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Research Article

The Application of Grey Correlation and Regression Model on Food Enterprise Performance Evaluation

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Abstract: Food enterprise performance evaluation is a core question in any economic system. With the high development of information technology and increasingly importance of strategy, traditional food enterprise performance has already become unsuitable. This study is exactly to satisfy the need of the present situation and launch the discussion of the application of Grey correlation and regression model evaluation on food enterprise performance evaluation to construct the mathematic model, evaluation procedure and relevant application technologies. The use of gray correlation method and regression model to integrate all the parts in performance evaluation is quite necessary to the optimization and integration of food enterprise strategic performance management.

Keywords: Food enterprise, gray correlation, regression model

INTRODUCTION

Based on the new trends and new demands of rapid development knowllayer economy, all countries in the world are making efforts to improve their comprehensive ability in order to comply with the pace of development of the world, to have the ability remain powerful nations in the world-lam, our country's 5th Plenary Session of the sixteen Central Committee and National Science and Technology Committee enhance the capability of independent innovation, building an innovation-oriented country as an important national strategies (Miao *et al*., 2003). Developing a number of food enterprises is one of the key points to build an innovation-oriented country. Our country has already put forward to build an innovation-oriented country in 2020 as a great strategic goal (Liu *et al*., 2010). The food enterprise is the foundation and the main body of a national system, the construction of food enterprises is the core that builds nation. Food enterprise is a kind of food enterprise with core technology of intellectual property rights, famous brands rights (Rengui and Chen, 2005). It also has stronger international competitiveness, use concepts and organizational culture as a guide, technical activities as supporting, R and D, absorption or re-as methods. Constantly innovate to encourage food enterprises to the sustained and stable development (Siddiqi *et al*., 2002). Up to now, there are about 500 food enterprises are affirmed by our country. In the process of building food enterprises, the hot issue is how to scientific evaluate the performance of food enterprises (Dimmit *et al*., 2008). But for food enterprises are a new kind of food enterprise, there is no performance evaluation methods use quantitative and qualitative methods together for food enterprises. So it has a great realistic and theoretical significance for the research of evaluation of food enterprise performance (Baysinger and Butler, 1985).

Combining with the research status of domestic and international about the performance evaluation. Use the core theory, the support theory and the theory of food enterprise as the basis theory of the article. the food enterprise performance evaluation of the core theory includes theoretical innovation (Forsberg, 1989) performance evaluation theory; food enterprise performance evaluation theory includes the food enterprise life cycle theory, coordination theory, the theory of knowllayer management; food enterprise performance evaluation theory on stakeholder theory, contingency theory of management. The above theory as the theoretical foundation and the combination of systems engineering, management science, economics, statistics and other relevant technical economy of amount of interdisciplinary integration method of food enterprise performance evaluation, were used to build the Grey correlation data envelopment analysis and regression model.

MATERIALS AND METHODS

Basic principles of grey correlation degree: Gray correlation method is proposed by Deng (1985), it can make quantitative analysis to the system dynamic

change with the situation, to investigate the correlation degree between the system factors. Gray correlation method is on the basis of system series of geometric shapes, curve graph similarity between research variables. Using the gray relation method, we can compare performance of a single food enterprise in different periods using vertical evaluation; also can compare between different companies in the same industry's financial status using transverse evaluation; the indicators can be stratified analysis

According to the gray correlation analysis of the gray system theory, the size of the gray correlation reflects the reference sequence and comparative sequence similarity. According to the different features between the gray value of the index layer points and the gray value of the background area is large , it is understood that the layer and its neighboring pixel values consisting of comparison sequence associated with the reference sequence is relatively small. The calculating process of Grey absolute correlation degree are described as follows.

The calculation steps of correlation degree is as follows.

Let the reference sequence $X_0 : \{x_i(k), k = 1,2,\cdots,n$ comparison sequence $X_i : \{x_i(k), k = 1,2,\cdots,n$:

- Initialization:

$$Y_0 : \{\frac{x_0(k)}{x_0(1)} = y_0(k) \quad Y_1 : \{\frac{x_i(k)}{x_i(1)} = y_i(k)$$

,

Initialized so that all sequences comparable.

- Calculate the correlation coefficients of each point:

$$r(y_0(k), y_i(k)) = \frac{1}{1+|(y_0(k+1)-y_0(k)-y_i(k+1)-y_i(k))|}$$
$$k = 1,2,\cdots,n-1$$

- Calculate the correlation degree:

$$r(x_0, x_i) = \frac{1}{n-1}\sum_{k-1}^{n-1} r(y_0(k), y_i(k))$$

Its basic algorithm thought: put index in the each pixel points corresponding to gray value considered initial series of Grey forecast model, then, put index in the pixel points x and its neighborhood pixel points into original sequence, accumulate the original sequence by using data processing for a regular series of Grey modeling, again for Grey forecast, after getting the forecast value sequence, for data reduction by that point in the actual forecast data ,if the difference between forecast value and actual value is larger, which is for layer points, otherwise, for non-layer points. The main steps of the algorithm of GM (1, 1) model are shown as follows:

- Let the original sequence as:

$$x^{(0)} = (x_{(1)}^{(0)}, x_{(2)}^{(0)}, \cdots, x_{(n)}^{(0)})$$

- Generates a sequence for the record:

$$x^{(1)} = (x_{(1)}^{(1)}, x_{(2)}^{(1)}, \cdots, x_{(n)}^{(1)})$$

Among them:

$$x_{(k)}^{(1)} = \sum_{i=1}^{k} x_{(i)}^{(1)} \quad k = 1,2,\cdots,n$$

- $z^{(1)}$ is close to $x^{(1)}$ as the mean value generates a sequence:

$$z^{(1)} = (z_{(2)}^{(1)}, z_{(3)}^{(1)}, \cdots, x_{(n)}^{(1)})$$

Among them:

$$z_{(k)}^{(1)} = 0.5x_{(x)}^{(1)} + 0.5x_{(k-1)}^{(1)}, \cdots, k = 2,3,\cdots,n$$

- GM (1, 1) model that is an order of 1 Yuan gray model, which is defined as:

$$x_{(k)}^{(0)} + az_{(k)}^{(1)} = b$$

where,
a = A factor of development
b = The grey action

- The whiting model of GM (1, 1) is:

$$\frac{dx^{(1)}}{dt} + ax^{(1)} = b$$

- The albino-response of GM (1, 1) is:

$$\hat{x}_{(k+1)}^{(1)} = (x_{(1)}^{(0)} - \frac{b}{a})e^{-ak} + \frac{b}{a}$$

$$\hat{x}_{(k+1)}^{(0)} = x_{(k+1)}^{(1)} - \hat{x}_{(k)}^{(1)}$$

- Under the least-squares criterion parameter:

$$\begin{bmatrix} a \\ b \end{bmatrix} = (B^T B)^{-1} B^T y^n$$

Among them:

Table 1: Controlled variables' definition

Variable	Symbol	Measuring method
Company size	SIZE	Take the natural logarithm of total assets
Financial leverage	LEV	The ratio of liabilities to assets, the ratio of liabilities to assets = total liabilities/total assets
Whether state-owned	TYPE	Dummy variables. If the controlling shareholder is state-owned it take 1, otherwise take 0
Concentration of ownership	CO	Square of the top ten shareholders' proportion
Size of the board	DI	The number of food enterprises in companies' board

Table 2: Descriptive statistics of some major variables in regression models

Variable		Sample number	Mean value	S.D.	Median	Min.	Max.
Dependent variable	ROE	3568	0.054	0.762	0.007	-0.837	1.616
	Tobin Q	3568	1.629	1.392	1.439	0.732	20.921
Independent variable	FEE	3568	4.732	16.718	5.102	0.000	29.104
Controlled variable	SIZE	3568	21.380	0.971	21.242	18.272	23.758
	LEV	3568	0.528	0.183	0.552	0.021	1.059
	TYPE	3568	0.512	0.324	1.000	0.000	1.000
	CO	3568	0.327	0.407	0.278	0.212	0.810
	DI	3568	9.472	2.849	10.000	21.000	5.000

S.D.: Standard deviation; Min.: Minimum; Max.: Maximum

$$B = \begin{bmatrix} -z_{(2)}^{(1)} & 1 \\ -z_{(3)}^{(1)} & 1 \\ \vdots & \vdots \\ -z_{(n)}^{(1)} & 1 \end{bmatrix} \quad y^n = \begin{bmatrix} x_{(2)}^{(0)} \\ x_{(3)}^{(0)} \\ \vdots \\ x_{(n)}^{(0)} \end{bmatrix}$$

The strong layer detection based on Grey prediction of Grey forecasting model of index layer detection studies focus on the sequence of points on the options and options for sequence points improvements are only detects the layers more informative, does not meet the requirements of full index layer. Based on Grey forecast detection out of layer exists serious of fracture phenomenon, but its can accurate to find index layer of location, this study has a new idea, puts Grey forecast application into index of strong layer of detection, base on strength layer connection of thought and put this strong layer and by Niblack value of the two algorithm get of weak layer for connection, then get index of layer information.

Based on the Grey prediction model in sequence point selection scheme and index index Gray scale characteristics analysis, the paper selected 12 masked sequences and choose GM (1, 1) model to model, thus get the strong layer in the index. The specific Grey prediction algorithm of the main steps are described below.

Let the size of an M×N index I, the Grey value of midpoint I (i, j) is g (i, j), i = 1, 2, …, M, J = 1, 2, …, N for each pixel in the index I, in turn, use mas sequences and GM (1, 1) model to calculate the gray forecast value of the center point x and constitutes the forecast index II.

Original I minus the predicted figure II gets error indexs III, its gray value of each point is ξ (i, j).

According to the error histogram of the index, the threshold value t, if ξ (i, j) >t, the pixel index B (i, j) = 1 is the binary index of strong layers, otherwise, B (i, j) = 0, thus, getting the binary indexs of layers obtained by gray forecast model.

Model building: In order to avoid one-sidedness, this study uses Tobin's Q value as the dependent variable. The calculation formula is as follows:

Tobin Q = (N*P + LIABILITY) /ASSET

Of which, N refers to the company's total number of shares; P refers to the company's stock closing price at the end of one year; LIABILITY refers to the company's debt level; ASSET refers to the total assets of the company at the end of one year.

In this study, the explanatory variable is independent food enterprise's compensation, denoted by FEE. The final results are expressed as million RMB.

The other controlled variables' selections are based on previous studies combined with the background of this study, as shown in Table 1.

According to the research and variable definitions above, this study established the regression model by using the following equation.

Tobin:

$$Q_t = \beta_0 + \beta_1 FEE_t + \beta_2 SIZE_t + \beta_3 LEV + \beta_4 TYPE_t + \beta_5 CO_t + \beta_6 DI_t + \varepsilon$$

$$ROE = \beta_0 + \beta_1 FEE_t + \beta_2 SIZE_t + \beta_3 LEV + \beta_4 TYPE_t + \beta_5 CO_t + \beta_6 DI_t + \varepsilon$$

RESULTS AND DISCUSSION

Descriptive statistics: The Table 2 is the descriptive statistics results of the major variables used the regression model, from which we can have a preliminary understanding of the sample data.

As can be seen from Table 2, Tobin's Q value's value is 1.629. The maximum value is 20.921, the minimum value is 0.732. The range of ROE is really wide, indicating that there is a difference in the market value among the listed corporations. The independent variable is 47320/capita, the largest salary per capita is

Table 3: Correlation test between variables

	ROE	Tobin Q	FEE	SIZE	LEV	TYPE	CO	DI
ROE	1							
Tobin Q	0.127* (0.132)	1						
FEE	0.142* (0.009)	0.212* (0.011)	1					
SIZE	-0.076 (0.371)	-0.032* (0.704)	-0.049 (0.563)	1				
LEV	-0.280* (0.001)	0.092 (0.278)	0.076 (0.367)	0.098 (0.245)	1			
TYPE	0.169* (0.045)	0.214* (0.011)	-0.001 (0.987)	0.032 (0.705)	0.018 (0.833)	1		
CO	-0.037 (0.665)	-0.005 (0.956)	0.131 (0.119)	-0.056 (0.504)	0.304* (0.011)	-0.407* (0.026)	1	
DI	-0.071 (0.402)	0.172* (0.041)	0.082 (0.335)	-0.169* (0.045)	0.065 (0.443)	-0.037 (0.663)	0.173* (0.040)	1

**: 1% level (two tailed) significantly correlated; *: 5% level (two tailed) significantly correlated

Table 4: Multiple regression conclusion

	ROE		Tobin Q	
	Estimated coefficients	t value	Estimated coefficients	t value
Intercept	0.315	4.819***	0.263	4.102***
FEE	0.106	1.008**	0.381	1.207**
SIZE	-0.016	-5.159***	-0.013	-4.120***
LEV	0.061	2.119**	0.017	2.934***
TYPE	0.005	9.215***	0.002	2.660***
CO	0.049	3.361***	0.005	1.478*
DI	-0.005	-1.258	-0.004	-1.035
N	3.568		3.568	
Adj R^2	0.266		0.485	
F value	4.526***		6.232***	

**: 1% level (two tailed) significantly correlated; *: 5% level (two tailed) significantly correlated

close to 300,000. Some independent food enterprises are not from the listed companies, resulting the minimum value of FEE is 0. Compared with the mean value of American listed corporations' independent food enterprise, we can see that China's independent food enterprise's compensation level still is not too high. In the control variables, the average size of companies has reached 21.380 and there is not abnormal value. The average debt to asset ratio is 52.8%, the level of debt is not particularly high. Maybe because of China's not perfect capital market, most companies prefer equity financing rather than bond financing. However, the overall asset liability ratio is still at reasonable level. The ownership concentration of China's listed corporation is high. CO mean is 0.327, which means the shareholding ratio of the top ten shareholders is up to 32.7% on average. The maximum reached 0.810, which is also a very high proportion. The first major shareholders have more than 50% which is state-owned shares and this is also consistent with our country's unique institutional background.

Correlation test: Table 3 is the correlation test between the major variables, in order to eliminate the effects of the correlation between variables on regression model, this study carried out the Pearson correlation test of the main variables in the model. In the Pearson test, the absolute value of the correlation coefficient is larger, indicating that the correlation between two variables is stronger. In Table 3, the absolute value of Pearson coefficient which is between 0.001 to 0.407 is below 0.6, so we can come to the conclusion that there are no serious multicollinearity problems among these variables conclusion.

From the table, we can see that the rate of Return on net assets (ROE) had significant positive correlation with Tobin Q, so the two level measured variables of corporate performance is basically similar and the results are basically credible. ROE and FEE are significant positive correlated. Tobin Q and the independent variable are significantly positive correlated, so we can make a conclusion that there is a positive relationship between independent food enterprise's compensation and corporate performance.

Regression analysis: After descriptive statistics and correlation test, this study used the SPSS 20.0 to built on the model of regression test.

Table 4 lists the results of multiple regression, no matter which dependent variable was use, the estimated coefficients of the independent variable FEE is positive and the proportion is larger in the group variable coefficient. We can draw the conclusion that FEE has a larger influence on explained variables. Adjusted R square of these 2 models are 0.266 and 0.485, showing that the dependent variable can be explained is 26.6 and 48.6%. The coefficient of independent variable FEE is positive. The level of significant $p<0.05$, shows that a correlation exists between our country's independent food enterprise's compensation and company performance and it is a positive relationship.

CONCLUSION

Using gray relation method mining index inherent law, the food enterprise can stand in the height of the overall goal. This study, based on the requirement of the food enterprise foothold, the index weight distribution and analysis the optimal state of existing performance level. The research of the evaluation of food enterprise performance is imminent problems, through paper's performance evaluation it can enhance food enterprise innovation management, further improve capability and overall business performance of

the food enterprises, enhance the competitiveness of food enterprises and promote the food enterprise sustainable development.

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REFERENCES

Baysinger, B.D. and H.N. Butler, 1985. Corporate governance and the board of directors: Performance effects of changes in board composition. J. Law Econ. Organ., 1: 101-124.

Dimmit, P., C. Phillips and K. Siddiqi, 2008. Robust and efficient skeletal graphs. Proceeding of IEEE Conference on Computer Vision and Pattern Recognition, pp: 1417-1423.

Forsberg, R.H., 1989. Outside directors and managerial monitoring. Akron Bus. Econ. Rev., 20(2): 24-32.

Liu, S.F., Y.G. Dang, Z.G. Fang and N.M. Xie, 2010. The Grey System Theory and its Application. 5th Edn., Science Press, Beijing, pp: 195-210.

Miao, M., X. Song-yun *et al*., 2003. The index edge detection new algorithm based on grey system theory. Chinese J. Index: A Edn., 8(10): 1136-1139.

Rengui, H. and J. Chen, 2005. Index edge detection based on grey prediction model. J. Northwestern Poly-Tech. Univ., 23(1): 15-18.

Siddiqi, K., S. Bouix, A. Tannenbaum and S.W. Zucker, 2002. Hamilton-jacobi skeletons. Int. J. Comput. Vision, 48(3): 215-231.

Deng, J.L., 1985. Relational space of grey system. Fuzzy Mathematics, 4(2): 1-10.