
Research on efficiency evaluation of financial refinement management based on DEA

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Abstract: Aiming at the low fitting degree of the traditional financial management performance evaluation method, a DEA-based financial refinement management effectiveness evaluation method is proposed. This paper analyses the overall structure of the financial department, takes the effectiveness evaluation index of financial management at home and abroad as the reference object, and constructs the effectiveness evaluation index system of financial fine management. According to the evaluation index system, CR model and BCC model in DEA method are adopted to evaluate the efficiency of financial delicacy management. Experimental results show that the method has small error, high fitting index and good practical performance.

Keywords: DEA; financial refinement management; efficiency evaluation; evaluation index system.

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1 Introduction

As a key part of the enterprise manufacturers, the financial management department organises a series of financial activities and deals with financial relations based on the overall development strategy of the enterprise and relevant rules and regulations, and comprehensively manages the aspects of financing and investment (Letaief et al., 2018; Meyer et al., 2017; Ben Ameur et al., 2018). Among them, the focus of fund-raising management is on how enterprises should obtain funds, including judging the amount of fund-raising, screening the ways of fund-raising, judging the time of fund-raising, balancing the cost and risk of fund-raising, and determining the scientific capital framework. The focus of investment management is to evaluate the return and risk of investment, try to minimise the risk while obtaining the return, or maximise the return when the risk is fixed.

Financial refinement management performance is an important component of the core competitiveness of an enterprise. To improve the performance of enterprise's financial management, the first thing to do is to evaluate its financial management performance, design and build a scientific evaluation system, so that enterprises can clearly recognise their own management level and weak links (Constantin et al., 2018; Xie et al., 2016; Jing, 2017). It can modify the weak links to improve the performance and efficiency of financial management. However, the current evaluation system for financial management performance of many enterprises has some problems, such as incomplete consideration, and inaccuracy evaluation results. In the environment of increasing financial risk of enterprises, experts and scholars in this field have invested in research and obtained good results.

Wang and Wang (2019) point out that the traditional evaluation of financial management has a big problem of fuzziness. Based on the types of financial risks, the index system of financial impact is constructed. Through the way of index weight assignment and intuitionistic fuzzy multi-attribute method in the fuzzy multi-attribute decision-making scheme, the enterprise financial evaluation is carried out, and the relevant solutions are given according to the problems. Xue et al. (2016) point out that the main basis of financial efficiency evaluation is the data of financial statements and financial systems of enterprises and institutions. Using accurate evaluation indexes and reasonable methods to evaluate the effectiveness of financial management can effectively judge the details of financial operations. Taking the county-level public hospitals in Inner Mongolia as the research object, this paper designs and constructs a set of measurement system suitable for the effectiveness evaluation of financial management of the hospital, and evaluates the financial performance of the hospital. In 2018, Hu based on the green value chain, the principles of determining financial evaluation indexes are set up. The evaluation indexes are selected in the internal and external value chains, and the fuzzy comprehensive evaluation method is constructed by using the hierarchical matrix model for financial evaluation. Taking Jiusan Grain and Oil Group as the experimental object, the financial management of Jiusan Grain and Oil Group is evaluated by the proposed method.

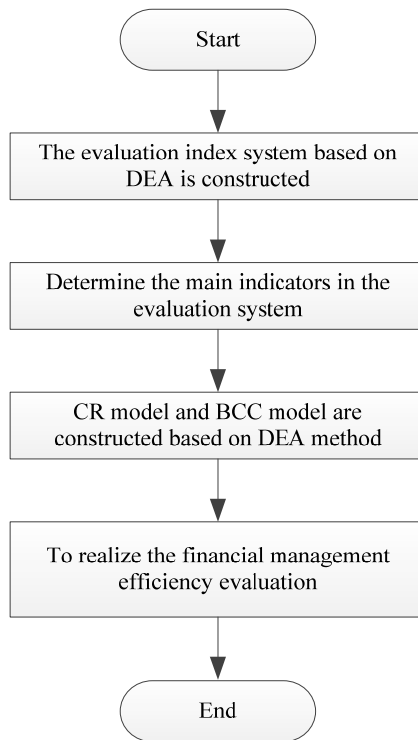
The evaluation of enterprise financial management efficiency is an effective way to perfect enterprise financial management scheme, which can improve the competitiveness of enterprises and the effective management of enterprise financial performance. It is an important part of promoting economic development. The accuracy of the above research results is poor, so a DEA based financial refinement management

effect evaluation method is proposed to evaluate the effectiveness of financial refinement management. DEA is a data processing method, which concentrates operations research, management and mathematical economics. It is an efficient data processing and linear standardisation method.

2 Efficiency evaluation of financial refinement management based on DEA

The flow chart of the financial refinement management efficiency evaluation method based on DEA is shown as follows:

Figure 1 The flow chart of the financial refinement management efficiency evaluation method based on DEA is as follows



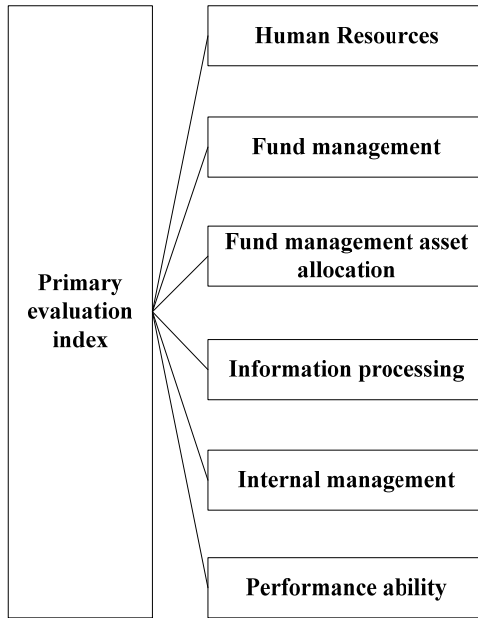
2.1 General composition of the financial sector

The general components of financial department can be roughly divided into financing department, financial accounting department and financial settlement department. At the same time, they are equipped with the post of financial director, responsible personnel of financial department, and accounting posts such as general ledger, statement and cashier. Each post has a clear division of labor and cooperates with each other.

2.2 Construction of evaluation index system based on DEA

Taking the effectiveness evaluation index of domestic and foreign financial management as reference object, and based on the construction principle of evaluation index system, this paper uses the analysis of financial management process to construct an effectiveness evaluation system for financial refinement management. Figure 2 is the first-level evaluation index:

Figure 2 First-level evaluation index



Necessity of indexes is described in detail below:

1 Human resources

Human resources in the efficiency of financial refinement management refer to the overall ability of enterprise management. In view of the gradual change of relevant national policies and social environment, the general framework of enterprise operation is also changing. Therefore, enterprise financial managers need to be a compound management talent, that is, their learning ability must be strong (Yang et al., 2016; Wang, 2018). In this regard, the secondary indexes of human resources are determined as the final educational background and title of directors, supervisors and senior managers.

2 Fund management

Under the condition of normal operation of enterprises, financial management procedure refers to the strategic development plan under which the long-term and balanced operation and allocation of development funds can be promoted as a

measure norm and the long-term profitability of enterprises can be regarded as the ultimate goal based on value analysis, namely, the relatively comprehensive management of financial activities such as enterprise fund raising, investment direction and allocation (Yun et al., 2018; Qiu, 2017; Fu, 2017). Effective use of resources can achieve long-term goals of enterprises. Building a good financial relationship can bring a positive impact on the short-term capital turnover of enterprises, and can find the best way to invest when the funds of enterprises are abundant. Therefore, the second-level indexes of fund management evaluation index are defined as: operating capital flow ratio; the number of successful loans and good financial institutions in the previous year, etc.

3 Asset allocation

Based on the overall situation of enterprises' operation activities in the knowledge economy environment, the financial management of enterprises will also change with the changes of natural resources economy and labor economy. The core of the financial management process is converting funds into funds and assets. Therefore, the second-level indexes of asset allocation are defined as current ratio and asset-liability ratio.

4 Information processing

At present, in the electronic information environment, financial managers of enterprises must have super information processing ability. That is to say, in the electronic information environment, financial managers need to have strong information processing ability, that is, timely conversion of data into information, conversion of information into knowledge, conversion of knowledge into leadership decision-making, and conversion of leadership decision-making into actual action (Zhan, 2018; Zhang, 2017; Ji et al., 2018). In summary, the second-level indexes of information processing are defined as the number of times information transformed into knowledge and knowledge into decision-making.

5 Internal management

In the operation of enterprises, financial management ability is the centralised performance of internal management performance. The role of enterprise financial control is not only embodied in its being a key component of financial management, but also a powerful tool for the smooth development of enterprise business plans. Therefore, in the evaluation of the effectiveness of financial management, whether the top management of enterprises abide by the relevant laws and regulations of finance and economics should also be taken into account. Coordination ability of enterprises and relevant government departments is an important performance of financial management effectiveness. It is an important way for enterprises to master development policies and obtain development information for enterprises (Jiao, 2016; Niu et al., 2018). In summary, the second-level indexes of internal management are defined as the number of economic violations and coordination problems between governments.

6 Financial performance ability

This index is the level of financial management reflected by the relevant financial indexes. The strength of the ability can not only reflect the situation of financial refinement management, but also show the intrinsic value of the enterprise. Therefore, EBITDA, the depreciation of unit tax and interest and pre-amortisation profit, is initially taken as the evaluation index of financial performance.

To sum up, the preliminary evaluation index system is as shown in Table 1.

Table 1 Evaluation index system

| <i>Primary indicator</i> | <i>Secondary indexes</i> |
|--------------------------|---|
| Human resources | Senior management qualifications Senior management title Senior management experience |
| Fund management | Number of well-connected financial institutions Well-connected financial institution executives Successful loan and investment experience in the previous year Operating cash flow ratio |
| Asset allocation | Assets and liabilities Current ratio Inventory turnover Accounts receivable turnover |
| Information processing | Number of times information is converted into knowledge and knowledge is converted into decisions |
| Internal management | Number of serious violations Executives overstep internal control system Coordinate major issues with the government |
| Performance ability | Unit EBITDA |

Effective selection of input and output indexes is the basic work of using DEA to evaluate the effectiveness of financial management. DEA is the abbreviation of Data envelopment analysis. Based on the concept of relative efficiency, it is a method to evaluate the relative effectiveness or benefit of units of the same type according to multi-index input and multi-index output. In the selection process, the following three aspects should be considered: input and output indexes need to obey the evaluation objectives set, and can reflect the purpose of evaluation more comprehensively; fully considers the correlation between input and output indexes; also needs to take into account the diversity of reference (Liu, 2016; Leng, 2018), which exists in the index system.

So far, there have been many research results on DEA's evaluation of enterprise's financial ability and competitiveness, but there are few studies on efficiency evaluation of enterprise's financial refinement management. Based on the above theory and analysis, the input and output indexes of DEA are selected as shown in Table 2.

Table 2 Preliminary selection of input and output indexes of DEA

| <i>Input indicator</i> | <i>Output indicator</i> |
|---|-------------------------|
| Senior management qualifications | Unit EBITDA |
| Senior management title | |
| Senior management experience | |
| Number of well-connected financial institutions | |
| Well-connected financial institution executives | |
| Successful loan and investment experience in the previous year | |
| Coordinate major issues with the government | |
| Number of serious violations | |
| Executives overstep internal control system | |
| Number of times information is converted into knowledge and knowledge is converted into decisions | |
| Assets and liabilities | |
| Current ratio | |
| Operating cash flow ratio | |
| Accounts receivable turnover | |
| Inventory turnover | |

of input and output indexes of DEA, the input and output indexes of DEA are further determined by the following steps. Firstly, the data is dimensionless: assuming that the j^{th} index in the i^{th} enterprise is expressed in the form of x_{ij} . Following formula (1) realises dimensionless data, p represents the capacity of samples.

$$x_{ij}^* = \frac{(x_{ij} - x_j^-)}{s_j} \tag{1}$$

where

$$x_j^- = \frac{1}{p} \sum_{j=1}^p x_{ij} \tag{2}$$

$$s_j = \sqrt{\frac{\sum_{j=1}^p (x_{ij} - x_j^-)^2}{p-1}} \tag{3}$$

Next, the common factors of the data are extracted, and the extraction method is principal component analysis. In this paper, SPSS is used to help extract input indexes, and the software is used to calculate the eigenvalues and variance contribution rates of the correlation matrix, as shown in Table 3.

Table 3 Variance table of input indexes

| <i>Ingredient</i> | <i>Initial eigenvalue variance contribution rate /%</i> | <i>Extract the square sum load variance contribution rate /%</i> |
|-------------------|---|--|
| 1 | 25.30 | 25.30 |
| 2 | 18.12 | 18.12 |
| 3 | 17.34 | 17.34 |
| 4 | 14.80 | 14.80 |
| 5 | 11.40 | 11.40 |
| 6 | 6.75 | |
| 7 | 5.36 | |
| 8 | 5.21 | |
| 9 | 4.49 | |
| 10 | 3.89 | |
| 11 | 1.94 | |
| 12 | 1.62 | |
| 13 | 1.36 | |
| 14 | 0.94 | |
| 15 | 0.56 | |

Table 4 Reflection table of factor load matrix

| <i>Index</i> | <i>Ingredient</i> | | | | |
|---|-------------------|----------|----------|----------|----------|
| | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> |
| Senior management qualifications | 0.76 | 0.34 | 0.22 | 0.40 | -0.70 |
| Senior management title | 0.71 | -0.042 | -0.006 | 0.33 | -0.14 |
| Senior management experience | 0.42 | 0.34 | 0.17 | 0.70 | -0.008 |
| Number of well-connected financial institutions | -0.034 | 0.64 | 0.008 | -0.25 | 0.28 |
| Well-connected financial institution executives | -0.87 | -0.35 | 0.65 | 0.009 | 0.52 |
| Successful loan and investment experience in the previous year | -0.68 | 0.30 | 0.16 | 0.09 | -0.14 |
| Coordinate major issues with the government | 0.42 | 0.16 | 0.59 | -0.42 | -0.18 |
| Number of serious violations | 0.43 | 0.17 | 0.26 | 0.03 | -0.17 |
| Executives overstep internal control system | 0.18 | -0.63 | 0.38 | 0.04 | -0.11 |
| Number of times information is converted into knowledge and knowledge is converted into decisions | 0.004 | 0.55 | 0.34 | 0.07 | 0.53 |
| Assets and liabilities | 0.73 | 0.12 | -0.42 | -0.36 | 0.09 |
| Current ratio | 0.28 | -0.57 | -0.02 | 0.08 | 0.54 |
| Operating cash flow ratio | -0.57 | 0.05 | 0.59 | 0.20 | -0.26 |
| Accounts receivable turnover | 0.56 | -0.08 | 0.46 | -0.43 | -0.30 |
| Inventory turnover | -0.03 | -0.32 | -0.18 | 0.42 | -0.10 |

Based on Table 4 factor load analysis, factor rotation is carried out. Constructing factor analysis model is not only to extract public factors, but also to understand the practical significance of public factors, so as to facilitate the final scientific decision-making. In the initial factor load matrix, most factors and many variables are correlated, which is not conducive to factor interpretation. Therefore, it is necessary to multiply the load matrix of the initial factor by the orthogonal matrix and transform it orthogonally, that is, factor rotation. In this paper, the orthogonal rotation method with the largest variance is selected to realise the rotation of factor load matrix, and the explanatory performance of factor is increased, as shown in Table 5:

Table 5 Factor rotation matrix

| <i>Index</i> | <i>Ingredient</i> | | | | |
|---|-------------------|----------|----------|----------|----------|
| | <i>1</i> | <i>2</i> | <i>3</i> | <i>4</i> | <i>5</i> |
| Senior management qualifications | -0.21 | 0.88 | 0.27 | 0.11 | -0.03 |
| Senior management title | -0.36 | 0.65 | 0.16 | -0.24 | 0.01 |
| Senior management experience | 0.08 | 0.89 | -0.10 | 0.08 | -0.005 |
| Number of well-connected financial institutions | -0.04 | -0.04 | 0.06 | 0.71 | -0.16 |
| Well-connected financial institution executives | 0.26 | -0.05 | 0.16 | 0.08 | 0.90 |
| Successful loan and investment experience in the previous year | 0.66 | -0.20 | -0.18 | 0.21 | -0.22 |
| Coordinate major issues with the government | 0.01 | 0.12 | 0.85 | 0.15 | 0.06 |
| Number of serious violations | 0.03 | 0.13 | 0.51 | 0.09 | 0.05 |
| Executives overstep internal control system | 0.06 | 0.03 | 0.31 | -0.50 | 0.44 |
| Number of times information is converted into knowledge and knowledge is converted into decisions | 0.15 | 0.25 | -0.01 | 0.74 | 0.26 |
| Assets and liabilities | -0.87 | 0.11 | 0.23 | 0.13 | -0.17 |
| Current ratio | -0.40 | 0.01 | -0.15 | -0.20 | 0.69 |
| Operating cash flow ratio | 0.87 | -0.35 | 0.11 | -0.06 | 0.05 |
| Accounts receivable turnover | -0.18 | 0.11 | 0.85 | -0.11 | 0.06 |
| Inventory turnover | 0.03 | 0.17 | -0.33 | -0.42 | 0.05 |

Based on the above analysis, detailed factor explanations are described in Table 6.

Table 6 Factor description

| <i>Indicator status</i> | <i>variable</i> | <i>Common factor</i> | <i>Initial variable</i> |
|-------------------------|-----------------|----------------------|---|
| Input indicator | x_1 | Fund management | Successful loan and investment experience in the previous year; operating cash flow ratio |
| | x_2 | Human Resources | Senior management qualifications, titles, experience |

Table 6 Factor description (continued)

| <i>Indicator status</i> | <i>variable</i> | <i>Common factor</i> | <i>Initial variable</i> |
|-------------------------|-----------------|------------------------|--|
| | x_3 | Asset allocation | Coordination of major issues with the government; asset-liability ratio; accounts receivable turnover |
| | x_4 | Information processing | Number of well-connected financial institutions; number of times information is converted into knowledge and knowledge is converted into decisions |
| | x_5 | Internal management | Well-kept financial institution executives; executives overpass internal control systems; current ratios; inventory turnover |
| Output indicator | y_1 | Business efficiency | Unit EBITDA |

Through the above analysis, factor analysis is used to extract the input indexes of DEA. The final input and output indexes of the DEA evaluation model for financial refinement efficiency are shown in Table 7.

Table 7 Final results of input and output indexes of DEA evaluation model for financial refinement efficiency

| <i>Input indicator</i> | <i>Output indicator</i> |
|------------------------|-------------------------|
| Fund management | Unit EBITDA |
| Human resources | |
| Asset allocation | |
| Information processing | |
| Internal management | |

2.3 Efficiency Evaluation of Financial Refinement Management based on DEA

Based on the above evaluation index system, two models of DEA method are used to evaluate the effectiveness of financial management in different situations.

1 CCR model

This model is mainly aimed at the problem of fixed-scale reward characteristics evaluation, as shown in formula (4):

$$h_j = \max \frac{\sum_{k=1}^S u_k y_{kj}}{\sum_{i=1}^m v_i x_{ij}} \tag{4}$$

The constraints are:

$$P_{C^2R} - s.t. = \begin{cases} \sum_{k=1}^S u_k y_{kj} \leq 1 \\ u_k \geq 0 \\ v_i \geq 0 \end{cases} \tag{5}$$

2 BCC model

This model is mainly aimed at the evaluation of the characteristics of compensation on an unsteady scale, as shown in formula (6):

$$\begin{aligned}
 & \min \theta && \leq \theta x_k \\
 \text{BCC - s.t.} = & \begin{cases} \sum_{j=1}^n x_j \gamma_j \\ \sum_{j=1}^n x_j \gamma_j \geq y_k \\ \sum_{j=1}^n \gamma_j = 1 \\ \gamma_j \geq 0 \end{cases} && (6)
 \end{aligned}$$

where n represents the number of decision-making units, S and m represents the number of output and input indexes, u_k represents the weight occupied by the k output indexes, v_i represents the weight occupied by the i^{th} output index, y_{kj} represents the output of the k^{th} output indexes corresponding to the j^{th} decision-making module, h_j represents the comprehensive efficiency evaluation index of financial refinement management, and θ represents relaxation variables.

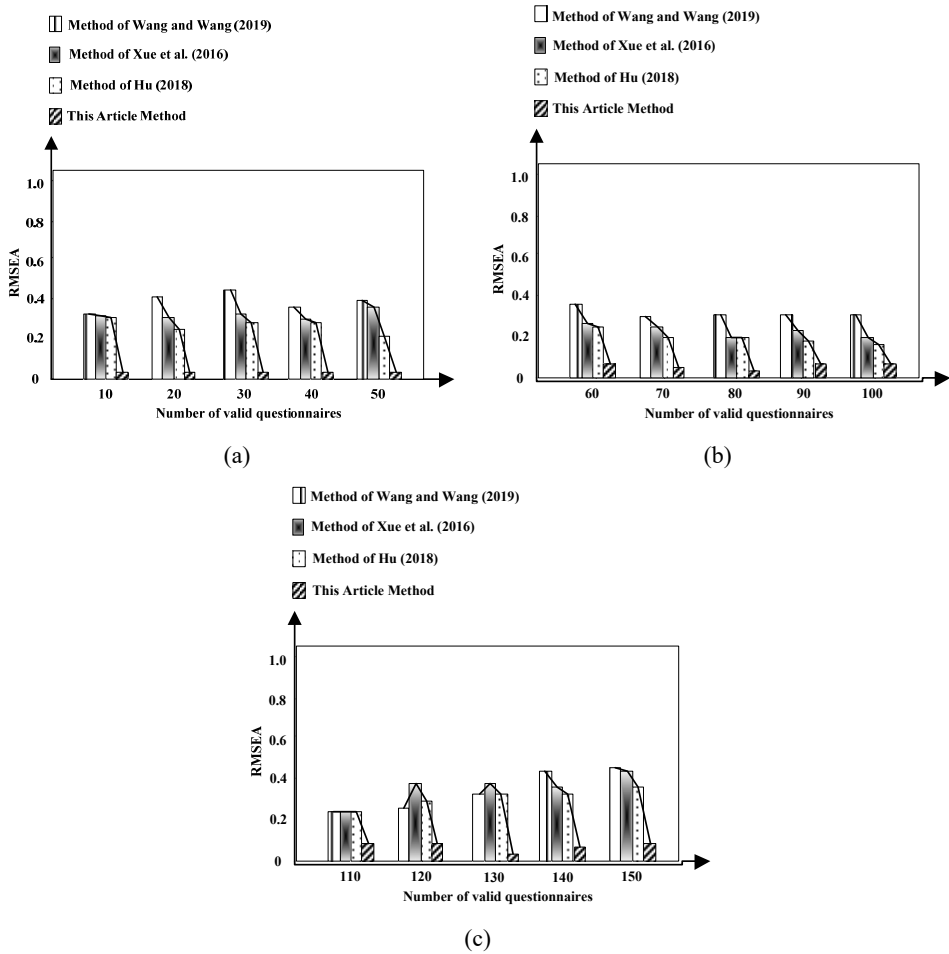
In the above, if the scale benefit is fixed value, CCR is used to evaluate the financial management efficiency; if the scale benefit is variable value, BCC is used to evaluate the financial management efficiency.

3 Experiments and discussion

In order to verify the effectiveness of DEA-based financial refinement management efficiency evaluation method, relevant experiments need to be carried out in the form of questionnaires. The questionnaire is mainly aimed at real estate companies, and the respondents are mainly corporate executives, experts and financial personnel. 170 questionnaires were issued to real estate financial personnel, experts and senior executives, and 150 valid questionnaires were obtained. The experimental data was input into MATLAB. The experimental environment was Windows 7 (64-bit) operating system, CPU frequency was 1.90 GHz, memory was 16.0 GB, and the volume of the mechanical hard disk was 1TB. Experiment index for approximate root mean square error, non standard fitting index and comparison of fitting, the approximate root mean square error can directly reflect the financial fine management efficiency evaluation method the accuracy of the numerical small precision higher and higher, the higher the accuracy of the evaluation results, non - standard fitting index and comparison of fitting can further reflect the evaluation of performance of this method, the numerical value is greater than or equal to 0.9, shows that the evaluation results with high accuracy. With the method proposed in this paper as the experimental group and Wang and Wang (2019) method, Xue et al. (2016) method and Hu (2018) method as the control group, the financial refinement management efficiency evaluation method was tested.

Firstly, the comparison test of approximate root-mean-square error RMSEA is conducted, and the experimental results are shown in Figure 3.

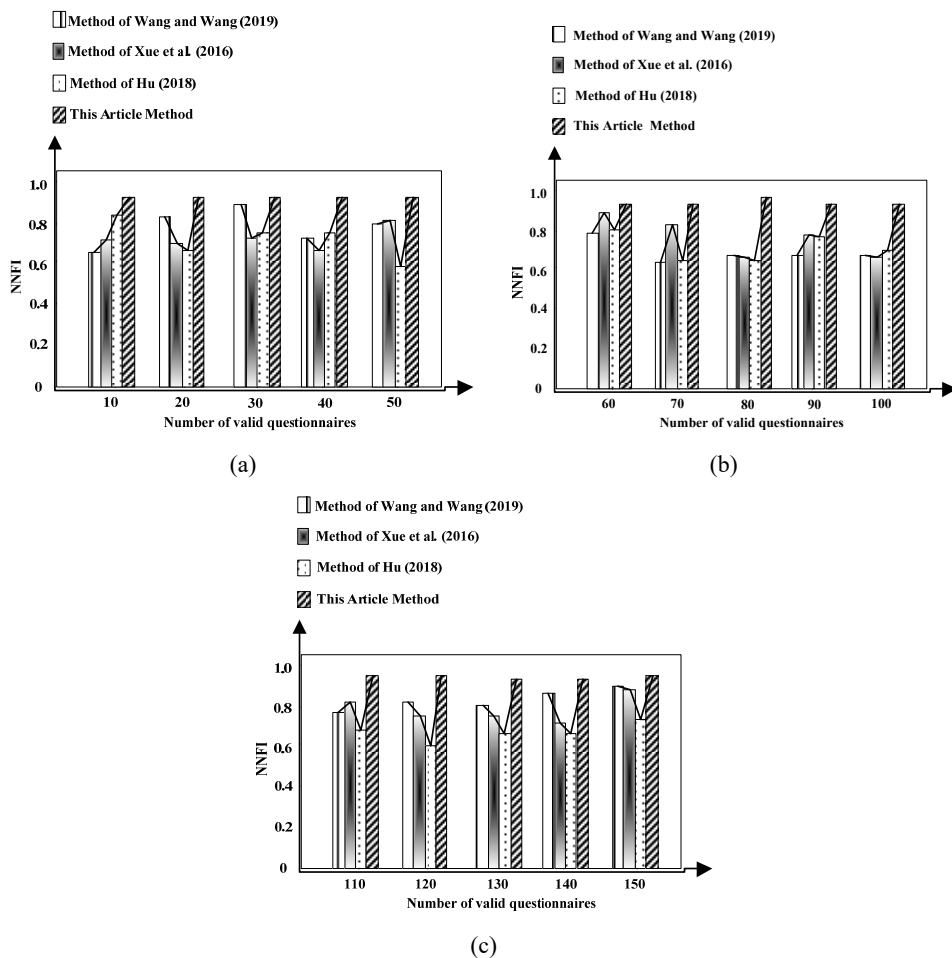
Figure 3 RMSEA comparison of different research methods, (a) RMSEA of different research methods when valid questionnaires are 10–50 (b) RMSEA of different research methods when valid questionnaires are 60–100 (c) RMSEA of different research methods when valid questionnaires are 110–150



It can be seen from Figure 3 that the approximate root-mean-square error of the proposed method is always lower than 0.1 under different experimental times, while the approximate root-mean-square error of the other three traditional methods is higher than 0.2 and the maximum value is 0.5, which can prove that the DEA-based financial refinement management efficiency evaluation method is more accurate. This is because the method refers to the effectiveness evaluation index of financial management at home and abroad, and constructs the financial delicacy management evaluation index system, which can more accurately realise the effectiveness evaluation of financial delicacy management.

Then, the comparison experiment of non-standard fitting index NNFI was conducted, and the experimental results were shown in Figure 4.

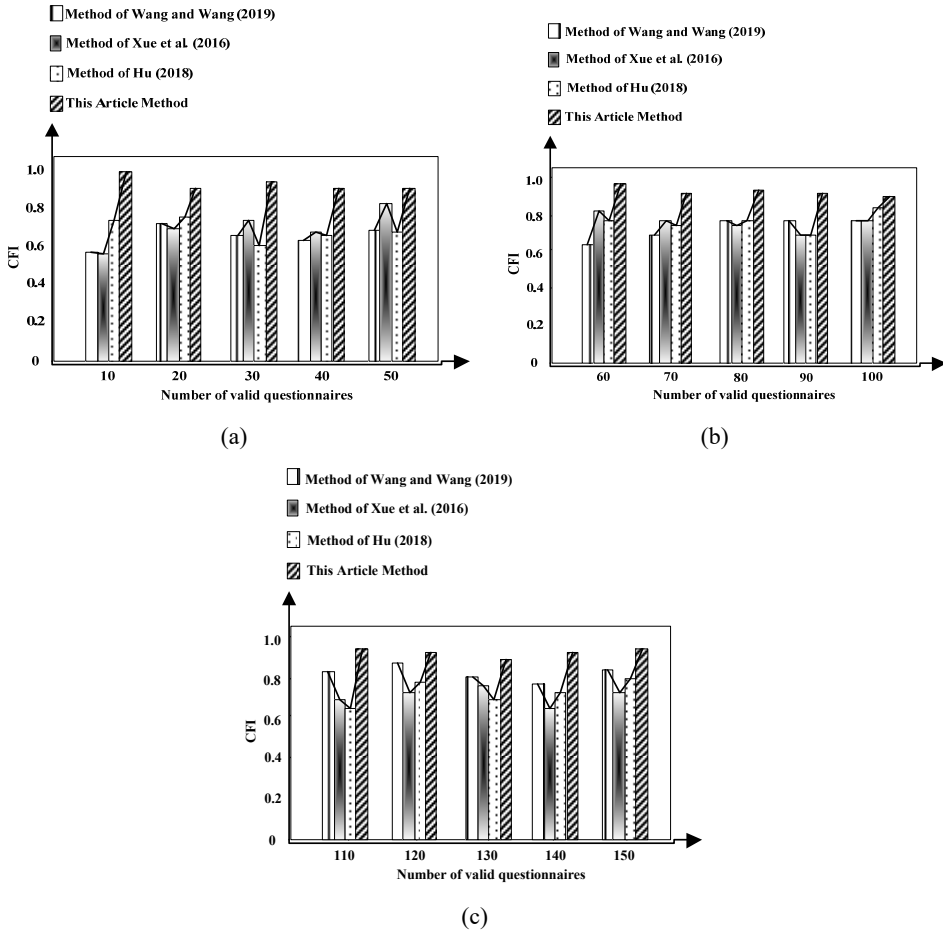
Figure 4 NNFI comparison of different research methods, (a) NNFI of different research methods when valid questionnaires are 10–50 (b) NNFI of different research methods when valid questionnaires are 60–100 (c) NNFI of different research methods when valid questionnaires are 110–150



According to Figure 4, under different experimental times, the non-standard fitting index of the proposed method is always between 0.9–1, while the non-standard fitting index of the other three traditional methods is all lower than 0.9, which can prove that the DEA-based financial refinement management efficiency evaluation method has better performance. This is because the financial delicacy management evaluation index system constructed by this method can better realise the evaluation of the effectiveness of financial delicacy management by reasonably elaborating the main indexes in the evaluation system.

Finally, the comparison experiment of the comparison fitting index CFI was conducted, and the experimental results were shown in Figure 5.

Figure 5 CFI comparison of different research methods, (a) CFI of different research methods when valid questionnaires are 10–50 (b) CFI of different research methods when valid questionnaires are 60–100 (c) CFI of different research methods with 110–150 valid questionnaires



According to Figure 5, the fitting index of the proposed method is always between 0.9–1 under different experimental times, while the non-standard fitting index of the other three traditional methods is all lower than 0.9, which can prove that the financial refinement management efficiency evaluation method based on DEA has better fitting performance. This is because the method adopts CCR model and BCC model respectively to evaluate the effectiveness of financial management, and improves the effectiveness of evaluation by considering different situations.

4 Conclusions

Fine financial management can realise the analysis function of intelligent financial, which is helpful to promote the development of enterprises and enhance their market competitiveness. In view of the importance of financial management to enterprises and

the problems existing in the current research results, a DEA-based financial refinement management effectiveness evaluation method is proposed. The evaluation index system is used to lay the foundation for the financial management evaluation, and DEA is introduced to realise the financial refined management evaluation. In the process of experiment, the feasibility of this method is verified by the application to actual enterprises. The results show that the approximate root-mean-square error of the method is always less than 0.1, and the non-standard fitting index and comparison fitting index are between 0.9–1, which has strong robustness and can provide some support for the research in this field. In the process of index selection, subjectivity plays a large role. In order to further improve the performance of financial refinement management efficiency evaluation method, more quantitative evaluation indexes should be introduced in the evaluation of financial management effectiveness to improve the accuracy of the evaluation.

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