Research on Evaluation of E-Commerce Development Level Based on Time Series Entropy Value Method

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Abstract: This article in view of the electric business development level evaluation problem, based on the entropy value method to select the infrastructure construction,Product transaction scale, development potential three indicators to measure. Using the entropy method to determine the index weight, it is concluded that infrastructure construction is the main factor affecting the development level of e-commerce, followed by the development potential, and finally the product transaction scale. Based on the time series ranking, it is found that the overall development of e-commerce in M region is on the rise, but the development of internal indicators is unbalanced. The variance is further used to obtain the difference between the secondary index and the total index. The results show that the number of computers used per 100 people and the number of websites owned by 100 enterprises are not good in the level of infrastructure construction. In the transaction scale of products, the proportion of e-commerce enterprises and e-commerce procurement development is weak; In the indicators of development potential, the mean difference between postal business outlets, employment in postal industry, express business volume and highway mileage is relatively negative, which is in urgent need of optimization. M city should start from the weaknesses and continue to optimize the coordinated and balanced development of e-commerce.

Key words: e-commerce development level: entropy method; Analysis of variance; Evaluation analysis

1 Introduction

The development level of e-commerce is an important indicator to measure the development level of a region [1], and also an important driving force to promote the development of a region. With the gradual emergence of the role of e-commerce, scholars' research on the evaluation of e-commerce is also increasing. In the 1990s, American scholars Machlup and Porat calculated the level of knowledge industry in the United States based on macro data, laying a foundation for the evaluation of the development level of e-commerce [2] [3]. Yue Liu and Wenqing Wang selected transaction, infrastructure, human capital and development potential indicators from the CII e-commerce index system to measure the development level of Chongqing e-commerce. The results show that the optimization of network conditions is conducive to improving the development of e-commerce[4]. Shengyu He et al. learned from previous studies and built an index system through indicators such as transaction level, infrastructure and development potential, so as to measure the development level of e-commerce [5]. Ying Han Tang constructs an index system from micro, enterprise and macro levels to measure and evaluate the

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development level of e-commerce [6]. The present level and future path of Li Jinhua's development of e-commerce in China provide a very good reference for the future development of e-commerce in our country [7]. In recent years, entropy method has emerged in the research of e-commerce development level evaluation. Entropy method has been widely used because of its special processing ability and strong data expressive force of highly differentiated data, and it is a good method for analyzing indicators of e-commerce development level with relatively large data differentiation. For example, by using entropy method to study the developing level of four departments of our country in recent years, East, middle, west and northeast, the paper obtained that there is an overall development trend of E-commerce of our country, but there are differences in four departments of east, middle, west and northeast, and the development level is decreasing according to east, middle, northeast and west [8]. Based on the study on the development level of rural e-commerce in Liaoning, it is found that the development level of e-commerce in this region is relatively backward [9]. The study on the development level of e-commerce in Shaanxi Province by using the entropy method [10] and so on.

2 The Research Use Model And The Construction Of Electronic Commerce Development Level Index System

2.1 The basis for the construction of the index system

The e-commerce measurement index system includes three categories: infrastructure construction, product transaction scale and development potential [11]. China Internet Research and Development Center has set up the research topic of "CII E-commerce Index System Research and Measurement", and its research results have determined the e-commerce development level index system [11].

2.2 Electronic commerce development level index system design

There are many types of indicators involved in the above index system, and there are some problems in the actual statistical process, such as inconsistent data statistical caliber and unsystematic and comprehensive data.

The comprehensive evaluation method of three first-level indicators of infrastructure construction, transaction scale of products and development potential and 16 second-level indicators is selected (see Table 1).

Table 1 Indicator system of e-commerce development level

Target	First-level indicator	Second-level indicator	Code
E-commerce development level system (A)	The construction of anfrastructure (B1)	Number of pages (ten thousand)	B11
		Internet broadband access users (ten thousand households)	B12
		Mobile phone penetration rate (units / 100 people)	B13
		Number of Internet Access ports (ten thousand)	B14
		Number of domain names (ten thousand)	B15
		Number of websites per 100 enterprises (number)	B16

	Number of computers per 100 people (units)	B17
	Proportion of e-commerce enterprises (%)	B21
	E-commerce sales (100 million yuan)	B22
	E-commerce purchase amount (100 million yuan)	B23
	Number of postal employees (person)	B31
	Revenue from express delivery business (RMB '000)	B32
	otal amount of telecommunications business (100 million yuan)	B33
	Express business volume (ten thousand pieces)	B34
	Postal outlets (offices)	B35
	Highway mileage (10,000 km)	B36

2.3 Index system model construction

m indicators and n samples were selected. In this paper, m=16, n=6, let Xij represent the data of the Xij index in the ith year, where i represents the year of evaluation index, i= 1,2,3..... 6, j represents the evaluation index, j= 1,2,3.....

(1)Standardized data processing

In this paper, positive index and extreme value method are used to standardize the data, and the minimum value is 0, The maximum value is 1:$x'_{ij} = \frac{x_{ij}-Min}{Max-Min}$ (formula 1)

(2)Calculate sample proportion pij： $p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{6} x_{ij}}$ (formula 2)

(3)Calculate entropy valueej ej： $\mathbf{e_j = -k\sum_{i=1}^{6} p_{ij} \ln(p_{ij})}$ (formula 3)

(4)Calculated variance coefficient dj： $\mathbf{d_j = 1 - e_j}$ (formula 4)

(5) Calculation of index weight wj： $w_j = \frac{d_j}{\sum_{j=1}^{16} d_j}$ (formula 5)

(6) Calculate the comprehensive evaluation score zi： $z_i = \sum_{j=1}^{16} w_j p_{ij}$ (formula 6)

3 Analysis Of empirical Results

3.1 Data source

The data in this paper comes from China Statistical Yearbook. Due to the problem of data update and data integrity in the yearbook itself, the selected data are the relevant data of M city from 2016 to 2021. Authoritative data source ensures data credibility and scientific rigor.

3.2 Analysis of calculation results by entropy method

Since the indicators selected for evaluation are all positive indicators, the maximum and minimum method is adopted in this paper for data standardization [5], and Formula 1 is used to calculate the maximum and minimum values and differences of each indicator (Table 2).

Table 2 Data standardization processing of e-commerce development level in M City

indicator	The construction of anfrastructure (B1)						The trading scale of the product(B2)			Potential for development (B3)				
Year	B11	B12	B13	B14	B15	B16	B21	B22	B23	B31	B32	B33	B34	B35
		B17									B36			
2021	0.05	1.00	0.96	1.00	1.00	0.00	0.43	1.00	1.00	0.95	1.00	0.02	1.00	1.00
		1.00									1.00			
2020	0.00	0.74	0.77	0.67	0.43	0.00	0.40	0.64	0.67	1.00	0.67	1.00	0.59	0.76
		0.80									0.96			
2019	1.00	0.59	1.00	0.69	0.47	0.25	0.00	0.00	0.25	0.64	0.54	0.74	0.46	0.56
		0.60									0.84			
2018	0.28	0.37	0.9	0.45	0.09	0.75	0.10	0.59	0.26	0.00	0.41	0.39	0.34	0.31
		0.20									0.34			
2017	0.39	0.15	0.42	0.22	0.03	1.00	0.33	0.05	0.00	0.32	0.20	0.10	0.15	0.27
		0.00									0.17			
2016	0.46	0.00	0.00	0.00	0.00	1.00	1.00	0.31	0.87	0.3	0.00	0.00	0.00	0.00
		0.00									0.00			

Secondly, translate the data, that is, add 0.00 to each data in the previous step, and calculate the weight value of each secondary index based on formula (1), (2), (3) and (4). The weights of first-level indicators are calculated according to equations (2), (3) and (4), as shown in Table 3.

Table 3 Weight of e-commerce development indicators in M City

First-level indicator	weight	Second-level indicator	weight
The construction of nfrastructure（B1）	0.48	Number of pages (ten thousand)	0.07
		Internet broadband access users (ten thousand households)	0.05
		Mobile phone penetration rate (units / 100 people)	
		Number of Internet Access ports (ten thousand)	0.04
		Number of domain names (ten thousand)	0.05
		Number of websites per 100 enterprises (number)	0.10
		Number of computers per 100 people (units)	0.08
		Proportion of e-commerce enterprises (%)	0.09
The trading scale of the product（B2）	0.18	E-commerce sales (100 million yuan)	0.06
		E-commerce purchase amount (100 million yuan)	0.07
		Number of postal employees (person)	0.05
		Revenue from express delivery business	0.05
Potential for development (B3)	0.34	Otal amount of telecommunications business (100 million yuan)	0.05
			0.10
		Express business volume (ten thousand pieces)	0.05
		Postal outlets (offices)	0.04
		Highway mileage (10,000 km)	0.05

As can be seen from Table 3, among first-level indicators, infrastructure construction has the largest weight, accounting for 47%. Next came development potential, at 35 percent; Finally, the volume of product transactions, at 18%. In the index of infrastructure construction, the number of domain names has the largest weight, accounting for 10%. This was followed by the number of computers per 100 people at 9 percent. E-commerce sales, accounting for 7%, has the largest weight in the index of product transaction scale. Followed by the proportion of e-commerce enterprises, e-commerce purchases. In the indicators of development potential, the largest weight is the total volume of telecommunications business, accounting for 10%; There was little difference among other indicators. On the whole, among the secondary indicators, the proportion of total telecommunications business, the number of domain names, the number of websites owned by 100 enterprises, the number of computers used by 100 people, and the index of e-commerce sales have a greater weight.

Entropy ej, difference coefficient dj, weight index wj and comprehensive index score were calculated from equations 3, 4, 5 and 6. Finally, the sum of the comprehensive index is 1, indicating that there is no calculation error in this data processing. The comprehensive index evaluation score zi is shown in Table 4.

Table 4 Two -level indicator comprehensive score

indicator	The construction of anfrastructure (B1)					The trading scale of the product(B2)			Potential for development (B3)				
Year	B11	B12	B13	B14	B15	B21	B22	B23	B31	B32	B33	B34	B35
			B16	B17					B36				
2021	0.02	0.35	0.24	0.33	0.49	0.19	0.38	0.33	0.30	0.35	0.01	0.39	0.34
			0.00	0.38					0.31				
2020	0.00	0.26	0.19	0.22	0.21	0.18	0.25	0.22	0.31	0.24	0.44	0.23	0.26
			0.00	0.31					0.29				
2019	0.46	0.21	0.25	0.23	0.23	0.00	0.00	0.08	0.20	0.19	0.33	0.18	0.19
			0.08	0.23					0.25				
2018	0.13	0.13	0.22	0.15	0.05	0.04	0.23	0.09	0.00	0.15	0.17	0.14	0.11
			0.25	0.08					0.10				
2017	0.18	0.05	0.10	0.07	0.02	0.15	0.02	0.00	0.10	0.07	0.05	0.06	0.1
			0.33	0.00					0.05				
2016	0.21	0.00	0.00	0.00	0.00	0.44	0.12	0.28	0.09	0.00	0.00	0.00	0.00
			0.34	0.00					0.00				

The sum of vertical indicators is 1, which is the proportion of the index in this index.Further processing the data in Table 4: according to the year and the sum/number of index items of data in each index row, the average value B, B1, B2 and B3 of the comprehensive index of e-commerce development from 2016 to 2021 can be obtained. If the sum of row data/index item number is 16, the average value B of e-commerce development comprehensive index from 2016 to 2021 is obtained. Similarly, the score of B1 e-commerce infrastructure construction comprehensive index is the sum of data of each year/index item 7. B2 development level index

comprehensive score is the sum of data of each year/index item 3; B3 is the sum of data of each year divided by indicator 7.

3.3 Variane analysis

In order to further understand the differences among indicators, variance analysis is used to analyze the characteristic differences among indicators among samples according to the index data in Table 4 and Table 5, and the level of evaluation indicators is judged according to the mean difference of indicators. Positive values represent high level, negative values represent low level, and the value values represent differences. The average value of each first-level indicator and the pair-pair samples of second-level indicator are set up. Since the number of each type of indicator group is different, Scheffe method in Post Hoc Tests is adopted for testing, and the test results are shown in the table below.

Table 5 Analysis of variance among different index groups

indicator	(I)group	(J)group	Mean difference(I～J)	Standard error	significance	95%Confidence interval	
						Lower limit	Upper limit
The construction of anfrastructure	B1	B11	.05667	.08100	.997	-.3166	.2033
		B12	.02833	.08131	1.000	-.2883	.2310
		B13	-.02167	.08032	1.000	-.2383	.2816
		B14	.00833	.07930	1.000	-.2683	.2511
		B15	.05833	.08535	.996	-.3183	.2013
		B16	-.00333	.08032	1.000	-.2566	.2633
		B17	-.00167	.08634	1.000	-.2583	.2618
The trading scale of the product	B2	B21	-.01000	.07900	.987	-.2115	.2315
		B22	.01000	.07908	.999	-.2314	.2116
		B23	-.05000	.07912	.921	-.1715	.2708
Potential for development	B3	B31	-.07000	.07800	.971	-.1750	.3150
		B32	-.05000	.07819	.995	-.1950	.2950
		B33	.01000	.07704	1.000	-.2553	.2350
		B34	-.04000	.07639	.999	-.2050	.2850
		B35	-.07167	.07935	.968	-.1734	.3162
		B36	-.03167	.07738	1.000	-.2134	.2767

It can be seen from Table 5 that the inherent differences and relations of infrastructure construction. Taking B1 as the benchmark, the B11-B17 secondary indicators are compared and analyzed to obtain the differences between each secondary indicators and the average indicators. Among the 7 items of infrastructure construction, the values of B13, B16and B17 are negative. It means that its development level is lower than the average index B1, and the others are higher than the average, in the order of B15>B11>B12>B14>B1>B17>B16>B13. B16 and B17 play a pivotal role in the index weight, so B13, B16 and B17 can be given priority to fill in the weak spots.

The internal difference and relationship between the trading scale and water development index of products.

Taking B2 as the benchmark, the B21-B23 secondary indicators are compared and analyzed. From the performance, the development of B21 and B23 is relatively weak, and the development order is B22>B2>B21>B23. Priority can be given to the coordinated development of B23 and B21indicators, so as to achieve balanced development of B2.Internal difference and relationship of development potential level index.Taking B3 as the benchmark, the B31-B36 secondary indexes are compared and analyzed. The results show that: B33 (that is, the total amount of telecom business) is above the overall index level, while other indicators are below it. On the whole, the mean difference of B35, B31, B34 and B36 is relatively negative, which is in urgent need of optimization. In particular, the low volume of express business and express business income should be focused on monitoring and investment improvement. The overall optimization sequence of B33>B3>B31>B35>B32>B34 makes the three first-level indicators develop harmoniously and improve the development level of e-commerce in M city.

4 Research Conclusion

In this paper, entropy method is used to evaluate the development level of e-commerce in M city, and relevant analysis draws the following conclusions:

1. The development level of e-commerce in M region generally presents an upward trend during the evaluation period, among which, the basic development level of e-commerce in M region

The potential for construction and development has grown considerably.

2. Infrastructure construction level is the main factor affecting the development level of e-commerce in M region, followed by

Development potential, and finally the volume of product trading water development.

3. There are problems of imbalance and discontinuity in the development of e-commerce in M region.

The development of 2018, 2020 and 2021 is more balanced, and the performance of 2021 is excellent, while the differences between 2016 and 2019 are significant.

4. Overall, the problem of development potential is obvious, followed by infrastructure construction and finally production

Trade size of goods.

Funded projects: Autonomous region's online and offline hybrid first-class course - "Web Design and Production";

Project number: bjg2021097, Project name: Discussion on Blended teaching of BOPPPS Enabling "Web Design and Production" based on learner feedback.

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