2011 International Conference on Economics and Finance Research
IPEDR vol.4 (2011) © (2011) IACSIT Press, Singapore

The Efficiency Evaluation of China's Basic Old-age Insurance System: Using the Analytic Hierarchy Process

Xiaowei Zhang
Center for Social Security Studies
Wuhan University
Wuhan, China
zhangxiaowei1983@gmail.com

Ying Zhang
Center for Social Security Studies, Wuhan University
Faculty of Applied Economics, Antwerp University
fslys7@yahoo.cn

***Abstract*—With the development of population aging, social security system becomes more and more important in China. The basic old-age insurance is the most serious part of China's social security system. Whether the basic old-age insurance system achieves its original goal is decisive for success, and we can only use scientific methods to evaluate the efficiency of the system. This paper uses the Analytic Hierarchy Process to evaluate the efficiency of China's basic old-age insurance system. Based on the data of 2008, we conclude that China's basic old-age insurance system operates moderately and has some problems, as the regional disparity in 31 provinces and the efficiency of the system is not closely connected with the regional economy**

Keywords: Old-age insurance system; the Analytic Hierarchy Process; Efficiency Evaluation

I. INTRODUCTION

Population statistics show that China's labor force will decline from 2012 to 2017; in 2035, the population over 65 will be about 294 million and 2 workers will support 1 pensioner. This situation will last after 2050, and China will enter the population aging society (2). Social security system becomes more and more important in China. The basic old-age insurance system was formally established in 1997, which is the most serious part of China's social security system. Whether the basic old-age insurance system achieves its original goal is decisive for further development, and we can only use scientific methods to evaluate its efficiency.

II. THE ANALYTIC HIERARCHY PROCESS

The Analytic Hierarchy Process (AHP) is an evaluation method presented by Professor Tomas L. Saaty, in the 20th century. It allows people to structure complex problems in the form of a hierarchy, or a set of integrated levels. The problem hierarchy lends itself to an analysis based on the impact of a given level on the next higher level. The process begins by determining the relative importance of the criteria in meeting the goals. Next, the focus shifts to measuring the extent to which the alternatives achieve each of the criteria. Finally, the results of two analyses are synthesized to compute the relative importance of the alternatives in meeting the goals.

A. The Hierarchical Indexes

This paper evaluates China's basic old-age insurance system through the performance, financial ratio and management. Specific indexes are described in Table I

TABLE I. EFFICIENCY INDEXES OF CHINA'S BASIC OLD-AGE INSURANCE SYSTEM

Total Index	**1st Class Index**	**2nd Class Index**	**3rd Class Index**
Efficiency Index of China's Basic Old-age Insurance System A	Performance Index B1	Society Index C1	Coverage Rate D1
			Benefit Rate D2
			Gini Coefficient D3
		Economy Index C2	GDP Growth D4
			Engel's Coefficient D5
	Financial Ratio B2	Revenue and Expenditure Index C3	Replacement Rate D6
			Elders' Support Rate D7
			Accumulated Surplus of Pension D8
			Surplus Rate of Pension within the same Year D9
			Rate of return on Individual Account Investment D10
		Cost Index C4	Ratio of Pension Expenditure to Local Fiscal Expenditure D11
			Expenditure Rate of Individual Old-age Insurance D12
			Expenditure Rate of Enterprise Old-age Insurance D13
	Management Index B3	Honest and Diligent Administration C5	Rate of Timely and Sufficient FundingD14
			Levied RateD15
			Ratio of Corrupted People to Administrators D16
			Amount of Labor Dispute on Old-age Insurance D17
		Administrative Efficiency Index C6	Socialized Extending Rate of Pension D18
			Ratio of Administrators to Local Population D19
			Information Management Level D20

B. *Judgment Matrixes of Paired Comparisons*

The judgments of factors in the same hierarchy are given in the form of paired comparisons matrix, as Table II. Although there are many scales that could be used for quantifying judgments, the scale given in Table III is the standard used for AHP analysis.

TABLE II. JUDGMENT MATRIX

A	B1	B2	B3
B1	b11	b12	b13
B2	b21	b22	b23
B3	b31	b32	b33

TABLE III. MEASUREMENT SCALE

Intensity of importance	Definition
1	Equal importance
3	Moderate importance of one over another
5	Essential or strong importance
7	Very strong importance
9	Extreme importance
2，4，6，8	Intermediate values between the two adjacent judgments

C. *Consistency Test*

In order to test the consistency of the judgment matrix, we adopt the consistency CI valued as (λmax-n)/(n-1). BW=λmaxW. The value is compared with the same index obtained as an average over a large number of reciprocal matrices of the same order whose entries are random. If the ratio (called the consistency ratio CR) of CI to that random matrices is significantly small (carefully specified to be about 10% or less), we accept the estimate of W. Otherwise, we attempt to improve consistency.

TABLE IV. EFFICIENCY OF THE SYSTEM

A	B1	B2	B3	W
B1	1	3	5	0.647
B2	1/3	1	2	0.229
B3	1/5	1/2	1	0.122

λmax=3.004 CI=0.002 RI=0.52 CR=0.003<0.1

TABLE V. PERFORMANCE OF THE SYSTEM

B1	C1	C2	W
C1	1	5	0.833
C2	1/5	1	0.167

TABLE VI. FINANCIAL RATIO OF THE SYSTEM B2

B2	C3	C4	W
C3	1	6	0.857
C4	1/6	1	0.143

TABLE VII. MANAGEMENT OF THE SYSTEM

B3	C5	C6	W
C5	1	7	0.875
C6	1/7	1	0.125

TABLE VIII. SOCIETY INDEX

C1	D1	D2	D3	W
D1	1	1	3	0.428
D2	1	1	3	0.428
D3	1/3	1/3	1	0.142

λmax=3 CI=0 RI=0.52 CR=0<0.1

TABLE IX. ECONOMY INDEX

C2	D4	D5	W
D4	1	1/4	0.20
D5	4	1	0.80

TABLE X. REVENUE AND EXPENDITURE INDEX

C3	D6	D7	D8	D9	D10	W
D6	1	1	7	4	5	0.366
D7	1	1	5	5	3	0.305
D8	1/7	1/5	1	1/3	1/5	0.038
D9	1/4	1/5	3	1	1/3	0.097
D10	1/5	1/3	5	3	1	0.194

λmax=5.294 CI=0.074 RI=1.12 CR=0.066<0.1

TABLE XI. COST INDEX

C4	D11	D12	D13	W
D11	1	1	1	0.333
D12	1	1	1	0.333
D13	1	1	1	0.333

λmax= 1 CI= –1 RI=0.52 CR=-1.923<0.1

TABLE XII. HONEST AND DILIGENT ADMINISTRATION C5

C5	D14	D15	D16	D17	W
D14	1	3	1/5	4	0.276
D15	1/3	1	1/7	2	0.117
D16	5	7	1	3	0.537
D17	1/4	1/2	1/3	1	0.07

λmax=4.1004 CI=0.0334 RI=0.89 CR=0.038<0.1

TABLE XIII. ADMINISTRATIVE EFFICIENCY INDEX

C6	D18	D19	D20	W
D18	1	1/4	1	0.175
D19	4	1	3	0.632
D20	1	1/3	1	0.192

λmax=3.009 CI=0.005 RI=0.52 CR=0.009<0.1

The consistency ratio CR is significantly small, we accept the estimate of W.

D. Summarize weights of each index

The final step of the AHP analysis is how the overall formulation scores are computed. This procedure can be explained as a simple weighted average technique. For a given region, twenty weights are computed. These twenty weights are multiplied by the appropriate criteria weights, and the results of the twenty multiplications are added to compute the total score, as table III.

TABLE XIV. SORTED EFFICIENCY INDEXES OF CHINA'S BASIC OLD-AGE INSURANCE SYSTEM

A	B1 (0.647)	C1 (0.5390)	D1 (0.2307)
			D2 (0.2307)
			D3 (0.0765)
		C2 (0.1080)	D4 (0.0216)
			D5 (0.0804)
	B2 (0.229)	C3 (0.1963)	D6 (0.0718)
			D7 (0.0599)
			D8 (0.0075)
			D9 (0.0190)
			D10 (0.0381)
		C4 (0.0327)	D11 (0.0109)
			D12 (0.0109)
			D13 (0.0109)
	B3 (0.122)	C5 (0.1068)	D14 (0.0295)
			D15 (0.0125)
			D16 (0.0574)
			D17 (0.0075)
		C6 (0.0152)	D18 (0.0027)
			D19 (0.0096)
			D20 (0.0029)

III. THE EMPIRICAL ANALYSIS OF CHINA'S BASIC OLD-AGE INSURANCE SYSTEM

A. Choice of data sources and indicators

Data mainly from the " China Statistic Yearbook 2009", " China Labor Statistic Yearbook 2009", " China Human Resources and Social Security Yearbook 2009", " Almanac of China's Population 2009". It is difficult to collect for some indexes, so these indexes should be stripped out in empirical analysis. Weights of excluded indexes are small; therefore, removing them cannot greatly affect the total scores of provinces. Due to space limitations, specific calculation of re-evaluating indexes weights is no longer described, and the adjusted results are as follows.

TABLE XV. ADJUSTED INDEXES WEIGHT

Indexes	Weight
Coverage Rate D1	0.2912
Benefit Rate D2	0.2912
GDP Growth D3	0.0314
Engel's Coefficient D4	0.1297
Replacement Rate D5	0.0849
Elders' Support Rate D6	0.0769
Accumulated Surplus Amount of Pension D7	0.0133
Surplus Rate of Pension within the same Year D8	0.0209
Ratio of Pension Expenditure to Local Fiscal Expenditure D9	0.0164
Expenditure Rate of Individual Old-age Insurance D10	0.0164
Amount of Labor Dispute on Old-age Insurance D11	0.0101
Socialized Extending Rate of Pension D12	0.0038

B. The Standardization of Evaluation Indexes

1) Dimensionless of Index data: In order to eliminate the dimensional effect of each index and comprehensively evaluate multiple indexes, we should standardize sample data sets and change values of each index to (0, 1). Evaluation indexes of China's basic old-age insurance system include two types: cost-based index (small is better) and benefit-based index (large is better).

Benefit-based index contains: Coverage Rate D1, Benefit Rate D2, GDP Growth D3, Replacement Rate D5, Accumulated Surplus Amount of Pension D7, Surplus Rate of Pension within the same Year D8, and Socialized Extending Rate of Pension D12. Cost-based index contains: Engel's Coefficient D4, Elders' Support Rate D6, Ratio of Pension Expenditure to Local Fiscal Expenditure D9, Expenditure Rate of Individual Old-age Insurance D10, and Amount of Labor Dispute on Old-age Insurance D11.

For the i-index, set the range [min(i), max(i)], where min(i), max(i) representing the minimum, maximum of the evaluation indexes, and r(i) is the standardized value. Benefit-based indexes are standardized formula for r(i)=[x(i)-min(i)]/[max(i)-min(i)]; cost-based indexes of the standardized formula: r(i)=[max (i))-x(i)]/[max(i)-min(i)].

2) Calculation of indicator data: The above indicator data cannot be found directly from the Statistical Yearbook, and they need to be calculated between the variables. As follows: D1= the number of insured/ the number of urban employment; D2= the number of retired/ the number of insured; D5= per pension expenditure/ the average money wage; D8= surplus of the year/ pension income of the same year; D9= local expenditure on basic old-age insurance/ local fiscal expenditure; D10= 8% of the average wage/ per disposable income of urban residents; D12= the number of socialized extending pensions/ the number of retired. The raw data of these indexes standardizes, multiplies the respective weight, and sum the score of every index, then we obtain the total score and rank of each province in China, as table XVI.

TABLE XVI. THE EVALUATION OF CHINA'S BASIC OLD-AGE INSURANCE IN EACH PROVINCE,2008 (PART 1)

Provinces	D1	D2	D3	D4	D5	D6	D7
Jilin	0.78	0.712	0.865	0.936	0.48	0.7	0.163
Shanghai	0.929	0.999	0.157	0.792	0	0.102	0.227
Heilongjiang	0.782	0.813	0.393	0.812	0.491	0.693	0.224
Liaoning	1	0.751	0.539	0.665	0.368	0.308	0.351
Neimenggu	0.57	0.59	1	1	0.657	0.832	0.096
Tianjin	0.759	0.897	0.921	0.757	0.134	0.168	0.108
Hebei	0.722	0.567	0.202	0.896	0.862	0.699	0.208
Shanxi	0.662	0.486	0	0.948	0.749	0.816	0.241

Xinjiang	0.552	0.658	0.303	0.755	0.671	0.897	0.153
Ningxia	0.593	0.449	0.438	0.877	0.766	1	0.036
Shaanxi	0.519	0.678	0.82	0.789	0.624	0.534	0.08
Shandong	0.704	0.321	0.427	0.957	1	0.523	0.42
Henan	0.613	0.519	0.427	0.889	0.539	0.797	0.213
Hubei	0.745	0.613	0.573	0.492	0.581	0.472	0.161
Hunan	0.683	0.666	0.506	0.614	0.393	0.355	0.174
Gansu	0.442	0.688	0.202	0.701	0.798	0.717	0.066
Hainan	0.719	0.607	0.169	0.342	0.681	0.545	0.026
Chongqing	0.531	0.813	0.674	0.629	0.381	0	0.081
Qinghai	0.481	0.623	0.494	0.584	0.667	0.947	0.02
Sichuan	0.659	0.734	0.135	0.394	0.494	0.153	0.31
Jiangxi	0.663	0.471	0.483	0.518	0.489	0.632	0.081
Anhui	0.613	0.626	0.494	0.555	0.452	0.219	0.131
Beijing	0.531	0.488	0.079	0.947	0.101	0.547	0.203
Guizhou	0.412	0.631	0.213	0.441	0.578	0.607	0.065
Jiangsu	0.627	0.404	0.449	0.721	0.417	0.193	0.467
Guangdong	0.719	-0.001	0.202	0.73	0.527	0.87	1.001
Guangxi	0.415	0.566	0.506	0.478	0.409	0.457	0.116
Yunnan	0.251	0.745	0.303	0.225	0.613	0.744	0.085
Zhejiang	0.616	0.11	0.202	0.803	0.48	0.39	0.512
Fujian	0.443	0.28	0.528	0.575	0.671	0.428	0.095
Tibet	0	0.954	0.202	0	0.458	0.978	0

TABLE XVII. THE EVALUATION OF CHINA'S BASIC OLD-AGE INSURANCE IN EACH PROVINCE,2008 (PART 2)

Provinces	**D8**	**D9**	**D10**	**D11**	**D12**	**Score**	**Rank**
Jilin	0.449	0.85	0.828	0.868	1	0.729	1
Shanghai	0.001	0.928	0.706	1	0.635	0.719	2
Heilongjiang	0.346	0.489	0.761	0.818	0.789	0.719	2
Liaoning	0.4	0.656	0.788	0.728	0.796	0.715	4
Neimenggu	0.476	0.852	0.837	0.902	0.894	0.67	5
Tianjin	0.344	0.124	0.693	0.425	0.911	0.663	6
Hebei	0.3	0.216	0.824	0.545	0.513	0.658	7
Shanxi	0.772	0.752	0.77	0.92	0.659	0.64	8
Xinjiang	0.749	0.545	0.689	0.789	0.95	0.635	9
Ningxia	0.645	0.977	0.598	0.931	1	0.626	10
Shaanxi	0.284	0.863	0.749	0.739	1	0.615	11
Shandong	0.466	0.53	0.918	0.344	0.001	0.604	12
Henan	0.287	0.578	0.809	0.424	0.693	0.604	12
Hubei	0.45	0.379	0.871	0	0.832	0.598	14
Hunan	0.452	0.827	0.842	0.857	0.332	0.598	14
Gansu	0.42	0.551	0.676	1	0.999	0.593	16
Hainan	0.419	0.814	0.869	0.843	0.484	0.583	17
Chongqing	0.473	0.746	0.808	0.912	0.914	0.576	18
Qinghai	0.419	0.003	0.477	0.99	1	0.573	19
Sichuan	0.594	0.849	0.764	0.451	0.682	0.565	20
Jiangxi	0.371	0.795	0.912	0.941	0.892	0.552	21
Anhui	0.537	0.436	0.744	0.82	0.927	0.548	22
Beijing	0.375	0.655	0.639	1	1	0.518	23
Guizhou	0.524	0.57	0.718	0.865	0.958	0.509	24
Jiangsu	0.634	0.61	0.886	0.232	0.77	0.507	25
Guangdong	1	0.92	0.893	0.724	0.849	0.496	26
Guangxi	0.884	0.333	0.835	0.709	0.998	0.483	27
Yunnan	0.428	0.282	0.836	0.948	0.813	0.479	28
Zhejiang	0.807	0.636	0.967	0.121	0.629	0.446	29
Fujian	0.301	0.712	0.997	0.802	0.434	0.437	30
Tibet	0.066	0.988	0	1	1	0.43	31

Data Sources including Part 1 and Part2：《China Statistic Yearbook 2009》、《China Labor Statistic Yearbook 2009》、《China Human Resources and Social Security Yearbook 2009》、《Almanac of China's Population 2009》

Indexes are adjusted indexes

Analysis the results: *As can be seen from the table, the efficiency of basic old-age insurance system in every province can be divided into three levels. The first category includes Jilin, Shanghai, Heilongjiang, and Liaoning, whose scores are higher than 0.7 and the efficiency of this system can be considered as well. One of these four regions is a municipality, others are in Northeast. The second category includes Neimenggu, Tianjin, Hebei, Shanxi, Xinjiang, Ningxia, Shaanxi, Shandong, Henan, Hubei, Hunan, Gansu, Hainan, Chongqing, Qinghai, Sichuan, Jiangxi, Anhui, Beijing,* Guizhou *and Jiangsu, whose score are between5.0 and 7.0 and he efficiency of this system are general. The third category includes Guangdong, Guangxi, Yunnan, Zhejiang, Fujian, and Tibet, whose scores are below 5.0 and the efficiency of this system is poor.*

- There is relatively more significant difference of the efficiency of China's basic old-age insurance system among regions: In general, the efficiency of northern regions is significantly higher than that of southern regions, and scores of most southern are lower, ranking later. As can be seen from the table, the top 10 are all in the northern except Shanghai, the last six are all south. It reflects the regional government in northern China emphasis more on the construction of basic old-age insurance system, while the achievements of the Northeast Three Provinces connect with experiments in the reform of China's basic old-age insurance system.
- The efficiency of China's basic old-age insurance system in each province is related a little with the local economy. The top 4 GDP regions in 2008 are Guangdong, Shandong, Zhejiang and Jiangsu, however, their scores are limited. To some extent, this reflects governments in these areas do not attach importance to the basic old-age insurance system, and the participation of local urban workers is not high.
- The efficiency of China's basic old-age insurance system is entirely average, and there is still regional disparity in some evaluation indexes. According to the original data, the coverage rate of most regions is relative high, 29 provinces achieve more than 70%, and the remaining two provinces include Yunnan (51.8%, more than 50%) and Tibet (18.8%), which shows that China's Basic Old-age Insurance has reached the target of wide coverage more or less. In contrast, the benefit rate is totally low, which of 31 provinces are below 40%. In the respect of revenue and expenditure, all the regions have slight surplus, the majority surplus rate is about 30%, and the max rate is 43%, which is beneficial for replenishing individual account. From statistical data, at present the pension burden is not so heavy both for the local government and individual. Ratio of Pension Expenditure to Local Fiscal Expenditure is below 10%, the min is less than 1%; Expenditure Rate of Individual Old-age Insurance is below 20% in most regions, only Qinghai and Tibet exceed. Socialized Extending Rate of Pension achieves over 80% except Shandong and Hunan, and some provinces achieve 100%, which indicates that the socialization

of China's basic old-age insurance system operates properly.

IV. CONCLUSIONS

In view of problems reflected by the statistical data, we should adopt measures to improve China's basic old-age insurance system

- The local government should transform into service-oriented government, and emphasize the construction of basic old-age insurance system. As we all know, the proper social security and the economic development promote mutually. Provinces whose efficiency score are limited but GDP grow high should figure out the causes, and then try to improve the efficiency of China's basic old-age insurance system. Such as to improve the coverage rate, it can increase collection efforts, and take coercive measures to gradually incorporate all types of employment.
- Each province should implement China's basic old-age insurance system based on uniform standards, so as to narrow the gap among other regions. For those inefficient both in economy and the system regions, the central government can support in funding and policies, and these areas need to find their own gap with other provinces. Such as the province whose Elders' Support Rate and Replacement Rate are high, should increase the premium and local fiscal expenditure. In addition, the central government also should try to establish the horizontal fiscal transfer payment system to balance local pension pressure. It is possible to construct China's uniform basic old-age insurance system only provinces have equal levels.
- For the existed problems of China's basic old-age insurance system which has not reflected by the statistic data, we also should solve to improve the efficiency of the system. Such as funding management, in order to avoid corruption, we should separate the administration from the operation, and the implementation from the supervision. In addition, improving the information management is also feasible. Finally, we should try proper investment to appreciate funding.

ACKNOWLEDGMENT

This paper is funded by the project 09JZD0027 granted by Ministry of Education of the People's Republic of China.

REFERENCES

[1] Deboran N. Wentworth, James D. Neaton, and Wayne L. Rasmussen, "An Evaluation of the Social Security Administration Master Beneficiary record File and the National Death Index in the Ascertainment of Vital Status," American Journal of Public Health, November 1983.

[2] Ministry of Human Resources and Social Security of the People's Republic of China, The Situation and Policies of Social Security,Spe. 2010.

[3] Rober L. Nydick, and Ronald Paul Hill, "Using the Analytic Hierarchy Process to Structure the Supplier Selection Procedure," International Journal of Purchasing and Materials Management, Spring 1992.

[4] Takashi Oshio, and Naohiro Yashiro, "Social Security and Retirement in Japan," NBER Working Paper No.6156.

[5] Thomas L. Saaty, "How to Make a Decision: The Analytic Hierarchy Process," European Journal of Operational Research 48 ,1990,pp 9-26.

[6] Xinbang, Cao, "Research on Performance Evaluation of Social Security System.," Chinese Public Administration, July 2006.

[7] Yoshinori Hiroi, "Development of Japan's Social Security System-An Evaluation and Implications for Developing Countries," Institute for International Cooperation Japan International Cooperation Agency (JICA),.July 2004.