

# Grey Prediction Analysis on the Scale of Cross-Border E-Commerce Retail Import Transaction in Hainan

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**Abstract:** Combined with the policy of Hainan free trade port, the advantages of cross-border e-commerce enable the retail import cross-border e-commerce of Hainan free trade port develop rapidly, but Hainan cross-border e-commerce started late, and the data is very limited, so there is almost no reference econometric model. Therefore, this paper used the grey prediction GM (1,1) model to make a short-term prediction analysis of Hainan cross-border e-commerce retail import transaction scale, and used the residual correction model to improve the prediction accuracy, hoping to provide data reference and relevant policy basis for subsequent researchers and managers by analyzing the results in many aspects.

## 1 Introduction

Cross border electricity supplier is a new mode of "Internet plus Trade". Compared with traditional export trade, cross-border electric business B-B, B-C and other new modes enable enterprises to directly face overseas retailers and consumers, reduce trade operation costs and less capital, and promote the growth of foreign trade, facilitate the facilitation and liberalization of foreign trade, etc., and avoid the traditional trade in foreign countries for long periods. There are many problems, such as large capital, information asymmetry and so on. The model of cross-border e-commerce weakens the influence of geography on foreign trade, reduces trade barriers, expands new distribution channels, and brings new opportunities for enterprises. Although cross-border e-commerce started relatively late in China, with the penetration of Internet technology, consumers are more and more dependent on online shopping, and the transaction scale cannot be underestimated. By 2020, the transaction scale of China's retail import cross-border e-commerce market has reached 3.07 trillion yuan, which is expected to reach 3.55 trillion yuan in 2021. Cross border e-commerce has become a new economic growth point worthy of the name.

As a new form of business, cross-border e-commerce is in line with the direction and characteristics of Hainan free trade port, and it is an important part of the free trade port policy and system. In order to promote the rapid development of Hainan's cross-border e-commerce, promote the transformation and upgrading of foreign trade, and create a high-quality business environment, the Hainan government has issued plenty of favorable policies to give strong support to Hainan's cross-border e-commerce. Due to the shortage of professionals, unsound logistics system, limited commodity structure and other

reasons, Hainan's e-commerce transaction scale is small, and the e-commerce enterprises that really carry out cross-border business are small in scale and low in participation.

Although Hainan's cross-border e-commerce started late, the data of Hainan's cross-border e-commerce retail import volume in recent years shows that from 105000 yuan in 2017 to 2312000 yuan in 2018, a year-on-year increase of 21 times, and 61.63 million yuan in 2019, a year-on-year increase of 25.66 times. By 2020, Hainan's cross-border e-commerce retail import volume has reached 526 million yuan. From this, we can see that the development potential of cross-border e-commerce of Hainan free trade port is huge. Therefore, it is urgent to find a quantitative model of cross-border e-commerce suitable for the actual situation of Hainan, study cross-border e-commerce more objectively, provide strong evidence for the economic transformation and upgrading of Hainan Province, and promote the economic development of Hainan Province.

## 2 Grey Prediction Model

Due to the late development of e-commerce in Hainan, there are few data available for Econometric Analysis and research. In view of the good research results obtained in Hainan's economic field by using the grey model suitable for few samples and poor information, the author intends to use the grey prediction model GM (1,1) to study the proposed scale of cross-border e-commerce in Hainan.

Firstly, the original data is dimensionless processed, and the processed original data sequence is  $X^{(0)} = (x^{(0)}(1), x^{(0)}(2), \dots, x^{(0)}(n))$ , It is accumulated once, where  $x^{(0)}(k) \geq 0, k = 1, 2, \dots, n$ . Then 1-AGM, the cumulative generating sequence of  $X^{(0)}$  is:

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

Where  $x^{(1)}(k) = \sum_{i=1}^k x^{(0)}(i)$ ,  $k=1, 2, \dots, n$ . Based on the 1-AGM sequence  $X^{(1)}$ , the nearest mean sequence is generated:

$$Z^{(1)} = (z^{(1)}(1), z^{(1)}(2), \dots, z^{(1)}(n))$$

Among them:  
 $z^{(1)}(k) = \frac{1}{2}(x^{(1)}(k) + x^{(1)}(k+1))$ ,  $k=2, 3, \dots, n$ .

Next, we can establish GM (1,1) prediction model. For non-negative quasi smooth sequence  $X^{(0)}$ , its first accumulation generating sequence  $X^{(1)}$  has quasi exponential law, which is called  $x^{(0)}(k) + az^{(1)}(k) = b$  as the basic form of GM (1,1), and  $\frac{dx^{(1)}}{dt} + ax^{(1)} = b$  as the whitening differential equation of the basic form of GM (1,1) model  $x^{(0)}(k) + az^{(1)}(k) = b$ . Assuming the parameter vector is  $\hat{a} = [a, b]^T$ , the GM (1,1) model is used to estimate  $\hat{a} = (B^T B)^{-1} B^T Y$ . Among them

$$Y = \begin{bmatrix} x^{(0)}(2) \\ x^{(0)}(3) \\ \vdots \\ x^{(0)}(n) \end{bmatrix}, B = \begin{bmatrix} -z^{(1)}(2) & 1 \\ -z^{(1)}(3) & 1 \\ \vdots & \vdots \\ -z^{(1)}(n) & 1 \end{bmatrix},$$

Then the time response formula of GM (1,1) model  $x^{(0)}(k) + az^{(1)}(k) = b$  is:

$$\hat{x}^{(1)}(k) = [x^{(0)}(1) - \frac{b}{a}]e^{-a(k-1)} + \frac{b}{a} \quad (k=1, 2, \dots, n)$$

The reduced formula  $\hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1)$ ,  $k=1, 2, \dots, n$  is obtained. Therefore, the simulated predicted value of  $X^{(0)}$  is:

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

The simulated data series  $\hat{x}^{(0)} = (\hat{x}^{(0)}(1), \hat{x}^{(0)}(2), \dots, \hat{x}^{(0)}(n))$  predicted by GM (1,1) model is obtained, and the residual data series  $\varepsilon^{(0)} = (\varepsilon(1), \varepsilon(2), \dots, \varepsilon(n))$  is used to test the prediction model results. Among them,  $\varepsilon(k) = x^{(0)}(k) - \hat{x}^{(0)}(k)$ . The relative error sequence is:

$$\Delta = \left( \left| \frac{\varepsilon(1)}{x^{(0)}(1)} \right|, \left| \frac{\varepsilon(2)}{x^{(0)}(2)} \right|, \dots, \left| \frac{\varepsilon(n)}{x^{(0)}(n)} \right| \right)$$

For  $k \leq n$ ,  $\Delta_k = \left| \frac{\varepsilon(k)}{x^{(0)}(k)} \right|$  is called relative error of  $k$

point simulation,  $\bar{\Delta} = \frac{1}{n} \sum_{k=1}^n \Delta_k$  is called average relative error,  $1 - \bar{\Delta}$  is called the average relative accuracy. Given  $\alpha$ , when  $\bar{\Delta} < \alpha$  and  $\Delta_n < \alpha$  hold, the model is called residual qualified model. Generally, the value of  $\alpha$  should not be less than 0.20.

### 3 Grey Prediction of Import Scale of Cross Border E-Commerce Retail Trade in Hainan

In previous studies, Chinese scholars selected different indicators to scientifically predict the scale of China's e-commerce based on objective factors such as data availability. Zhang Yilan makes an empirical analysis on the scale of cross-border e-commerce transactions in China with one-dimensional variable and two-dimensional variable grey prediction models, and finds that the two-dimensional variable grey prediction model has higher accuracy, and the results show that the scale of cross-border e-commerce transactions in China will continue to grow in the next few years. Li Jiajia uses multiple regression model to make an empirical analysis on the scale of cross-border e-commerce market in China, and selects 11 indicators to predict the scale of cross-border logistics market, which proves that the relative error of each year's forecast value is greater than that of the grey forecast value. Therefore, the top three influencing factors are express business income, online shopping user scale and express delivery volume. Wang Dongfeng selects 8 factors to analyze the gray correlation degree of the e-commerce market transaction volume, and draws the conclusion that the online shopping user scale has the highest correlation degree with the e-commerce transaction volume in China.

In this paper, combined with previous literature, according to the principle of data availability, the cross-border e-commerce retail import volume of Hainan Province in the e-commerce data of Hainan Provincial Department of Commerce from 2017 to 2020 is finally determined as the representative index of Hainan e-commerce scale transaction, and the data sequence is quasi smooth, so GM (1,1) grey prediction model can be used. The results of grey prediction model of Hainan cross-border e-commerce retail import volume from 2021 to 2023 are as follows: (unit: 10000 yuan, with 2 decimal places reserved)

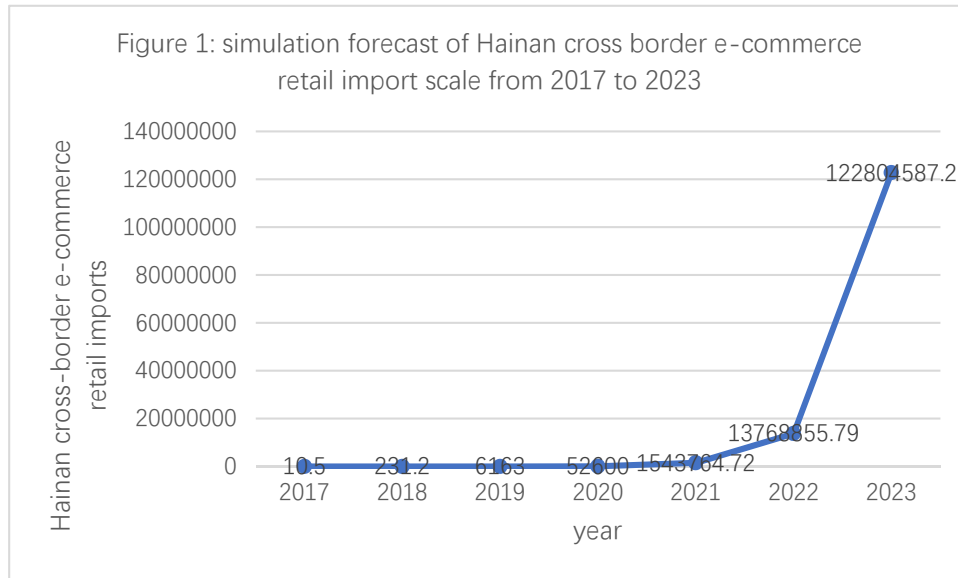
(1) The 1-AGO sequence of the original sequence was as follows:  $X^{(1)} = (10.50, 241.70, 6404.70, 59004.70)$ ,

(2) The development coefficient and grey action quantity are:  $-a=0.89, b=233.63$

(3) The simulated values are as follows:  $\hat{x}^{(0)} = (10.50, 2167.79, 19342.44, 172586.19)$ ,

(4) The predicted simulated values of 2021-2023 are 1543764.72, 13768855.79 and 122804587.22 (as shown in

Figure 1)



(5) The average simulation error is much larger than the normal acceptable error of 20%. From the average simulation error, we can see that the model error is large and the accuracy is low. On the one hand, the reason is that Hainan province's cross-border e-commerce started late, resulting in less data. In September 2017, Hainan province's cross-border e-commerce public service and regulatory platform was officially launched. On the other hand, the continuous introduction of follow-up policies has led to big data fluctuations: in July 2018, Haikou City was approved to set up China (Haikou) cross-border e-commerce comprehensive pilot zone, and in January 2019, the bonded stock module (1210 supervision mode) of the provincial cross border e-commerce public service and supervision platform was launched. So far, the policy line of Hainan free trade port has been relatively clear. These policies make the total volume of Hainan cross-border e-commerce retail imports expand rapidly in recent years, so the data of Hainan cross-border e-commerce retail imports show dramatic changes in recent years. Professor Liu Sifeng studied the relationship between the prediction period of GM (1,1) model and the range of development coefficient. He thought that when the development coefficient was between 0.8 and 1, the residual modified GM (1,1) model should be used to modify the original model.

#### 4 Residual Modified GM (1,1) Model

Residual correction model is to build GM (1,1) model for residual sequence, and improve the simulation accuracy by modifying the original prediction model. If 1-AGM of  $X^{(0)}$  is  $X^{(1)}$ , the time response of GM (1,1) model is

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

$$\text{Then } d\hat{x}^{(1)}(k+1) = (-a)[x^{(0)}(1) - \frac{b}{a}]e^{-ak}$$

is called derivative reduction value. Because

$d\hat{x}^{(1)}(k+1) \neq \hat{x}^{(1)}(k+1)$ , in order to reduce the error caused by the reciprocating operation, the analog value  $\hat{x}^{(1)}$  of  $X^{(1)}$  is corrected by the residuals of  $X^{(1)}$  and  $\hat{X}^{(1)}$ . Assuming  $\varepsilon^{(0)} = (\varepsilon^{(0)}(1), \varepsilon^{(0)}(2), \dots, \varepsilon^{(0)}(n))$ ,  $\varepsilon^{(0)} = x^{(1)}(k) - \hat{x}^{(1)}(k)$  is the residual sequence of  $X^{(1)}$  and  $\hat{X}^{(1)}$ . Suppose  $\varepsilon^{(0)} = (\varepsilon^{(0)}(1), \varepsilon^{(0)}(2), \dots, \varepsilon^{(0)}(n))$  exists and satisfies

(1)  $\forall k \geq k_0$ , and  $\varepsilon^{(0)}(k)$  have the same sign;

(2)  $n - k_0 \geq 4$ , then

$(|\varepsilon^{(0)}(k_0)|, |\varepsilon^{(0)}(k_0+1)|, \dots, |\varepsilon^{(0)}(n)|)$  is called the tail segment of the modelable residual, which is still recorded as

$$(\varepsilon^{(0)}(k_0), \varepsilon^{(0)}(k_0+1), \dots, \varepsilon^{(0)}(n))$$

The time response formula of the first order accumulation sequence

$(\varepsilon^{(1)}(k_0), \varepsilon^{(1)}(k_0+1), \dots, \varepsilon^{(1)}(n))$  is

$$\hat{\varepsilon}^{(1)}(k+1) = [\varepsilon^{(0)}(k_0) - \frac{b_\varepsilon}{a_\varepsilon}]e^{-a_\varepsilon(k-k_0)} + \frac{b_\varepsilon}{a_\varepsilon}, k \geq k_0$$

then the simulation sequence of the residual tail segment is

$$\hat{\varepsilon}^{(0)} = (\hat{\varepsilon}^{(0)}(k_0), \hat{\varepsilon}^{(0)}(k_0+1), \dots, \hat{\varepsilon}^{(0)}(n)).$$

If  $\hat{X}^{(1)}$  is modified by  $\hat{\varepsilon}^{(0)}$ , the modified time response is

$$\hat{x}^{(1)}(k+1) = \begin{cases} [x^{(0)}(1) - \frac{b}{a}]e^{-ak} + \frac{b}{a}, & k < k_0 \\ [x^{(0)}(1) - \frac{b}{a}]e^{-ak} + \frac{b}{a} \pm a_\varepsilon [\varepsilon^{(0)}(k_0) - \frac{b_\varepsilon}{a_\varepsilon}]e^{-a_\varepsilon(k-k_0)}, & k \geq k_0 \end{cases}$$

which is called residual correction GM (1,1) mode. Among them, the symbol of residual correction value is

$$\hat{\varepsilon}^{(0)}(k+1) = a_\varepsilon [\varepsilon^{(0)}(k_0) - \frac{b_\varepsilon}{a_\varepsilon}]e^{-a_\varepsilon(k-k_0)}$$

shall be consistent with the symbol of residual tail  $\varepsilon^{(0)}$ .

The simulated value of residual modified GM (1,1) model is:  
 $\hat{x}^{(0)} = (10.50, 2042.70, 19258.25, 168574.43)$ , and the predicted simulated values are 1210487.239516595.36 and 76917329.74, respectively. The average simulation error  $\bar{\Delta} = 52.13\%$  is still more than 20%, but the accuracy has been greatly improved compared with the traditional GM (1,1) model.

## 5 Conclusion Analysis

Although the prediction accuracy of traditional and residual modified GM (1,1) models is low due to various reasons, the growth of cross-border e-commerce retail imports in Hainan Province is still the trend. Therefore, the rapid development of Hainan's e-commerce has prompted Hainan government departments to issue a lot of relevant policies to support the construction of cross-border e-commerce infrastructure, such as supporting the infrastructure construction of international express supervision sites, supporting international freight enterprises, etc. Hainan cross-border e-commerce still has many aspects to be developed. E-commerce elements can be optimized and a relatively complete e-commerce product industry chain need to be built. We can explore the multi-mode development path of Hainan cross-border e-commerce, encourage the introduction of third-party cross-border payment platform, improve online trading platform, and cultivate consumer habits. We can also set up supervision platform and service platform, use big data and other base to realize resource sharing and improve efficiency. With the help of the construction of cross-border e-commerce warehouse in Hainan Free Trade Zone, we can solve the problem of high logistics cost, and make Hainan an international transit station worthy of the name. We can transfer part of their business to Hainan, drive the activity of cross-border e-commerce transactions and stimulate the atmosphere of cross-border e-commerce by attracting leading enterprises of well-known cross-border e-commerce platforms at home and abroad. Meanwhile, local cross-border e-commerce enterprises policy support should be given in finance and operation, with the purpose of guiding local enterprises to become bigger and stronger and achieve two-pronged approach. At the same time, the policy also gives local cross-border e-commerce enterprises policy support in finance, operation and so on, guiding local enterprises to become bigger and stronger, so as to achieve a two-pronged approach. The urgent task is to solve the extreme shortage of cross-border e-commerce talents in Hainan. The government can cooperate with universities and enterprises to establish a number of training bases for entrepreneurship and innovation talents urgently needed by cross-border e-commerce enterprises, so as to cultivate talents for the development of cross-border e-commerce in Hainan.

We will explore a cross-border e-commerce with Hainan Free Trade Port characteristics, and the sustainable development of Hainan Free Trade Port cross-border e-commerce ecosystem is just around the corner.

## Acknowledgement

School-level scientific research project of Haikou University of Economics: Research on the development mechanism and realization path of cross border e-commerce in our province under the background of free trade port construction

Project No.: HJKY (ZD) 20-02

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