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Research on Grain system based on combination forecasting Model

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Abstract: In order to solve the instability and other problems of the food system, achieving equity and sustainability goals, we will optimize the past food system. First of all, this paper establishes a safety evaluation model of the food system, and discusses the production, supply and distribution of food by evaluating the safety of the food system. Then a prediction model is established to predict when the optimized system should be implemented.

1. Introduction

From the relevant data and reports, there are still many people in the world suffering from hunger. But in developed countries, people waste food, leading to all kinds of obesity problems [1]. The distribution and operation of the food system faces enormous challenges. Food system plays an important role in society, and its health is closely related to social health, economic development and ecological environment. Therefore, the establishment of a more perfect food system to lay the foundation for sustainable development can greatly accelerate the realization of sustainable development goals [2].

Some data show that the current unstable food system also has an impact on the environment, and improving our food system is very important to alleviate environmental problems. Therefore, we will combine the above background factors to establish a more stable food system.

2. Construction of Evaluation Model of Grain system

In order to achieve the goal of an equitable food system, we have chosen to use food security assessments to discuss food production capacity, supply capacity and the content of interests and policies [3-4]. A fair food system must ensure that there are no food shortages and that food insecurity occurs. So, we decided to make the necessary evaluation of the safety of the food system [5].

For the multi-objective evaluation, we set up the subsystems and we have established food production capacity, food supply levels and food distribution as subsystems. The corresponding indicators for each subsystem are shown below:

Table 1: Indicators corresponding to each subsystem

Subsystem	Index
Food production capacity	Per capita arable land area, per unit grain output
Food supply level	Total grain output (unit: ten thousand tons), Food supply per capita (unit: kg), Average animal protein supply (unit: g/ person/day), Food imports, Food self-se ratio
Food distribution	Domestic grain price index, Food Insufficiency Incidence (unit: %), Engel's coefficient (unit: %)

The risks caused by the surge of grain imports mainly come from domestic and foreign markets. The factors affecting the risk of grain imports are summarized as follows: (1) International grain price index; (2) Domestic currency exchange rate; (3) Domestic grain price index; (4) GDP; (5) Domestic grain production.

Using multiple regression methods, we establish the following relationship:

$$IM = C + a_1 IFPI + a_2 LCER + a_3 GFPI + a_4 GDP + a_5 DCP + \mu \quad (1)$$

In the formula, the grain import quantity is expressed by IM, the international grain price is expressed by $IFPI$, the domestic currency exchange rate is expressed by $LCER$, the domestic grain price is expressed by $GFPI$, the domestic grain production is expressed by DCP, μ is the error term, and $a_1 \sim a_5$ is the parameter of the multiple regression model.

Grain self-sufficiency rate = grain import/grain output 100 (unit: %).

Due to the differences in the magnitude, magnitude, positive and negative of different indicators, it is necessary to standardize the original data and deal with the indicators with positive and negative effects.

Calculate the proportion of the j index value in the i year:

$$Y_{ij} = X'_{ij} / \sum_{i=1}^{m} X'_{ij} \quad (2)$$

The calculation of index information entropy:

$$e_j = -k \sum_{i=1}^{m} \left(Y_{ij} \times \ln Y_{ij} \right) \quad (3)$$

If $k = 1/\ln m$, then $0 \le e_j \le 1$, and if $Y_{ij}=0$, then $Y_{ij} \times \ln Y_{ij} = 0$.

Calculation of information entropy redundancy: $d_j = 1 - e_j$

Determination of index weight: $w_i = d_j / \sum_{j=1}^{n} d_j$

In the formula, X_{ij}' and X_{ij} are respectively the standardized value and the original value of the j single index in the year I; $\min X_{ij}$ and $\max X_{ij}$ are the minimum and maximum values for item j individual indicators in all years, m is the number of years of evaluation, and n is the number of indicators. The index weights were determined according to the above methods, and the weight of each single index was calculated respectively. According to the food system evaluation index system. and method constructed, the development index and its changing trend of the food subsystem and the food security system were obtained by using the weight function. Its calculation formula is:

$$S=\sum_{i=1}^{4}\sum_{j=1}^{n}\left(X_{ij}^{'}\cdot w_i\right) \tag{4}$$

In the formula: $X_{ij}^{'}$ is the standardized value of the individual indicators corresponding to each food security subsystem, $\sum_{j=1}^{n}\left(X_{ij}^{'}\cdot w_i\right)$ is the evaluation value of the food security subsystem development index, and S is the comprehensive evaluation value of the food system development index.

3. Model establishment of combination forecasting method

Analyze the factors influencing the comprehensive index of the food system, the impact factor of previous data are exponential smoothing processing, using the grey theory, predict the new data, impact factor, through iteration default after a threshold, by influencing factor correlation analysis, correlation factor, selected data from the past food system comprehensive index for differential treatment, using multiple linear regression and residual error correction annual food system comprehensive index to predict.

Step 1: Differencing Operator is carried out on the data of the influence factor of the comprehensive index of grain system in previous year, calculates the amount of volatility in the data adjacent to the influence factor. The fluctuation of adjacent data is:

$$z(k)=\frac{x(k)-x(k-1)}{x(k-1)} \tag{5}$$

The overall average fluctuation is: $z=\frac{\sum_{k=1}^{n}\left|z(k)\right|}{n}$

If the absolute value of a fluctuation is greater than the overall average volatility, then the data is replaced by the previous data plus (or minus) the overall average volatility, and the data is found to:

$$x(k)=x(k-1)+(1+\frac{z(k)}{\left|z(k)\right|})\times z \tag{6}$$

Step 2: Exponential smoothing is performed on the data processed in Step 1 to further reduce the volatility of the data. The exponential smoothing processing formula is as follows:

$$x'(k)=e^{x(k)} \tag{7}$$

Step 3: By using the grey model and processed data of the impact factor of the comprehensive index of grain system in previous years, the grey model of the impact factor data of the next few years is predicted as follows:

Set the time series $X^{(0)}$ there are n views to measure column $X^{(0)}=\{X^{(0)}(1),X^{(0)}(2),\cdots,X^{(0)}(n)\}$, the new sequence $X^{(1)}=\{X^{(1)}(1),X^{(1)}(2),\cdots,X^{(1)}(n)\}$, is generated by add-up, and the corresponding split equation for model $GM(1,1)$ is: $\frac{dX^{(1)}}{dt}+aX^{(1)}=\mu$

In the formula: a is the number of grays for development

The parameter vector to be estimated is α, $\alpha=[a \quad \mu]^T$ is achieved by the least-multiplication method.

$$\alpha = (B^T B)^{-1} B^T Y_n \tag{8}$$

Step 4: The comprehensive index of grain system is predicted by using the predicted future impact factor data and multiple regression methods. In previous years, the comprehensive index and influence factor data of grain system were initially imagined and first-order buffer operators were calculated.

Step 5: The correlation coefficient between the comprehensive index $x_0'''(k)$ and the impact factor $x_i'''(k)$ of the grain system was calculated, i.e.

$$G(i) = \frac{\min\left|x_0'''(k) - x_i'''(k)\right| + 0.5 \times \max\left|x_0'''(k) - x_i'''(k)\right|}{\left|x_0'''(k) - x_i'''(k)\right| + 0.5 \times \max\left|x_0'''(k) - x_i'''(k)\right|}, i = 1, 2, 3, \cdots, m \tag{9}$$

Step 6: Filter the influence factors with large correlation factors. In order to improve the prediction accuracy, only the influence factor with an association coefficient greater than 0.8 is retained.

Step 7: Using multiple linear regression models in the comprehensive index for food system.

Step 8: Perform the inverse operation of step 4.

Step 9: Residual correction. The difference between the forecasted comprehensive index of food system and the actual comprehensive index of food system in previous years is used as input data. The error of the comprehensive index of food system in the next few years is predicted by grey theory (step 4), and the error is used to revise the comprehensive index of food system in the coming years.

Step 10: Calculate the relative error of the food system comprehensive index prediction.

Step 11: Normalize the results. Complete the forecast.

4. Model result

This paper selects the factors that have a great impact on the new grain system, and uses our pre-established evaluation model to form a comprehensive index. Collate the United States from 1995 to 2005 using MATLAB tools to achieve forecasting models.

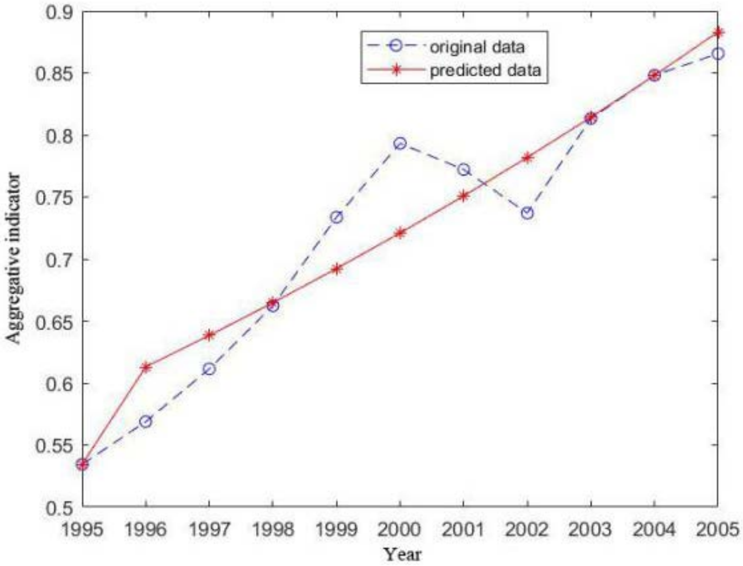

Figure 1: Data of the United States

5. Conclusion

Based on the analysis and research of the global food system, this paper first compares the global food system and establishes the food system safety evaluation model. Then the grey prediction model is established by combining the evaluation model, and then through the correlation analysis of influence factors and correlation factors, the data are selected from the previous grain system comprehensive index for differential processing, and the results of the American prediction model are obtained.

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