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Financial Comprehensive Appraisal Empirical Research on Grey Relational Model
——Testing in Listed Companies in Real Estate Industry in China

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Abstract: The financial comprehensive appraisal method plays an essential role in decision-making for investors and reflecting real company's financial comprehensive situation. Because of the grey characteristics of financial information, this paper constructs a grey relational model with a index system of financial comprehensive appraisal by grey relation theory. It is applied to listed companies in real estate industry in China and tested in the both dynamic and static state, and then the result is that the ranking of financial comprehensive evaluation of the listed companies in the real estate industry is almost as same as the real ranking. It shows that the financial comprehensive appraisal method on the grey relational analysis is a kind of effective and good method of evaluating company's financial comprehensive situation.

Keywords: Financial Comprehensive Appraisal; Grey Relational Model; Financial Indexes; Empirical Research

0. INTRODUCTION

A correct decision-making is based on an objective financial comprehensive appraisal of companies. Therefore, taking the grey characteristics of financial information itself into account, we constructed grey relational appraisal model on the basis of grey relational theory, which was then examined from dynamic and static view respectively. Before shaping into a financial comprehensive index system, the process of constructing the companies financial appraisal model abodes by comprehensive, significant and operational rules. Taking china's listed-companies in real estate industry as examples, we selected both static and dynamic samples to test the model, and the former consists of 8 listed companies with 14 financial indexes per company at the end of 2007, whereas the latter is WanKe A (stock code 000002 in Shenzhen Security Exchange in China) with 14 financial indexes per year from the end of 2003 to 2007. Based on static and dynamic samples eigenvalue matrix is formed respectively, Then the data in the matrix are done by nondimensionalization and weighting. On these data the grey relational degree of model was figured out by the rules. According to the numerical size of the grey relational degree the relational ranking is drawn, which means the ranking of financial comprehensive appraisal of companies. The sequence shows that the ranking of eight companies during the given period or that of one company during varied periods. We will compare research conclusion with real financial situation among the samples in order to test the validity of the model.

1. QUESTION

In this context, financial comprehensive appraisal was defined as "regarding each financial analytical index as a whole to analyse, explain and evaluate the company's financial and operating status quo systematically and completely". Currently, the Alexander Wall System, Composite Grade Method, DuPont

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evaluation method and Z-model scoring methods are widely employed internationally as comprehensive financial analysis models. However, by no means are they perfect, some shortcomings exist in themselves, for instance, in the Alexander wall system the selection of the 7 indexes and the correspond ratio has not been validated yet, especially one heavily abnormal indicator may cause severely biased influence on total scores. Besides, it is not appropriate for certain moderate indexes to employ Composite grade method before non-dimensionalization. Furthermore, it is the DuPont Analysis that is merely suitable for issues afterwards and emphasis upon Return On Equity, which implies it is not able to conduct financial comprehensive analysis efficiently. In addition, the scope of application of Z model scoring method is unbelievably limited that solely for bankrupt ones. Thus in order to address mentioned analogous issues, the presented paper carried out grey relational analytical method to process financial comprehensive analysis. Specifically, we employed grey relational analytical method to establish models resting on grey systematic theory so that we are able to work on enterprises' financial comprehensive analysis from development capability, earning capability, operating capability & debt paying ability, on which enterprises' financial comprehensive appraisal came to form. As we all know, Grey system[2] is such a system consisting of some clear information as well as unclear information. However, in social economic field, mutiple systems display grey characteristics[3] attributing to the drawbacks in operating mechanisms together with limited means to handle issues, therefore a wealth of listed-companies' financial information shows grey characteristics, which fits in with the research scope of grey systematic theory. Grey relational analysis (GRA) asks for relatively low quality, and it can be applied[4][5] to any systems no matter how many the samples are or whether they are in law, which guarantees that the precondition of grey relational analysis in the presented paper can be met.

2. STRUCTURING THE FINANCIAL COMPREHENSIVE APPRAISAL MODEL ON GREY RELATIONAL THEORY

GRA model is not a functional model but an order relational one . As what GRA focuses on is not the data itself, but the sequential relationship that the numerical size represents. Then the listed-companies' comprehensive financial appraisal can be viewed as a grey multi-target decision-making issue, which can be evaluated from dynamic and static dimensions respectively, and with corresponding dynamic and static grey appraisal model, assuredly. Static appraisal model is a horizontally comparative one by comparing many listed-companies' financial condition during the given accounting period. While dynamic is a longitudinally comparative one ,which compares one company's financial condition during the varied accounting periods. Thus the evaluated listed-companies must be in the same period(horizontally comparative appraisal) or the one in the varied periods(longitudinally comparative appraisal),then such financial indexes with identical benchmarks were selected and a target eigenvalue matrix came out.

As a matter of fact, we have to standardize all kinds of financial indexes to the identical dimension, that is, nondimensionalization, so as to compare various financial indexes. After nondimensionalization, it is required to calculate out absolute difference between comparative list and referential list, from which the maximum and minimum ones can be located. Then the next step is to pick out the value of grey relational resolution ratio combined with calculation, and we can work out the relational coefficient along with degree of each company in the identical accounting period or one company during the varied accounting periods. In accordance with the counted results, the sequence of relational degree is equal to the corresponding relative merits of financial conditions of different listed-companies in the identical accounting period or one listed-company during the varied accounting periods.

Construction of the listed-companies' grey relational appraisal model can be conducted as the following four steps:

(1) The construction of financial index matrix :

Suppose there are m listed-companies or m given accounting periods of one company., and marking them as $X=\{X_1,X_2,X_3,\ldots\ X_m\}$, and each company or each accounting period of one company owns a set, which consists of n financial indexes, so Xij(i=1,2…,m; j=1,2…n) refers to the Jth index value of the ith company or the ith accounting period of that company, therefore the m×n financial indexes matrix is:

$$X=\begin{bmatrix} X_1(1),X_1(2), & \cdots\cdots, & X_1(n) \\ X_2(1),X_2(2), & \cdots\cdots, & X_2(n) \\ \cdots\ \cdots & & \\ \cdots\cdots & & \\ X_m(1),X_m(2) & \cdots\cdots & X_m(n) \end{bmatrix} \quad (1)$$

In the static grey relational appraisal model, the X_i (k) in the equation(1)signifies the kth financial appraisal index of the ith company, similarly, X_i (k) signifies the kth financial appraisal index of the ith accounting period in the dynamic model.

(2)Non-dimensional financial index

Standardizing all the financial indexes of the matrix, so as to make comparisons among indexes. Besides all the financial indexes can be classified as three categories, including the bigger-and-better efficient indexes, the few-and-better cost indexes and moderate indexes（ the more impending to one target, the better it is）.For instance, in the process of the financial comprehensive appraisal, net profit growth rate, total profit growth rate, net assets growth rate and total assets growth rate are the bigger-and-better efficient indexes, whereas assets liabilities ratio and liquid ratio are better-approaching moderate indexes. Obviously, these indexes are equiped with different dimensions as well as relative big discrepancy between numerical values, thus it is a necessity to standardize them through nondimensionalization. Usually, there are three ways to accomplish this purpose:

$$x_i(k)=[x_i(k)-minx_i(k)]/[\max x_i(k)-minx_i(k)] \quad (2)$$

$$x_i(k)=1-|x_i(k)-u_i|/max|x_i(k)-u_i| \quad (3)$$

$$x_i(k)=[maxx_i(k)-x_i(k)]/[\max x_i(k)-mtnx_i(k)] \quad (4)$$

The equation (2) is applied for the bigger-and-better efficient indexes, the equation(3) is for the better-approaching moderate ones, and the equation(4)is for the few-and-better cost ones.

(3)Determination for the weight w(k) of each financial indexes.

W(k) is equal to the proportion that the kth financial index shares in the n ones, which conveys its significance in the whole financial comprehensive appraisal. Without saying goes, weight must meet two prerequisites in each weighting systematic appraisal, on the one hand, the numerical area of w(k) is between 0 and 1. On the other hand, the sum of all the weight is definitely equal to 1.

Additionally, the determination of weight can be classified as subjective and objective weighting approaches according to the sources of original data that employed by us to calculate. And the former, to a great extent, comes to shape resting upon experts' subjective judgment based on their long-term empirical rules, on the contrary, the latter is qualified with strong objective characteristics, whose original data are formed in the process of each index appraisal. Because objective weighting approach always takes advantages of quantitative data to realize the aim, and a great many factors are not available to quantitative descriptions in real conditions, then objective weightings are not so popular as subjective ones. So it is the same with the financial comprehensive appraisal, so to say, it is not advisable to adopt the objective weighting approach to determine the weight, then subjective one took its place in the presented paper. What's more, we determined each weighting based on the "details on companies efficient appraisal" issued by the forth commission of china's

financial ministry on Feb.22th 2002, and the final weightings are 38% for earning capability, 18%for operating capability, 20% for debt paying capability and 24%for development ability.

(4)Constructing comprehensive appraisal matrix and calculating the grey relational degree

Based on appraisal indexes weight w=w(k),k=1,2,3,…the first and foremost thing is to calculate out the absolute difference $\Delta X_i(k)=|X_0(k),-X_i(k)|$ between the referential list $X_0(k)$ and comparative list $X_i(k)$, then the maximum value Δmax and minimum values Δmin can be located. Secondly, selecting the p of grey relational resolution coefficient attributing to the connection between p and the resolution ratio of relational degree. If p=1, the numerical area of relational coefficient is between 0.5 and 1,then the smaller the numerical area is, the lower the resolution ratio is. If p=0.1,the relational coefficient is between 0.09 and 1, then the bigger numerical area means higher resolution ratio, a rational as well as reasonable conclusion can come to draw that we are available to select varying resolution coefficient in light of relational degree between factors, and usually p is no more than 0.5. As a constant number p, whose numerical area is between 0 and 1, exerts its function by adjusting the size of comparative circumstances. Generally speaking, such circumstance may disappear when p=0, whereas the circumstance is likely to keep still[7].In this context, we endowed p=0.5. Next, we calculated out the relational coefficient and degree of each sample. Actually, the relational coefficient and degree of comparative list and referential list, which concern each listed-company during the identical accounting period(static appraisal)and one company during the varied accounting period(dynamic appraisal model),can be calculated through the following equations:

$$\beta_i(k) = (\Delta min + p\Delta max)/(\Delta x_i(k) + p\Delta max) \tag{5}$$

We can draw the financial comprehensive appraisal matrix by marrying the index weight W=w(k),K=1,2,3…n with each index relational coefficient matrix A:

$$R=A\times W$$

$$r_i = \sum_{j=1}^{n} \beta_{ij} \times w_j, (1 = 1,2 \ldots, m) \tag{6}$$

Thereinto, $A=\{\beta_{ij}\}_{m\times n}$ represents the relational coefficient matrix of each financial index, $w=\{w_i\}$ is the weighting distribution matrix of n appraisal indexes, R is comprehensive appraisal matrix, so to say, relational degree matrix. After figuring out the connotation of these matrix, we ranked the relational degree R_J according to their numerical size, which implies the companies' situation. In details, the bigger relational degree shows closer relationship between referential list and comparative list, which in turn indicates the fabulous condition the company is in, vice versa!

Moreover, it is the rank of the grey relational degree that is the sequence of the relative merits concerning the financial comprehensive condition by comparing among listed-companies(static appraisal model) or the varied accounting periods of one companies(dynamic appraisal model)

3. VALID TESTIFICATION OF THE FINANCIAL COMPREHENSIVE APPRAISAL MODEL ON GREY RELATIONAL THEORY

3.1 Constructing the financial comprehensive appraisal indexes system .

Constructing the financial comprehensive appraisal indexes system is the prerequisite to accomplish the financial comprehensive appraisal. Moreover, the selection of financial comprehensive indexes abides by comprehensive, significant and operational rules reflecting the companies' financial as well as operating conditions fully. In this context, we established four sorts of indexes on the basis of Hangbo Zhang's[8] researches, they are, debt-paying-ability assets, operating capability, development capability and earning capability. Where, debt paying ability index consists of asset-liability ratio, liquid ratio and interests coverage

ratio. Operating capability one: receivable turnover, inventory turnover and total assets turnover. Development capability one: net profit growth rate, total profit growth rate, growth rate of net assets, growth rate of total assets. And earning capability one: net sale profit rate, return on total assets, return on net assets, earning per share. Apparently, the reason why we selected these 14 financial indexes is that they are qualified to indicate companies' comprehensive conditions and appropriate to all kinds of companies.

3.2The financial comprehensive appraisal of grey relational static model

Ranking the relative merits, after comparing the financial comprehensive condition of the mentioned listed companies during the identical accounting period horizontally, relies on the grey relational static appraisal model to realize.

3.2.1 Selection of samples

In this context, we studied 8 listed-companies, in turn is WanKe A (stockcode 000002), ShenChangcheng (stockcode 000042) , ZhongLiang Real Estate (stockcode 000031) , TianBaoTiJian (stockcode 000965) ,HuaFa Ltd.(stock code 600325), ShaHe Ltd.(stockcode 000014), GuangYu Development(000537) GuoXing Real Estate (stockcode 000838) and take x1,x2,x3,x4,x5,x6,x7,and x8 to represent them respectively in the following tables .

In addition, in this paper, the selected financial index can be classified into four aspects—debt paying capability, operating capability, development ability and earning capability, and each of them would be represented by corresponding marks respectively, namely, s1,s2,s3 are to three indexes of debt paying capability, s4,s5,s6 to operating capability, s7,s8,s9 to development ability and s11,s12,s13,s14 to earning capability.

3.2.2 Original financial data.

In this context, we extracted the data from the financial report by the end of 2007 of the mentioned 8 listed-companies, then the following tables can be drawn after calculating the original data: Table 3-1 named debt-paying capability analysis, Table 3-2 named operating capability analysis, Table 3-3 named developing ability analysis, Table 3-4 named earning capability analysis. We counted the figure in the 4 tables on the basis of the original ones, but we didn't display them by and large owing to the limitation.

3.2.3 The formation of target matrix of the financial indexes .

The target eigenvalue matrix of the financial appraisal index matrix $X_{8\times1}$ by 14 indexes is as follows:X=

0.6611	1.957	22.26	57.79	0.4095	0.4736	1.108	1.225	0.9613	1.005	0.1364	0.0646	0.1655	0.73
0.6451	1.542	3.848	14.5	0.332	0.2218	2.806	2.422	0.0897	0.2246	0.1864	0.0413	0.1068	0.8427
0.3915	2.128	40.31	93.24	0.2938	0.1798	1.82	2.033	1.015	0.9066	0.5656	0.1017	0.1354	0.3
0.3679	1.699	27.86	9.394	0.8083	0.4583	2.571	2.926	0.2154	0.1548	0.246	0.1128	0.1763	0.442
0.7545	1.725	−95.49	7762	0.8293	0.2986	1.455	1.177	0.6491	0.5776	0.1675	0.0492	0.1842	1.22
0.669	3.002	1.341	29.79	0.1353	0.1738	−0.945	−0.915	−0.477	0.073	0.01	0.0017	0.005	0.014
0.7702	1.159	−97.5	7.525	0.468	0.3642	1.908	73.78	0.1325	0.2142	0.2511	0.0186	0.1023	0.097
0.6255	1.614	−96.8	25.03	0.6946	0.6373	28.73	26.27	−0.072	0.3373	0.1145	0.0732	0.1708	0.6496

In the 14 financial index exhibited above, assets liabilities and liquid ratio are approaching-better indexes, others are more-better efficient indexes. According to international practice, in the present paper we embodied assets liability ratio with 60% ,liquid ratio with 2. So the referential list is:

X=(0.6255,1.957,40.31,7762,0.8083,0.6373,28.73,73.78,1.015,1.005,0.5656,0.1128,0.1842,1.22)

3.2.4 Standardization

Assets liability and liquid ratio are both approaching-better moderate indexes; and they can be standardized with accordance to equation (3), and others are more-better efficient indexes .Standardization them with accordance to equation(2).The results are in table 3-5(not showed on account of the length of the paper).

3.2.5 Weight determination of different financial indexes

W(k) is the kth financial index's ratio of the n financial indexes mirroring the significance of index. In the presented paper , we adopted subjective evaluation and at the same time . we also calculated the index weighting by AHP and entropy method, According to the "Details on companies efficient appraisal " issued in 2006 . we evaluate the debt paying capability with 20%,operating capability with 18% , earning capability with 38%. And development Relative data of index weighting evaluated by researchers by objective evaluation are reported as following table 3-6.

Table 3-6 Weighting Table

	index	weight		index	weight
Debt paying capability	Liquid ratio	0.06	Operating capability	Accounts receivable turnover	0.05
	Debt to asset ratio	0.08		Inventory turnover ratio	0.05
	Times interest earned	0.06		Total asset turnover	0.08
Earning capability	Net sales	0.08	Developing capability	Net profit growth	0.05
	Return on total assets	0.12		Total profit growth	0.05
	Return on net assets	0.12		Growth rate of net assets	0.07
	Earnings per share	0.06		Growth rate of total assets	0.07

3.2.6 Static ranking on grey relational degree of the listed companies

After non-demensionalization, we calculated the absolute difference between reference and relative list with accordance to the equation $\Delta X_i(k)=| X_0(k),- X_i(k)|$.Table 3.7 is the results-table(not showed due to limited the length of this article). And from the table 3.7, we found that the max value is max=1, the min value is min=0. From above, we know that the best value is p=0.5 and calculate out the grey relational coefficient by equation(5).Then closely followed by the relational degree calculated by equation(6). Lastly, we arranged them according to numerical sizes, which was displayed in the table3-8.Meanwhile the table 3-9 was shaped concerning the ranking of the financial comprehensive conditions.

Table 3-9

Ranking	1	2	3	4	5	6	7	8
Company	WanKeA	ZhongLiang real estate	GuoXing real estate	TianBao ji jian	HuaFa Ltd.	Shen Changchen	Guang Yu development	Sha He Ltd.
Relational degree	0.652129	0.641484	0.63029	0.611025	0.598228	0.482089	0.436262	0.38504

Generally, the price of the stock is the reflection of value (except some special situations) mirroring the financial comprehensive status fully. In the presented paper, we compared the price of the 8 companies in 2007 end and their relational degree , from which we can easily find out that the rank of their financial comprehensive status is in good agreement with the prices of the stocks. Among these, GuoXing Real estate is an exception because in 2007 it went through an asset reorganization and most of its houses have been accomplished and in sale, as a result, the profit was very profound, so the stock price is the highest of the 8 companies. But in fact, the financial comprehensive status of GuoXing is worse than WanKe's, and it can be found out from the companies financial status two years later. So it is the same with the conclusion of the model constructed in the presented paper. That is to say, not only is the model we constructed efficient, but also highly proper.

3.3 Financial comprehensive appraisal of grey relation dynamic model

Lead a longitudinal comparison of a same company financial comprehensive status in different accounting period, rank them to form a merit rank of the company financial status in different accounting period. In the presented paper, we realized it by grey relation dynamic appraisal model.

3.3.1 Selection of sample

We chose WanKe A (stock code 000002) as a research target and chose the financial reporting data of the every end of the years from 2003 to 2007, then lead a constant financial comprehensive appraisal for the 5 years.

Using Y1, Y2, Y3, Y4, Y5 to represent 2007, 2006, 2005, 2004, 2003 respectively. S1, S2…S14 is the same as mentioned above.

3.3.2 Original financial data

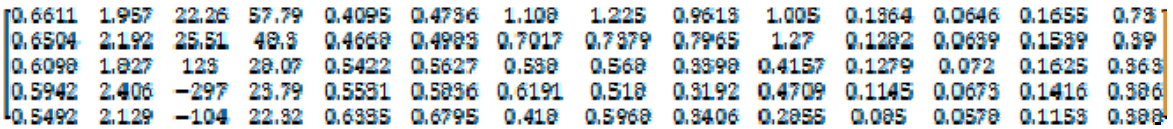
The result we calculated out from the financial data from WanKe A is presented as table 3-10.

Table 3-10

year	2003	2004	2005	2006	2007
Net sales	0.084994	0.114514	0.127889	0.128242	0.136355
Return on total assets	0.057759	0.067291	0.071967	0.063908	0.064583
Return on net assets	0.11534	0.1416	0.1625	0.1539	0.1655
Earning per share	0.388	0.386	0.363	0.39	0.73
Debt to assets ratio	0.549243	0.594162	0.609809	0.650369	0.661124
Liquid ratio	2.1293	2.4062	1.827	2.1921	1.9566
Interest coverage ratio	-1036.7954	-297.6222	123.008	25.5055	22.2562
Accounts receivable turnover	22.3173	23.7923	28.0687	48.3027	57.7906
Inventory turnover rate	0.6335	0.5513	0.5422	0.4668	0.4095
Total assets turnover rate	0.6795	0.5876	0.5627	0.4983	0.4736
Growth rate of net asset	0.417992	0.619129	0.537987	0.701678	1.108129
total profit growth rate	0.596824	0.517798	0.567988	0.737944	1.224957
Growth rate of net assets	0.340578	0.3192535	0.339783	0.796541	0.961252
Growth rate of total assets	0.285451	0.470917	0.415719	1.269868	1.005103

3.3.3 Construction of the target matrix of financial indexes

The target eigenvalue matrix Y with the 14 financial indexes of the five years is as follows: Y=



Referential list:

Y_0=(0.5942,1.957,25.51,57.79,0.6335,0.6795,1.108,1.225,0.9613,1.27,0.1364,0.072,0.1655,0.73)

3.3.4 Dynamic ranking on grey relational degree .

After nondimensionalization, the absolute difference between referential and relative list was calculated out, which is exhibited in the table 3-11 and 3-12(not displayed due to the limitation), the calculated grey relational degree during varied accounting periods is exhibited in the below table 3-13.

Table 3-13

index	2007	2006	2005	2004	2003
S1	0.026667	0.029864	0.05452	0.08	0.034164
S2	0.06	0.029303	0.038059	0.02	0.033932
S3	0.051119	0.051364	0.06	0.034776	0.02
S4	0.05	0.032575	0.018687	0.017142	0.016667
S5	0.016667	0.020093	0.027546	0.028836	0.05
S6	0.026667	0.028985	0.037479	0.042268	0.08
S7	0.05	0.022958	0.018852	0.020686	0.016667
S8	0.05	0.021032	0.017494	0.016667	0.018008
S9	0.07	0.046263	0.023842	0.023333	0.027696
S10	0.045516	0.07	0.025591	0.026685	0.023333
S11	0.08	0.060794	0.060165	0.043232	0.026667
S12	0.05884	0.056221	0.12	0.072367	0.04
S13	0.012	0.008205	0.010718	0.006145	0.004
S14	0.06	0.021032	0.02	0.020872	0.020951
Relational degree (sum)	0.657475	0.498687	0.532953	0.453008	0.412085

From table 3-13, in 2003-2007 the result of financial comprehensive appraisal of WanKeA shows in 2007 it rank 1-st, 2006 3-rd, 2005 2-nd, 2004 4-th, 2003 5-th.It can be seen that the financial status has become better since 2003, except a bit abnormal conditions in 2006, which is in line with the fact very well, which in turn tells that grey relation dynamic model works efficiently in calculating the company financial comprehensive appraisal, and can rightly work out the company financial and operating status.

4. CONCLUSIONS

In this paper, we pointed out the shortcomings of the popular financial comprehensive analysis method and the grey characteristics of company's financial information. The model of financial comprehensive appraisal on grey relational analytical method is structured and tested in China's listed-companies in real estate industry from both static and dynamic view. The result shows that grey relation financial appraisal analysis method is a efficiency analysis tool in the financial comprehensive appraisal of companies. Although we testified that the model applied to a financial comprehensive appraisal on grey theory is effective, the selection of the financial indexes and the distribution of weighting in a model should be conducted according to the company's specific conditions.

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