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Research on Special Employment Funds Performance Evaluation Based on Fuzzy TOPSIS

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Abstract: Employment is vital to people's livelihood, which is an important content of building the harmonious society. In recent years, China increased the investment and spending scale of the special employment funds constantly, but the performance for the special employment funds has no systematic evaluation in a long term. This study puts forward the special employment funds performance evaluation based on fuzzy TOPSIS method. Firstly, reduce and establish the special employment funds performance evaluation indicator system on the basis of other research results. Then, the method of determining indicator weight by using the fuzzy consistent matrix method is proposed and the performance evaluation model based on fuzzy TOPSIS is constructed. Finally, an numerical example is given to verify the feasibility of the method proposed.

Key words: Special employment funds, performance evaluation, triangular duzzy number, TOPSIS

INTRODUCTION

Employment is vital to people's livelihood, which is an important content of building the harmonious society. In recent years, government at all levels made efforts to increase the investment of special employment funds, continuously strengthen the management of funds and indeed improve the efficiency in the use of employment funds. There still exist many problems in the special employment funds management such as unreasonable scale and expenditure structure of employment funds and unsystematic of performance evaluation method. In order to solve these problems and further improve the safety, normative and effectiveness of the special employment funds, truly achieve the efficient use of special employment funds, we urgently need to set up a comprehensive, feasible and effective special employment funds performance evaluation system. Carrying out performance evaluation of special employment funds is the urgent needs of improving the public finance system and promoting open government, which has very important significance on promoting the employment policies, stabilizing and expanding employment, strengthening the employment special funds management and improving the efficient use of funds.

In 2012 the finance ministry and human resources and social security ministry in China issued a notification about carry out the pilot work of special employment funds performance evaluation, which proposed the evaluation indicator system and evaluation method according to these problems. Tu (2010) built an indicator system of special employment funds performance evaluation and settled the evaluation standard to evaluate using several simple evaluation methods such as target method, cost-benefit method, factor analysis and public judgment method, etc. Wu and Yu (2012) proposed the indicator system of re-employment performance evaluation and determined multi-indicator using AHP for evaluation. Xiu *et al*. (2013) argue that special employment funds performance indicator system can be divided into three types such as operational indicator, financial indicator and social efficiency indicator and gave an empirical analysis of the special employment funds performance evaluation in Fujian Province. Although the documents above provide a certain basis for the indicator system and performance evaluation method of the special employment funds performance evaluation, but they still have some deficiencies on the scientific and systematic of the designing of the performance evaluation indicator system and evaluation method.

This study tries to study a new method based on fuzzy TOPSIS to the performance evaluation of the special employment funds. The remainder of this study is organized as follows: in Section 2, we present the theoretical basis of special employment funds performance evaluation. Section 3 described the performance index system and evaluation steps of the special employment funds. In section 4, an numerical example is given for illustrating the use of the method. Finally, the conclusions are provided in section 5.

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PRELIMINARIES

In this section, we state some basic knowledge related to the considered problem (Zadeh, 1965, 1968; Hwang and Yoon, 1981; Wei, 2010; Hu *et al*., 2011).

Triangular fuzzy numbers and its operations:

- The fuzzy number $\tilde{\alpha}$ = (S, M, U) is said to be a Triangular Fuzzy Mumber (TFN) if its membership function $\mu_{\tilde{\alpha}}$ (x): R→[0, 1] is equal to:

$$\mu\tilde{\alpha}(x)=\begin{cases}\dfrac{x-S}{M-S}, S\le x\le M;\\ \dfrac{U-x}{U-M}, M\le x\le U;\\ 0, \text{otherwise}\end{cases}$$

where, x∈R, S≤M≤U, the distribution of triangular fuzzy number can be shown in Fig. 1, α^L and α^U are the lower and upper boundary respectively which stand for the fuzzy degree and if α^U-α^L is greater, the fuzzy degree is stronger.

- Let $\tilde{\alpha}$ = [S, M, U] and BB = [S', M', U'] be two triangular fuzzy numbers, λ>0 be a real number, then the operation on triangular fuzzy numbers is defined as bellow:

- $\lambda\otimes\tilde{a}=[\lambda S,\lambda M,\lambda U]$
- $\tilde{a}\oplus\tilde{b}=[S+S',M+M',U+U']$
- $\tilde{a}\otimes\tilde{b}=[SS',MM',UU']$
- $1/\tilde{a}=[1/U,1/M,1/S]$

- Suppose there are two random triangular fuzzy numbers $\tilde{\alpha}$ = [S, M U] and $\tilde{b}$ = [S', M', U'], then the distance between $\tilde{\alpha}$ and $\tilde{b}$ is defined as:

$$d(\tilde{a},\tilde{b})=\sqrt{\frac{(|S-S'|^2+|M-M'|^2+|U-U'|^2)}{3}}$$

Basic principle of TOPSIS: TOPSIS method is the abbreviation of Technique for Order Preference by Similarity to Ideal Solution. Its basic principle is to rank by calculating the distance from each evaluation objects x_i to positive-ideal solution x^+ and negative-ideal solution x^-. One of the evaluation objects is the best scheme if it is close to x^+ and far away from x^-, then the opposite is the worst. Where various indicators of x^+ is the optimal value of each evaluation indicator and all indicators of x^- is the worst value of each indicator.

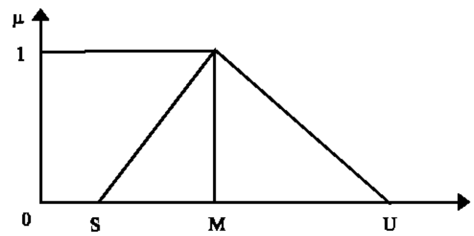

Fig. 1: Membership of TFN

PERFORMANCE INDICATORS SYSTEM AND EVALUATION STEPS OF SPECIAL EMPLOYMENT FUNDS

Indicators system: Taking the principle of policy, importance, scientificity, operability and the combination of quantitative and qualitative, this study firstly reduces the complex special employment funds evaluation indicators and then constructs a performance evaluation indicator system of special employment funds on the basis of reading a lot of related literature of special employment funds use performance evaluation. This evaluation indicator system which consisted of 5 level indicators and 16 secondary indicators is shown as Table 1.

Determination method of weight: In this study, fuzzy consistent matrix method is used to determine the value of indicator weights, which has the advantage of scientific and operational. And the results have better consistency. The steps of this method are as follows:

- Rank the importance of every indicator using expert scoring method and establish the fuzzy precedence relationship coefficient matrix S = $(s_{xy})_{n\times n}$ which can reflect the importance of indicators on the basis of ranking consequence. Where n is the number of evaluation indicators, s_{xy} is precedence relationship coefficient of indicator G_x to G_y which value is:

$$s_{xy}=\begin{cases}0\ , & \text{if } G_y\succ G_x\\ 0.5\ , & \text{if } G_y \text{ is equal to } G_x\\ 1\ , & \text{if } G_y\prec G_x\end{cases}$$

- Transform S into fuzzy consistent matrix E = $(e_{xy})_{n\times n}$, where e_{xy} = $(e_x-e_y)/(2n)+0.5$:

$$e_x=\sum_{l=1}^{n}s_{xl},\ e_y=\sum_{l=1}^{n}s_{ly}$$

- **Calculate the priority values:** The priority w_x (x = 1, 2 ,..., n) associated with every indicator is

Table 1: Performance evaluation indicator system of special employment funds

Fund procurement indicator G_1	Corresponding level fiscal special employment funds of corresponding level fiscal expenditure G_{11}
	Corresponding level fiscal special employment fund raise of total fiscal special employment fund raise G_{12}
Fund expenditure indicator G_2	The proportion of special employment funds actual expenditure G_{21}
	Central policy commitment of total special employment funds expenditure G_{22}
Fund investment effect G_3	Re-employment rate of laid-off workers G_{31}
	Re-employment rate after training G_{32}
	Occupation description success rate G_{33}
	Entrepreneurial success rate G_{34}
	The proportion of urban new jobs G_{35}
	The satisfaction of target groups G_{36}
Employment aim and task indicator G_4	The timeliness of fund available G_{41}
	The timeliness of fund expenditure G_{42}
	The compliance of fund expenditure G_{43}
Financial control system indicator G_5	The soundness of institution G_{51}
	The effectiveness of management G_{52}
	The constmct of hardware and soft ware facilities G_{53}

calculated by root method which can be the indicator weight and that is shown as following equation:

$$w_x = w'_x / (\sum_{l=1}^{n} S'_l),\ w'_x = (\prod_{l=1}^{n} e_x l)^{1/n} \quad (1)$$

Then, the level indicators weight w_x and secondary indicators weight w_{xy} can be calculated by Eq.(1), where $x\in (1, 2, \ldots, 5)$, $y\in (1, 2, \ldots, 6)$.

Steps for evaluating the special employment funds based on fuzzy TOPSIS: Suppose there are n evaluation objects $x_1, x_2,\ldots,x_n$ and m evaluation indicators $G_1, G_2,\ldots, G_m$, in this research and the weight of evaluation indicators w_I and w_{ij} are confirmed, where:

$$\sum_{j=1}^{m} w_j = 1, \sum_{j=1}^{m} w_{ij} = 1$$

- **Step 1:** Establish indicator triangular number decision matrix $\tilde{A}$

  Suppose the indicator of scheme x_i $(i = 1, 2, \ldots, n)$ under evaluation indicator G_j $(j = 1, 2, \ldots m)$ is triangular fuzzy number $\tilde{\alpha}_{ij} = (S_{ij}, M_{ij}, U_{ij})$, then the evaluation indicators fuzzy decision matrix $\tilde{A}$ is:

$$\tilde{A} = \begin{bmatrix} \tilde{a}_{11} & \tilde{a}_{12} & & \tilde{a}_{1m} \\ \tilde{a}_{21} & \tilde{a}_{22} & & \tilde{a}_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & & \tilde{a}_{nm} \end{bmatrix} \quad (2)$$

- **Step 2:** The normalization treatment of decision matrix $\tilde{A}$

An normalization treatment of decision matrix $\tilde{A}$ is given by Eq. 3 and 4 to eliminate the influence of decision results from different physical dimension and the consequence is $\tilde{A}'$. The equations are shown as follows

Suppose J_1 is the subscript set of efficiency indicators, J_2 is the subscript set of cost indicators.

Then, for efficiency indicators:

$$\tilde{a}'_{ij} = \left(\frac{S_{ij}}{\sum_{i=1}^{n} U_{ij}}, \frac{M_{ij}}{\sum_{i=1}^{n} U_{ij}}, \frac{U_{ij}}{\sum_{i=1}^{n} U_{ij}}\right), j \in J_1 \quad (3)$$

For cost indicators:

$$\tilde{a}'_{ij} = \left(\frac{\frac{1}{U_{ij}}}{\sum_{i=1}^{n} \frac{1}{S_{ij}}}, \frac{\frac{1}{M_{ij}}}{\sum_{i=1}^{n} \frac{1}{S_{ij}}}, \frac{\frac{1}{S_{ij}}}{\sum_{i=1}^{n} \frac{1}{S_{ij}}}\right), j \in J_2 \quad (4)$$

- **Step 3:** The weighted normalized decision matrix is:

$$\tilde{Y} = w \otimes \tilde{A}' = \begin{bmatrix} [w_1S_{11}, w_1M_{11}, w_1U_{11}] & [w_2S_{12}, w_2M_{12}, w_2U_{12}] & & [w_mS_{1m}, w_mM_{1m}, w_mU_{1m}] \\ [w_1S_{21}, w_1M_{21}, w_1U_{21}] & [w_2S_{22}, w_2M_{22}, w_2U_{22}] & & [w_mS_{2m}, w_mM_{2m}, w_mU_{2m}] \\ \vdots & \vdots & \vdots & \vdots \\ [w_1S_{n1}, wM_{n1}, w_1U_{n1}] & [w_2S_{n2}, w_2M_{n2}, w_2U_{n2}] & & [w_mS_{nm}, w_mM_{nm}, w_mU_{nm}] \end{bmatrix} \quad (5)$$

- **Step 4:** Respectively, the positive-ideal solution x^+ and negative-ideal solution x^- are:

$$y_j^+ = [\max_{1\le i\le n} wS_{ij}, \max_{1\le i\le n} wM_{ij}, \max_{1\le i\le n} wU_{ij}] = [S^+, M^+, U^+] \quad (6)$$

$$y_j^- = [\min_{1\le i\le n} wS_{ij}, \min_{1\le i\le n} wM_{ij}, \min_{1\le i\le n} wU_{ij}] = [S^-, M^-, U^-] \quad (7)$$

Then, the positive-ideal solution is $x^+ = (y_1^+, y_2^+,\ldots, y_m^+)$, the negative-ideal solution is $x^- = (y_1^-, y_2^-,\ldots, y_m^-)$.

- **Step 5:** Calculate the distance from each alternative x_i to x^+ and x^- by the following Eq. 8 and 9:

$$D_i^+ = D(x_i, x^+) = \sqrt{\sum_{j=1}^{m} \left[(w_jS_{ij} - S^+)^2 + (w_jM_{ij} - M^+)^2 + (w_jU_{ij} - U^+)^2\right]} \quad (8)$$

$$D_i^- = D(x_i, x^-) = \sqrt{\sum_{j=1}^{m} \left[(w_jS_{ij} - S^-)^2 + (w_jM_{ij} - M^-)^2 + (w_jU_{ij} - U^-)^2\right]} \quad (9)$$

- **Step 6:** Calculate the adjacent degree C_i from each evaluation object to positive-ideal solution:

$$C_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (10)$$

- **Step 7:** Rank the evaluation objects according to the descending order of C_i, if C_i is greater, the corresponding scheme is better.

NUMERICAL EXAMPLE

This section gives a specific example to prove the feasibility of the method. Suppose one province intents to evaluate three cities' special employment funds performance. Let $X = \{x_1, x_2, x_3\}$ be the set of the three cities, the evaluation indicators of them are given in Table 1 and all of them are efficiency indicators. Assume that the experts give the evaluation objects number grades under these indicators and each evaluation objects' attribute value under indicators is given by triangular fuzzy numbers. The concrete results are summarized in Table 2.

Ranking the three evaluation objects using the method proposed in this study as described below:

- The weight of level indicators and secondary indicators are calculated respectively for both of them have important influence on the evaluation results

  The experts make a comparison and give a mark on the importance of the indicators using fuzzy consistent matrixes. According to Eq. 1, calculate the indicator weights W and W_{ij}, we have:

$$\begin{aligned} &W = (0.20, 0.24, 0.29, 0.16, 0.11);\\ &W_{1j} = (0.50, 0.50); W_{2j} = (0.32, 0.68);\\ &W_{3j} = (0.25, 0.07, 0.11, 0.16, 0.19, 0.22);\\ &W_{4j} = (0.22, 0.33, 0.45);\\ &W_{5j} = (0.22, 0.33, 0.45) \end{aligned}$$

- From Table 2, we can get a fuzzy decision matrix of secondary indicators which is bigger because of the more indicators, so we decide to integrate the secondary indicators weights and fuzzy decision matrix for a fuzzy decision matrix $\tilde{A}$ of level indicators:

$$\tilde{A} = \begin{bmatrix} (0.43,0.47,0.49) & (0.95,0.96,0.99) & (0.63,0.65,0.67) & (0.82,0.86,0.89) & (0.72,0.76,0.78) \\ (0.43,0.46,0.49) & (0.94,0.95,0.97) & (0.64,0.66,0.68) & (0.83,0.85,0.87) & (0.73,0.78,0.80) \\ (0.43,0.47,0.51) & (0.95,0.98,0.99) & (0.65,0.67,0.70) & (0.79,0.82,0.85) & (0.77,0.80,0.83) \end{bmatrix}$$

- Due to all the indicators are efficiency indicators, we can get the normalized decision matrixes by Eq. 3 which is shown as:

$$\tilde{A}' = \begin{bmatrix} (0.29,0.31,0.33) & (0.32,0.33,0.34) & (0.31,0.32,0.33) & (0.31,0.33,0.34) & (0.30,0.31,0.32) \\ (0.29,0.31,0.33) & (0.32,0.32,0.33) & (0.31,0.32,0.33) & (0.32,0.32,0.33) & (0.30,0.32,0.33) \\ (0.29,0.32,0.34) & (0.32,0.33,0.34) & (0.32,0.33,0.34) & (0.30,0.31,0.32) & (0.32,0.33,0.35) \end{bmatrix}$$

- Then, we use (5) to calculate the weight normalized decision matrixes $\tilde{Y}$ and get:

Table 2: Evaluation object's attribute values under indicators

Indicators	x_1	x_2	x_3
G_{11}	[0.11,0.13,0.16]	[0.11,0.14,0.17]	[0.10,0.13,0.18]
G_{12}	[0.75,0.80,0.81]	[0.74,0.78,0.81]	[0.76,0.81,0.84]
G_{21}	[0.93,0.95,0.97]	[0.91,0.93,0.94]	[0.94,0.96,0.98]
G_{22}	[0.96,0.97,1.00]	[0.95,0.96,0.98]	[0.95,0.99,1.00]
G_{31}	[0.58,0.60,0.61]	[0.64,0.66,0.69]	[0.61,0.63,0.65]
G_{32}	[0.79,0.81,0.82]	[0.84,0.85,0.88]	[0.80,0.84,0.88]
G_{33}	[0.86,0.90,0.93]	[0.89,0.91,0.92]	[0.93,0.94,0.96]
G_{34}	[0.63,0.64,0.67]	[0.63,0.65,0.67]	[0.65,0.68,0.72]
G_{35}	[0.21,0.23,0.25]	[0.18,0.20,0.21]	[0.21,0.23,0.25]
G_{36}	[0.90,0.93,0.96]	[0.89,0.91,0.93]	[0.91,0.94,0.97]
G_{41}	[0.80,0.85,0.90]	[0.91,0.96,0.98]	[0.83,0.85,0.88]
G_{42}	[0.72,0.76,0.80]	[0.83,0.85,0.89]	[0.70,0.77,0.78]
G_{43}	[0.91,0.93,0.96]	[0.78,0.79,0.81]	[0.83,0.85,0.88]
G_{51}	[0.95,0.96,0.98]	[0.94,0.97,0.99]	[0.94,0.96,0.99]
G_{52}	[0.70,0.77,0.78]	[0.78,0.79,0.81]	[0.81,0.83,0.88]
G_{53}	[0.62,0.65,0.68]	[0.60,0.67,0.70]	[0.65,0.69,0.72]

Table 3: Distance and adjacent degree

x_i	D_i^+	D_i^-	C_i	Rank
1	0.781×10^{-2}	0.489×10^{-2}	0.39	3
2	0.624×10^{-2}	0.449×10^{-2}	0.42	2
3	0.422×10^{-2}	0.848×10^{-2}	0.67	1

$$\tilde{Y} = \begin{bmatrix} (5.79,6.26,6.53) & (7.73,7.84,8.05) & (8.87,9.19,9.49) & (5.04,5.24,5.47) & (3.28,3.46,3.55) \\ (5.72,6.20,6.60) & (7.62,7.73,7.87) & (9.07,9.34,9.62) & (5.05,5.18,5.35) & (3.35,3.54,3.65) \\ (5.79,6.33,6.87) & (7.70,7.97,8.08) & (9.17,9.51,9.88) & (4.82,5.04,5.18) & (3.50,3.63,3.80) \end{bmatrix} \times 10^{-2}$$

- According to Eq. 6 and 7, we obtain the positive-idea solution x^+ and the negative-idea solution x^-:

$x^+ = ([5.79, 6.33, 6.87], [7.73, 7.97, 8.08], [9.17, 9.51, 9.88], [5.05, 5.24, 5.47], [3.50, 3.63, 3.80])\times10^{-2}$
$x^- = ([5.72, 6.20, 6.53], [7.62, 7.73, 7.87], [8.87, 9.19, 9.49], [4.82, 5.04, 5.18], [3.28.3.46, 3.55])\times10^{-2}$

- According to Eq. 8-10, we can obtain the distance between the evaluation objects and idea solution and the adjacent degree, which are shown as Table 3
- From Table 3, the ranking order of three evaluation objects is $x_3 \succ x_2 \succ x_1$ and the best city in special employment funds performance is x_3.

CONCLUSION

In this study, we propose a new approach for evaluating the special employment funds performance based on TOPSIS method and fuzzy sets theory, where triangular fuzzy values are used to represent evaluation values of the experts with respect to evaluation projects. On the basis of reducing the complex evaluation indicators, we first constructs a performance evaluation indicator system of the special employment funds, then proposes a new approach for the special employment funds performance evaluation based on fuzzy TOPSIS method. The proposed approach provides us with a useful way for evaluating the special employment funds performance under fuzzy environment.

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