Performance Evaluation of the Social Security System using Fuzzy Theory and Principle Component Analysis

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***Abstract* — The work of this paper is based on social insurance, social welfare, social assistance and special care. Supplemental Security four types of evaluation index, an analysis of the social security performance be evaluated to determine the establishment of social security performance evaluation index by principal component analysis and principal component based on fuzzy theory, and based on fuzzy theoretical evaluation of selected indicators, a reasonable performance evaluation of the social security system.**

Keywords - fuzzy theory; principal component analysis; performance evaluation

I. INTRODUCTION

Social Security is to maintain the country's economic development, social harmony and development base, because society there are unemployment, old age, disasters, diseases and other problems that make a person, some people even lose life conditions for survival. To establish an effective social security system is one of the basic conditions, followed by expanding the scope of protection, enhanced guarantee and expand beneficiaries of a national social security system, the integrity of the significance.

The social security system for each indicator reflects different social point of view, from the overall assessment of the performance of social security, the need to establish a comprehensive and correct evaluation, due to the vague uncertainty indicators of existence, the paper select principal component analysis and fuzzy theory social security performance evaluation system be set up.

II. PRINCIPAL COMPONENT ANALYSIS OF SOCIAL SECURITY PERFORMANCE EVALUATION

TABLE I PERFORMANCE INDICATORS OF SOCIAL SECURITY

Level indicators	Secondary indicators	Three indicators
Social Security Performance Evaluation U	Social insurance T_1	Medical Insurance K_1
		Unemployment insurance K_2
		Pension Insurance K_3
		Commercial Insurance K_4
		Social security expenses K_5
		Focus on rural social security situation K_6
	Social welfare T_2	Construction of community service facilities K_7
		NCMS K_8
		Unemployment rate guarantee K_9
		Social welfare expenditure K_{10}
		Social Welfare Review K_{11}
		Rural compulsory education guaranteed rate K_{12}
	Social assistance and special care T_3	Rural Social Security class K_{13}
		Towns Social Security class K_{14}
		Social special care category K_{15}
		Natural disasters Social Security K_{16}
	Supplemental security T_4	Insurance Social Security K_{17}
		Children, old age dependency and social charity K_{18}

A. *The calculation process for the Principal Component Analysis*

The method of calculation of principal components analysis as follows:

(1) For the correlation coefficient, first to calculate the corresponding matrix, as follows:

$$R=\begin{cases} r_{11} & r_{12} & \cdots & r_{1p} \\ r_{21} & r_{22} & \cdots & r_{2p} \\ \cdots & \cdots & \cdots & \cdots \\ r_{p1} & r_{p2} & \cdots & r_{pp} \end{cases} \quad (1)$$

In the above formula, x_i and x_j corresponding to the original variable is the correlation coefficient r_{ij}（i，j=1,2,…，p), the calculation formula for its main

$$r_{ij}=\frac{\sum_{k=1}^{n}(x_{ki}-\bar{x}_i)(x_{ki}-\bar{x}_j)}{\sqrt{\sum_{k=1}^{n}(x_{ki}-\bar{x}_i)^2(x_{ki}-\bar{x}_j)^2}} \quad (2)$$

(2) The feature vectors, calculating Eigen values $|\lambda I-R|=0$ determined for the corresponding feature value λ_i（i=1,2,…，p），and are arranged corresponding $\lambda_1\geq\lambda_2\geq\ldots,\geq\lambda_p\geq 0$；Then strike with the corresponding feature vector e_i（i=1,2，…，p).

(3) Calculate the principal component contribution rate and the contribution rate of lightning

Principal component contribution rate：

$$r_i/\sum_{k=1}^{p}\gamma_k(i=1,2,\cdots,p) \quad (3)$$

Corresponding to the cumulative contribution rate：

$$\sum_{k=1}^{m}\gamma_k/\sum_{k=1}^{p}\gamma_k \quad (4)$$

B. Establishment of model on indicators

By using factor analysis KMO detection methods for testing, the result is 0.879, so the show can be the factor analysis, but also proved that factor analysis is valid, according to the relevant data of each index, by using principal component analysis obtained a variance cumulative rate table:

TABLE II EIGEN VALUES AND THE CONTRIBUTION RATE

Index	Eigen values	Variance contribution rate (%)	Cumulative contribution rate (%)
1	4.523	26.104	63.214
2	6.958	36.829	36.579
3	1.461	7.126	84.071
4	2.719	13.997	77.161

C. Load factor calculation model

Based on factor loading model for the initial variance maximize payload rotation, the results they obtained in the following table:

TABLE III LOADING MATRIXES AND FACTOR SCORE COEFFICIENT MATRIX OF TWIDDLE FACTOR

Variable	Factor loading matrix				Factor score coefficient matrix			
	F1	F2	F3	F4	F1	F2	F3	F4
Medical Insurance K_1	0.926	0.245	0.037	0.145	0.237	-0.02	0.004	-0.04
Unemployment insurance K_2	0.934	0.214	0.045	0.165	0.227	-0.023	-0.012	-0.042
Pension Insurance K_3	0.958	-0.186	0.055	0.158	0.237	-0.019	-0.011	-0.049
Commercial Insurance K_4	0.920	0.185	0.045	0.167	0.211	-0.024	-0.014	-0.039
Social security expenses K_5	0.080	0.325	0.941	0.039	-0.044	0.114	0.489	-0.035
Focus on rural social security situation K_6	0.842	0.489	-0.123	0.184	0.253	0.167	-0.082	0.059
Construction of community service facilities K_7	-0.005	0.454	0.924	0.085	-0.060	0.170	0.498	0.006
NCMS K_8	0.052	0.070	0.098	0.847	-0.025	-0.004	0.032	0.512
Unemployment rate guarantee K_9	0.063	0.724	-0.025	-0.085	-0.035	0.281	-0.051	-0.523
Social welfare expenditure K_{10}	0.165	0.862	0.021	0.076	-0.086	0.335	0.019	-0.115
Social Welfare Review K_{11}	0.876	-0.042	-0.086	0.195	0.432	-0.014	-0.056	0.110
Rural compulsory education guaranteed rate K_{12}	0.163	0.221	0.865	0.069	-0.091	-0.014	0.462	0.059
Rural Social Security class K_{13}	0.054	-0.006	0.165	0.812	0.452	-0.017	0.081	0.474
Towns Social Security class K_{14}	-0.084	0.936	-0.007	0.054	-0.078	0.357	-0.003	0.035
Social special care	0.010	0.898	0.005	-0.042	0.0051	0.341	-0.025	-0.092

category K_{15}								
Natural disasters Social Security K_{16}	0.112	0.812	0.142	0.015	-0.031	0.221	0.049	-0.049
Insurance Social Security K_{17}	0.114	0.798	0.071	0.046	-0.023	0.296	0.024	-0.036
Children, old age dependency and social charity K_{18}	0.055	-0.012	0.812	0.089	0.005	-0.017	0.468	0.055

The above table shows that we were able to find four indicators corresponding eigenvalues, 1.278,2.676,4.843,7.071 after AHP can get its corresponding contribution of each index is: 0.080,0.170,0.306, 0.445, therefore obtain social security system of evaluation of performance evaluation, as follows:

TABLE IV SOCIAL SECURITY PERFORMANCE EVALUATION FACTOR

Level indicators	Secondary indicators	Three indicators
U	$T_1(0.445)$	$K_1(0.138)$
		$K_2(0.137)$
		$K_3(0.134)$
		$K_4(0.136)$
		$K_5(0.207)$
		$K_6(0.246)$
	$T_2(0.306)$	$K_7(0.113)$
		$K_8(0.198)$
		$K_9(0.235)$
		$K_{10}(0.152)$
		$K_{11}(0.121)$
		$K_{12}(0.188)$
	$T_3(0.167)$	$K_{13}(0.325)$
		$K_{14}(0.413)$
		$K_{15}(0.012)$
		$K_{16}(0.253)$
	$T_4(0.082)$	$K_{17}(0.481)$
		$K_{18}(0.528)$

Right three indicators were analyzed for heavy draw graph as shown below:

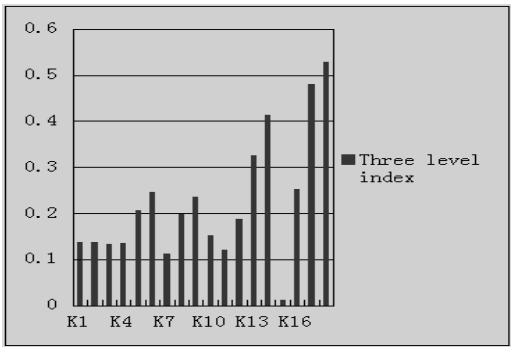

Figure 1. Figure 1 Three level index

III. SOCIAL SECURITY PERFORMANCE EVALUATION UNDER FUZZY THEORY

Through the establishment of the above factors model principles set U, where $U=(U_1 \quad U_2 \quad U_3 \quad U_4)$. It is social insurance U_1, social welfare classes U_2, social assistance and special care category U_3, Supplemental Security class U_4, the results of Table V. This article focuses on the establishment of small factor set in four important factors.

TABLE V PERFORMANCE EVALUATION INDEX SYSTEM OF SOCIAL SECURITY IN CHINA

social insurance U_1	social welfare classes U_2	social assistance and special care category U_3	Supplemental Security class U_4
Medical Insurance	Construction of community service facilities	Rural Social Security class	Insurance Social Security
Unemployment insurance	NCMS	Towns Social Security class	Children, old age dependency and social charity
Pension Insurance	Unemployment rate guarantee	Social special care category	
Commercial Insurance	Social welfare expenditure	Natural disasters Social Security	
Social security expenses	Social Welfare Review		
	Rural compulsory education guaranteed rate		

By three indicators on the table V, we can determine rankings for each indicator separately to obtain weight vector.

$$\beta=\{\beta_1,\beta_2,\beta_3,\beta_4\}=\{0.4,0.3,0.2,0.1\}$$

$$U_i^*=U_i\cdot\beta^T$$

$$U_1^* = 14\ ,\ \ U_2^* = 9.4\ ,\ \ U_3^* = 4\ ,\ \ U_4^* = 5.6$$

The normalization process

$$U_1^* = 0.35\ ,\ \ U_2^* = 0.3\ ,\ \ U_3^* = 0.2\ ,\ \ U_4^* = 0.15$$

got

$$\bar{A} = \begin{pmatrix} 0.35 & 0.3 & 0.2 & 0.15 \end{pmatrix}$$

Single-layer index weighting factor fuzzy set is:

$$U_1^* = \{U_{11}, U_{12}, U_{13}, U_{14}, U_{15}\} = \{0.25, 0.25, 0.2, 0.15, 0.15\}$$

$$U_2^* = \{U_{21}, U_{22}, U_{23}, U_{24}\} = \{0.54, 0.1, 0.24, 0.14\}$$

$$U_1^* = \{U_{31}, U_{32}, U_{33}, U_{34}\} = \{0.4, 0.3, 0.1, 0.2\}$$

$$U_1^* = \{U_{41}, U_{42}, U_{43}\} = \{0.3, 0.4, 0.3\}$$

In this paper, according to the language membership, got the evaluation of social insurance, social welfare classes, social assistance and special care category, Supplemental Security class:

Social insurance:

$$U_1 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \end{pmatrix}$$

Social welfare classes:

$$U_2 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.95 \\ 0 & 0.05 & 0.9 & 0.95 \\ 0.05 & 0.9 & 0.05 & 0 \end{pmatrix}$$

Social assistance and special care category:

$$U_3 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0.05 & 0.9 & 0.05 & 0 \end{pmatrix}$$

Supplemental Security class:

$$U_4 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \end{pmatrix}$$

Collection of the above evaluation is calculated as follows:

$$B_i = A_i \cdot R_i$$

Get fuzzy evaluation matrix.

$$\bar{B} = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{pmatrix} = \begin{pmatrix} 0.07 & 0.27 & 0.23 & 0.43 \\ 0 & 0.1 & 0.7 & 0.5 \\ 0.08 & 0.16 & 0.28 & 0.28 \\ 0.14 & 0.2 & 0.3 & 0.36 \end{pmatrix}$$

Get the comprehensive evaluation value:

$$Z = U^* \cdot B = \begin{pmatrix} 0.35 & 0.24 & 0.11 & 0.30 \end{pmatrix}$$

IV. CONCLUSION

In this paper, the model based on principal component analysis and fuzzy evaluation model for social security performance evaluation studies. This paper obtained in improving the productivity of the national body, while the need to increase the coverage of social security, improve the social assistance system, increasing the intensity of the township health insurance, and thus achieve a balanced development of social health coverage.

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