Analysis and Decision-making of Regional Economic Vitality

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***Abstract*—In order to study the impact of different leaders on the U.S. economy, this paper uses a gray correlation model to obtain the more sensitive and prominent factors among all the factors. After that, these factors are used to calculate the corresponding multiple linear regression equations to predict the U.S. economy.**

Keywords-advanced correlation analysis, multiple linear regression, gray prediction model

I. INTRODUCTION

The U.S. presidential elections are held every four years. 2020 is the annual U.S. presidential election, with Republican candidate Donald Trump and his opponent, Democrat Joe Biden, running for president. The candidates of the two parties have different political positions on key development areas such as finance and trade. The election of the different candidates will have a large impact on the U.S. economy as well as the global economy.

Economic dynamics is an important indicator that can reflect the economic situation and economic development potential, and the gray model can be better applied to predict the development trend of GDP in the future[1].Analyzing the impact of different indicators [2] on the U.S. economy through the gray correlation method and used the principal component analysis to extract the main factors[3],which finally gave the quantitative calculation of economic vitality indicators.

Therefore, it is important to objectively and compreh - ensively evaluate the impact of the policies of the two candidates on the economy and explore the reasons for the differences, in order to have a greater impact on the U.S. economy as well as the global economy. In this paper, our study intend to analyze and model the impact of different factors on economic development and use them to make predictions for future U.S. economic development

II. MODEL BUILDING

.Gray correlation analysis

1)Determine the reference series and comparison series.

The data series reflecting the characteristics of the system behavior is called the reference series. The data series consisting of factors that affect the system behavior is called the comparison series.

2)Dimensionless processing of the reference series and comparison series

The physical meaning of the factors in the system is different, resulting in the data not necessarily having the same magnitude, which does not facilitate comparison.

3)Finding the gray correlation coefficient of the reference series and the comparison series

The degree of correlation is, in essence, the degree of difference in geometry between the curves. Therefore, the size of the difference between the curves can be used as a measure of the degree of correlation. For a reference series X_0, there are several comparative series $X_1, X_2, \ldots, X_n$ .The correlation number $\xi(X_i)$ between each comparative series and the reference series at each moment (i.e., each point in the curve) can be calculated by the following formula: ρ is the coefficient of discrimination, usually between 0 and 1, usually 0.5

$\Delta\max$ is the maximum difference between the two levels.

To absolute difference between each point on the Xi curve of each comparison series and each point on the X0 curve of the reference series, and is given as $\Delta_{oi}(k)$.

So the number of contacts $\xi(X_i)$ can also be simplified as the following equation：

$$\xi_{oi} = \frac{\Delta(\min) + \rho\Delta(\max)}{\Delta_{oi}(k) + \rho\Delta(\max)}$$

4)Find the degree of relevance

Because of the correlation series correlation:

$$r_i = \frac{1}{N}\sum_{k=1}^{N} \xi_{oi}(k)$$

r_i - compares the gray correlation of a series X_i to a reference series X_0, or serial, average, or line correlation.

The closer the r_i value is to 1, the better the correlation.

5)Relevance

The degree of association between factors is mainly described by the order of the degree of association, not just the size of the association. The correlation degree of m subsequences to the same parent sequence is arranged in the

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order of size, then the correlation sequence is formed as $\{x\}$, which reflects the "superiority" relationship of each subsequence to the parent sequence.

If $r_{0i} > r_{0j}$, then $\{x_i\}$ is said to be better than $\{x_j\}$ for the same parent sequence $\{x_0\}$, and is recorded as $\{x_i\} > \{x_j\}$; r_{0i} represents the eigenvalue of the subsequence.

Gray correlation analysis [4] is to consider the factor values of the object of study and the influencing factors as points on a line, compare them with the curve drawn by the factor values of the object to be identified and the influencing factors, compare the closeness between them, and quantify them separately to calculate the correlation degree of closeness between the object of study and the influencing factors of the object to be identified, and judge the degree of influence of the object to be identified on the object of study by comparing the magnitude of each correlation degree.

.Multiple Linear Regression

1)Create multiple linear regression equations

Due to the multifaceted nature of the relationship between things, changes in a dependent variable may be influenced by multiple other independent variables, so multiple linear regression equations are created.

2) Basic Model and Steps：

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_m x_m + e$$

The above equation indicates that the variable y in the data can be approximated as the linear function of independent variable $x_1, x_2, \ldots, x_m$.

β_0 is a constant term, β_m is the partial regression coefficient，which represents the average change in when x_j increases or decreases by one unit, holding the other independent variables constant, e is the random error (residual) after removing the effect of m independent variables on y.

3) General steps

a.Find the partial regression coefficient$b_0, b_1, b_2, \ldots\ b_m$

b. Derive the regression equation：

$$\hat{y} = b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_m x_m$$

c. Test and evaluate the regression equation and the effect of each variable.[5]。

.GM(1,1)(Grey prediction model)

1)The basic principle

Gray Prediction identifies the degree of disparity in development trends between system factors, that is, performs correlation analysis, and generates and processes the original data to find the rules of system changes, generates data sequences with strong regularity, and then establishes corresponding differential equations to predict the future developments. It constructs a Gray Prediction Model with a series of quantitative values of the characteristics of the prediction object observed at equal time intervals and predicts the feature quantity at a certain time in the future, as well as the time it takes to reach a certain feature quantity.

2)Basic steps

a. Data inspection and processing

To ensure the feasibility of the $GM(1,1)$ modeling method, it is necessary to check the known data

.Set the original data column as $x^{(0)} = (x^0(1), x^0(2), \ldots, x^0(n))$，calculate the ratio of the sequence：

$$\lambda(k) = \frac{x^{(0)}(k-1)}{x^{(0)}(k)}$$

If all the grade ratios fall within the acceptable coverage interval, the sequence $x^{(0)}$can establish a $GM(1,1)$ model and can perform gray prediction. Otherwise, perform appropriate transformation processing on the data, such as translation transformation:

$$y^{(0)}(k) = x^{(0)}(k) + c \quad , k = 1,2, \ldots, n$$

c is taken so that the rank ratio of the data column falls within the acceptable coverage.

b. Establish $GM(1,1)$ model

May wish to set $x^{(0)} = (x^0(1), x^0(2), \ldots, x^0(n))$ to meet the above requirements, and use it as a data column to establish a $GM(1,1)$model.：

$$x^{(0)}(k) + a x^{(1)}(k) = b$$

Use regression analysis to obtain the estimated values of a and b, so the corresponding whitening model is :

$$\frac{dx^{(0)}(t)}{dt} + a x^{(1)}(t) = b$$

Solution to：

$$x^{(1)}(t) = \left(x^{(0)}(k) - \frac{b}{a}\right) e^{-a(t-1)} + \frac{b}{a}$$

So get the predicted value:

$$\hat{x}^{(1)}(k+1) = \left(x^{(0)}(1) - \frac{b}{a}\right) e^{-ak} + \frac{b}{a}$$

To get the predicted value accordingly:

$$\hat{x}^{(0)}(k+1) = \hat{x}^{(1)}(k+1) - \hat{x}^{(1)}(k)$$

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III. MODELS SOLUTION

I. Models Solution

(1)Grey correlation method to extract key factors.

Based on data provided by the World Bank in various parts of the United States from 2008 to 2018, 8 factors have been selected initially that have a greater impact on US GDP (the proportion of fossil fuel energy consumption, railways (total kilometers), renewable energy power generation and energy consumption). Screening these 8 factors by gray correlation degree with MATLAB software, and then their correlation degrees are shown in Table 1.

Factors	Employment rates	railway	Renewable power generation	Science and technology research
Correlation coeffient	0.6946	0.4681	0.5193	0.6776
Factors	taxation	Commodity trade	Fossil fuels	Energy consumption
Correlation coeffient	0.7272	0.9368	0.7115	0.6522

Table 1. The gray correlation degree

From this figure, a 5-factor correlation filtered from these 8 factors can form obviously. It includes commodity trade, taxation, fossil fuels, employment rates, science and technology research and development expenditures, all of which are associated with a greater likelihood of economic growth.

(2)Gray prediction for five-factor

Using the gray correlation method, the five factors with a greater degree of correlation applied to gray prediction models later can be screened out. The specific prediction result is as follows:

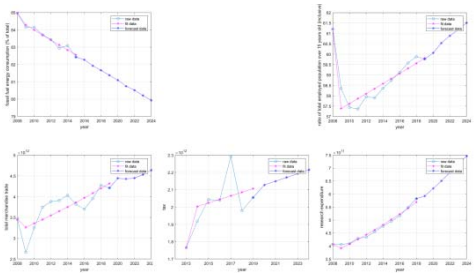

Figure 1. The five factors are respectively used to predict the results of the gray prediction model

To predict their impact on future GDP, the forecast data obtained from each factor of our forecasts are substituted for Trump and Biden into the multiple regression equation (Below are the predictors of the two different leaders: x1, x2, x3, x4, and x5 represent the proportion of fossil fuel energy consumption, commodity trade, technology research and development expenditure, employment rate, and taxation) Based on 19 years of data, the following rationalized predictions based on Biden's policies during the general election have been made: x1 (fossil fuel) decreases by 3% each year, x2 (trade volume) increases by 3% each year, x3 (research and research expenditures) An annual increase of 3%, x4 (the employment rate) an annual increase of 0.635% (based on the population of the United States), and x5 (tax revenue) an annual increase of 3%.

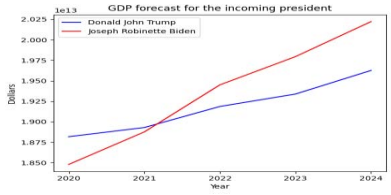

Figure 2. GDP forecast for the incoming president

II. Model Adaptability Test

An improved neural network model for sensitivity analysis. Figure IV below shows the average relative residuals and rank ratio bias tests. The results show that the five factors fit well.

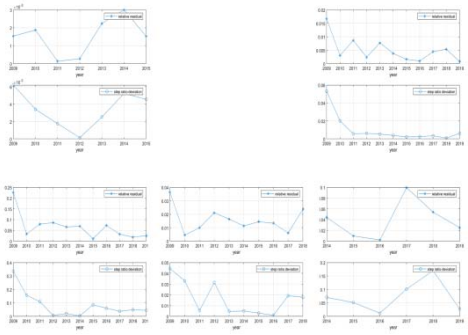

Figure 3. Test of average relative residual and grade deviation

IV. .CONCLUSION

.In summary, in the long run, Biden's policies are good for the U.S. economy. However, in the short term, Biden's policies have not worked as well as Trump's policies. In the long run, Biden's policies are far better than Trump's policies in terms of the long-term development of the United States. His presidency will benefit the U.S. economy. It is not difficult to conclude that new energy sources and energy conservation and environmental protection have huge economic benefits and prospects, although they do not bring the same benefits as traditional energy sources in the short term

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