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The Rating of Insurance Companies Based on The Regulatory Indicators Using Three Different Scenarios

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Abstract:
The rating of insurance companies is one of the necessary and operational policies to regulate and evaluate the performance of the insurance industry. It informs shareholders, customers, insurers, and even regulatory authorities, as well as formal and informal support bodies, about the current performance of insurance companies and their capabilities and prospects for the future.
The rating of insurance companies in terms of the regulatory indicators and decision-making and implementation of the administrative measures for the companies based on the regulatory rating of each company is one of the needs of the regulatory body. Therefore, doing this properly requires using the indicators in principal areas, weighting them according to their importance, and implementing the model, finally. For this reason, in this study, first, the effective indicators for the regulatory rating of insurance companies were identified using documentary studies and relevant writings, and the initial indicators were scrutinized and completed using the results of a questionnaire. Then, the indicators prioritization and weighting and implementation of the model for regulatory rating of insurance companies are performed for 2019. Weighting the indicators is done by the Shannon entropy method, and the rating of insurance companies is implemented under three different scenarios with the TOPSIS model and the weighted average method.

Keywords: Regulatory Rating, The Shannon Entropy Method, The TOPSIS Model, Weighting.
JEL Classifications: G22, G24.

1 Introduction

The insurance industry, acting as a service sector, has a protective and compensatory role in each country's economy, so the formation of economic activities in the last century has been such that its continuation without the support of insurance is strongly affected. The successful operations of the insurance industry also create some incentives for other industries. Therefore, insurance companies,

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like any other company, must perform effectively to fulfill their mission, goals, and strategies. Because they are the key institutions in the capital markets that play a significant role in the economic development of countries by accepting various risks and strengthening financial resources to invest in the money and capital markets [1], [25]. Therefore, monitoring and evaluating the insurance industry's performance is very important, and rating insurance companies is one of the crucial information provided to company managers to examine the strengths and weaknesses to make appropriate decisions for strengthening the powers and fixing and improving the weaknesses. Insurance companies should significantly evaluate their performance and pay attention to the financial and non-financial (quantitative and qualitative) dimensions to maintain and gain competitive management, [4].
Nowadays, Iran's insurance industry faces a gap in the performance evaluation and rating of insurance companies. In general, the principal purpose of the rating is to assess the insurance company's reliability; increase efficiency, transparency, and productivity; more competition in the market, protect consumers and attract investors' satisfaction. Rating is a complex assessment of the condition and situation of the insurance company that is done by independent experts and determines the current and future status of the company from different dimensions [23], [25].
Nazari (2012) identified 27 indicators in four categories of financial, customer, internal processes, and learning and growth, based on experts' opinions, and then rated insurance companies using the scorecard method and TOPSIS model [22]. Mehdipoor (2016) evaluated the performance of Iranian insurance companies from 2007 to 2011. The indicators are divided into four categories: operational, financial, ability to perform obligations, and customer access to insurance and customer-oriented services. The weight of indicators was also determined by using the Shannon entropy method. Then the rating of insurance companies is done through Multi-Criteria Decision-Making methods such as Lam, Vikor, TOPSIS, and Saw [20]. Shahrokhi (2016) identified 16 indicators in four categories of operating ratios, financial ratios, ability to perform obligations, and customer access to insurance and customer-oriented services. Then the weight of each indicator was calculated using the network analysis process. Finally, rating active insurance companies in the Tehran stock exchange from 2009 to 2013 was done using the TOPSIS model [27].

Akhisar and Tunay (2015) provided a framework for measuring the factors of the Turkish life insurance sector according to the financial indicators of insurance companies. Then they obtained the rating of these companies by using the Analytic Hierarchy Process (AHP) and TOPSIS model [2]. Grishunin, Bukreeva, Astakhova (2022) ranked 161 Russian insurance companies based on the financial and non-financial indicators from 2013 to 2019 through the logistic regression modeling [16].

The related studies about the rating of insurance companies did not consider the rating under different scenarios and their comparison. In this research, we rate insurance companies under three scenarios and we choose the best scenario. The rest of this paper is organized as follows:

In section 2, the Multi-Criteria Decision Making (MCDM) method, the TOPSIS model, and the Shannon entropy method are described. In Section 3, the indicators are extracted by using the studies and the insurance experts' opinions. Then, the weights are obtained through the Shannon entropy method and the rating of insurance companies is implemented under three different scenarios with the TOPSIS model and the weighted average method. Finally, We concluded this paper in section 4.

2 Methodology

2.1 The Multi-Criteria Decision Making method

The Multi-Criteria Decision Making (MCDM) method involves optimizing the problems by considering several criteria. The MCDM models are divided into the multi-objective and multi-indicator models. In general, The MCDM consists of the following steps: [5] , [22]

- Creating a decision matrix
- Non-scaling
- Calculating the indicators weight
- Choosing model and implementation

Different methods such as linear, Euclidean, and fuzzy are used to unscale the decision matrix. In the linear method, when the variables of an indicator have a positive impact, r_{ij} is divided by the maximum of the corresponding column:

$$n_{ij} = \frac{r_{ij}}{Maxr_{ij}}$$

And if they have a negative impact (cost) or they are a combination of the positive and negative impacts, one of the following formulas can be used:

$$n_{ij} = 1 - \frac{r_{ij}}{Maxr_{ij}}$$

$$n_{ij} = \frac{Minr_{ij}}{r_{ij}}$$

In the Euclidean method, $n_{ij} = \frac{r_{ij}}{\sqrt{\sum r_{ij}^2}}$ is used, and in the fuzzy method, the following formulas are used for the positive and negative impacts, respectively, and the values of zero and one are the worst and the best results, respectively:

$$n_{ij} = \frac{Maxr_{ij} - r_{ij}}{r_{ij} - Minr_{ij}}$$

$$n_{ij} = \frac{r_{ij} - Minr_{ij}}{Maxr_{ij} - Minr_{ij}}$$

2.2 The TOPSIS model

In the TOPSIS model, m alternatives are assessed through n indicators. The preferred alternative in this model is the one with the closest to the positive ideal alternative (solution) (A_i^+) and the farthest to the negative ideal alternative (solution) (A_i^-). The TOPSIS model begins with the creating of a decision matrix and normalizing it through non-scaling methods.

$$N_d = [r_{ij}]$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$

$$R = \begin{bmatrix} r_{11} & \cdots & r_{1j} & \cdots & r_{1n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ r_{i1} & \cdots & r_{ij} & \cdots & r_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ r_{m1} & \cdots & r_{mj} & \cdots & r_{mn} \end{bmatrix}$$

In the next step, the value of the normalized weight (V_{ij}) is obtained from multiplying the unscaled matrix by the diagonal matrix of the indicators weights (W_{nm})

$$V = N_d \times W_{nm}$$

$$V = \begin{bmatrix} v_{11} & \cdots & v_{1j} & \cdots & v_{1n} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ v_{i1} & \cdots & v_{ij} & \cdots & v_{in} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ v_{m1} & \cdots & v_{mj} & \cdots & v_{mn} \end{bmatrix}$$

The positive and negative ideal alternatives are determined from the following formulas, respectively:

$$A_i^+ = [(max_i V_{ij} | J \in J_1), (min_i V_{ij} | J \in J_2) | i = 1, 2, ..., n] = (V_1^+, V_2^+, ..., V_n^+)$$

$$A_i^- = [(min_i V_{ij} | J \in J_1), (max_i V_{ij} | J \in J_2) | i = 1, 2, ..., n] = (V_1^-, V_2^-, ..., V_n^-)$$

Then the n-dimensional Euclidean distance is used to compare each alternative with the above alternatives:

$$S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)^2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_j^-)^2}$$

And the relative proximity of each alyernative with the above alternatives is calculated as follows:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}$$

C_i ranges between zero and one. If this value is closer to one, the alternative optimization will be higher. Otherwise, it will be lower. [5] , [22]

2.3 The Shannon entropy

Knowledge of the relative indicators weight is decisive in the MCDM method. There are various methods such as Linmap, least squares, and Shannon entropy for determining the indicators weight. We use the Shannon Entropy in this research. Entropy represents the current uncertainty about the expected information content of a message. The decision matrix in the MCDM model contains information that entropy can be used as a criterion for evaluating them. To calculate the weight of the indicators by using the Shannon entropy, the normalized decision matrix is first calculated as follows:

$$P_{ij} = \frac{r_{ij}}{\sum_{i=1}^{m} r_{ij}}$$

Next, the entropy of each indicator is calculated:

$$E_j = -k\sum_{i=1}^{m} P_{ij} ln P_{ij}$$

$$k = \frac{1}{lnm}$$

Where k holds the entropy value between zero and one as a constant value. The degree of deviation is then calculated, which states how much practical information is provided to the decision-maker.

$$d_j = 1 - E_j$$

Finally, the weight is calculated as follows:

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j}$$

If the decision-maker has already set a specific weight λ_j for each indicator, then the new weight is calculated as follows:

$$W_j^{'} = \frac{\lambda_j W_j}{\sum_{j=1}^{n} \lambda_j W_j}$$

[5] , [22]

3 Results and discussion

In this research, the indicators of insurance companies in 2019 are used for creating the decision-making matrix and rating. The statistical population of this research is Iranian insurance companies except for the reinsurance, mutual, and life companies. Finally, the three scenarios are used to perform the rating:

3.1 Studying the indicators of the well-known international rating agencies

The rating indicators were identified by studying the rating indicators of the international rating agencies. The results are summarized in Table 1.

3.2 Identifying and determining the indicators and analyzing the results of the questionnaire

In this section, the intended indicators for the rating of insurance companies were determined by reviewing the literature and international rating agencies. Then, a questionnaire was distributed among insurance industry experts to confirm these indicators and receive suggestions about new indicators. Finally, the indicators are divided into five categories of financial (F), technical and operational (TO), corporate governance (CG), life (L), and agents (A). They are shown in Table 2.

3.3 Weighting the indicators using the Shannon entropy method

The weight of each indicator expresses its relative importance compared to the other indicators. The Shannon entropy is one of the efficient and superior methods in weighting the indicators. This method has a high degree of adaptation and takes into account the dispersion and fluctuations of the data. To weight the indicators, a decision matrix should be created first. It should be noted that due to the confidentiality of the data, we used codes instead of the names of the insurance companies. The weighting results for 2019 using the Shannon entropy method are shown in Table 3.

3.4 Implementation of the rating model

In this section, the rating of insurance companies is performed under three different scenarios for 2019.

- **The 1st Scenario:** (Rating insurance companies by using the TOPSIS model with the variable weights). In this scenario, the indicators are weighted

Table 1: The indicators of the well-known international rating agencies

Rating Agency	**Indicator**
Moody's [21]	-Business status indicators: market position in terms of competitiveness, product distribution, and reputation; concentration and product and market diversification. - Financial indicators: asset quality, capital adequacy, profitability and earning, reserve adequacy, financial flexibility -Operating environment indicators: insurance systemic risk, insurance market development
SPX [6], [26]	-Country risk assessment: economic risk, political risk, financial system risk, payment culture, and the law of governance -Insurance Industry Risk Assessment (IICRA): Return on Equity (ROE), product risk, barriers to entry in the insurance industry, market growth outlook, institutional framework. -Business status indicators: market position in terms of competitiveness, product distribution, and reputation; concentration and product and market diversification. -Financial indicators: asset quality, capital adequacy, profitability and earning, reserve adequacy, financial flexibility. -Operating environment indicators: insurance systemic risk, insurance market development. -Enterprise Risk Management (ERM) -Management and corporate governance - Company's liquidity
Fitch [15]	-Qualitative indicators: the restriction of the government and the country; operating environment and the condition of the insurance industry; business status; type of the company ownership; management and corporate governance, -Quantitative indicators: capital and financial leverage; debt service capabilities and financial flexibility; financial performance and earnings; investment and asset risk; liquidity and asset/liability management; reserve adequacy; reinsurance, risk reduction, and catastrophic risk.
A.M. Best [3]	- Market position - Degree of competition - Distribution channels - Pricing sophistication and data quality - Management quality - Production / geographical concentration - Production risk - Regulatory, event, market and country risks - Organizational risk management - Production and underwriting - Reserving - Concentration - Reinsurance - Liquidity and Capital Management - Investments - Legal / Regulatory / Judicial / Economic / Operational
JCR [18] , [19]	Characteristics of the industry - Important factors in market position and competitiveness, management strategy and policy - Return On Asset (ROA) - Premium income - Loss ratio - Expense ratio - Income balance ratio (combined ratio) - Liquidity - Capital adequacy - Financial flexibility - Risk management system
DBRS [12]	-Franchise strength - Risk profile - Earnings ability - Liquidity - Capitalization and asset quality
HR [11], [17]	- Qualitative indicators: industry risk; management evaluation; asset quality; accounting, insurance, regulatory, legal, and competition calculations - Quantitative indicators: level of profitability, operating return, solvency, liquidity risk
Egan-Jones [13], [14]	Country risk - Corporate governance - Business and industry risk - Financial risk
CARE [9], [10]	- Profitability ratio: premium growth, risk retention , loss ratio, expense ratio combined ratio, investment yield, return on networth. - Liquidity ratio: liquid assets to technical reserves, current liquidity, - Solvency: solvency margin, operating leverage

through the Shannon entropy method based on their importance in the model and the total weight of all the indicators is one.

- **The 2nd Scenario:** (Rating insurance companies by using the TOPSIS model with equal weights). In this scenario, the weight effect is eliminated and all the indicators have equal importance.

PACRA [24], [28]	-Operational performance: underwriting expertise and market knowledge; distribution and combination capabilities; business classes and changes in combination; Market share and growth, brand name recognition and franchise value; cost efficiency and operating scale; product and geographical combination; administrative and technology capabilities. - Organizational performance - Managerial performance: strategic vision; risk appetite; credibility and background of expectations fulfillment, Risk control, and risk management capabilities; depth, scope, and success of programs, achievements of key managers - Financial performance: underwriting quality; profitability; investment; use of reinsurance; reserves and capital adequacy, liquidity
CE [7], [8]	- Balance sheet status and financial flexibility - Revenue status and its stability - Company risk profile- corporate ownership and corporate governance - Strategy and model of business - Operational environment

- **The 3rd Scenario:** (Rating insurance companies by using the weighted average method). In this scenario, the weighted average method is used to determine the rating of the insurance companies. Moody's mainly uses this method to combine the indicators to reach the final rating. The indicators are divided into five categories of financial, technical and operational, corporate governance, life, and agents, and a weight is assigned to each category through the Shannon entropy method. The total weight is equal to one, here.

The final rating in this research is based on the quartiles. The rating results are classified in four levels with the following symbols:

- **A:** In this category, there are companies with strong financial strength that can meet their obligations. These companies can continue operating in a financial crisis.
- **B:** In this category, companies have good financial strength. But under the influence of changing conditions, including unfavorable economic conditions, they may become weak in meeting their obligations.
- **C:** In this category, the companies have an average financial status and are completely dependent on the financial status and existing conditions. The obligor may not be able to meet the financial obligations in the event of adverse economic or financial conditions.
- **D:** This category has a slightly lower level than C.

Implementation of the 1st and 2nd scenarios:

The rating results for the 1st and 2nd scenarios are shown in Table 4. The comparison of the results of the 1st and 2nd scenarios shows that although the weight effect elimination in the 2nd scenario has improved the rating of some insurance companies, it has also decreased the rating of some companies. Because in the 2nd scenario, the effect of indicators with low weight has increased and had a greater impact on the rating.

Table 2: The final rating indicators and their codes

Code	Indicator
F1	Return On Investment (ROI)
F2	The adequacy of the technical reserves of the third party car
F3	The ratio of the premiums written to equity
F4	The ratio of the claims to the assets (excluding reinsurers' share of technical reserves)
F5	Financial solvency ratio
F6	Meeting of cash obligations ratio
F7	Combined ratio
F8	The ratio of the cash assets to the technical reserves
TO1	The loss ratio of the health
TO2	The loss ratio of the third party
TO3	The loss ratio of the other insurance lines
TO4	The proportion of the health insurance share in the company's portfolio
TO5	The proportion of the third party share in the company's portfolio
CG1	The number of vacant technical managers to all managers
CG2	The number of unqualified managers to all managers
CG3	The number of the key employee's violations in the insurance company
CG4	The number of violations of the insurance company to the insurance industry
L1	The ratio of the surrender among of the cash values policies in the company
L2	The ratio of the number of surrenders of the cash value policies in the company
L3	The share of technical reserves of life insurance to the total technical reserves
L4	The ratio of the liquid assets to the life obligations
L5	Premium growth rate
L6	The ratio of the losses paid to the life insurance premium written (excluding surrender and refund)
A1	Average production premium of each agent
A2	The ratio of claims from agents to premium written

Implementation of the 3rd Scenario:

In the 3rd scenario, the weights of the five main categories are calculated as follows: financial (0.2078), technical and operational (0.2086), corporate governance (0.2008), life (0.1925), and agents (0.1903), and the weighting results for the indicators are shown in Table 5.

As can be seen, the rating of the insurance companies under the 3rd scenario is very different from the 1st scenario. It is because of the change in the indicators weight. In general, the results of the implementation of the three scenarios are shown in Table 7

Table 3: The results of weighting the indicators in 2019

Indicator	E_j	d_j	λ_j	$W_j^{'}$
F1	0.94915	0.05085	0.03762	0.02445
F2	0.82779	0.17221	0.12913	0.28417
F3	0.98461	0.01539	0.02724	0.0536
F4	0.96683	0.03317	0.06108	0.02589
F5	0.97867	0.02133	0.09724	0.02650
F6	0.91290	0.08710	0.06032	0.06714
F7	0.99786	0.00214	0.05031	0.00138
F8	0.92671	0.07329	0.03993	0.03740
TO1	0.99303	0.00697	0.08070	0.0719
TO2	0.98869	0.01131	0.08070	0.01166
TO3	0.96125	0.03875	0.08070	0.03996
TO4	0.93404	0.06596	0.03301	0.02782
TO5	0.95406	0.04594	0.03301	0.01938
CG1	0.91847	0.08153	0.03301	0.03439
CG2	0.94078	0.05922	0.00010	0.00008
CG3	0.70052	0.29948	0.02532	0.09690
CG4	0.70047	0.29953	0.03147	0.12046
L1	0.95115	0.04885	0.00020	0.00012
L2	0.94945	0.05055	0.00608	0.00393
L3	0.89660	0.10340	0.00493	0.00651
L4	0.96419	0.03581	0.04070	0.01863
L5	0.93995	0.06005	0.01185	0.00909
L6	0.86558	0.13442	0.00010	0.00017
A1	0.94371	0.05629	0.00224	0.00161
A2	0.69231	0.30769	0.03301	0.12981

4 Conclusion

The rating of insurance companies is one of the important concerns in the development of insurance services and, as a result, increasing the penetration rate of insurance in countries. Rating insurance companies is a financial evaluation that leads to transparency, increasing efficiency, creating competition in the market, and satisfying customers. In general, the insurance companies with the rating of A and B have a desirable situation, and the companies with the rating of C and D need more regulatory attention, and more focus on their risk areas to be promoted to B. In this paper, the insurance companies are rated based on the regulatory indicators by using three different scenarios. In the 1st scenario, the indicators weights depended on their importance in the model. The indicators with high weight in this scenario have a great impact on the rating changes. In the 2nd scenario, all the indicators had the same importance due to eliminating the weight effect. The comparison of the results of these two scenarios shows that in the 1st scenario, some

Table 4: The final results of the model implementation based on the 1st and 2nd scenarios

Insurance company code	C_i for the 1st scenario	C_i for the 2nd scenario
B1	0.50026	0.56348
B2	0.84240	0.53938
B3	0.51887	0.50201
B4	0.49008	0.47066
B5	0.049780	0.46255
B6	0.61601	0.46119
B7	0.85901	0.56790
B8	0.64700	0.45915
B9	0.46929	0.51844
B10	0.86519	0.56197
B11	0.57549	0.48039
B12	0.83731	0.50439
B13	0.88235	0.56134
B14	0.64128	0.61314
B15	0.82618	0.53152
B16	0.83651	0.57362
B17	0.69854	0.51804
B18	0.80289	0.49951
B19	0.74454	0.53385
B20	0.83713	0.57015
B21	0.79117	0.43624
B22	0.85253	0.50366
B23	0.81071	0.59692
B24	0.87435	0.54536
B25	0.72592	0.54686
B26	0.80737	0.56306

indicators with high weight have caused an unfavorable rating, but eliminating the weight effect in the 2nd scenario gave them a better rating. The rating of the insurance companies under the 3rd scenario is very different from the 1st scenario. It is because of the change in the indicators weight. In the 1st scenario, each indicator had weight and the total weight was equal to one. In the 3rd scenario, the indicators were divided into five categories (financial, technical and operational, corporate governance, life, and agents), and each category had a weight (the sum of the weights was equal to one). In our opinion, reserve adequacy is one of the principal indicators in rating agencies. Therefore, it should not have the same importance as other indicators. Finally, we chose the 1st scenario as the best scenario because it assigns different weights to the indicators. Using the 1st scenario makes the insurance companies focus on managing their portfolio risk to get a better

Table 5: The final indicators weights in the 3rd scenario

The indicator code	Weight
F1	0.0986
F2	0.4244
F3	0.0300
F4	0.0709
F5	0.0492
F6	0.1773
F7	0.0044
F8	0.1452
TO1	0.0432
TO2	0.0701
TO3	0.2402
TO4	0.3811
TO5	0.2654
CG1	0.1108
CG2	0.0751
CG3	0.4062
CG4	0.4079
L1	0.1161
L2	0.1205
L3	0.2452
L4	0.0892
L5	0.1427
L6	0.2863
A1	0.1534
A2	0.8466

rating.

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Table 6: The final results of the weighted average method

Insurance company code	Score
B1	0.2102
B2	0.1442
B3	0.2805
B4	0.1544
B5	0.2889
B6	0.2887
B7	0.1550
B8	0.2742
B9	0.2481
B10	0.1655
B11	0.2898
B12	0.1679
B13	0.1329
B14	0.1381
B15	0.1773
B16	0.2036
B17	0.1525
B18	0.2282
B19	0.1652
B20	0.1349
B21	0.1683
B22	0.1421
B23	0.2530
B24	0.1412
B25	0.2771
B26	0.2672

Table 7: The result of implementing the three scenarios in 2019

Rating	The 1st scenario	The 2nd scenario	The 3rd scenario
A	B13, B24, B10, B7, B22, B2	B14, B23, B16, B20, B7 ,B1	B11, B5, B6, B3, B25, B8
B	B12, B20, B16, B15, B23, B26, B18	B26, B10, B13, B25, B24, B19, B2	B26, B23, B9, B18, B1, B16, B15
C	B21, B19, B25, B17, B8, B14, B6	B15, B9, B17, B12, B22, B18, B3	B21, B12, B10, B19, B7, B4, B17
D	B11, B3, B1, B5, B4, B9	B11, B4, B5, B6, B8, B21	B2, B22, B24, B14, B20, B13

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