The effect of Import Solid Waste Ban on China's Economy and Environment based on Grey Prediction Model

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ABSTRACT

In order to explore the impact of imported solid waste ban on China's economy and environment, a grey prediction model was established in this paper. GDP, comprehensive income from the utilization of waste resources, the number of imported solid waste treatment enterprises, and the discharge of polluting waste gas and waste water were selected as the indicators to measure the economy and environment. The model was used to predict the data of the unreal garbage ban and compare it with the data after the actual implementation, and get the proportion of the impact on China's economy and environment after the introduction of the policy. The results showed that before and after the promulgation of the ban on foreign waste, China's environmental pollution had improved significantly, the total exhaust gas emissions have been reduced by 34.1%, and the number of imported waste enterprises had decreased by 66.1%, stimulating the rise of the domestic waste utilization industry, and the overall domestic economy had grown steadily.

Keywords: Grey Prediction; Import solid waste ban; Chinese economy and environment

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1. Introduction

For China, "imported solid waste" refers to the solid waste imported from other countries. Since 2004, China has become the largest garbage producer in the world, importing more than half of the global trade volume every year^[1]. In April 2018, the Ministry of Ecology and Environment issued a notice on the adjustment of the catalogue of imported wastes, and decided to adjust 32 varieties of solid wastes, such as waste hardware, scrap ships and scrap automobile pressing parts, to "import ban"^[2]. 32 varieties of solid waste will be banned by the end of 2019. After part of the ban came into effect, it led to a large-scale restructuring of the waste industry chain around the world^[3]. The ban on importing garbage will not only improve China's environment, but the economy of imported solid waste-related industries may also fluctuate.

After the ban, many scholars have discussed its impact on China's future environment and economy. For example, Zhang et al.^[4] through the quantitative analysis of Granger causality test, it was concluded that there is no causal relationship between producer price index and unsorted waste paper import in papermaking and paper products industry. Sun et al.^[5] qualitatively analyzed the changes of the garbage ban on China and the global garbage trading system. At present, most of the studies were theoretical analysis, and the analysis of data is less. This paper established a model to predict the data that do not implement the "imported solid waste ban", compared it with the data actually implemented by the "imported solid waste ban", and analyzes the impact of the ban on China's economy and

environment. The purpose of this study was to provide a relevant basis for the study of the impact of imported solid waste ban.

2. Definition of grey prediction model

Grey prediction modeling technology is an important part of grey system theory^[6]. By regarding the discrete data scattered on the time axis as a group of continuously changing series, the unknown factors in the grey system are weakened and the influence degree of the known factors is strengthened by the way of accumulation and reduction. Finally, a continuous differential equation with time as a variable is constructed, and the parameters in the equation are determined by mathematical method, so as to achieve the purpose of prediction. Without a large number of data samples, the short-term prediction effect is good, and the operation process is simple.

2.1 Data collection and Analysis

We have collected data on the amount of imported waste, the discharge of waste gas and waste water, the comprehensive income of waste resources, the number of imported waste enterprises and the number of harmless treatment plants in the past five or six years. These are compiled from the China data Yearbook and authoritative platforms such as the World Bank. Fig.1 shows the total amount and changes of imported solid waste in China from 2013 to 2018. Fig.2 shows China's emissions from 2012 to 2018, and Fig.3 shows China's recycling benefits and changes in the number of imported solid waste treatment enterprises from 2014 to 2017.

Fig.1 Imported solid waste volume and imported waste enterprises

Fig.2 Discharge of waste gas and waste water in China from 2012 to 2018

From 2017 to 2018, before and after the promulgation of the ban on foreign waste, the total amount of imported waste in China decreased by 50%, and the number of enterprises dealing with imported waste also decreased by nearly half, indicating that the effect of the ban on foreign waste is more obvious. The reduction of

garbage import leads to a decrease in the number of corresponding enterprises. At the same time, the emissions of nitrogen oxides, sulfur dioxide, smoke and dust decreased year by year from 2016 to 2018, and the total emissions in 2018 were close to 1/3 of those in 2012, and environmental pollution was greatly reduced.

Fig.3 Income from Comprehensive Utilization of waste and the number of harmless Chemical plants in China

Apart from a marked reduction in emissions, the ban has brought about industrial changes in the economy. There are two distinct scenes of the rise of domestic waste resources utilization industry, the annual increase of comprehensive income and the decline of enterprises dealing with imported waste.

2.2 Stage ratio test

In order to ensure the feasibility of the data and the feasibility of the modeling method [7], it is necessary to verify the collected data, so let the reference data be $x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n)$. The series formula for calculating the sequence is

$$\lambda(k) = \frac{x_{k-1}^{(0)}}{x_k^{(0)}} \quad (k = 1, 2, \dots, n)$$

3. Results and Discussion

Each selected index data is substituted into the above prediction model formula, which is realized based on MATLAB platform operation [8]. Forecast the economic and environmental indi-

cators for 2018 without the implementation of the "foreign waste ban", and compare the 2018 predicted values with the measured values, as shown in Fig.4 and Fig.5.

Fig.4 Comparison between Forecast and actual value of Chinese Environmental Indexes

In terms of the environment, the ban on imported solid waste has reduced the degree of environmental pollution. As can be seen from Fig.4 the degree of environmental pollution has been significantly reduced after the implementation of the ban, in which air pollution has a significant down-

ward trend, especially smoke and dust has been reduced by 2.103 million tons, by 31%, and sulfur dioxide by 1.151 million tons by 13%. At the same time, wastewater and nitride were reduced by 0.4% and 4.8%, respectively.

Fig.5 Comparison between Forecast and actual value of China's Economic indicators

On the aspect of economy, although the "ban on foreign waste" has brought about an economic boost to the waste recycling industry, it has dealt a blow to the development of imported waste treatment enterprises. To a certain extent, the reduction of imported garbage has stimulated the growth of the domestic "garbage recycling industry" and surrounding industries, with a GDP growth value of 16743 trillion. Among them, the economy of abandoned resources has only increased by 0.1%, indicating that the stimulus of the industry is not obvious in just one year, and it is possible that the monopoly of domestic garbage imports will further stimulate economic growth in the next few years. As a result, the ban

has no negative impact on the overall economy to some extent, but it has dealt a severe blow to the imported waste disposal industry, with the number of enterprises reduced by 39%.

4. Model Test

Variance ratio test is an important method to detect model prediction. According to the ratio of mean square error, the accuracy of the model is very good when the ratio is less than 0.35. When the ratio is between 0.35 and 0.5, it is qualified, and when the ratio is greater than 0.65, it is not qualified. By calculating the variance ratio of each forecast index, as shown in figure 6:

Fig.6 Each error index

The above figure clearly shows the relative error of each index and the corresponding accuracy interval of the model. Compared with the standard scale, it can be found that only smoke and dust is grade 3, that is, barely. The other inspection grades are grade 1 and grade 2. Therefore, it can be explained that the overall grey prediction effect is good, and the model is reasonable.

5. Conclusion

In this paper, a grey prediction model is established to reasonably quantify the impact of ban on China's environment and economy. GDP, comprehensive income from the utilization of waste resources, the number of imported solid

waste treatment enterprises, and the discharge of polluting waste gas and waste water are selected as the indicators to measure the economy and environment. The model is used to predict the data of the non-implementation of the ban on imported solid waste and compare it with the data after the actual implementation. The results show that after the implementation of the ban, the degree of environmental pollution has been significantly reduced. Economically, the "imported waste ban" has dealt a blow to the development of imported waste treatment enterprises, and to a certain extent stimulated the growth of the domestic "waste recycling industry" and surrounding industries. To some extent, the ban

has no negative impact on the overall economic improvement, but it has dealt a severe blow to the imported waste disposal industry.

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