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Psychological Prediction of Digital Economy Consumption Considering Deep Neural Network

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Abstract: Scientific and accurate forecasts can not only help people to formulate correct work plans and action arrangements in a timely manner, but also provide important policy recommendations for economic development and promote stable and healthy economic development. In real life, everyone hopes to obtain very effective forecast results and provide necessary solutions for scientifically responding to future market changes. The main purpose of this paper is to analyze and study the prediction of consumer psychology in the digital economy based on DNNs. This paper establishes an analytical framework for the dynamic correlation characteristics of consumption and economic growth, and innovatively comprehensively evaluates the changes of the correlation between the two over time from three aspects: gravity coupling, cycle synergy and interactive influence. To compare the forecast results, the error function was used to calculate the error of the three forecast methods using the mean squared error. The experimental study shows that the DNN algorithm in this paper has the best prediction effect through the comparison charts and error comparison tables of three prediction results. The prediction error of the multiple linear regression algorithm is 0.483, the prediction error of the principal component regression algorithm is 0.214, and the prediction error of the DNN algorithm is 0.059, which is an order of magnitude higher than the previous two algorithms in accuracy.

1. Introduction

The consumption cycle is a reflection of the fluctuating characteristics of consumer demand. When the economic and social system's demand for consumption is in the rising period, the consumption will increase; when the consumption demand is in the declining period, the consumption will decrease. The consumption cycle is exactly the description of the continuous

increase and decrease of consumption, but unlike the mathematical standard cycle, it does not have symmetry and repetition. Looking back on history, the research on the consumption cycle was inspired by the research on the economic cycle, and the first research on cyclical fluctuations started from the research on the economic cycle. The economic cycle is an economic phenomenon that exists objectively in the process of economic development, and economic things related to economic development may naturally exhibit cyclical phenomena [1-2].

In a related study, Claveria mentioned that in the context of increasing uncertainty, the perceptions of companies and consumers on the expected development of the main variables affecting their activities are crucial for economic forecasting [3]. Work focused on using forecast content from surveys of economic trends is highlighted, evaluating the forecast performance of quarterly unemployment expectations in the euro area obtained through machine learning methods. The analysis revealed the potential of new analytical techniques for analyzing business and consumer surveys for economic forecasting. The Saxena study highlights consumers' general perceptions of luxury goods; it then discusses the behavioral structure of consumers purchasing luxury goods, and then concludes the study by showing the impact of sociocultural influences on luxury consumption behavior [4]. The research provides direction for brands to enter new markets and will facilitate marketers to position and reposition brands based on consumer psychology and luxury consumption culture.

This paper establishes an analytical framework for the dynamic correlation characteristics of consumption and economic growth, and innovatively comprehensively evaluates the changes of the correlation between the two over time from three aspects: gravity coupling, cycle synergy and interactive influence. In terms of center of gravity coupling, we innovatively extend the center of gravity theory and apply it to the construction of the center of gravity of consumption, and discuss its coupling with the center of economic gravity. Whether there is synergy in the author cycle, it is quantitatively measured by constructing a consistency index. In terms of interactive influence, the Granger causal relationship between the two is tested from a nonlinear point of view, and the dynamic change of the influence degree between the two is analyzed by constructing a time-varying parameter model, rather than a reflection of the averaged influence.

2. Design Research

2.1. Characteristics of Market Experts and Customer Value Perception

(1) Characteristics of market experts and perception of functional value.

The characteristics of market experts mainly include four dimensions: personal influence, professional quality, information dissemination and interaction, which constitute the interaction characteristics between the personal characteristics of market experts and consumers [5-6]. The relationship between the four dimensions of market expert characteristics and the functional value perception dimension in customer value perception is mainly derived from the following elaboration and analysis. Personal influence characteristics mainly include leadership qualities, social status, social relationships, and social influence.

(2) Characteristics of market experts and perception of social value.

The connotations of social status, social relations, and social influence in the characteristics of personal influence are highly consistent with conspicuous consumption (connotations such as social status satisfaction, self-worth, etc.) in the perception of social value. It is not difficult to see that the higher the social status of market connoisseurs The higher the quality of social relations and the higher the social influence, the easier it is to promote consumers to imitate consumption [7-8]. Professionalism, especially the professional knowledge of market experts, is the basis for consumers to recognize product value, while market experts' familiarity with the field and ability to

grasp information serve to accumulate professional knowledge. In addition, fairness and reliability is the guarantee that professional knowledge can be smoothly accepted by consumers [9-10].

(3) Characteristics of market experts and perception of emotional value.

In the aspect of interactive relationship characteristics, market experts are willing to maintain continuous communication with product consumers, quickly respond to followers' demands, and maintain the smoothness of communication and interaction, which will bring followers a pleasant interactive experience, which in turn will bring followers to the works. Perception of emotional value [11-12].

At the same time, in order to further study the correlation between the four elements of market connoisseur characteristics and the three elements of customer value perception, based on the above assumptions, the correlation model of market connoisseur characteristics and customer value perception constructed in this study is shown in the figure below. :

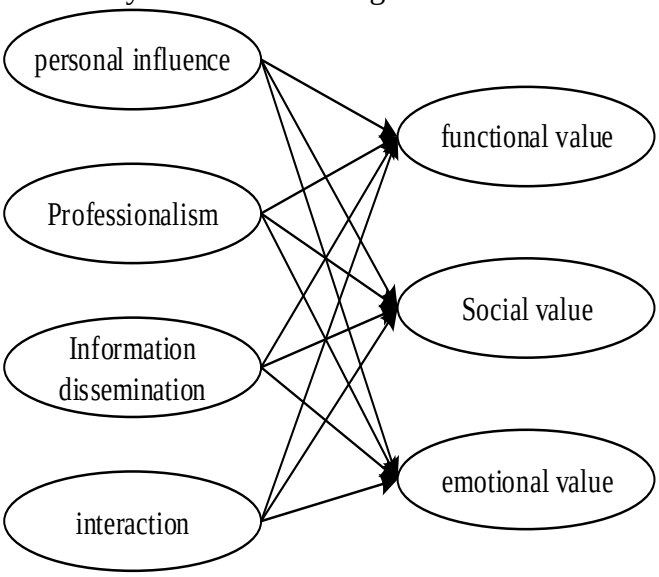

Figure 1. Correlation model of market expert characteristics and customer value perception

2.2. System Logic Architecture Design

The architecture of the consumer psychology prediction system, the design of the architecture is based on the general process of data mining, and refers to the construction method of the conventional application platform [13-14]. The architecture mainly includes the following three levels:

(1) Data processing layer

The data processing layer is located at the bottom layer of the system architecture, and is mainly responsible for data preprocessing for the underlying data in the business management system, and provides data support for subsequent data analysis.

(2) Data analysis layer

In the data analysis layer, it aims to analyze and predict business needs through the constructed regional economic analysis indicators, extract the corresponding data from the underlying subject database, and analyze and predict the data by the model.

(3) Data display layer

The data display layer is mainly for the visualization of data in the data analysis layer. Different data visualization displays are carried out for different data analysis topics and different analysis indicators.

2.3. Model Applicable Conditions

The model is suitable for the following conditions.

(1) The data relationship is more complicated. If the relevant attributes of the research data are high-dimensional and contain many cumbersome similar attributes, it will make the NN structure cumbersome. The RBF NN model based on principal component analysis proposed in this paper first makes the data relationship relatively simple, which not only achieves the purpose of dimensionality reduction, but also simplifies the structure of the RBF NN, which is beneficial to the learning and training of the NN.

(2) The data has multiple attribute indicators. Multiple attribute indicators will increase the difficulty of data modeling and increase redundant information. Therefore, we use the principal component analysis algorithm to reduce the dimensionality of multiple attribute indicators, which not only achieves the purpose of dimensionality reduction, but also retains information. .

(3) The data relationship satisfies nonlinearity. The RBF NN can approximate any nonlinear relational expression while avoiding getting trapped in local minima [15-16].

2.4. Center of Gravity Model

The center of gravity was originally a concept in the field of physics. It describes the point of interaction of gravity on various parts of an object. At this point, the object can reach equilibrium. Therefore, the location of the center of gravity is usually used to reflect the spatial distribution of the object. Inspired by this, American scholar Walker built a center of gravity model to analyze the spatial characteristics of the U.S. population. Since then, the model has been gradually extended and applied to the field of economic environment after being revised and improved by Bellone and Cumininghani, and has now become an important tool for spatial analysis. , is often used to study the direction and balance of national or regional development [17-18].

Assuming that the study area is composed of n sub-regions, the geographic center coordinates of the i-th sub-region are (X, Y), where xi and yi represent its longitude and latitude, respectively. Hi is the value of a certain attribute of the ith subordinate area, then the calculation formula of the area barycentric coordinates (X, Y) of this attribute is shown in formula (1) and formula (2):

$$\overline{X} = \frac{\sum_{i=1}^{n} H_i X_i}{\sum_{i=1}^{n} H_i} \tag{1}$$

$$\overline{Y} = \frac{\sum_{i=1}^{n} H_i Y_i}{\sum_{i=1}^{n} H_i} \tag{2}$$

The calculation formula for measuring the degree of deviation is shown in formula (3):

$$\theta = arctg \frac{\overline{Y}_t - \overline{Y}_{t-1}}{\overline{X}_t - \overline{X}_{t-1}} \tag{3}$$

In the formula, $\overline{X}_t - \overline{X}_{t-1}$ and $\overline{Y}_t - \overline{Y}_{t-1}$ represent the changes in longitude and latitude of the regional attribute center of gravity in year t relative to year t-1, respectively. θ is the degree of

deviation from the direction of the center of gravity of the regional attribute reflected by the Euclidean geometric angle.

Table 1. Direction of movement of area attribute center of gravity

Longitude change	Latitude change	Quadrant distribution	Moving direction
$(\overline{X}_t - \overline{X}_{t-1}) > 0$	$(\overline{Y}_t - \overline{Y}_{t-1}) > 0$	First quadrant	Northeast
$(\overline{X}_t - \overline{X}_{t-1}) < 0$	$(\overline{Y}_t - \overline{Y}_{t-1}) < 0$	Second quadrant	Northwest
$(\overline{X}_t - \overline{X}_{t-1}) < 0$	$(\overline{Y}_t - \overline{Y}_{t-1}) < 0$	Third quadrant	Southwest
$(\overline{X}_t - \overline{X}_{t-1}) > 0$	$(\overline{Y}_t - \overline{Y}_{t-1}) > 0$	Fourth quadrant	Southeast

The moving distance D of the regional attribute center of gravity in the t-th year relative to the t-1-th year can be calculated by formula (4):

$$D = C \bullet \sqrt{(X_t - X_{t-1})^2 + (Y_t - Y_{t-1})^2} \tag{4}$$

In the formula, C is the distance coefficient.

3. Experimental Study

3.1. The Research Method of This Paper

On the basis of drawing lessons from previous research experience, starting from the research purpose, this paper comprehensively applies a variety of research methods to achieve better research results, mainly including the following:

(1) Comparative analysis method. Di Guo's comparative analysis of objective things reveals the similarities and differences between them, so as to realize the understanding of the essence of things. This paper has tracked the growth and changes of consumption, the evolution of the relationship between consumption and economic development, and the time-series evolution of consumption efficiency from a dynamic perspective.

(2) This paper defines the relationship between consumption and economic development, consumption efficiency and the development trend of consumption from a qualitative point of view, and calculates and analyzes it through some specific quantitative indicators.

(3) The combination of theoretical analysis and empirical analysis. Theoretical analysis is to understand the essence of things through rational thinking under a certain theoretical framework, while empirical analysis uses feasible analytical tools to objectively reflect things through statistical data, models, etc. The development trend is studied and judged, and then the analysis of consumption characteristics and the forecast of consumption are realized by establishing a characteristic analysis model and a prediction model respectively.

3.2. Scenario Design

(1) Scenario design considering consumption characteristics

Scenario simulation analysis is to make assumptions about its possible future development scenarios after rigorous and detailed analysis of the internal and external environment of the research object. Considering the uncertainty of China's social and economic development and its consumption, this paper proposes three scenarios for the development of China's future consumption: the baseline scenario, the policy planning scenario and the enhanced energy conservation scenario. Based on these three development scenarios, forecasts are made for China's

consumption in the future, covering aspects such as consumption volume, consumption structure, consumption efficiency, supply, and carbon emissions implied by production. By comparing the forecast results of various development scenarios, it is expected to provide a reference for the formulation of efficient and green policies to promote consumption. The specific meaning of each development scenario setting is as follows:

The baseline scenario is an extension of the trend based on the historical development trend of consumption, which assumes that the current situation of consumption will continue, and any future intervention policies will not be adopted. Considering that the consumption characteristics of the new normal period of the economy are quite different from the consumption characteristics of the old normal period, the parameters of the model in this scenario are mainly based on the consumption characteristics of the new normal period and the laws of economic development in this period.

The policy planning scenario is an outlook on the development trend of future consumption in accordance with various policies and plans issued and implemented by the government, taking into account the country's socio-economic development goals. Considering the long forecast period of this paper and the lack of long-term quantitative policies, the research results of domestic and foreign authoritative research institutions or scholars were also referred to when setting the model parameters in this scenario.

Strengthening the energy-saving scenario is a comprehensive consideration of the new characteristics of consumption, energy-saving emission reduction technologies, electric energy substitution and other factors. On the basis of ensuring the realization of the national social and economic development goals, by optimizing and adjusting the existing relevant policies, Make judgments on the development situation of consumption. In this scenario, the supply structure is cleaner, the consumption structure is more reasonable, and the consumption efficiency is more effective.

(2) Scenario parameter setting

In this subsection, according to the setting goals and principles of the three scenarios, the key assumption module, the requirement module and the transformation module of the LEAP model are set up with parameters.

3.3. Scenario Analysis

Scenario analysis is a method of simulating and predicting the impact of the status quo lasting to a certain point in time according to a certain plan based on historically formed data, as well as possible future situations. It not only has qualitative analysis, but also quantitative calculation. On the premise of acknowledging various possibilities, it focuses on the extraction and analysis of key factors.

1) Characteristics of scenario analysis method

(1) There is a historical real data basis. Scenario analysis is to infer possible future situations on the basis of actual data generated after historical operations, rather than simply predicting the future based on the current status quo or policy orientation, and objectively guarantees the accuracy of the forecast.

(2) The combination of qualitative and quantitative. Scenario analysis needs to first use qualitative methods to extract key variables from policy factors to make a rough judgment on possible scenarios; then use quantitative analysis to further calculate different future scenarios accurately, so as to accurately grasp the future trends of the research object.

(3) Reflect the subjectivity of the researcher. The future is unpredictable, especially long-term trends, and it is difficult to fully consider various factors. This poses a challenge to researchers, who

need to give full play to their subjective imagination and make reasonable and scientific judgments about long-term trends.

2) Steps of Scenario Analysis

First, clear goals. First of all, the research objectives must be specified, which determines the selection of different variables for the scenarios to be analyzed, and is also the basis for subsequent forecasting work.

Second, analyze the current situation. Conduct in-depth mining and analysis of historical real data, find out the influencing factors between the respective variables, and provide a data basis for the setting of scenarios.

Third, set the scene. Guided by policy, various factors that may change are considered comprehensively, and different development scenarios are set up in terms of probability of occurrence and importance of impact.

The general flow of scenario analysis can be represented by Figure 2:

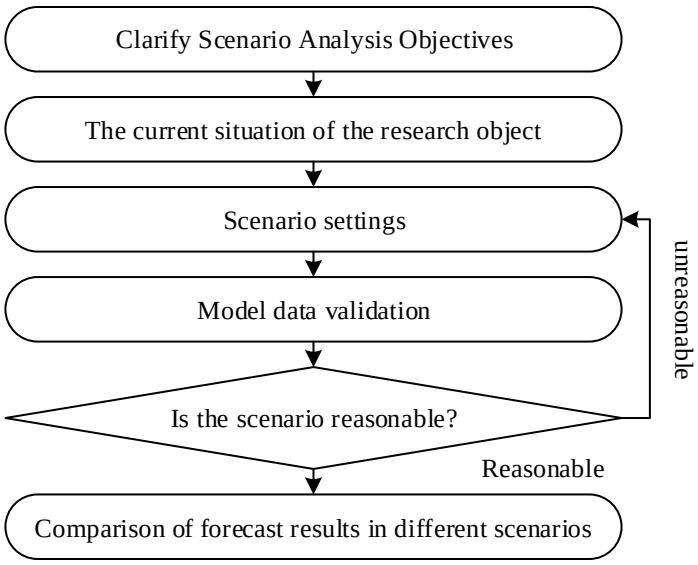

Figure 2. Flow of scenario analysis

4. Experiment Analysis

4.1. Key Assumptions GDP Acceleration Module Parameter Setting

The progress and development of the economy and society is driven by the factors of production, and it is an extremely important factor of production. The improvement of the level of economic development will inevitably lead to the growth of consumption, and the speed of its improvement also affects the growth rate of consumption. From the perspective of historical trend evolution, taking GDP as the characterization variable of economic development level shows the characteristics of trend continuity and stage. The GDP growth rate settings under each development scenario are shown in Table 2.

Table 2. GDP growth rate under various development scenarios

Development Scenario	First Year	Fifth Year	Tenth Year
Baseline Scenario	6.9%	6.9%	6.9%
Policy Planning Scenario	6.6%	6.1%	5.7%
Enhanced energy saving scenarios	6.4%	5.9%	5.6%

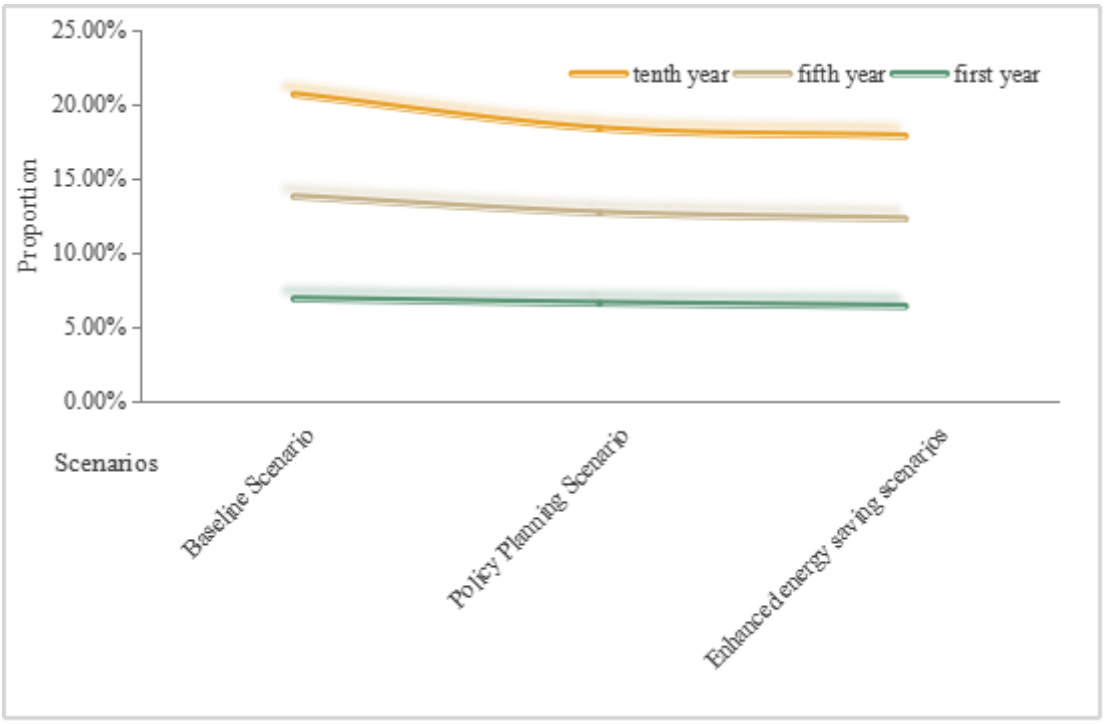

Figure 3. Analysis of GDP growth under various development scenarios

Specifically, GDP has always shown an upward growth trend, but after entering the new normal stage of the economy, its growth rate has changed from the previous high-speed model and has slowed down significantly. According to the outline of the long-term development plan formulated by the government and the prediction of economic growth rate in previous studies, this paper sets the GDP growth rate under the policy planning scenario and the enhanced energy saving scenario. Among them, the GDP growth rate under the enhanced energy saving scenario is lower than The GDP growth rate under the policy planning scenario is mainly due to the strengthening of the energy-saving scenario, more emphasis on the high quality of economic growth, and more implementation of energy-saving and consumption-reducing work.

4.2. Comparison of Results of Several Prediction Algorithms

To compare the predictions, the mean squared error is taken using the error function:

$$MSN = \frac{1}{n}\sum_{p=1}^{n}\sum_{k=1}^{k+1}(T_k^p - Y_k^p)^2 \tag{5}$$

Where T is the actual value and Y is the predicted value.

The errors of the three prediction methods are calculated, and the error results obtained are shown in the table.

Table 3. Errors obtained by three prediction algorithms

Method of Prediction	Error%
Multiple Linear Regression Algorithm	0.483
Principal Component Regression Algorithm	0.214
DNN Model	0.059

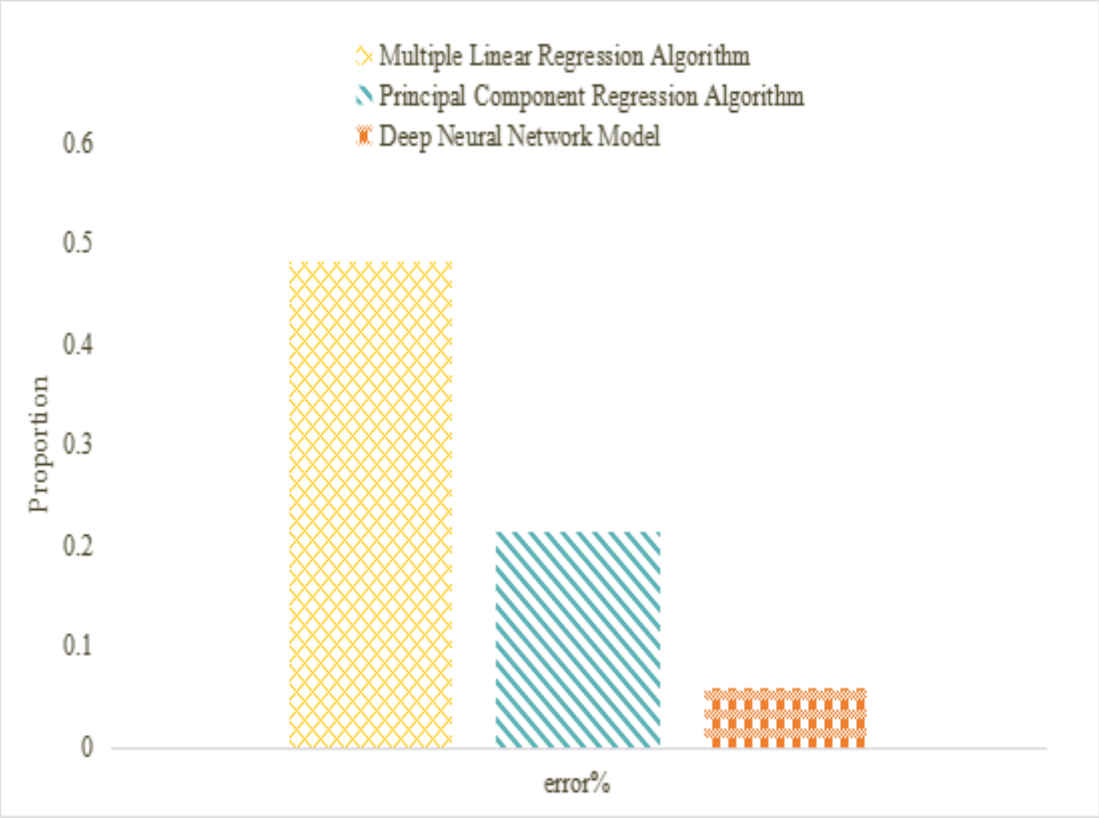

Figure 4. Error analysis plots obtained by three prediction algorithms

Through the comparison charts and error comparison tables of the three prediction results, it is found that the RBF NN algorithm in this paper has the best prediction effect. The prediction error of the multiple linear regression algorithm is 0.483, the prediction error of the principal component regression algorithm is 0.214, and the prediction error of the deep neural network (DNN) algorithm is 0.059, which is an order of magnitude higher than the previous two algorithms in accuracy.

5. Conclusion

Although there have been fruitful research results on the analysis of the relationship between consumption and economic development, the analysis of influencing factors, the analysis of consumption efficiency, and the forecast analysis of development trends, due to the regional attributes of consumption and temporal properties, and no uniform and authoritative conclusion emerges. Considering that China has become the world's largest producer and consumer, analyzing and forecasting its consumption is of great significance for leading the evolution of the global consumption pattern, adapting to and mitigating climate change, especially at the current stage of China's economy in the transition of old and new kinetic energy and transformation and upgrading. , the ongoing core changes are the driving force behind the challenges facing economic transformation and upgrading. Similarly, the transformation and upgrading of the economy is also actively promoting the transformation and development of China. Affected by this, the characteristics of Chinese consumption in this context are different from those of the past, and there is an urgent need to systematically analyze them. Therefore, in terms of cycle synergy, on the basis of in-depth analysis of the consumption cycle law, this paper abandons the previous use of graphs to judge whether there is synergy between the two cycles, but quantitatively measures by constructing a consistency index.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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