

Competitive Advantage Evaluation of Real Estate Industry Based on Principal Component Analysis: An Illustrative Example from China

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Abstract—Compared with the extensive research on Competitive Advantage Evaluation of Real Estate Industry (CAEoREI) in developed countries, empirical work is still rare in China. Therefore, we deeply analyze the evaluation and empirical study of CAEoREI by the usage of Principal Component Analysis (PCA) method. Based on the literature review of CAEoREI and explanation of principal component method, a new evaluation index system for CAEoREI evaluation is set up which contains fourteen factors, namely Gross Regional Product per Capita (GRPPC), Disposable Income of Urban Households per Capita (DIUHPC), Consumption Expenditure of Urban Households per Capita (CEUHP), Number of Employed Persons in Enterprises for Real Estate Development (NEPERED), Number of Enterprises for Real Estate Development (NERED), Total Investment in Residential Buildings (TIRB), Earning of Employed Persons in Real Estate (EPPRE), Floor Space of Buildings Under Construction (FSBuC), Floor Space of Buildings Completed (FSBC), Price of Commercialized Housing Sold (PCHS), Area of Commercialized Housing Sold (ACHS), Value of Commercialized Housing Sold (VCHS), Completion Rate of Floor Space of Buildings (CRFSB), Rate of Projects of Fixed Assets Completed and Put into Operation (RPFAC&PO), to classify 30 main regions (including 22 provinces, 4 municipalities and 4 autonomous regions) in People's Republic of China into 4 clusters according to their characteristics. Finally, we draw some good conclusions for improving their CAEoREI and make suggestions for future study.

Index Terms—competitive advantage evaluation, principal component analysis, index system, real estate industry

I. INTRODUCTION

With the introduction of an open-door policy in 1978, recent years have seen China emerge as a major economic force in Asia and internationally. Having the world's largest population of over 1.31 billion and major international-standard cities such as Beijing and Shanghai have been key factors in this recent economic development[1]. The Chinese real estate management and development market grew by 12% in 2004, to reach a value of \$12 billion [2]. In 2009, the Chinese real estate management and development market is forecast to have a value of \$19.5 billion, an increase of 62.2% since 2004 [3].

Strong economic growth and the urbanization of the Chinese population have driven impressive growth within the Chinese real estate industry. The Chinese real estate

industry, is set to receive a considerable boost from the 2008 Olympics Games being hosted in Beijing [4].

The real estate industry has become an important part of China's economy in recent years. For example, in Shanghai, real estate output accounted for 0.5 percent of the city's gross domestic product (GDP) in 1990. This percentage jumped to 6.9 percent in 2002, and then 7.4 percent in 2003. The industry as a whole added approximately 1 percent to the city's economic growth rate in 2003 [5]. Recently, Beijing's 2008 Olympic Games and China's acceptance into the World Trade Organization (WTO) in 2001 are serving as stimuli to speed up the reforms in China's legal and regulatory framework to improve the real estate investment environment [6].

The purpose of the present study is to develop an alternative measure of CAEoREI based on fourteen selected indicators for 30 regions in People's Republic of China by the application of a simple multivariate technique known as Principal Component Analysis (PCA). PCA is used here as a tool for measuring different dimensions in the data. Thus the factors used for the present study are measuring different dimensions of CAEoREI. However, the indices so derived are also ordered so that *PC1* (the first component) displays the largest amount of variation, *PC2* (the second component) displays the second largest amount of variation and so on. When doing a principal component analysis, there is always the hope that the variances of most of the indices will be so low as to be negligible. In that case, the variation in the data set can be adequately described by the few observed variables (in this case fourteen variables) with variances that are not negligible [7]. Thus PCA is best suited for deriving a small set of linear combinations of the original variables that account for most of the total variance [8].

This paper is organized into 5 sections. In section 1, a brief description of real estate industry in People's Republic of China is introduced. Then the method of principal component is explained in section 2. After comparing and analyzing different evaluation system of CAEoREI and overview of CAEoREI theory, a new CAEoREI evaluation system is proposed in section 3, which is composed of fourteen indicators. In section 4, CAEoREI is classified into 4 clusters by using PCA method for 30 main regions (including 22 provinces, 4 municipalities and 4 autonomous regions) in People's Republic of China. In the final section draw some

conclusions for improving their CAEOREI and make suggestions for future study.

II. THE METHOD OF PRINCIPAL COMPONENT ANALYSIS

The method used to derive the component scores using six economic and demographic variables for reflecting environmental degradation is Principal Component Analysis (PCA). PCA transforms the original set of variables into a smaller set of linear combinations that account for most of the variations of the original set. The principal components are extracted so that first principal component denoted by $PC(1)$ accounts for the largest variation in the data.

Let us consider the variables X_1, X_2, \dots, X_p . A principal component analysis of this set of variables can generate p new variables, known as the principal components, PC_1, PC_2, \dots, PC_p . The principal components can be expressed as follows:

$$PC_1 = b_{11}X_1 + \dots + b_{1p}X_p = Xb_1$$

$$PC_p = b_{p1}X_1 + \dots + b_{pp}X_p = Xb_p$$

or, in general,

$$PC = Xb$$

where b 's are the coefficients for principal component and each column of b contains the coefficients for one principal component. Here, the coefficient for PC_1 is chosen such that its variance is the largest, and PC_2 is chosen to have the second largest variance subject to the condition that PC_1 and PC_2 are uncorrelated, and so on. For any principal component, the coefficients of principal components are chosen such that $\sum_{i=1}^p b_{ij}^2 = b_j' b_j = 1$. Now,

if we consider that the sample variance-covariance matrix of the original variables, X , is S_x then the coefficient vector, b_j , can be obtained by solving the following equations:

$$|S_x - \lambda I| b = 0$$

Where λ is the vector of characteristic roots and b is a matrix comprising of the characteristic vectors corresponding to each characteristic root [9]. There may be p characteristic roots, some of which may be zero if there are linear dependence among the original variables, X . It may be noted here that PC_1 is computed by using the characteristic vector corresponding to the largest characteristic root, λ_1 , similarly, PC_2 is computed by using characteristic vector corresponding to the second largest characteristic root, λ_2 , and so on [9].

It must be stressed that a principal component analysis does not always work in the sense that a large number of original variables are reduced to a small number of transformed variables. Indeed if the original variables are uncorrelated then the analysis does absolutely nothing. The best results are obtained when the variables are correlated, positively or negatively [6]. One merit of PCA is that an increase in the number of variables that one may wish to include for deriving a composite index imposes very little cost on the analysis and one can

include many related variables for deriving the principal components [10].

III. EVALUATION SYSTEM OF CAEOREI

Hu and Pan identified the evaluation system of real estate industry, based on seven key indicators: Gross Domestic Product (GDP), Floor Space of Buildings per Capita (FSBpC), Average Wage (AW), The Number of Households (NoH), Disposable Income of Urban Households per Capita (DIUHpC), Floor Space of Buildings under Construction (FSBuC) and Total Investment in Residential Buildings (TIRB) [3]. Zhou and Li set up a index system including 20 indicators to evaluate the early risk of real estate industry [11].

The comprehensive evaluation of CAEOREI needs a synthetic evaluation system that takes factors as much as possible into consideration to release the objective evaluation for different impacts of different factors. In general, we select 14 factors as shown in Tab. I.

IV. PRINCIPAL COMPONENT ANALYSIS OF CAEOREI

A. Sample Province/City Selection and Data Statistics

Due to imperfect evaluation index system for CAEOREI static in China, and the statistical indicators are inadequate in Urban Statistical Yearbook of China and China Statistical Yearbook, it is impossible for the sample we selected to contain all the influence indicators, i.e. to take factors from the available statistical data into consideration to covering influence indicators that we discussed as much as possible.

According to the difference inherent attributes of different region and distribution channel, 30 regions in China are selected, which exclude Hong Kong, Macao, Taiwan and Tibet for statistical indicator and method difference. 30 major regions include:

- North China economic region with Beijing as the center, covering Tianjin, Hebei, Shanxi and Inner Mongolia;
- Northeast China economic region with Liaoning as the center, covering Jilin and Heilongjiang;
- East China economic region with Shanghai as the center, covering Jiangsu, Zhejiang, Anhui, Fujian, Jiangxi and Shandong;
- Central China economic region with Guangdong as the center, covering Henan, Hubei, Hunan, Guangxi, Hainan;
- Southwest China economic region centered in Chongqing, covering Sichuan, Guizhou, Yunnan, Tibet excluded;
- Northwest China economic region centered in Shaanxi, covering Gansu, Qinghai, Ningxia and Xinjiang.

Based on National Bureau of Statistics of People's Republic of China (2005), China Statistical Yearbook (2005) and China City Statistical Yearbook (2005), fourteen indicators of the evaluation index system is

analyzed above as statistical variables, we have the data showed in Tab. II.

B. Principal Component Analysis

Since most of the indicators suffer from simultaneity and multi-colinearity, PCA is best suited for removing such difficulties because it maximizes the variance rather than minimizing the least square distance where any other technique (such as regression analysis) fails to do so.

In this paper, we apply the “Factor Analysis” method in Statistical Package for Social Sciences (SPSS) to analysis the 30 major regions. The results shown in Tab. III suggest a three-factor solution. The eigenvalues clearly show that only three common factors are present by using the criterion of “eigenvalue greater than 1” and it is further confirmed by the fact that the break point occurs at the four eigenvalue of the scree plot (see Fig. 1). This being the case, the three-factor solution would

appear to be acceptable. Tab. IV shows the three component loadings. From Tab. IV we see that NERED, FSBUc, FSBC and VCHS carried more weight than the others in case of ranking CAEoREI of regions. We also find that the first component explains 64.017%, the second component explains 13.152% and the third explains 10.136% of the total variation in the data. Since all of the eigenvalues (in case of fourteen variables) are greater than 1, in the present case the three components are used to calculate component score for each region to determine the ranking of selected regions. The three Principal Components (PC) explain about 87.305% of the variations in the level of CAEoREI. The variables like NERED, FSBUc, FSBC and VCHS played a major role in classifying the regions in terms of CAEoREI compared to the variables such as CRFSB and RPFAC&PO.

TABLE I. EVALUATION INDEX SYSTEM FOR CAEoREI

First-grade factor	Second-grade factor	Indicator (unitage)	Abbreviation
Economic development level	Overall economy level	X1-Gross regional product per capita (yuan/capita)	GRPpC
	Disposable income	X2-Disposable income of urban households per capita (yuan/capita)	DIUHpC
	Total consumption	X3-Consumption expenditure of urban households per capita (yuan/capita)	CEUHpC
Industrial structure for real estate	Number of employed persons	X4-Number of employed persons in enterprises for real estate development (person)	NEPERED
	Number of Enterprises	X5-Number of enterprises for real estate development (unit)	NERED
	Total Investment	X6-Total investment in residential buildings (billion)	TIRB
	Earning of employed persons	X7-Earning of employed persons in real estate (yuan)	EEPRE
Real estate market	Buildings under construction	X8-Floor space of buildings under construction (1,000 m2)	FSBUc
	Buildings completed	X9-Floor space of buildings completed (1,000 m2)	FSBC
	Price of commercialized housing sold	X10-Price of commercialized housing sold (yuan/m2)	PCHS
	Area of commercialized housing sold	X11-Area of commercialized housing sold (1,000 m2)	ACHS
	Value of commercialized housing sold	X12-Value of commercialized housing sold (billion)	VCHS
	Completion rate of floor space of buildings	X13-Completion rate of floor space of buildings (percentage)	CRFSB
	Rate of projects of fixed assets completed and put into operation	X14-Rate of projects of fixed assets completed and put into operation (percentage)	RPFAC&PO

Source: arranged by the author

TABLE II. SYNTHETIC SCORES OF 30 REGIONS IN CHINA

Province /City	Indicator													
	X1a	X2	X3	X4	X5	X6	X7	X8	X9	X10a	X11	X12	X13	X14
Beijing	50467	19978	14825	85473	3035	95	10	10483	31939	8280	26076	216	31	59
Tianjin	41163	14283	10548	33400	1007	33	3	41426	15202	4774	14586	70	37	76
Hebei	16962	10305	7343	44690	1272	78	5	47695	13789	2068	3035	38	29	59
Shanxi	14123	10028	7171	34267	1393	35	3	31009	6747	3579	1372	16	22	63
Inner Mongolia	20053	10358	7667	31649	1173	37	2	36015	13329	2368	2153	26	37	61
Liaoning	21788	10370	7987	56411	2771	104	5	85788	28888	3376	12438	92	34	55
Jilin	15720	9775	7353	27223	902	35	2	28467	9349	2558	4083	20	33	68
Heilongjiang	16195	9182	6655	31257	1214	38	6	31065	13981	2703	6744	33	45	70
Shanghai	57695	20668	14762	91290	3255	85	5	10938	32743	7196	30254	218	30	62
Jiangsu	28814	14084	9629	90990	4137	170	7	19108	59335	4477	10105	219	31	84
Zhejiang	31874	18265	13349	74809	3685	146	20	16970	38775	6218	7618	169	23	55
Anhui	10055	9771	7295	58805	2182	75	4	70624	20672	3110	6503	54	29	49

Province /City	Indicator													
	X1a	X2	X3	X4	X5	X6	X7	X8	X9	X10a	X11	X12	X13	X14
Fujian	21471	13753	9808	64526	2754	61	6	69927	14083	4397	6646	81	20	35
Jiangxi	10798	9551	6646	45792	1859	40	3	46256	16215	3126	3835	30	35	55
Shandong	23794	12192	8468	11041	3172	156	11	12392	36991	3525	2847	106	30	54
Henan	13313	9810	6685	54611	2100	102	9	70172	16814	2888	8008	48	24	71
Hubei	13296	9803	7397	72627	2170	56	7	55041	18177	3690	9609	52	33	56
Hunan	11950	10505	8169	68453	2282	58	7	63410	17063	2644	7417	39	27	57
Guangdong	28332	16016	12432	15852	5504	165	11	16977	43141	6548	13169	251	25	64
Guangxi	10296	9899	6792	40513	1750	40	3	47083	11337	2872	4560	33	24	45
Hainan	12654	9395	7127	9342	310	9	1	9952	1259	2786	1416	8	13	49
Chongqing	12457	11570	9399	70498	1936	50	5	88644	22248	2269	22285	51	25	52
Sichuan	10546	9350	7525	90412	3057	99	10	10606	32387	3646	15906	93	31	54
Guizhou	5787	9117	6848	31748	1432	18	3	33090	6421	2373	3877	16	19	65
Yunnan	8970	10070	7380	33357	1072	40	3	33224	11604	2903	9133	40	35	50
Shaanxi	12138	9268	7553	31196	918	53	3	35612	7921	3317	6215	27	22	58
Gansu	8757	8921	6974	21424	895	14	2	15854	4203	2614	2086	9	27	37
Qinghai	11762	9000	6530	6612	288	4	1	4578	1331	2022	1064	2	29	80
Ningxia	11847	9177	7206	8729	314	8	1	11405	5245	2399	2400	8	46	62
Xinjiang	15000	8871	6730	19481	824	23	3	15677	6791	2166	4135	17	43	82

Note: a computed by gross regional product divide by population of the region and, base the data of capital city of the region.

Source: National Bureau of Statistics of People's Republic of China (2007); China Statistical Yearbook (2007); China City Statistical Yearbook (2007), arranged by the author.

TABLE III. EIGENVALUES OF THE CORRELATION MATRIX (FOURTEEN VARIABLES)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.962	64.017	64.017	8.962	64.017	64.017
2	1.841	13.152	77.169	1.841	13.152	77.169
3	1.419	10.136	87.305	1.419	10.136	87.305
4	.632	4.516	91.821			
5	.437	3.122	94.943			
6	.295	2.104	97.047			
7	.167	1.194	98.241			
8	.094	.674	98.915			
9	.078	.555	99.470			
10	.031	.222	99.692			
11	.023	.163	99.854			
12	.011	.077	99.932			
13	.008	.055	99.987			
14	.002	.013	100.000			

Source: Calculated by the author.

In order to calculate the the ranking of the selected regions, the principal components can be expressed as follows:

$$PC1=0.25721*X1+0.29529*X2+0.29329*X3+0.29362*X4+0.30531*X5+0.28594*X6+0.25387*X7+0.30899*X8+0.30130*X9+0.29362*X10+0.23249*X11+0.32602*X12-0.04109*X13+0.01403*X14$$

$$PC2=0.42452*X1+0.26532*X2+0.26901*X3-0.23437*X4-0.24321*X5-0.29186*X6-0.27343*X7-0.22037*X8-0.15551*X9+0.22184*X10+0.30733*X11+0.05159*X12+0.31913*X13+0.28743*X14$$

$$PC3=-0.05373*X1-0.18049*X2-0.20567*X3+0.04617*X4+0.05960*X5+0.20315*X6+0.05289*X7+0.12508*X8+0.24093*X9-0.19056*X10-0.12592*X11+0.04113*X12+0.58763*X13+0.63213*X14$$

$$PC4=0.2463113*X1+0.2355379*X2+0.2316994*X3+0.1853601*X4+0.1941602*X5+0.1892932*X6+0.1511081*X7+0.2078983*X8+0.2254843*X9+0.2265937*X10+0.2021522*X11+0.2516086*X12+0.0861677*X13+0.1269748*X14$$

TABLE IV. COMPONENT LOADINGS (EIGENVECTORS)

Indicator	Component		
	PC1	PC2	PC3
GRPpC	0.770	0.576	-0.064
DIUHpC	0.884	0.360	-0.215
CEUHpC	0.878	0.365	-0.245
NEPERED	0.879	-0.318	0.055
NERED	0.914	-0.330	0.071
TIRB	0.856	-0.396	0.242
EEPRED	0.760	-0.371	0.063
FSBuC	0.925	-0.299	0.149
FSBC	0.902	-0.211	0.287
PCHS	0.879	0.301	-0.227
ACHS	0.696	0.417	-0.150
VCHS	0.976	0.070	0.049
CRFSB	-0.123	0.433	0.700
RPFAC&PO	0.042	0.390	0.753

Based on the expressions mentioned above, we can calculate the ranking of the selected regions. Tab. V shows the ranking of the selected regions based on Principal Component (PC) scores as well as ranking based on GDP. From the Tab. V, We can classify CAEoREI into 4 clusters among the selected regions in People's Republic of China. For the purpose of analysis conveniently, here we define the first cluster as the high CAEoREI regions, the second cluster as the medium CAEoREI regions, the third cluster as the low CAEoREI regions, the fourth cluster as the lowest CAEoREI regions. The high CAEoREI regions including Guangdong, Shanghai, Beijing, Zhejiang and Jiangsu; the medium CAEoREI regions including Shandong, Sichuan, Tianjin, Liaoning, Fujian and Chongqing; the low CAEoREI regions including Henan, Hubei, Hunan, Anhui,

Heilongjiang, Hebei, Jiangxi, Inner Mongolia and Yunnan; the lowest CAEoREI regions including Shaanxi, Jilin, Guangxi, Shanxi, Xinjiang, Guizhou, Ningxia, Qinghai, Gansu and Hainan.

From Tab. V, we see that, Guangdong topped the list in terms of CAEoREI followed by Shanghai and Beijing. For Price of Commercialized Housing Sold (PCHS) and PC score are quite high, Guangdong is the front runner among the selected regions. The high CAEoREI regions are almost in Yangtze River Delta Region (including Shanghai, Jiangsu and Zhejiang), Pearl River Delta Region (including Guangzhou) and Bohai Bay Region (including Beijing). The lowest CAEoREI regions are almost among the Northwest China region (including Shaanxi, Xinjiang, Ningxia, Qinghai, Gansu, etc.), as illustrated in Tab. VI.

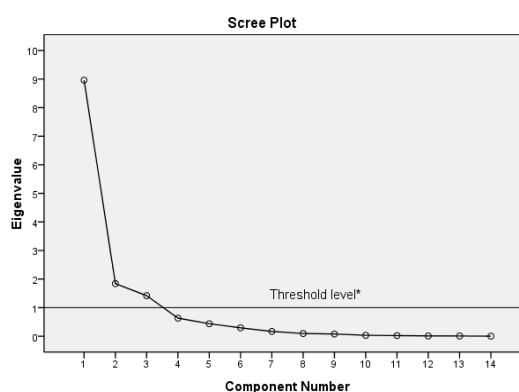


Figure 1. Scree plot of eigenvalues

Note: * Only factors with eigenvalues > 1 are retained

TABLE V. RANKING OF 30 REGIONS IN CHINA ON INDICATORS OF ENVIRONMENT (USING 14 VARIABLES)

Name	PC1	PC1	PC2	PC2	PC3	PC3	PC	PC	PCHS	PCH
Guangdong	6.60911	1	-1.3819	28	0.46032	12	4.69153	1	251.30	1
Shanghai	5.76445	3	3.42076	1	-1.2139	26	4.60122	2	217.71	3
Beijing	5.83788	2	2.74753	3	-1.2973	27	4.54397	3	215.90	4
Zhejiang	5.50994	4	-1.073	25	-0.5809	21	3.8112	4	169.25	5
Jiangsu	4.77097	5	-0.8007	22	2.74933	1	3.69699	5	219.17	2
Shandong	2.5987	6	-2.148	30	0.83227	5	1.67861	6	105.99	6
Sichuan	1.52825	7	-1.6593	29	0.52251	11	0.93134	7	93.11	7
Tianjin	0.40093	11	3.19101	2	0.4116	13	0.82244	8	69.63	10
Liaoning	0.87774	8	-0.4404	16	0.54735	9	0.64083	9	92.41	8
Fujian	0.87092	9	-0.7699	21	-2.3581	30	0.24887	10	80.75	9
Chongqing	0.40917	10	-0.2638	14	-0.8203	24	0.16505	11	50.57	13
Henan	-0.1454	12	-1.1549	27	0.71501	7	-0.1976	12	48.47	14
Hubei	-0.2231	13	-0.5163	19	0.23941	15	-0.2136	13	52.10	12
Hunan	-0.3347	14	-0.9592	24	-0.1353	17	-0.4057	14	38.99	16
Anhui	-0.5187	15	-1.1136	26	-0.1718	18	-0.568	15	53.59	11
Heilongjiang	-1.7295	19	0.83351	7	1.83313	3	-0.9298	16	32.55	19
Hebei	-1.2567	16	-0.512	18	0.23485	16	-0.9714	17	38.38	17
Jiangxi	-1.5608	17	-0.3025	15	0.31781	14	-1.1532	18	30.35	20
Inner Mongolia	-1.8451	22	0.60823	9	0.62546	8	-1.1887	19	25.88	22
Yunnan	-1.793	20	0.20902	10	-0.2446	19	-1.3117	20	40.30	15
Shaanxi	-1.8129	21	-0.1412	12	-0.7875	23	-1.442	21	27.48	21

Name	PC1	PC1	PC2	PC2	PC3	PC3	PC	PC	PCHS	PCH
Jilin	-2.2103	24	0.67247	8	0.54322	10	-1.4564	22	19.59	23
Guangxi	-1.6327	18	-0.907	23	-1.1726	25	-1.47	23	32.99	18
Shanxi	-1.8945	23	-0.1315	11	-0.617	22	-1.4806	24	15.74	25
Xinjiang	-2.7051	26	1.36446	5	2.14792	2	-1.5286	25	16.58	24
Guizhou	-2.4239	25	-0.5422	20	-0.5696	20	-1.9252	26	15.68	26
Ningxia	-3.3192	29	1.41101	4	1.07166	4	-2.0969	27	7.84	28
Qinghai	-3.6285	30	1.05575	6	0.74267	6	-2.4154	28	2.30	30
Gansu	-2.969	27	-0.4662	17	-1.6804	28	-2.4424	29	9.17	27
Hainan	-3.1749	28	-0.2299	13	-2.345	29	-2.6349	30	7.70	29

TABLE VI. PROFILE OF CAEOREI

Region	High $PC \geq 3.00$	Medium $0.00 \leq PC < 3.00$	Low $-1.40 \leq PC < 0.00$	Lowest $PC < -1.40$
North China economic region	Beijing	Tianjin	Hebei, Inner Mongolia	Shanxi
Northeast China economic region		Liaoning	Heilongjiang	Jilin
East China economic region	Shanghai, Zhejiang, Jiangsu	Shandong, Fujian	Anhui, Jiangxi	
Central China economic region	Guangdong		Henan, Hubei, Hunan	Guangxi, Hainan
Southwest China economic region		Sichuan, Chongqing	Yunnan	Guizhou
Northwest China economic region				Shaanxi, Xinjiang, Ningxia, Qinghai, Gansu

V. CONCLUSIONS

In this paper, 30 regions in China are classified into 4 clusters using principal component analysis according to Competitive Advantage Evaluation of Real Estate Industry (CAEOREI). The empirical evidence presented in section 4 gives a better method of ranking CAEOREI. The following conclusions can be drawn:

(1) The evaluation system made up of 14 indicators is effective to analysis CAEOREI in China.

(2) 30 regions' CAEOREI in China are classified into 4 clusters based on principal component analysis method.

(3) We found that the high CAEOREI region are almost in coastal areas (including Shanghai, Jiangsu and Zhejiang Guangzhou), the lowest CAEOREI region are almost in the Northwest China region (including Shaanxi, Xinjiang, Ningxia, Qinghai, Gansu, etc.).

(4) The evaluation framework of CAEOREI is partly tested by empirical study and needs further and deeper research.

In order to put this research into practice, there is a lot of effort should be done, among others, such as the definition and calculation of the statistical indicators for CAEOREI, the statistical data collection, and the scientific feasibility of the method we used here.

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