Garment E-commerce Forecast Based on Grey Model

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Abstract— **Garment e-commerce sales forecast is important for the e-business development strategy planning and the integration of garment supply chain upstream and downstream enterprises. GDP, per capita consumption expenditure of urban residents, the total retail sales of consumer goods, the number of internet users are selected as economic forecast indexes. On the basis of grey incidence degree, close correlation indexes are chosen to establish multi-variable grey model to forecast. In consideration of the historical data of garment e-commerce not being obtained, experts' estimation is cooperated. By many iterative fitting on grey model, the credible garment e-commerce forecast amount is calculated. A case analysis of Hebei Garment e-commerce is provided for illustrative purposes.**

Keywords- e-commerce; garment; forecast; grey model

I. INTRODUCTION

E-business has been adopted by more and more enterprises and users worldwide for the advantage of low cost, high efficiency and fast convenience. At present, the e-business applications expand from retail, transportation, foreign trade to all types of fields of business and industries, showing the strong vitality [1]. Among the domestic e-commerce, garment e-commerce shows more robust upward trend. In the state of economic downturn outside the world, the clothing e-commerce continues to remain strong, and has not been the slightest impact of the financial crisis, but more development. IResearch [2] studied e-commerce of China clothing market as a whole, as well as the field of market segmentation and trends, and made specific analysis from different angle, such as the development of the industry environment, the core business and profit model, the user, the web site marketing strategy and so on. [3] studied the b2b market by Delphi method. [4] examined the impact that information technology was having on business relationships by survey method. [5] proposed a structured methodology for the evaluation of alternative e-commerce technologies to be introduced into SMEs' (small to medium enterprises) every-day business practices. [6] presented a new credit evaluation method based on the AHP and the SPA to determine the credibility of the electronic commerce participants in the analysis of China garment network. Forecast for the amount of e-commerce literature is less. Understanding of garment e-commerce transactions amount is of great significance to improve the environment for the development of e-commerce, to increase the level of investment and training human resources of e-commerce, as well as to integrate garment supply chain upstream and downstream enterprises.

E-commerce amount forecast is to analyze, estimate and infer future status of the transaction applying historical data and information by appropriate methods. A large number of forecasting methods are based on historical data to forecast. Since e-commerce is a new thing, no statistics for this index, market survey is necessary to obtain the amount of e-commerce, which takes a lot of human and financial resources. In this paper we use grey prediction method to study the clothing e-commerce forecast issues. By grey incidence between garment e-commerce amount and its close causal relationship factors, indexes with high correlation degree are selected. By the indexes with exact statistics data, the existent but not known e-commerce amount can be fitted. Then the stable fitted value can be used to predict. This method is effective in less data, poor information to get more credible results. Case study result of garment e-commerce forecast in Hebei province is satisfactory.

II. PREDICTION INDEX SELECTION

The garment e-commerce transaction amount(GETA) has close relationship with GDP, per capita consumption expenditure of urban residents(PCCE), the total retail sales of consumer goods(TRSCG), the number of internet users(NIU) and so on. GDP reflects the overall performance of the economy, GDP growth, reflecting the rapid economic development and national income increase, which means strong consumption capacity. Rapid and healthy development of economy, income growth and increasing consumer confidence can be reflected in per capita consumption expenditure of urban residents, which will be showing a growth. The total retail sales of consumer goods, including retail sales of residents and retail sales of social groups, is an important indicator to examine people's living standards, consumer purchasing power and so on. The number of internet users supports the development of e-commerce based on network technology, which has close relation with the increase of garment e-commerce transaction amount. These four indexes belong to statistics indicator, the relevant data easily accessible.

III. MGM(1, N) MODEL

The grey model needs less information, but can reflect the actual system situation better with higher preciseness. The variables are selected by the analysis of grey incidence

and dynamic model of the differential equations is set up for discrete data based on the characteristics of discrete formula, consequently, the response to time formula for variables is available [7].

A. Grey Incidence Analysis

Grey incidence measures the correlation degree between two factors. Judge whether they are close or not according to the similar degree of sequence curve shape. The more similar the curve is, the higher the correlation degree between relative series is, and vise versa. Compared with the normally used methods, such as regression analysis, time series and neural networks, it is applicable disregarding the number and the disorder of samples, and the involved calculation is easy to be programmed [8].

Given that x_i is the system factor, its sequent observation data are $x_i(k), k=1,2,\cdots,n$, where k is time sequence variable; and $x_i=[x_i(1),x_i(2),\cdots,x_i(n)]$ is called behavior sequence. Its initial zero image can be defined as $x_i^0=[x_i(1)-x_i(1),\ x_i(2)-x_i(1),\ \cdots,\ x_i(n)-x_i(1)]$.

Define ε_{0i} as the absolute degree of grey incidence between x_0 and x_i ,

$$\varepsilon_{0i}=\frac{1+|S_0|+|S_i|}{1+|S_0|+|S_i|+|S_i-S_0|}. \tag{1}$$

Here,

$$|S_i|=\left|\sum_{k=1}^{n-1}x_i^0(k)+\frac{1}{2}x_i^0(n)\right|. \tag{2}$$

$$|S_i-S_0|=\left|\sum_{k=1}^{n-1}[x_i^0(k)-x_0^0(k)]+\frac{1}{2}[x_i^0(n)-x_0^0(n)]\right|. \tag{3}$$

Given system factor x_i , its initial image can be defined as $x_i^{'}=[x_i(1)/x_i(1),\ x_i(2)/x_i(1),\cdots,\ x_i(n)/x_i(1)]$; then define r_{0i} as the relative degree of grey incidence between x_0 and x_i ,

$$r_{0i}=\frac{1+|S_0^{'}|+|S_i^{'}|}{1+|S_0^{'}|+|S_i^{'}|+|S_i^{'}-S_0^{'}|}. \tag{4}$$

According to the absolute and the relative degree of grey incidence, given the synthetic coefficient $\theta\in[0,1]$, the synthetic degree of grey incidence (ρ_{0i}) can be calculated, $\rho_{0i}=\theta\varepsilon_{0i}+(1-\theta)r_{0i}$. θ can be chosen as the value of 0.5, and if the correlation between absolute quantity is more emphasized, the value of θ could be larger; conversely, if the changing speeds are more emphasized, the value of θ could be smaller.

B. Equation of MGM(1, n) Model

MGM(1, n) model is set up by using generating series. Suppose the problem has n M-dimension time sequence data. Given that $x_i^{(1)}$ is the accumulated generalization for original sequence $x_i^{(0)}(i=1,\cdots,n)$. The first-order ordinary differential equation of MGM(1, n) is shown as follows.

$$\begin{cases}\dfrac{dx_1^{(1)}}{dt}=a_{11}x_1^{(1)}+a_{12}x_2^{(1)}+\cdots+a_{1n}x_n^{(1)}+b_1\\ \dfrac{dx_2^{(1)}}{dt}=a_{21}x_1^{(1)}+a_{22}x_2^{(1)}+\cdots+a_{2n}x_n^{(1)}+b_2\\ \vdots\\ \dfrac{dx_n^{(1)}}{dt}=a_{n1}x_1^{(1)}+a_{n2}x_2^{(1)}+\cdots+a_{nn}x_n^{(1)}+b_n\end{cases}. \tag{5}$$

Parameter vector a_{ij} and b_i can be obtained by least square method. Then the accumulated generalization sequence $x_i^{(1)}$, can be calculated; after subtraction, get the fitting forecasting value of original sequence $x_i^{(0)}(i=1,\cdots,n)$. The concrete calculation process is shown in the following case studies.

IV. Case Studies

Take statistic data of Hebei province, from year 2001 to 2008, as an example to analyze and calculate. According to main factors affecting GETA, 4 typical indexes, GDP, PCCE, TRSCG and NIU are selected. The corresponding data, shown in Table 1, are selected from statistic yearbook [9].

TABLE I. Statistical Data in Hebei Province

No.	Year	GDP	PCCE	TRSCG	NIU
		10^8 RMB	*RMB*	*10^8 RMB*	*10^4*
1	2001	5517	4480	1778	170
2	2002	6018	5068	1968	219
3	2003	6921	5440	2178	289
4	2004	8477	5820	2576	387
5	2005	10096	6700	2953	486
6	2006	11516	7344	3397	631
7	2007	13710	8235	3986	830
8	2008	16189	9087	4482	1080

A. Determination of GETA

Since there is no e-commerce index in the current statistical system, the amount of industry-specific e-commerce can only be obtained in the survey, which takes a lot of time and costs. Therefore, we adopt experts to estimate a general value first, and then grey model calculation is used to revise the estimation to obtain credible results. Through experts' interviews, garment e-commerce accounting for the proportion of GDP in Hebei province is given, resulting in the estimated value of the past year.

TABLE II. ESTIMATED VALUE OF GETA IN HEBEI PROVINCE

No.	Year	GDP	Percentage	GETA
		10^8 RMB	*%*	*10^8 RMB*
1	2001	5517	0.03	1.65
2	2002	6018	0.039	2.35
3	2003	6921	0.057	3.94
4	2004	8477	0.06	5.09
5	2005	10096	0.066	6.66
6	2006	11516	0.09	10.36
7	2007	13710	0.12	16.45
8	2008	16189	0.15	24.28

B. Grey Incidence Calculation

Calculate initial zero image of original sequence and get the synthetic grey incidence degree of GDP, PCCE, TRSCG and NIU by (1) to (4). The results are shown in Table 3, where $\theta = 0.2$.

TABLE III. RESULTS OF GREY INCIDENCE

	GDP	PCCE	TRSCG	NIU
Absolute incidence	0.5008	0.5017	0.5030	0.5102
Relative incidence	0.6011	0.5639	0.5853	0.7443
Synthetic incidence	0.5811	0.5514	0.5689	0.6975

Obviously, NIU has the closer correlation degree than the other three indexes. Hence, we choose NIU to calculate in the grey model.

C. Establishment of MGM(1, 2) Model

8 groups of data of GETA from Table 2 and NIU from Table 1 are taken to set up MGM(1, 2) model, which is shown in (6).

$$\begin{cases} \dfrac{dx_1^{(1)}}{dt} = a_{11}x_1^{(1)} + a_{12}x_2^{(1)} + b_1 \\ \dfrac{dx_2^{(1)}}{dt} = a_{21}x_1^{(1)} + a_{22}x_2^{(1)} + b_2 \end{cases}. \tag{6}$$

Let

$$L = \begin{bmatrix} (x_1^{(1)}(2) + x_1^{(1)}(1))/2 & (x_2^{(1)}(2) + x_2^{(1)}(1))/2 & 1 \\ (x_1^{(1)}(3) + x_1^{(1)}(2))/2 & (x_2^{(1)}(3) + x_2^{(1)}(2))/2 & 1 \\ \vdots & \vdots & \vdots \\ (x_1^{(1)}(m) + x_1^{(1)}(m-1))/2 & (x_2^{(1)}(m) + x_2^{(1)}(m-1))/2 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} 2.83 & 279.5 & 1 \\ 5.97 & 533.5 & 1 \\ 10.49 & 871.5 & 1 \\ 16.36 & 1308 & 1 \\ 24.87 & 1866.5 & 1 \\ 38.28 & 2597 & 1 \\ 58.64 & 3552 & 1 \end{bmatrix},$$

$$Y = [Y_1 \quad Y_2] = \begin{bmatrix} x_1^{(0)}(2) & x_2^{(0)}(2) \\ x_1^{(0)}(3) & x_2^{(0)}(3) \\ \vdots & \vdots \\ x_1^{(0)}(m) & x_2^{(0)}(m) \end{bmatrix} = \begin{bmatrix} 2.35 & 219 \\ 3.94 & 289 \\ 5.09 & 387 \\ 6.66 & 486 \\ 10.36 & 631 \\ 16.45 & 830 \\ 24.28 & 1080 \end{bmatrix}.$$

Where, Y_1, Y_2 represents GETA and NIU respectively. Parameter a_{ij} and b_i can be estimated as follows:

$$\hat{a}_i = [\hat{a}_{i1},\ \hat{a}_{i2}, \cdots,\ \hat{a}_{in},\ \hat{b}_i]^T = (L^T L)^{-1} L^T Y_i. \tag{7}$$

Utilizing MATLAB to calculate, the parameter vector is

$$\hat{A} = \begin{bmatrix} 0.5336 & -0.0024 \\ 0.7740 & 0.2487 \end{bmatrix},\ \hat{B} = \begin{bmatrix} 1.592 \\ 151.77 \end{bmatrix}.$$

According to the time-response equation

$$\hat{X}^{(1)}(k) = e^{A(k-1)}X^{(0)}(1) + \hat{A}^{-1}(e^{A(k-1)} - I)\cdot\hat{B}, \tag{8}$$

where $k = 1, \cdots, 8$ and I is the unit matrix, calculate $\hat{x}_1^{(1)}(k)$, $\hat{x}_2^{(1)}(k)$; and fitting forecast value can be generated by reducing accumulatively as following equation

$$\begin{cases} \hat{x}^{(0)}(k) = \hat{x}^{(1)}(k) - \hat{x}^{(1)}(k-1) \quad k = 2, \cdots, 8 \\ \hat{x}^{(0)}(1) = \hat{x}^{(0)}(1) \end{cases}. \tag{9}$$

The fitting value(FV) results are listed in Table 4. Compared with actual value(AV), the relative error(RE) and the average relative error(ARE) are listed too.

TABLE IV. RESIDUAL TEST OF SIMULATED VALUE

	No.	1	2	3	4	5	6	7	8	ARE%
GETA (10^9)	AV	1.65	2.35	3.94	5.09	6.66	10.36	16.45	24.28	6.78
	FV	1.65	2.43	3.37	4.72	6.74	9.79	14.48	21.81	
	RE %	0	3.57	14.58	7.20	1.20	5.52	11.98	10.16	
NIU (10^4)	AV	170	219	289	387	486	631	830	1080	1.33
	FV	170	222	288	373	483	627	815	1060	
	RE %	0	1.70	0.30	3.62	0.57	0.67	1.90	1.88	

Table 4 shows that average fitting precision of NIU is 98.67%. The model effect is good from the angle of average relative error.

D. Revision of GETA

The actual value of GETA in Table 4 is estimated by the experts, which may not be precise. In order to decrease the uncertainty, we substitute the fitting value of GETA and actual value of NIU in (6) again to calculate the new fitting value of GETA. The method is feasible because of the interrelated

relationship between GETA and NIU. During the calculation, the ARE of NIU, as a standard, should be under 3%. When the ARE of GETA is less than 3%, the repeated process is ended. The 3 repeated fitting results is listed in Table 5.

TABLE V. ITERATIVE FITTING RESULTS

No.		1	2	3	4	5	6	7	8	ARE%
1	GETA FV	1.65	2.40	3.29	4.59	6.50	9.33	13.64	20.26	
	RE %	0	1.58	2.10	2.78	3.63	4.65	5.82	7.11	3.46
	NIU FV	170	222	288	373	484	628	816	1062	
	RE %	0	1.55	0.36	3.60	0.47	0.51	1.72	1.70	1.24
2	GETA FV	1.65	2.36	3.23	4.47	6.28	8.93	12.91	18.94	
	RE %	0	1.49	1.98	2.60	3.36	4.28	5.33	6.51	3.19
	NIU FV	170	222	288	373	484	628	816	1062	
	RE %	0	1.55	0.36	3.60	0.47	0.51	1.72	1.70	1.24
3	GETA FV	1.65	2.33	3.17	4.36	6.08	8.58	12.27	17.81	
	RE %	0	1.44	1.88	2.44	3.13	3.96	4.92	5.99	2.97
	NIU FV	170	222	288	373	484	628	816	1062	
	RE %	0	1.54	0.37	3.60	0.47	0.51	1.72	1.70	1.24

By (8) and (9), let $k = 9$, the corresponding forecast results of GETA in 2009, Hebei province, can be calculated. The value is 2.6203 billion Yuan.

CONCLUSIONS

Grey forecast model is more appropriate to predict e-commerce amount, which reliance on data is not so much for the usage of poor and grey information. In the current lack of available statistical data on e-commerce, the application of research methods in this paper can obtain the e-commerce transaction amount for references, which has a positive meaning for the development of e-commerce and garment industry in Hebei province. Of course to get more accurate data, it would be best to carry out field survey, while the methods and conclusions of this paper can serve as a useful reference and supplement.

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