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Research on the Impact of the COVID-19 on the Volume of Road Freight in Chongqing

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Abstract: The outbreak of COVID-19 at the ending of 2019 has had a serious impact on the economy of China and the world. This paper collected data on the volume of road freight in Chongqing from 2014 to 2020. The grey model GM (1,1) is used to predict the data in 2020. Then compare the predicted results with the actual values, and discusses the impact of COVID-19 on the volume of road freight in Chongqing.

Keywords: Chongqing, COVID-19, The Volume of Road Freight, Grey Prediction Model.

1. Introduction

Since the diagnosis of COVID-19 in December 2019, it was during the Spring Festival travel tide. Liao (2020) considered due to the high mobility and density of the population, the epidemic has not yet ended, and because of its extremely contagious nature, the epidemic has spread rapidly across the country and the world in a short period[1]. It has caused huge economic losses to China's manufacturing, tourism, transportation, medical and health industries. Chongqing Municipal People's Government (2020) initiated the first-level response to major public health emergencies, As of December 15, 2021, the cumulative number of new coronavirus infections in Chongqing has reached 610. Due to strict prevention and control measures against COVID-19, it has a larger impact on the economic development of Chongqing [2].

In recent years, domestic and foreign scholars have made many achievements in research on the demand for the volume of road freight. Liang (2018) The grey relational analysis model is established, and the main statistical indicators which are highly correlated with road freight volume are studied by combining the grey relational analysis model [3]. Yang (2019) proposed an exponential smoothing model, grey forecast, and linear trend extrapolation used to analyze the civil aviation traffic in the Pearl River Delta region from 2004 to 2017, and a combined forecast model was established [4]. Yao (2021) selected the relevant data of Xinghua City from 2004 to 2018 and used the grey forecast model to predict the logistics demand of agricultural products in Xinghua City from 2019 to 2025 [5]. Lou (2022) proposed a combination model of the grey GM (1,1) model, Markov model, and metabolic thought, and the freight turnover of expressways in my country from 2009 to 2016 is used as the original data sequence to predict the freight turnover of expressways in 2017 to 2019 [6].

To sum up, although many studies have applied the grey model to the volume of road freight prediction, there is no study on the volume of road freight in Chongqing. Among the four municipalities directly under the Central Government of China, Chongqing is a bridgehead for reform and opening in the west, integrating big cities, big rural areas, large mountain areas, and large reservoir areas. Although Chongqing is the only city in the western region with water, road, rail, and air transportation, table 1 lists the proportion of road freight volume in the total freight volume from 2015 to 2020, and it is found that the proportion of the volume of road freight in the total freight volume is as high as 80%. Therefore, exploring the impact of COVID-19 on the volume of road freight transportation in Chongqing can not only promote the high-quality development of the logistics industry but also contribute to the high-quality development of Chongqing's economy and society, as well as the countermeasures to improve the volume of road freight transportation after similar events.

Table 1. Chongqing's proportion of the volume of road freight in total freight volume

Time/year	2015	2016	2017	2018	2019	2020
Total Freight volume/ten thousand tons	103833	107966	115537	128491	112970	121692
The Volume of Road Freight/ten thousand tons	86931	89390	95019	107064	89965	99679
proportion	83.72%	82.79%	82.24%	83.32%	79.64%	81.91%

Data source: Chongqing Statistical Yearbook

This article selects the grey forecasting model to forecast the demand for the volume of road freight in Chongqing, compared with the actual value, the author analyzes whether COVID-19 has an impact on the volume of road freight in Chongqing and analyzes the reasons.

2. Data and Method

This article selects the reading data of Chongqing's volume of road freight from 2014 to 2020 as the research object. Due to the lack of December data from 2014 to 2016, to restore the data trend as much as possible and predict and analyze it, by

finding the total volume of road freight, and knowing the value of the previous 11 months, so the value in December is calculated by calculation; February is a traditional Chinese holiday-the Spring Festival, and all walks of life are on vacation, so the data in February of each year is abnormal, so delete Data for February each year. The data used is shown in Table 2.

Table 2. The volume of road freight in Chongqing on 2014-2020 (Unit: ten thousand tons)

month	Year						
	2014	2015	2016	2017	2018	2019	2020
1	7534	8417	7975	7808	9137	4058	7133
3	7667	7747	9356	9264	10233	11250	9506
4	7093	7475	7218	7341	8491	8822	8395
5	7126	7286	4048	6850	8117	8284	8256
6	6728	6890	6825	7168	8459	8628	8188
7	6925	7070	7462	7956	8973	9100	8262
8	7205	7746	8282	8760	10127	10224	9869
9	7276	8031	8592	9529	10481	10554	10105
10	6754	5391	7564	7987	9242	9334	9177
11	7071	7832	8150	9331	10084	10133	9868
12	6508	5817	7030	8434	9185	9200	8770
Total	71379	73885	75472	81994	93344	81986	88759

Data source: National Bureau of Statistics（http://www.status.gov.cn）

2.1. Descriptive Analysis of The Volume of Road Freight in Chongqing

It can be seen from Figure 1 that before the outbreak of COVID-19, the volume of road freight in Chongqing showed a nonlinear growth trend in general and a seasonal fluctuation trend in some parts, especially in the two months around February every year. From 2014 to 2016, the growth rate of the volume of road freight in Chongqing was relatively slow. The growth rate from 2016 to 2018 was faster than that from 2014 to 2016 and reached a peak in 2018. The growth rate in 2019 and 2020 was negative compared with that in 2018. The year 2020 showed growth compared with 2019. In January 2020, there was a sharp decline. After the epidemic was effectively brought under control, the volume of road freight in Chongqing began to rebound in the second quarter, indicating that the resumption of work and production stimulated the rebound of the volume of road freight.

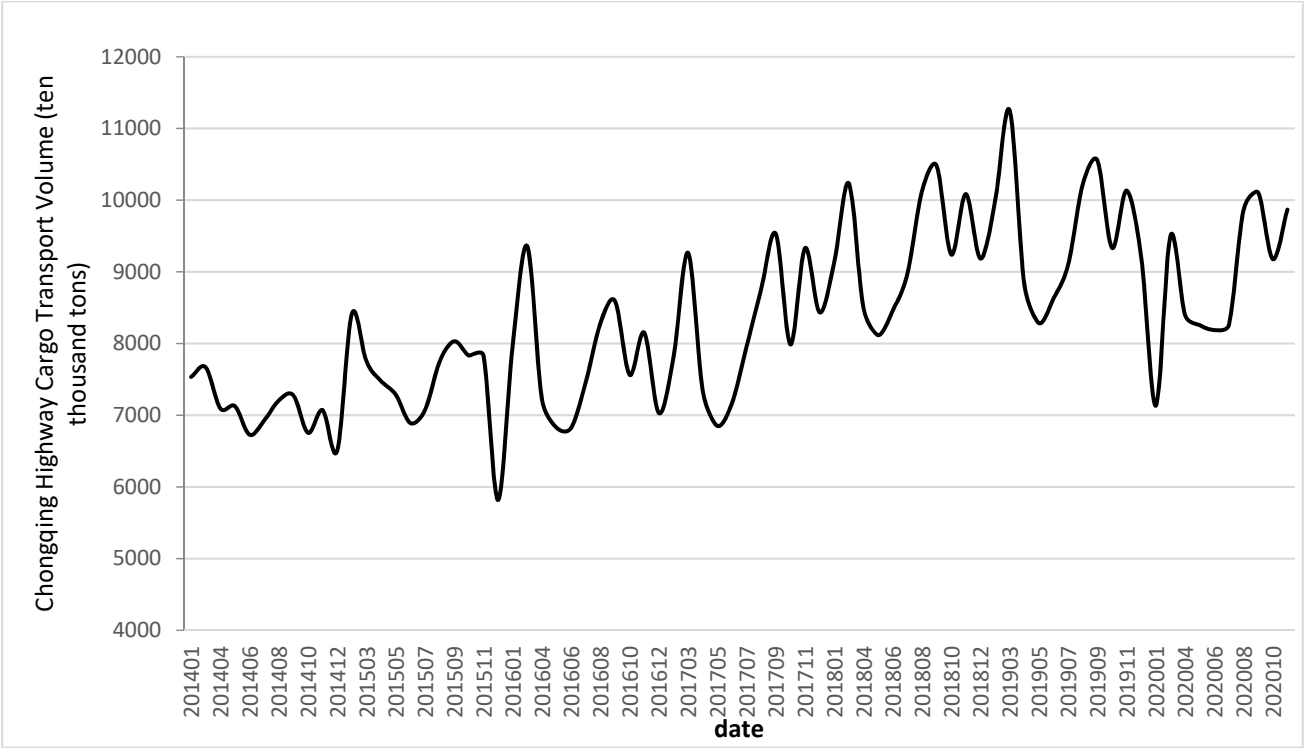

Figure 1. The trend of the volume of road freight in Chongqing

2.2. Build Model

Deng (1982) put forward the grey system theory, mainly used in the study, the state and the structure, the boundary is not clear and incomplete information behavior, modeling of the system operation mechanism is not very clear, forecasting,

decision-making, and control have been successfully applied in the transportation systems, port, logistics park system prediction [7].

This paper mainly uses the grey time series prediction model to study [8].

$GM(1,1)$ The steps of the model build are as follows:

Step1: Let the original or preprocessed data sequence be x^0

$$x^{(0)} = \{x^0(1), x^0(2), \dots, x^0(n)\} \quad (1)$$

Step 2: Add up the data

If accumulate once, get an accumulative sequence

$$x^{(1)} = \{x^1(1), x^1(2), \dots, x^1(n)\} \quad (2)$$

Accumulate the data sequence x^0 for r times to get the sequence.

$$x^{(r)} = \{x^r(1), x^r(2), \dots, x^r(n)\} \quad (3)$$

Among them:

$$x^{(r)}(k) = \sum_{i=1}^{k} x^{(r-1)}(i) = AGOx^{(r-1)}(k) \quad (4)$$

Step 3: To $x^{(1)}$build$GM(1,1)$ model

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = u \quad (5)$$

In the formula: a is the development coefficient (also known as the development grey number), u is the gray action, and equation (5) is discretized

$$x^{(r0)}(k+1) = a\left[-\frac{1}{2}\left(x^{(1)}(k) + x^{(1)}(k+1)\right)\right] + u \quad (6)$$

Step 4: The least square method is used to obtain specific parameters a, u

Construct matrix B and vector as follows:

$$B = \begin{bmatrix} \left[-\frac{1}{2}\left(x^{(1)}(1) + x^{(1)}(2)\right)\right], 1 \\ \left[-\frac{1}{2}\left(x^{(1)}(2) + x^{(1)}(3)\right)\right], 1 \\ \dots \quad \dots \\ \left[-\frac{1}{2}\left(x^{(1)}(n-1) + x^{(1)}(n)\right)\right], 1 \end{bmatrix} \quad (7)$$

$$y_N = \left[x^{(0)}(2), x^{(0)}(3), \dots, x^{(0)}(n)\right]^T \quad (8)$$

Obtained

$$\hat{a} = \begin{bmatrix} a \\ u \end{bmatrix} = (B^T B)^{-1} B^T y_N \quad (9)$$

Step 5: Substitute a, u, so $GM(1,1)$: Grey differential equation $x^{(0)}(k) + az^{(1)}(k) = u$ the time response sequence is

$$\hat{x}^{(1)}(k+1) = \left(x^{(1)}(0) - \frac{u}{a}\right)e^{-ak} + \frac{u}{a}, k = 1,2, \dots, n \quad (10)$$

After the reduction

$$\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1) \quad (11)$$

Step 6: Model checking

① Residual error test: use the difference between the original sequence $x^{(0)}$ and the predicted sequence $\hat{x}^{(0)}$ to test

Residual error:

$$q^{(0)}(k) = x^{(0)}(k) - \hat{x}^{(0)}(k) \quad (12)$$

Relative error:

$$e(k) = \frac{q^{(0)}(k)}{x^{(0)}(k)} \times 100\% \quad (13)$$

Average relative error:$\bar{e}(k) = \sum_{i=1}^{n} e(i)/n$

The relative error is required to be as small as possible, generally

$$e \leq 10\% \quad (14)$$

② Posterior error test: Following the probability distribution of the residual error, the calculation method is as follows.

Find the average value $\bar{x}$ of $x^{(0)}(t)$

$$\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x^{(0)}(i) \quad (15)$$

Find the variance S_1 of $x^{(0)}(t)$

$$S_1 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x^{(0)}(i) - \bar{x})^2} \quad (16)$$

Find the average value $\bar{q}$ of the residual

$$q^{(0)} \quad \bar{q} = \frac{1}{n}\sum_{i=1}^{n} q^{(0)}(i) \quad (17)$$

Find the variance S_2 of the residual

$$q^{(0)} \quad S_2 = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(q^{(0)}(i) - \bar{q})^2} \quad (18)$$

Calculate the posterior difference ratio C

$$C = \frac{S_2}{S_1} \quad (19)$$

Calculate the frequency of small errors P

$$P = \left\{\left|q^{(0)}(t) - \bar{q}\right| < 0.6745S_1\right\} \quad (20)$$

C is required to be as small as possible, and the value is generally C<0.35, no more than 0.65. The frequency of small errors is required to be large, and the value is generally P>0.95, Must not be less than 0.7. According to the C, P value size, The accuracy of the model can be divided into four levels, and the standards for each level are shown in Table 3. If the inspection fails, the model should be revised.

Table 3. Accuracy Test Grade

Prediction accuracy	First level	Second level	Third level	Unqualified
P	>0.95	>0.80	>0.7	≤ 0.7
C	<0.35	<0.5	<0.65	≤ 0.65

2.3. Analysis of Prediction Results

Predict the data onto Table 1 through SPSS, and model the data onto accumulation, one accumulation, and two accumulations. The results compare and find that the results obtained by one accumulation are the best, so this prediction adopts Table 1 accumulated after one time is used as the data source for analysis.

Table 4. The result of the model build

Development coefficient a	The gray effect amount b	The posterior difference ratio C
-0.0132	409650.5175	0.0026

It can be seen from Table 4 that after the model is constructed, the development coefficient, the gray effect amounted, and the posterior difference ratio; The posterior difference ratio 0.0026<=0.35, which means that the model accuracy level is very good. In addition, the small error probability p, the value is 1.000<1.0, which means that the model accuracy is very good.

Table 5. $GM(1,1)$ The Table of Model Checking

number	Original value	Predictive value	Residual	Relative error	Step ratio deviation	number	Original value	Predictive value	Residual	Relative error	Step ratio deviation
1	7534	7534	0	0.000%	-	34	253117	248480.849	4636.151	1.832%	0.021
2	15201	27900.875	-12699.875	83.546%	0.499	35	262381	256601.012	5779.988	2.203%	0.025
3	22294	33760.227	-11466.227	51.432%	0.311	36	269722	264804.402	4917.598	1.823%	0.017
4	29420	39679.634	-10259.634	34.873%	0.234	37	276572	273091.872	3480.128	1.258%	0.015
5	36148	45659.712	-9511.712	26.313%	0.178	38	283740	281464.284	2275.716	0.802%	0.015
6	43073	51701.081	-8628.081	20.031%	0.152	39	291696	289922.507	1773.493	0.608%	0.017
7	50278	57804.371	-7526.371	14.970%	0.135	40	300456	298467.423	1988.577	0.662%	0.019
8	57554	63970.216	-6416.216	11.148%	0.117	41	309985	307099.918	2885.082	0.931%	0.021
9	64308	70199.257	-5891.257	9.161%	0.096	42	317972	315820.892	2151.108	0.677%	0.015
10	71379	76492.142	-5113.142	7.163%	0.09	43	327303	324631.25	2671.75	0.816%	0.019
11	77887	82849.526	-4962.526	6.371%	0.074	44	335737	333531.909	2205.091	0.657%	0.015
12	86304	89272.068	-2968.068	3.439%	0.088	45	344874	342523.794	2350.206	0.681%	0.017
13	94051	95760.438	-1709.438	1.818%	0.073	46	355107	351607.841	3499.159	0.985%	0.019
14	101526	102315.31	-789.31	0.777%	0.064	47	363598	360784.993	2813.007	0.774%	0.013
15	108812	108937.365	-125.365	0.115%	0.057	48	371715	370056.206	1658.794	0.446%	0.012
16	115702	115627.292	74.708	0.065%	0.05	49	380174	379422.444	751.556	0.198%	0.012
17	122772	122385.787	386.213	0.315%	0.048	50	389147	388884.679	262.321	0.067%	0.013
18	130518	129213.552	1304.448	0.999%	0.05	51	399274	398443.897	830.103	0.208%	0.015
19	138549	136111.298	2437.702	1.759%	0.048	52	409755	408101.091	1653.909	0.404%	0.016
20	146381	143079.742	3301.258	2.255%	0.044	53	418997	417857.265	1139.735	0.272%	0.012
21	154213	150119.608	4093.392	2.654%	0.041	54	429081	427713.434	1367.566	0.319%	0.013
22	160030	157231.628	2798.372	1.749%	0.026	55	438266	437670.623	595.377	0.136%	0.011
23	168005	164416.542	3588.458	2.136%	0.038	56	448248	447729.867	518.133	0.116%	0.012
24	177361	171675.097	5685.903	3.206%	0.043	57	459498	457892.213	1605.787	0.349%	0.014
25	184579	179008.048	5570.952	3.018%	0.029	58	468320	468158.716	161.284	0.034%	0.009
26	191404	186416.157	4987.843	2.606%	0.026	59	476604	478530.444	-1926.444	0.404%	0.007
27	198229	193900.195	4328.805	2.184%	0.025	60	485232	489008.477	-3776.477	0.778%	0.008
28	205691	201460.94	4230.06	2.057%	0.026	61	494332	499593.903	-5261.903	1.064%	0.008
29	213973	209099.178	4873.822	2.278%	0.029	62	504556	510287.823	-5731.823	1.136%	0.01
30	222565	216815.703	5749.297	2.583%	0.029	63	515110	521091.35	-5981.35	1.161%	0.01
31	230129	224611.318	5517.682	2.398%	0.023	64	524444	532005.606	-7561.606	1.442%	0.008
32	238279	232486.833	5792.167	2.431%	0.024	65	534577	543031.726	-8454.726	1.582%	0.009
33	245309	240443.068	4865.932	1.984%	0.019	66	543777	554170.858	-10393.858	1.911%	0.007

It can be seen from Table 5 that the relative error value of the first 6 items in the table exceeds 0.2, and the remaining relative error value does not exceed 0.2, which confirms the effectiveness of the gray prediction model $GM(1,1)$ for long-term prediction, and the model fitting effect meets the requirements; Excluding the stage ratio deviation from the first five stages, all the other stage ratio deviation values are less than 0.2, Indicating that the grey prediction model meets the requirements, and starting from the 9th period, the deviation value of the grade ratio is less than 0.1, indicating that the gray forecast model meets higher requirements for medium and long-term forecasts. From the analysis of the relative error and the deviation from the grade ratio, the gray prediction model is effective. Restore the predicted value to obtain the predicted value, as shown in Table 6.

Table 6. Comparison of forecast and actual value of the volume of highway freight in Chongqing in each month of 2020

month	Predictive value	Actual value	Difference	month	Predictive value	Actual value	Difference
1	11253	7133	4120	8	11963	9869	2094
3	11369	9506	1863	9	12086	10105	1981
4	11485	8395	3090	10	12210	9177	3033
5	11603	8256	3347	11	12335	9868	2467
6	11722	8188	3534	12	12461	8770	3691
7	11842	8262	3580				

The forecast results are shown in Figure 2:

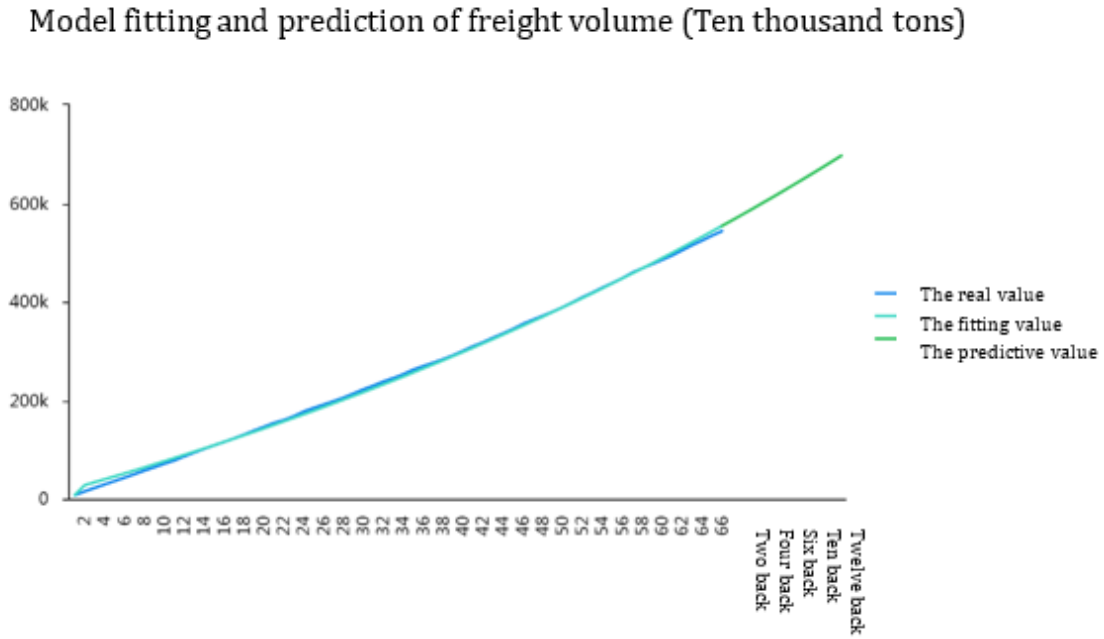

Figure 2 Results Model fitting and prediction

The actual data from the National Bureau of Statistics were compared with the projections calculated using the grey forecasting model $GM(1,1)$. In January 2020, the actual value of the volume of highway freight in Chongqing was 71.33 million tons, and the difference between the predicted value of 112.53 million tons was 41.2 million tons. The industry reduced shipments by 41.2 million tons due to the epidemic. It can be seen intuitively that the outbreak of the new crown pneumonia in January 2020 has affected the amount of the volume of highway freight in Chongqing. As the epidemic has been effectively controlled in China and various industries have resumed work and production, starting from March 2020, Chongqing's volume of highway freight has begun to return to life. Although it has not yet reached the predicted value, the situation is improving. The data in Table 6 show that the actual value of the volume of highway freight in Chongqing in March 2020 was 95.06 million tons, 1,863 tons different from the predicted value of 113.69 million tons. Compared with the data in January, the gap between the predicted data and the actual value was narrowed, mainly because a lot of medical supplies were needed this month due to the impact of the epidemic, so the situation was slightly improved. The actual value of the volume of highway freight in Chongqing in April was 83.95 million tons, which was 3090 tons different from the predicted value of 11485 million tons. Compared with March, the gap has further widened because many medical supplies are already in place at this time, but other industries have not yet recovered, so the gap is larger. The actual value of the volume of highway freights from May to July showed a trend of growth compared with the previous month, which was due to the small-scale epidemic recurrence in some parts of China at this time, which led to a larger gap between the actual value and the predicted value. The actual value of the volume of highway freight in Chongqing in August was 98.69 million tons, 2094 tons less than the predicted value of 119.63 million tons. Chongqing's volume of highway freight in September the actual value is 101.05 million tons, 1981 tons less than the predicted value of 120.86 million tons. when this outbreak of diminishing the influence of Chongqing's volume of highway freight, but October to December due to the presence of the mutation, result in many parts of the city, Chongqing is due to a new mutation appears. As a result, many industries have stopped production, so Chongqing's volume of highway freight has been affected again, leading to repeated data. Due to the epidemic, people's lifestyle has changed a lot. Although the economic impact has not been eliminated, it has changed the way of life of many people. For example, due to the impact of not being able to go out, many people choose to shop online and develop such a habit, thus increasing the traffic of road goods. It can be seen from these data that the epidemic situation has less and less impact on the volume of highway freight in Chongqing, but there will be some rebound gradually due to the changes of the epidemic situation 4

Conclusions and policy recommendations.

Taking the volume of highway freight in Chongqing as the research object, the volume of highway freight in Chongqing from January to December 2020 is predicted. The grey prediction model is used to analyze the impact of COVID-19 on the volume of highway freight in Chongqing, and the following conclusions and suggestions are obtained:

(1) In the short term, the new crown epidemics will have a relatively large impact on Chongqing's volume of highway freight;

(2) In the long run the trend that Chongqing's volume of highway freights did not produce change. Since May 2020, the year-on-year growth rate of the volume of highway freight in Chongqing has been positive, and the year-on-year growth rate has been steadily increasing month by month. Enterprises have made some progress in steadily promoting the resumption of work and production, and domestic epidemic prevention has achieved phased success. At the same time, the international epidemic situation is still severe, and there is a large demand for epidemic prevention materials and daily necessities in foreign severely affected areas [9]. The volume of highway freight should seize this opportunity to stabilize economic growth.

(3) With the advent of the digital economy era, many new consumption methods based on the Internet have emerged, such as " live streaming ", " online education " and " cloud tourism". The power of new consumption should not be underestimated. The organic integration of online and offline consumption should be promoted. At the same time, the upgrading and transformation of offline consumption should be accelerated and consumer demand should be explored. The advantages of the Internet era should be fully utilized, and the consumption environment should be improved to stimulate consumption vitality.

3. Conclusion and Discussion

To study the impact of COVID-19 more intuitively on the volume of highway freight, the gray prediction model $GM(1,1)$ is used in this study to predict the current value of the volume of highway freight in Chongqing in 2020 without the COVID-19 outbreak, and compare it with the actual value of the current situation. The results showed that COVID-19 did have a certain impact on the road cargo transport in Chongqing, but with the gradual control and normalization of the epidemic in China, the impact was gradually weakened, and finally, the volume of highway freight in Chongqing returned to the normal level. Because of a series of fiscal policies issued by the current government, this paper puts forward some suggestions for enterprises: seize the opportunity for policy orientation.

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