Research Article **JME (2020) 3:12**

Journal of Modern Economy
(ISSN:2577-8218)

Assessing the Impact of Garbage Classification on China's Economic Environment

Baogang Song[1*], Xing Li[2], Weiming Jing[3], Qian Zhang[4]

[1]College of Hydraulic & Environmental Engineering, China Three Gorges University, Yichang, 443002, China. [2]College of Mechanical & Power Engineering, China Three Gorges University, Yichang, 443002, China. [3]College of Computer & Information Technology, China Three Gorges University, Yichang, 443002, China. [4]College of Arts & Communication, China Three Gorges University, Yichang, 443002, China.

ABSTRACT

This article mainly studies the impact of waste classification on China's economy and environment. For the economy, the annual per capita waste removal volume, waste disposal cost, and waste disposal profit from 2008 to 2017 were selected as the three input indicators, and GDP was used as the output value. A BP neural network model based on GM (1,1) was established. The GM (1,1) model is used to predict the values of the three indicators in the next five years. The relationship between GDP and the three input indicators is determined using the BP neural network. The three indicators are substituted into the model to obtain the GDP in the next five years. value. As for the environment, the number of resource processing plants, resource processing capacity, and resource processing capacity are selected as three input indicators, and the per capita green space area is used to measure the impact on the environment. The same method is used to predict the per capita public green area in the next five years. The results show that garbage classification will have a beneficial impact on China's economy and environment, but the impact will weaken year by year.

Keywords: Garbage classification; Gray prediction; BP neural network

***Correspondence to Author:**
Baogang Song
College of Hydraulic & Environmental Engineering, China Three Gorges University, Yichang, 443002, China.

How to cite this article:
Baogang Song, Xing Li, Weiming Jing, Qian Zhang. Assessing the Impact of Waste Classification on China's economic environment Based on Gray Prediction and BP Neural Network Model. Journal of Modern Economy, 2020; 3:12

eSciPub LLC, Houston, TX USA.
Website: http://escipub.com/

1. Introduction

In order to alleviate the shortage of domestic resources, China once relied on imported solid waste from developed countries for recycling. In 2017, the Chinese government issued a ban on foreign garbage, announcing that from December 31, 2017, imports of four types of solid waste, including waste plastics, waste paper, waste textile raw materials, and boron residue, were banned. In 2018, the State Council proposed to basically achieve zero imports of solid waste by the end of 2020. In the long run, this policy has also forced China to increase the domestic waste recycling rate and build a greener and healthier waste recycling system. At present, the state has taken action. In March 2017, the National Development and Reform Commission and the Ministry of Housing and Urban-Rural Development's "Implementation Scheme for the Classification of Domestic Waste" required 46 cities to implement mandatory classification of domestic waste first, and the recycling rate of domestic waste by the end of 2020 should be more than 35%. This paper establishes a GM (1,1) - based BP neural network model by selecting appropriate indicators, and studies and analyzes the impact on China's economy and environment after the formal implementation of China's garbage collection policy. The two indicators of gross domestic product (GDP) and environmental performance index (EPI) are used to express changes in China's economy and environment. Take the impact on the economy as an example: first, use the per capita waste removal and transportation volume, waste disposal costs, and waste disposal profits for the ten years from 2008 to 2017 to make gray predictions, and obtain the three sets of indicators for 2018 to 2024, and Carry out the residual error test, the step deviation test, the correlation test, and the posterior error test, and proceed to the next step on the premise that all tests are qualified. Then, based on the data of the previous ten years, the relationship between per capita waste removal volume, waste disposal cost, waste disposal profit and GDP were obtained through BP neural network training. Based on the gray forecast of the three sets of indicators from 2018 to 2024, which are substituted into the results of the BP neural network, the GDP value for the next seven years can be obtained, and the impact of the garbage collection policy on the Chinese economy can be analyzed.

2. Model establishment

First, use the per capita waste removal and transportation volume, waste disposal cost, and waste disposal profit for the ten years from 2008 to 2017 to make a gray forecast, and predict three index values from 2018 to 2024. Then based on the data of the previous ten years, the relationship between per capita waste removal volume, waste disposal cost, waste disposal profit and GDP were trained through BP neural network. Through the gray forecast of the three index values from 2018 to 2024, which are substituted into the results of the BP neural network, the GDP value for the next seven years can be obtained, and the impact of the garbage policy on the Chinese economy can be obtained.

2.1 Application of gray prediction model:

Analyze the data of the past ten years, apply the gray prediction model to predict the per capita waste removal, waste disposal cost, and waste disposal profit in the next seven years, and make three predictions in total. Select any one group as an example to establish 1) Forecasting model.

(1) Select a set of original series and set:

$$h^{(0)}(t) = (h^{(0)}(1), h^{(0)}(2), \cdots, h^{(0)}(10))$$

Perform a step test, so that the step ratio of the series is $\lambda(t) = \frac{h^{(0)}(t-1)}{h^{(0)}(t)} \quad (t = 2, 3, 4\cdots, 10)$

It is necessary to determine whether each item of the sequence falls within the tolerable coverage of $(e^{-\frac{2}{n+1}}, e^{\frac{2}{n+2}})$, and to obtain the rank ratio of the sequence. If the rank ratio of the sequence has not fallen within the tolerable coverage range, a translation transformation is required, and the constant c is introduced: $y^{(0)}(t)=h^{(0)}(t)+c$

Make the new series' ratio $\lambda'(t)=\frac{y^{(0)}(t-1)}{y^{(0)}(t)}$ within the required tolerable coverage $(e^{-\frac{2}{n+1}}, e^{\frac{2}{n+2}})$, and then use the new series to calculate; if the original series meets the original tolerable coverage, no translation transformation is required.

(2) Accumulate new data that meets the requirements:

$$y^{(1)}(t)=(y^{(1)}(1), y^{(1)}(2),,\cdots, y^{(1)}(10))=$$
$$(y^{(0)}(1), y^{(1)}(1)+y^{(0)}(2),\cdots y^{(1)}(7)+y^{(0)}(10))$$

among them, $y^{(1)}(t)=\sum_{i=1}^{t} y^{(0)}(t) \quad t=1,2,\cdots,10$

Find the mean series:

$$z^{(1)}(t)=0.5y^{(1)}(t)+0.5y^{(1)}(t-1) \quad (k=2,3,\cdots,10)$$

(3) Construct the data matrix B and data vector Y

$$B=\begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(10) & 1 \end{bmatrix}=\begin{bmatrix} -(0.5y^{(1)}(2)+0.5y^{(1)}(1)) & 1 \\ -(0.5y^{(1)}(3)+0.5y^{(1)}(2)) & 1 \\ \vdots & \vdots \\ -(0.5y^{(1)}(10)+0.5y^{(1)}(9)) & 1 \end{bmatrix}$$

$$Y=(y^{(0)}(2), y^{(0)}(3), y^{(0)}(4),\cdots, y^{(0)}(10))^T$$

Let $\hat{u}=(a,b)^T=(B^TB)^{-1}B^TY$ the value of a,b can be obtained and substituted into the following model $\frac{dy^{(1)}}{dt}+ay^{(1)}=b$

Available

$$\hat{y}^{(1)}(t+1)=(y^{(0)}(1)-\frac{b}{a})e^{-at}+\frac{b}{a} \quad t=1,2,\cdots,9$$

(4) Substituting different values of t can be used to obtain the sequence of $\hat{y}^{(1)}(t+1)$, and then this sequence is gradually descended to obtain $\hat{y}^{(0)}(t+1)=\hat{y}^{(1)}(t+1)-\hat{y}^{(1)}(t)$

If the original sequence has been transformed by translation, the constant c must be subtracted to obtain the predicted value.

Use Matlab software to get the per capita waste removal volume, waste disposal cost and waste disposal profit in the next seven years. The specific results are shown in the table below:

Table 1 Gray prediction results

years (year)	Per capita waste removal volume (tons / person)		Cost of domestic waste disposal (100 million yuan)		Profit from waste disposal (100 million yuan)	
	actual	forecast	actual	forecast	actual	forecast
2008	0.116	0.116	109.100	109.100	1124.435	1124.435
2009	0.118	0.113	208.200	361.947	1381.943	1210.590
2010	0.118	0.117	408.800	386.541	1529.190	1480.339
2011	0.122	0.122	587.000	411.656	1577.890	1779.780
2012	0.126	0.126	465.100	437.302	2138.597	2112.183
2013	0.127	0.131	475.200	463.490	2505.309	2481.174
2014	0.131	0.136	419.300	490.233	2826.147	2890.782
2015	0.139	0.140	505.400	517.543	3339.401	3345.478
2016	0.147	0.146	577.700	545.430	3907.782	3850.224

2017	0.155	0.151	540.900	573.907	4452.181	4410.530
2018		0.156		602.987		5032.512
2019		0.162		632.683		5722.959
2020		0.168		663.007		6489.407
2021		0.174		693.973		7340.221
2022		0.180		725.595		8284.688
2023		0.187		757.886		9333.118
2024		0.194		790.860		10496.954

(5) Predicted value test

a. Residual test

Residual $\varepsilon(t)=\frac{y^{(0)}(t)-\hat{y}^{(0)}(t)}{y^{(0)}(t)} \quad (t=1,2,\cdots,7)$

If $\varepsilon(k)<0.2$, it can be considered to meet the general requirements; if $\varepsilon(k)<0.1$, it is considered to meet the higher requirements.

Known by calculation, it can be known that all the test residuals meet $\varepsilon(k)<0.2$,and can be concluded that the prediction results meet the general requirements, and the model is initially qualified.

b. Step deviation test

$$\rho(t)=1-(\frac{1-0.5a}{1+0.5a})\lambda(t)$$

If $\rho(t)<0.2$, it can be considered to meet the general requirements; if $\rho(t)<0.1$, it is considered to meet the higher requirements.

Known by calculation, it can be known that all the values meet $\rho(t)<0.2$, the prediction result can be considered to meet the general requirements, and the preliminary judgment model is qualified.

c. Association test

Define the correlation coefficient, $\Delta^{(0)}(t)$ is the absolute error of the t-th points $y^{(0)}$ and $\hat{y}^{(0)}$; ρ is the resolution, and the change interval is between (0,1), generally ρ=0.5 ;

$$\eta(t)=\frac{\min\Delta^{(0)}(t)+\rho\max\Delta^{(0)}(t)}{\Delta^{(0)}(t)+\max\Delta^{(0)}(t)}$$

The definition of the correlation between $y^{(0)}$ and $\hat{y}^{(0)}$ is $r=\frac{1}{n}\sum_{t=1}^{n}\eta(t)$

Calculate the correlation coefficient of the original sequence $y^{(0)}$ and $\hat{y}^{(0)}$ according to the above method, and then calculate the correlation degree. According to the data, when ρ=0.5 , the correlation degree is greater than 0.6 to meet the test criteria.

According to calculations, the correlations of the three groups of predicted values are: 0.6534, 0.7024, and 0.6875, and the correlations are greater than 0.6, and the test results are acceptable.

d. Posterior difference test

Calculate the standard deviation of the original series and the standard deviation of the absolute error series, respectively

$$S_1=\sqrt{\frac{\sum_{t=1}^{n}[y^{(0)}(t)-\bar{y}^{(0)}]^2}{n-1}}, \quad S_2=\sqrt{\frac{\sum_{t=1}^{n}[\Delta^{(0)}(t)-\bar{\Delta}^{(0)}]^2}{n-1}}$$

Calculate the variance ratio $C = \frac{S_2}{S_1}$ and find the small error probability $P = P\{e_t < S_0\}$, where $e_t = \left|\Delta^{(0)}(t) - \bar{\Delta}^{(0)}\right|$, $S_0 = 0.6745 S_1$, Calculate the magnitude of this probability $P = P\left\{\left|\Delta^{(0)}(t) - \bar{\Delta}^{(0)}\right| < 0.6745 S_1\right\}$

Evaluation of gray prediction accuracy standards for P and C.

Table 2: Grey prediction accuracy checklist

Inspection index	excellent	good	moderate	poor
P	> 0.9	> 0.8	> 0.7	≤ 0.7
C	< 0.35	< 0.5	< 0.65	≥ 0.65

According to the prediction results, the four tests mentioned above were performed, and the results passed the tests. Therefore, the prediction result obtained by using the gray prediction model is good and can be used for the next calculation.

2.2 Application of BP neural network prediction model

The annual GDP per capita is estimated by using the amount of garbage removal and transportation per person, the cost of waste disposal, and the profit of waste disposal. The BP neural network is established as follows.

(1) BP neural network topology

Construct a three-layer neural network, which is an input layer, a hidden layer, and an output layer. The three neurons in the input layer are per capita waste removal volume, waste disposal cost, and waste disposal profit. Learn to calculate the national GDP of the output layer. After continuous learning and error back-propagation correction, change the error and improve the correct rate of the network response to the input mode. The structure of the BP network model is as follows:

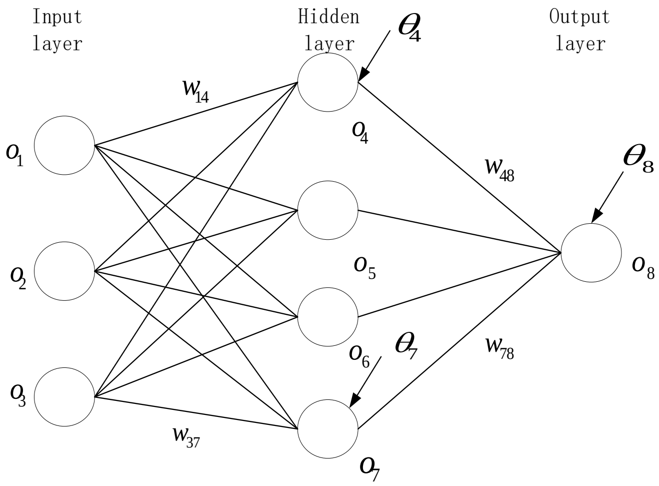

Fig. 1: BP neural network model

(2) BP neural network training

a. Forward input

Let $o_i \quad (i = 1, 2, 3)$ be the input value. In this paper, it is the per capita waste removal volume, waste disposal cost, and waste disposal profit; $o_j \quad (j = 4, \cdots, 8)$ is the neuron representation of the hidden layer and the output layer; o_8 is the output layer neuron, which is the national GDP; w_{ij} is the weight between each unit and the next unit connection; θ_j is the bias of each neuron in the hidden layer and the output layer.

It is transformed into the output value of the next layer through non-linear changes. For the input layer, the output of the next layer is the value in the hidden layer, and for the hidden layer, the output of the next layer is the value in the output layer $o_j = \frac{1}{1+e^{I_j}}$

The first forward input can make all the neurons in the hidden layer and the input layer assign values, and then correct the errors by back propagation.

b. reverse transmission

Output layer error calculation. o_j is the value of the last forward broadcast, T_j is the actual value of the output layer

$$E_{rrj} = o_j(1-o_j)(T_j - o_j)$$

Weight update:

$$\Delta w_{ij} = l \times E_{rrj} o_i$$

$$w_{ij} = w_{ij} + \Delta w_{ij}$$

Biased update:

$$\Delta \theta_j = l \times E_{rrj}$$

$$\theta_j = \theta_j + \Delta \theta_j$$

After one backpropagation, the weight and bias can be corrected once, and the neurons in the hidden layer and the input layer are assigned a second time through a forward propagation, the error is calculated again, and the broadcast is reversed until the error is small enough, that is, training carry out.

Substituting the predicted three input values for the next seven years into the trained network can obtain the national GDP, and analyzing the changes in GDP can draw relevant conclusions.

In the same way, replace the three indicators of economic impact with the three indicators of environmental impact: the number of resource processing plants, resource processing capacity, and resource processing capacity per year. First, the predicted values of these three indicators in the next seven years are predicted. In the test of the gray prediction results, the test results are good.

The BP neural network model of the relationship between the per capita green space area and the index trained from the data of the past ten years is used to obtain the per capita green space area in the next seven years. Finally, the impact of waste classification on the environment is analyzed.

3. Model solving

This model is a BP neural network model based on gray predictions. The predicted values of GNP and per capita green space in the next five years are obtained by using Matlab software. The specific data are shown in the table below：

Table 3: Predicted values of GNP and per capita green space

Year (year)	2020	2021	2022	2023	2024
Gross National Product (100 million yuan)	963900	998400	1022000	1037700	1048200
Per capita green space (square meters)	14.2679	14.2966	14.3114	14.3181	14.3205

According to the predicted values of China's economic and environmental indicators in the table, the impact of waste classification on China's economic environment in the next five years can be analyzed.

4. Results analysis

4.1 The results of solving the economy

From the predicted and actual values of the per capita waste removal and transportation volume, the cost of waste disposal, and the profit of waste disposal in Table 1, the following grey prediction results can be drawn.

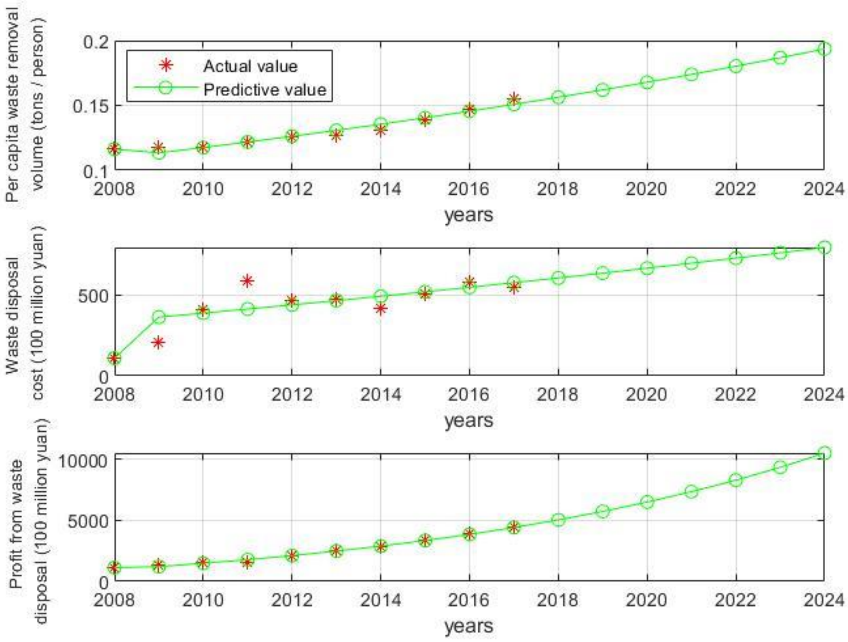

Fig.2: Grey forecast results for the economy

It can be seen from the figure that in the results obtained by using the gray prediction model, the actual value of the per capita waste removal volume is basically near the curve simulated by the predicted value, and only the deviation between the predicted value and the actual value in 2013 and 2014 is slightly larger; garbage disposal The deviation between the actual value of the cost and the curve simulated by the predicted value is large, and the predicted value in 2011 has the largest deviation; the actual value of the waste disposal profit is in good agreement with the curve and is located on the fitted curve.

It can be seen that the predicted value predicted by the gray prediction is basically qualified and can be applied.

The network output GDP value obtained by using Matlab software can be drawn as follows：

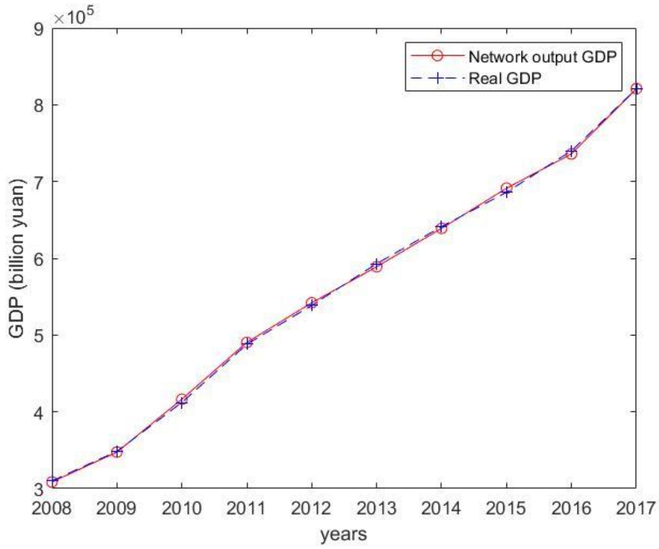

Fig.3: BP neural network results graph for the economy

It can be seen from the figure that the simulation curve of the network output GDP is very close to the simulation curve of the actual GDP, and the deviation is very small. Only the deviation of the network output GDP value from the actual value in 2016 is relatively large. It can be roughly judged that the model results are reasonable. This model can be used to solve the GDP value of the next seven years, so as to analyze the impact of the implementation of waste classification on China's economy.

4.2 Solving results for the environment

Based on the predicted annual and actual values of the number of resource processing plants, resource processing capacity, and resource processing capacity, the following gray forecast results can be drawn.

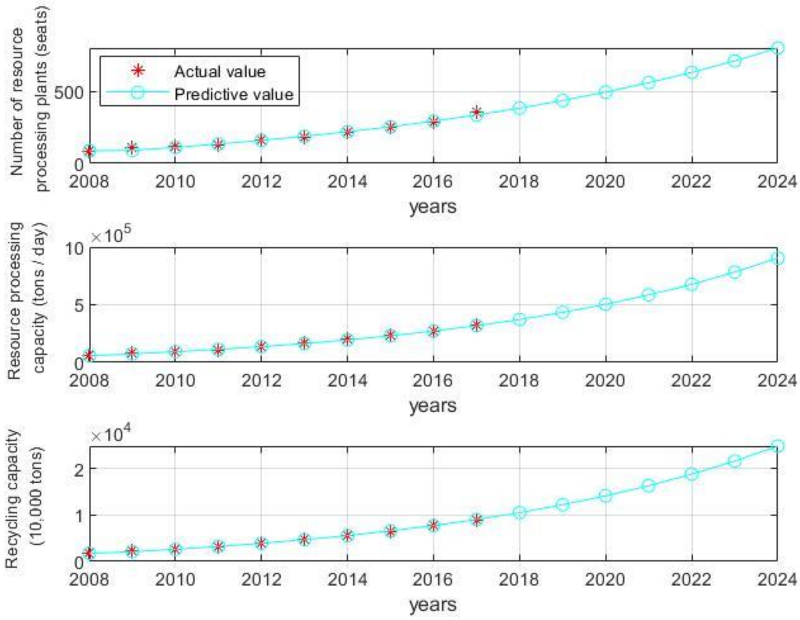

Fig.4: Gray prediction results for the environment

It can be seen from the figure that in the results obtained by using the gray prediction model, the actual number of resource processing plants, resource processing capacity, and resource processing capacity are basically on the curve of the predicted value fitting, and the fit is very high. It can be seen that the predicted value of the solution obtained by the gray prediction is good, and the next calculation can be performed.

Use Matlab software to solve the network output per capita green space area value, you can draw the following figure

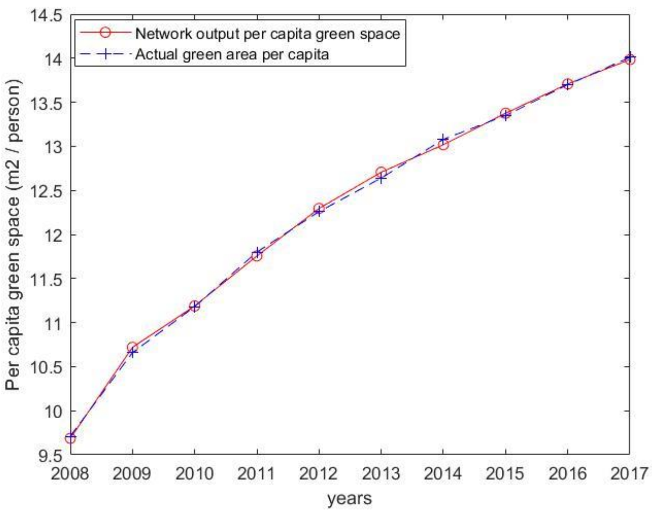

Fig.5: BP neural network results graph for the environment

It can be seen from the figure that the simulation curve of the per capita green space area output by the network is very close to the simulation curve of the actual per capita green space area, and the deviation is extremely small, and the result of the model can be roughly judged. This model can be used to find out the size of the green space per capita in the next seven years, so as to analyze the impact of waste classification on China's environment.

Based on the gross national product and per capita green space area calculated by using Matlab software in the next five years, the following line chart can be drawn.

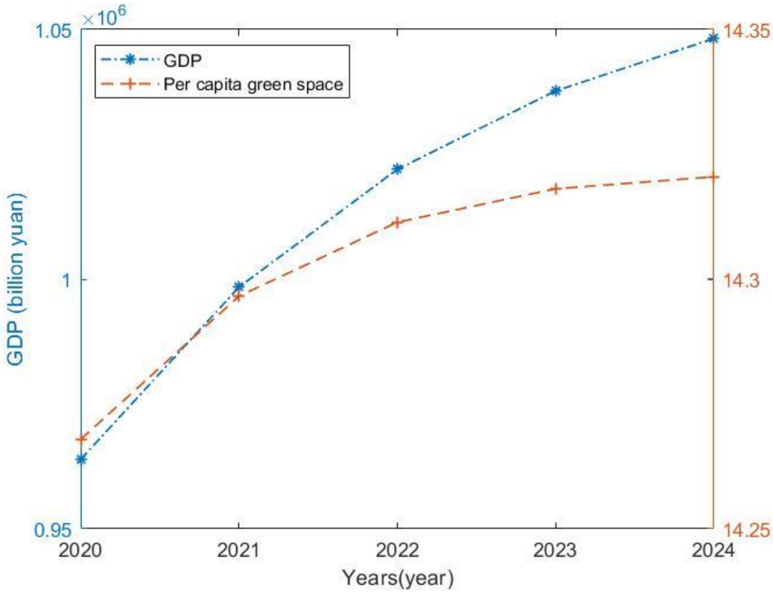

Fig.6: Forecasts of GDP and per capita green space in the next five years

It can be seen from the figure that in the next five years, the indicators used to measure China's economy and environment will increase year by year, which shows that the impact of waste classification policies on China's economy and environment is extremely beneficial, but it can also be clearly seen that the GDP and The increase in the per capita green space area has gradually decreased, indicating that the impact of waste classification on China's economy and environment is not static and will affect it, but this impact will gradually decrease year by year.

5. Conclusion

This paper starts from two aspects of economy and environment, and establishes a BP neural network model based on GM (1,1), analyzes and solves the impact of China's implementation of waste classification policy, and predicts the economic and environmental impact of China in the next five years. As a result, it was found that the impact of garbage classification policy on China's economy and environment is extremely beneficial, but the impact of this impact will be weakened year by year.

References

1. Shuwen Wang, Jiali Wang, Hui Wang. Analysis on the impact of "foreign garbage" on China's ecological environment and customs risk management and control [J]. China Population, Resources and Environment, 2016, 26 (05): 22-31.
2. Jun Zhang, Hongping Xie, Dong Zhang, Ting Liu. Research on Cost Risk Evaluation of Transmission and Transformation Projects Based on Multistage Fuzzy Mathematics and Entropy Weight Method [J]. Shaanxi Electric Power, 2015, 43 (10): 62-67.
3. Wei Li, Hui Yang. Application of CCR model with non-Archimedean infinitesimal ε [J]. Journal of

Tongren University, 2015, 17 (04): 165-167.

4. Ran Qin. Prediction of mine gas emission based on BP neural network based on principal component analysis [D]. Beijing Jiaotong University, 2015.
5. Pei Yao, Xibo Liu, Ming Li. Quantitative evaluation of the influence of Shanghai World Expo [J]. Mathematics in Practice and Theory, 2011, 41 (12): 39-46.
6. Wenju Yang. Dynamic Environmental Performance of Industries in China: An Empirical Analysis Based on DEA [J]. Journal of Quantitative & Technical Economics, 2009, 26 (06): 87-98 + 114.
7. Ying Cao, Dong Cao. Research on China's Environmental Performance Evaluation Index System and Evaluation Method [J]. Environmental Protection, 2008 (14): 36-38.
8. Zhiqiang Zhang, Maoqi Wang, Wen Shang, Zheng Wang, Feng Deng, Shili Jiang, Renjun Wei, Qunming Chen, Jiawei Wang. Application of multi-level fuzzy mathematics comprehensive evaluation model to evaluate and compare the implementation status of "food factory hygiene standards" [J]. Journal of Food Hygiene, 1996 (01): 8-13 + 47.
9. Changling Jia. Mathematical model of multi-level fuzzy mathematics comprehensive evaluation and its application in separation machinery [J]. Journal of Huainan University of Mining and Technology, 1988 (03): 92-101.
10. China Urban Hygiene Association. Development Report of China's Domestic Waste Treatment Industry [Z]. 2017—10
11. Science and Technology Network. Performance Evaluation of Chinese Municipal Solid Waste [Z]. 2018—01
12. Beijing Environmental Protection Bureau. 2010 Beijing Environmental Status Bulletin [Z] .2010