rapid development of the modern economy, the traditional GDP accounting system had been difficult to meet the various needs of the government for economic and social development. Therefore, it was necessary to improve the structure and accounting methods of GDP, to provide an effective decision-making basis for government departments at all levels. By analyzing the traditional GDP theory, this paper expounded the shortcomings of the existing GDP accounting methods. On the basis of expounding the concept of green GDP and its accounting model, this paper pointed out that the key problems such as the dynamic evaluation of ecological resource consumption and environmental pollution cost should be solved in the accounting of green GDP. According to the characteristics of green GDP accounting and its relationship with relevant supporting indicators, this paper puts forward the accounting method of GDP indicators based on numerical simulation, and the accounting results of green GDP can be better detected and evaluated based on the econometric model method. The results of the empirical analysis showed that the GDP index and its accounting method proposed in this paper were feasible and effective. With the continuous economic transformation, building a GDP accounting system suitable for economic development is an issue that needs to be deeply studied in the future.

Data Availability

The labeled data set used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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