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Construction of Jiangxi Province's "Dual Cycle" Logistics Economic Evaluation System Based on Entropy Weight Grey Correlation Method

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ABSTRACT
The COVID-19 pandemic has caused greater uncertainty in the global environment, accelerate the development of modern logistics industry, improve the modern circulation system, build a new pattern of "dual cycle" development, improve the market competitiveness of leading industries, and serve and guarantee the people's growing demand for a better life. Jiangxi Province is deeply integrated into the "The Belt and Road", and it is of great significance to speed up of catching up with the high-quality open development. This paper takes the economic categories of internal and external circular logistics in Jiangxi Province as the research objects, by applying entropy grey correlation method to analyze the economic categories of Jiangxi Province's logistics, then proposes a dual-cycle indicator system for evaluating the development of Jiangxi's logistics economy. Finally, we get the logistics economic evaluation index system.

Keywords: *Entropy grey relation method, Dual cycle, Logistics, Economic evaluation.*

1. INTRODUCTION

The logistics industry is a basic, strategic, and leading industry that effectively connects production and consumption and supports the development of the national economy [1]. It is one of the four leading industries that will focus on the development of the national modern service industry during the 14th Five-Year Plan. The logistics industry in Jiangxi Province has superior location and transportation conditions, a good industrial foundation, and a broad market space [2]. Besides, the good policy environment and major strategic platform support, especially with industrial transformation, consumer services and emergency security upgrades, business logistics, energy Chemical logistics, international logistics, cold chain logistics and e-commerce logistics have become new logistics formats with comparative advantages and development potential in Jiangxi Province [3; 4].

The COVID-19 pandemic has caused greater uncertainty in the global environment, which leads to the termination of the traditional domestic and international circulation model. The 2020 National Government Work Report proposed to "build a new development pattern of mutual promotion of domestic and international double cycles" [5]. Under the background of the unprecedented changes in a century, accelerate the development of modern logistics industry, improve the modern circulation system, build a new pattern of "dual cycle" development, improve the market competitiveness of leading industries, and serve and guarantee the people's growing demand for a better life [6]. Jiangxi Province is deeply integrated into the "The Belt and Road", and it is of great significance to speed up of catching up with the high-quality open development.

2. RELATED WORK

In recent years, logistics economy has always been a research hotspot. These works mainly focus on logistics efficiency, logistics space analysis, and logistics development capability evaluation. For example, Li Pan and Peng Huiping analyzed the logistics competitiveness of nine provinces and cities along the Chinese section of the "The Belt and Road" using entropy grey correlation analysis [7]. Wang Bo, Zhu Honghui, and Liu Lin proposed a three-stage DEA method to analyze the logistics efficiency of regions along the "Belt and Road" [8]. Yeo et al analyzed the development capability of logistics industry by using fuzzy comprehensive evaluation method for the six major container ports such as Shanghai and Hong Kong [9]. Yuan Dan and Lei Hongzhen used the Malmquist index method to analyze

the logistics efficiency of the Silk Road Economic Belt [10]. Mothilal et al used multiple regression methods to analyze the competitiveness of the logistics industry in the United States, India and Hong Kong [11]. Jiang Zhijuan and Dong Qianli used systematic cluster analysis to study the spatial relationship of various provinces [12; 13]. Xu Wenjing used factor analysis and cluster analysis to analyze the logistics competitiveness of 14 coastal port cities in the "The Belt and Road" [14]. Liang Hongyan used principal component analysis and gravity model to analyze the spatial network relationships of the logistics industry in the five major urban agglomerations: the Yangtze River Delta, the Pearl River Delta, Beijing-Tianjin-Hebei, the middle reaches of the Yangtze River, and Chengdu-Chongqing [15].

Based on the above analysis, it is found that there are few studies on the evaluation of logistics economy, especially the dual-cycle system [16]. Therefore, this paper takes the retail sales of the circular logistics economy category in Jiangxi Province and the circular logistics economy category outside Jiangxi Province as the research objects, and uses the entropy grey correlation. This work analyzes the logistics economy of Jiangxi Province and proposes a dual-cycle index system to evaluate the development of the logistics economy in Jiangxi Province.

3. MODEL BUILDING

Entropy weight grey correlation method has four steps: data standardization,determination of index entropy weight, determination of the correlation coefficient, determination of entropy weight grey correlation degree .

Data Standardization

$$d_{xy} = \frac{p_{xy} - \min(p_{xy})}{\max(p_{xy}) - \min(p_{xy})} \tag{1}$$

p_{xy} means the original data of the y index of the x city while d_{xy} is the value of normalized p_{xy}.

Determination of Index Entropy Weight

R_{xy} is the proportion occupied by the x city of the y index in that index:

$$R_{xy} = \frac{d_{xy}}{\sum_{x=1}^{n} d_{xy}} \tag{2}$$

Q_j is the entropy of the y index:

$$Q_j = -k \sum_{x=1}^{n} R_{XY} \ln R_{xy} \quad , \quad k=1/\ln n, \tag{3}$$

Determination of the Correlation Coefficient

In this study, we select the overall level of Jiangxi Province as the reference series. The formula for the correlation coefficient of the comparison series D* to the reference series in the T_y index is as follows:

$$T_y = \frac{\min_x \min_y \left|d_y^* - d_{xy}\right| + \rho \max_x \max_y \left|d_y^* - d_{xy}\right|}{\left|d_y^* - d_{xy}\right| + \rho \max_x \max_y \left|d_y^* - d_{xy}\right|} \tag{4}$$

Determination of Entropy Weight Grey Correlation Degree

$$U_x = \sum_{y=1}^{m} Q_j T_y \tag{5}$$

Where U_x is the grey weighted correlation degree of the evaluation object to the evaluation standard, the greater the better.

4. DATA PROCESSING OF THE "DUAL CYCLE" ECONOMIC INDICATORS OF JIANGXI PROVINCE

4.1. Internal Circular Economy Data Processing

The total retail sales of consumer goods in Jiangxi Province was 744.81 billion yuan, an increase of 12.3% over the previous year. Daily consumer goods maintained rapid growth. The retail sales of grain, oil and food were 28.66 billion yuan, an increase of 18.5% over the previous year; clothing, shoes and hats, knitted textiles were 16.84 billion yuan, an increase of 11.6% over the previous year; daily necessities were 7.18 billion yuan, an increase of 11.2% over the previous year; Sales continued to grow rapidly, with automobile retail sales of 98.33 billion yuan, an increase of 16% over the previous year. The retail sales of consumer goods related to consumption upgrades grew rapidly. The retail sales of gold, silver and jewelry were 47.9% billion yuan, an increase of 23.9% over the previous year; Chinese and Western medicines were 22.92 billion yuan, an increase of 20% over the previous year; sports and entertainment products were 660 million Yuan, an increase of 16.1% over the previous year; construction and decoration materials 5.07 billion yuan, an increase of 14.7% over the previous.

Due to the deviation of the statistical caliber of the above data, it is necessary to standardize the data so that the indicators of various categories can be compared in order to find the key indicators of the economic internal cycle. According to formula 1 to formula 5, four data processing steps are carried out including standardize the

data, determine the index entropy weight, determine the correlation coefficient, and determine the entropy gray correlation degree. Then determine the correlation degree of each index, and compare and sort them. As shown in table 1 to table 2.

Table 1. Retail sales of circular logistics economy category in Jiangxi Province

ID	Category	Retail sales (100 million)	Data standardization (dxy)	Index weight(Rxy)	index entropy weight (Q j)
1	grocery	286. 59	0. 29	0. 098710371	
2	beverage	41. 34	0. 041202695	0. 013984516	
3	tobacco & alcohol	63. 33	0. 063585286	0. 021581342	
4	clothes	168. 42	0. 170551473	0. 0578865	
5	cosmetic	22. 97	0. 022504733	0. 007638282	
6	jewelry	47. 87	0. 047849276	0. 016240418	
7	daily necessity	71. 79	0. 072196324	0. 024503995	
8	hardware	17. 17	0. 016601185	0. 005634572	
9	sports	6. 59	0. 005832299	0. 001979528	
10	magazine	41. 26	0. 041121267	0. 013956879	
11	audiovisual product	9. 95	0. 009252285	0. 003140298	0. 709012115
12	electrical appliances	183. 68	0. 186083912	0. 063158331	
13	medicine	229. 24	0. 232457301	0. 078897821	
14	office supply	30. 12	0. 029782383	0. 010108373	
15	furniture	63. 96	0. 064226533	0. 021798986	
16	communication equipment	32. 70	0. 032408444	0. 010999679	
17	coal product	5. 41	0. 004631232	0. 001571876	
18	petroleum product	540. 56	0. 549335342	0. 1864487	
19	construction & decoration material	50. 68	0. 050709444	0. 017211181	
20	mechanical & electrical product	15. 74	0. 015145655	0. 005140553	
21	vehicle	983. 32	1	0. 3394078	
22	cotton product	0. 86	0	0	

Table 2. Determination of entropy weight grey correlation degree

ID	Category	correlation coefficient (Ty)	entropy weight grey correlation degree (Ux)	rank
1	grocery	0. 797288287	0. 573787754	20
2	beverage	0. 901740155	0. 648959062	8
3	tobacco & alcohol	0. 941926633	0. 67788023	5
4	clothes	1	0. 71967413	1
5	cosmetic	0. 87070749	0. 626625656	13
6	jewelry	0. 91331112	0. 657286386	7
7	daily necessity	0. 958357913	0. 689705397	3
8	hardware	0. 861348364	0. 619890134	14
9	sports	0. 844784312	0. 607969415	17
10	magazine	0. 901600215	0. 648858351	9
11	audiovisual product	0. 849975272	0. 611705214	16
12	electrical appliances	0. 968210724	0. 69679621	2
13	medicine	0. 884283766	0. 63639615	11
14	office supply	0. 88252874	0. 635133103	12
15	furniture	0. 943130797	0. 678746836	4
16	communication equipment	0. 886873507	0. 63825992	10
17	coal product	0. 842976308	0. 606668241	18
18	petroleum product	0. 555343713	0. 399666503	21
19	construction & decoration material	0. 91838225	0. 660935947	6
20	mechanical & electrical product	0. 859071691	0. 618251672	15
21	vehicle	0. 363198228	0. 261384369	22
22	cotton product	0. 836076626	0. 601702719	19

4.2. External Circular Economy Data Processing.

The total import and export value of general trade in Jiangxi Province was 246.85 billion yuan, an increase of 16.6% over the previous year. Among them, the export value was 196.52 billion yuan, an increase of 16.5% over the previous year; the import value was 50.33 billion yuan, an increase of 16.7% over the previous year; The total export value was 52.98 billion yuan, an increase of 5.2% over the previous year; of which, the export value was 24.39 billion yuan, a decrease of 9.1% over the

Table 3. Economic category of external circular logistics in Jiangxi Province

ID	Category	Amount (100 million)	Data standardization (dxy)	Index weight(Rxy)	index entropy weight (Q j)
1	clothes & accessory	219. 6	0. 25	0. 09180622	0. 74671337
2	electronics	858. 1	1	0. 364576213	
3	unwrought copper and copper material	35. 4	0. 035973752	0. 013115174	
4	cultural product	185. 9	0. 212327162	0. 077409433	
5	vehicle	16. 9	0. 014295758	0. 005211893	
6	Tungsten products	10. 9	0. 007265057	0. 002648667	
7	medicine	26. 5	0. 025544879	0. 009313055	
8	lights	64. 6	0. 070189829	0. 025589542	
9	plastic product	56. 5	0. 060698383	0. 022129187	
10	luggage	54. 0	0. 057768924	0. 021061176	
11	furniture	66. 7	0. 072650574	0. 026486671	
12	china product	60. 9	0. 06585423	0. 024008886	
13	steel	57. 3	0. 06163581	0. 02247095	
14	wooden product	4. 7	0	0	
15	high-tech product	281. 9	0. 324818374	0. 118421053	
16	semiconductor device	80. 8	0. 089172721	0. 032510253	
17	fabric product	82. 4	0. 091047574	0. 03319378	
18	solar battery	71. 4	0. 078157956	0. 028494532	
19	ferroalloy	5. 4	0. 000820248	0. 000299043	
20	glass product	9. 7	0. 015145655	0. 005140553	
21	shoes	108. 3	1	0. 3394078	
22	toy	86. 3	0	0	

Table 4. Determination of entropy weight grey correlation degree

ID	Category	correlation coefficient (Ty)	entropy weight grey correlation degree (Ux)	rank
1	clothes & accessory	0. 780705395	0. 582963156	20
2	electronics	0. 335832218	0. 250770407	22
3	unwrought copper and copper material	0. 837711488	0. 625530368	13
4	cultural product	0. 839393264	0. 626786173	12
5	vehicle	0. 804575583	0. 600787345	15
6	Tungsten products	0. 794384632	0. 593177626	16
7	medicine	0. 821436368	0. 613377519	14
8	lights	0. 895952382	0. 669019622	7
9	plastic product	0. 879000234	0. 656361227	10
10	luggage	0. 873896889	0. 652550491	11
11	furniture	0. 900454655	0. 67238153	6
12	china product	0. 888128393	0. 663177346	8
13	steel	0. 880645917	0. 65759008	9
14	wooden product	0. 784121693	0. 585514152	19
15	high-tech product	0. 691346684	0. 516237812	21
16	semiconductor device	0. 931896979	0. 695859934	4
17	fabric product	0. 935604178	0. 698628149	3
18	solar battery	0. 910697	0. 680029626	5
19	ferroalloy	0. 785267112	0. 586369452	18
20	glass product	0. 792377343	0. 591678756	17
21	shoes	1. 000000001	0. 746713371	1
22	toy	0. 944765253	0. 705468846	2

previous year; the import value was 28.59 billion yuan, an increase of 21.6% over the previous year. According to key commodity statistics, the export value of mechanical and electrical products was 85.81 billion yuan, an increase of 5.8% over the previous year; the import value was 31.36 billion yuan, a decrease of 4.7% over the previous year. The export value of high-tech products was 28.19 billion yuan, down 3% from the previous year; the import value was 22.83 billion yuan, down 7.5% from the previous year. The export value to the United States, the European Union, South Korea, and Japan was 38.42 billion yuan, 31.8 billion yuan, 13.82 billion yuan, and 7.99 billion yuan respectively, an increase of 19.5%, 27.5%, 22.8%, and 22.8% from the previous year. The value of Australia's imports was 6.56 billion yuan, 7.29 billion yuan, and 8.8 billion yuan, respectively, an increase of 47.6%, 43.6%, and 166.7% over the previous year.

Due to the deviation of the statistical caliber of the above data, it is necessary to standardize the data so that the indicators of various categories can be compared in order to find the key indicators of the economic external circulation. According to formula 1 to formula 5, four data processing steps are carried out including standardize the data, determine the index entropy weight, determine the correlation coefficient, and determine the entropy gray correlation degree. Then determine the correlation degree of each index, and compare and sort them. As shown in Table3 to Table4.

5. CONSTRUCTION OF DUAL-CYCLE ECONOMY INDEX IN JIANGXI PROVINCE

As we can see from the analysis of the dual-cycle data and the degree of data fit in Jiangxi Province that the internal and external cycles of Jiangxi Province are highly coupled. Besides, the internal and external complement each other to jointly promote the coordinated development of the logistics economy (Figure1 and Figure2). From the perspective of commodity categories, the cross-section of internal and external cycles is very large, where vehicle, communication equipment, audiovisual product, mechanical & electrical product, medicine, etc. perform well in the dual-cycle. On this basis,the Jiangxi Province dual-cycle economy indicators are constructed as follows (Table 5).

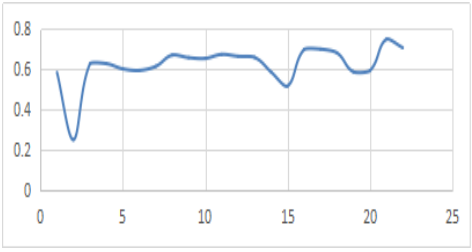

Figure 1 Extemal circular data fit.

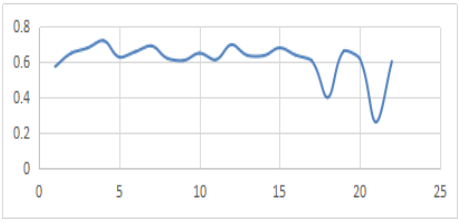

Figure 2 Internal circular data fit.

6. CONCLUSION

From the above analysis it can be concluded as follows:

1) The internal circulation commodities are dominated by light industrial products such as clothing, electrical appliances, daily necessities and furniture. Therefore, we should strengthen the development of business logistics related to daily life, intensive urban distribution, and green development.

2) External circular export commodities are mainly raw materials or original ecological primary products, while the export of high value-added electromechanical products and high-tech products is obviously low. On the one hand, technological transformation and upgrading should be strengthened to improve the intelligence, personalization, and intensive deep processing. Meanwhile, strengthen the integration of this field to form a supply chain industry such as electronic

Table 5. Jiangxi Province dual-cycle economy indicators

ID	Category	ID	Category
1	Clothes	11	solar battery
2	daily necessity	12	fabric product
3	toy	13	furniture
4	electrical appliances	14	plastic product
5	semiconductor device	15	china product
6	medicine	16	office supply
7	communication equipment	17	luggage
8	mechanical & electrical product	18	furniture
9	vehicle	19	cosmetic
10	high-tech product	20	sports

information, automotive equipment, electromechanical equipment. Then strengthen the linkage development of the logistics industry and the equipment manufacturing industry.

3) As we can see from the analysis of the dual-cycle data, Jiangxi Province should strengthen the manufacturing of vehicle, communication equipment, audiovisual product, mechanical and electrical product, and strengthen the development of intelligent, refined, and green supply chains to promote the sound development of the dual-cycle.

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