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Influencing Factors and Forecasting of Carbon Emissions in China's Logistics Industry——Based on GM-ARIMA Model

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Abstract: *As an important industry in China's national economy, the logistics industry has an increasing proportion of carbon emissions year by year. In order to achieve China's carbon emission reduction target, it is urgent to study the emission reduction path of the logistics industry. In this paper, GM and ARIMA are combined in a weighted way to improve the prediction accuracy, uses the GM-ARIMA method to select 12 influencing factors such as population, per capita GDP, and per capita urban road area to establish a carbon emission prediction model for China's logistics industry. And take the carbon emission data from 2000 to 2020 as an example to conduct empirical research. The results show that: Compared with the GM (1,1), the GM-ARIMA prediction has a 4.33% reduction in error, which has a better prediction effect on the carbon emissions of the logistics industry. The carbon emission of China's logistics industry will peak at 967.45Mt* CO_2 *in 2028. To achieve the carbon peaking target, China should introduce more emission reduction policies related to logistics.*

Keywords: *Logistics Industry, Carbon Peak, Carbon Emission, GM - ARIMA Model*

1. Introduction

Since the concept of global warming was put forward, the global climate problem has gradually been paid attention to by the world. The Intergovernmental Panel on Climate Change (IPCC) stated in its fourth assessment report that humans have produced a large amount of greenhouse gases, especially CO_2 emitted from burning fossil energy, which has largely contributed to global climate change [1]. As one of the world's major sources of carbon emissions, China's total carbon emissions now account for 30% of the world's total carbon emissions in 2021, which has a great impact on the world. Therefore, how to effectively reduce emissions has attracted widespread attention from scholars at home and abroad. China's logistics industry is the main carbon emission sector in the tertiary industry, which plays a negative role in China's emission reduction and emission reduction. Predicting carbon emissions is the basis for formulating emission reduction policies, and scientific prediction is of great significance for China to better achieve its goals.

The current academic research on carbon emissions is mainly the research on the influencing factors and forecasting of carbon emissions, such as Liu Longzheng links economic growth, logistics industry development and carbon emissions to study the driving factors [2]. Among them, the prediction of carbon emissions is mainly to study regional carbon emissions. For example, Du Qiang's prediction of China's total carbon emissions, the research on sectoral carbon emissions is still relatively blank [3]. The prediction of carbon emissions in the logistics industry is even less, and the existing predictions mainly use the BP neural network model [4], and such models are limited in carbon emission prediction, the accuracy needs to be strengthened.

Based on China's carbon emissions related data from 2000 to 2020, this paper analyzes the influencing factors of carbon emissions in the logistics industry, such as per capita GDP, etc., and combines the advantages of GM and ARIMA to form a new model — GM-ARIMA by weighting method, which greatly improves the prediction accuracy and proposes targeted emission reduction path. In order to provide a strong basis for China to achieve carbon peaks, it also provides guidance for in-depth research on carbon emissions.

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2. Indicator Model & Data Source

2.1. Data Source and Processing

Since the logistics industry isn't classified separately in China's national economic industry, and the transportation industry, warehousing industry, and postal industry play a major role in the logistics industry, the statistical data of the three can roughly reflect China's logistics industry. The logistics industry is the transportation industry, the warehousing industry and the postal industry. [5]

The data in this paper are mainly from China's carbon dioxide inventory calculated by Carbon Emission Accounts & Datasets (CEAD) - IPCC Sectoral Emissions and "China Statistical Yearbook", the data interval is 2000-2020. The calculation methods and representative symbols of each data are shown as follows.

$X_{22} = X_{01}/X_{02}$; $\{X_{22}, X_{01}, X_{02}\}$ = {railway density, operating mileage, national area};

$X_{24} = X_{03}+X_{04}+X_{05}$; $\{X_{24}, X_{03}, X_{04}, X_{05}\}$ = {number of logistics employees, employment in other units of the logistics industry, employment in urban units, private and individual employment};

$X_{23} = X_{06}/X_{24}$; $\{X_{23}, X_{06}\}$ = {per capita logistics GDP, total logistics GDP};

$X_{25} = X_{07}/X_{15}$; $\{X_{25}, X_{07}\}$ = {per capita cargo turnover, total logistics turnover volume};

$X_{27} = X_{08}/X_{06}$; $\{X_{27}, X_{08}\}$ = {energy intensity, logistics energy consumption};

$X_{26} = X_{07}/X_{06}$; $\{X_{26}\}$ = {Transportation intensity};

$\{X_1, X_2, X_{11}, X_{12}, X_{13}, X_{14}, X_{15}, X_{21}, X_{31}, X_{32}, X_{33}, X_{34}, X_{35}, X_{36}, Y_1\}$ = {logistics environment, logistics capacity, per capita GDP, per capita retail sales of social consumer goods, resident consumption level, per capita import and export volume, population size, per capita urban road area, economic proportion of logistics industry, proportion of service industry, energy structure, energy price, energy efficiency, transportation structure, carbon emission of logistics industry}.

2.2. The Establishment of the Index System

This paper establishes an index model that affects the carbon emissions of China's logistics industry from the aspects of logistics environment and logistics capacity. For the data with some vacancies, the data is supplemented according to the interpolation method. Correlation analysis is used to empirically analyze the initially selected 18 indicators and the carbon emissions of China's logistics industry. The results of the correlation coefficient are shown in Table 1.

Table 1: Correlation coefficient results.

	X_{15}	X_{12}	X_{22}	X_{24}	X_{32}	X_{21}	X_{11}	X_{27}	X_{33}
Y1	0.996	0.97	0.951	0.95	0.936	0.991	0.975	-0.953	0.865
	X_{34}	X_{35}	X_{13}	X_{36}	X_{26}	X_{23}	X_{25}	X_{31}	X_{14}
Y1	-0.389	0.944	0.961	0.84	-0.97	0.966	0.986	-0.945	0.976

The indicators with correlation below 0.95 were deleted, and 12 strong influencing factors were obtained. The construction of the logistics industry carbon emission prediction index system is shown in Table 2.

Table 2: Indicator system.

X_1	$X_{11}, X_{12}, X_{13}, X_{14}, X_{15}$
X_2	$X_{21}, X_{22}, X_{23}, X_{24}, X_{25}, X_{26}, X_{27}$

3. Prediction Model of Carbon Emissions in Logistics Industry

3.1. GM-ARIMA Model

The GM can make more accurate forecasts with only a small sample, and the ARIMA can make forecasts with only endogenous variables. The combined GM-ARIMA model has higher prediction accuracy. As shown in Figure 1.

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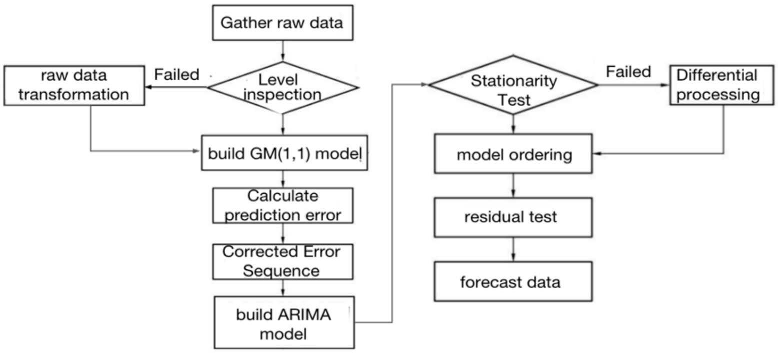

Figure 1: Flow chart.

3.2. Example Calculation and Prediction Result Analysis

According to the aforementioned GM-ARIMA model, the carbon emission data of the logistics industry from 2000 to 2020 was used as the original time series for prediction. From the results, it can be seen that the average relative error of the GM-ARIMA prediction model is 0.43%, and the performance is excellent, and the model meets the requirements. In order to verify the accuracy of the prediction model, when using the GM-ARIMA prediction method, this paper also uses the ridge regression prediction and the linear regression prediction method to compare the prediction results. The results are shown in Figure 2 and Table 3.

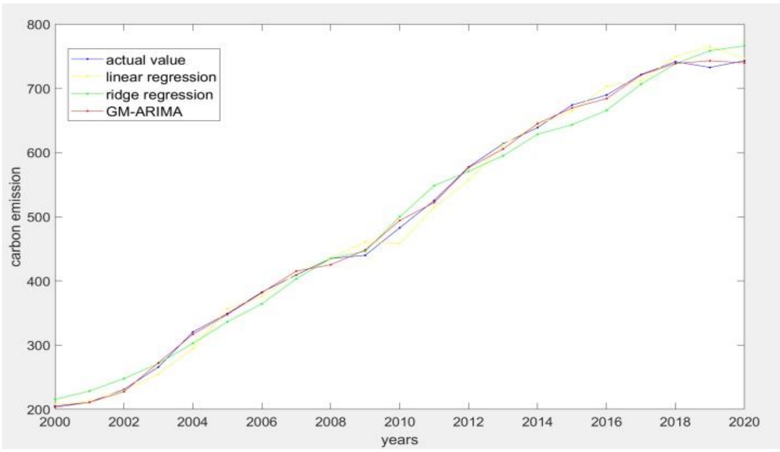

Figure 2: Multi-model line chart.

Table 3: Error of each model.

	ridge regression	linear regression	GM-ARIMA
MSE	268.44	76.19	31.72
RMSE	16.384	8.729	5.632
R^2	0.992	0.995	0.999

Using the GM-ARIMA model to predict the carbon emissions of China's logistics industry from 2021 to 2030, the results are shown in Table 4.

Table 4: Forecast results and growth rates.

Years	Emission (Mt CO_2)	growth rate
2021	787.15	5.967%
2022	812.36	3.202%
2023	838.02	3.159%
2024	863.85	3.082%
2025	889.73	2.996%
2026	915.63	2.911%
2027	941.54	2.829%
2028	967.45	2.752%
2029	993.36	2.678%
2030	1016.27	2.306%

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It can be seen that China's emission reduction policy has good effects, but the current trend is not enough to achieve carbon peaking before 2030.

4. Conclusions

In this paper, 12 influencing factors are firstly screened according to the correlation analysis method; secondly, the GM-ARIMA model is established to predict the carbon emissions of China's logistics industry from 2021 to 2030, and compared with the linear regression and ridge regression methods, the results show that GM-ARIMA model is more accurate than the GM(1,1) model, has better prediction effect in the case of small samples, and can objectively and scientifically reflect the changing trend of carbon emissions in China's logistics industry.

With the improvement of the new crown epidemic, the carbon emissions of China's logistics industry will continue to increase with the economic development, and will exceed 1000Mt CO_2 in 2030. Although the growth rate will decrease year by year, it cannot be achieved before 2030 under the current situation The growth rate is 0. In order to achieve the carbon emission reduction goal of peaking, this paper puts forward the following suggestions for China's logistics industry emission reduction policies based on the research results and future development trends:

(1) In terms of national policies, carbon dioxide tax is levied on companies with high energy consumption and high pollution, and companies are required to plant trees in various aspects, which not only helps carbon peaking, but also accelerates carbon neutrality.

(2) In terms of logistics, accelerate the development of low-carbon logistics and reduce the use of fossil energy. It is also necessary to increase investment in science and technology, strengthen the low-carbon construction of logistics parks, and improve logistics efficiency.

References

[1] Xu Li, Qu Jiansheng, Li Hengji, Zeng Jingjing, Zhang Hongfen. Current Situation Analysis and Forecast of Carbon Emissions from Chinese Residents' Energy Consumption [J]. Ecological Economy, 2019,35(01):19-23+29.

[2] Liu Longzheng, Pan Zhaoan. Research on the driving factors of carbon emissions in China's logistics industry [J]. Business Research, 2012(07): 189-196. DOI: 10.13902/j.cnki.syyj. 2012.07.022.

[3] Du Qiang, Chen Qiao, Lu Ning. Prediction of China's future carbon emissions based on the improved IPAT model [J]. Journal of Environmental Science, 2012, 32(09): 2294-2302. DOI: 10.13671/j.hjkxxb. 2012.09.020.

[4] Song Jiekun, Zhang Yu. Prediction of my country's carbon emission scenarios based on BP neural network [J]. Science, Technology and Engineering, 2011, 11(17): 4108-4111+4116

[5] Ma Yueyue, Wang Weiguo. Analysis of carbon emission characteristics and influencing factors of China's logistics industry - based on LMDI decomposition technology [J]. Practice and Understanding of Mathematics, 2013, 43(10): 31-42.