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Features Affecting Customers Behavior towards Life Insurance Policies: A Case Study in Intuitionistic Fuzzy Set Theory

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Abstract

Life is beautiful but also uncertain. Whatever we do, however smart and hard we work, we are never sure what life has in store for us. It is therefore important that we do not leave anything to chance, especially 'Life Insurance'. So know it better over here and secure your life at the earliest. Life insurance policy provides us assurance that our family will get financial security and support even when we are not around. This is the best way where the insured person can save his family from financial crisis at the time of any mishappening or after death. But prior to this it is necessary to compare or choose best life insurance policies offered by different companies, their contract terms, cost premium quotes, limitations and benefits. To overcome this difficulty, this article deals with customer's choice criteria in selecting life insurance policies by studying their types and features. In this paper, we use one parametric entropies in the intuitionistic fuzzy set theory. For this purpose, we develop a hypothetical case study containing information about customers, features and types of life insurance policies with assigned degree of membership, non-membership and intuitionistic index.

Keywords: Fuzzy Sets, Intuitionistic Fuzzy Sets (IFS), Fuzzy Relations, Renyi Entropy, Tsallis Entropy, Life Insurance Policies, Intuitionistic Index, Case study

Introduction

Today, there is no shortage of investment options for a person to choose from. Modern day investments include gold, property, fixed income instruments, mutual funds and of course, life insurance. Given the plethora of choices, it becomes imperative to make the right choice when investing our hard-earned money. Life insurance is a unique investment that helps us to meet our dual needs- saving for life's important goals and protecting our assets. A life insurance policy is an intangible risk protection obligation. The business of a life insurance company involves risks related to birth, aging, illness death, injuries etc. Each insurance policy is related individually to create a rate for that person based on statistics and the insurance company's rating rules. With the development of economy the selection of a life insurance policy by an individual has become a complex and highly confused task. There are many types of life insurance policies like term insurance policy, whole life policy, endowment policy, money back policy; unit linked insurance plan, universal life insurance, permanent life insurance etc. There are so many features such as risk cover, tax benefit, investment, loan facility, exchange of policy, mortgage recovery etc. that a life insurance policy has. The requirements of the customers (policy holders) are changing very fast with time. Now a day, customers have a lot of choices among the different insurance policies. There are a number of techniques that can be used in selection of a life insurance policy. On this basis, here we use Max-Min-Max composition of IF relations, Renyi entropy, and Tsallis entropy in intuitionistic fuzzy information theory.

Fuzzy set theory is a generalization of conventional set theory that was introduced by Zadeh [13] in 1965. The basic idea of fuzzy sets is easy to grasp. Fuzzy set theory provides a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously studied. Fuzzy sets are sets with boundaries that are not precise. In fuzzy set theory we have a membership function whose value is defined in the interval [0, 1]. Fuzzy interpretations of data structures are a very natural and intuitively plausible way to formulate and solve various problems. Applications of fuzzy set theory to real problems are abound. Yadav and Tiwari [12] have studied factors that affect customers' investment towards life insurance policies. Kothari, Agrawal, Bhat and Sharma [8] have also done a study on factors affecting individuals' investments towards life insurance policies. Dash and Sood [5] have explained that why should a person invest in a life insurance policy. Upadhyay [11] has described about satisfaction of the policy holders protection in insurance sector. Sharma and Chowhan [9] have done a comparative study of public and private life insurance. Barik and Patra [4] have done an empirical research on emerging trends in insurance in India. Horn [7] has also explained life insurance earnings and release from risk policy reserve system. While Gupta, Prince and Kumar [6] have applied Sanchez's method and Shannon's entropy for the fuzzy diagnosis procedure of the types of TB.

Methodology

Exploratory and descriptive type research is carried out to describe the phenomenon. The study aims to find out the type of life insurance policy which is more suitable for a customer by studying factors influencing customer's life insurance investment decision and their preferences at the time of policy buying decision. Firstly, we establish IF relation between customers and features that affect a life insurance policy with assigned degree of membership and non-membership elements as explained in table (1.1). Secondly, we establish IF relation between features and types of life insurance policies with assigned degree of membership and non-membership elements as explained in table (1.2) by taking information about different insurance policies. Then we apply maximum-minimum composition and minimum-maximum composition of IF relations as explained in table (1.3). Finally, we use Renyi's and Tsallis entropies in the intuitionistic fuzzy set theory for different values of the parameter (α) as explained in tables (1.4) and (1.5). The minimum weight for each customer from the possible analysis has been taken. If there is a tie in weight elements, then the customer may take both types of life insurance policies.

Introduction to Intuitionistic Fuzzy Measures

The beginning of the idea of intuitionistic fuzziness was a happenstance. Intuitionistic fuzzy set theory was introduced by Atanassov [3] has become a popular topic of investigation in the fuzzy set community. The membership and non-membership degrees in IFS_s may represent something else, namely the idea that concepts are more naturally approached by separately envisaging positive and negative instances. It leads to the idea of loosely related membership and non-membership functions. In IFS we propose a function may called intuitionistic index in the sense of axioms but has some advantages when measuring the fuzziness of an intuitionistic fuzzy set. If the value of intuitionistic index is zero, IFS theory coincides with fuzzy set theory. Applications of IFS appear more and more frequently in the literature and some of them seem to be serious and claim good results. Szmidt and Kacprzyk [10] have derived some new measures of entropy for intuitionistic fuzzy sets.

For a fixed set X, an IFS of A is defined as: $A = \{ < x, u_A(x), v_A(x) > | x \in X \}$
Where $u_A(x)$: X → [0, 1] and $v_A(x)$: X → [0, 1] define the degree of membership and degree of non-membership of the element x ∈ X to the set A.

For every x ∈ X, 0 ≤ $u_A(x) + v_A(x)$ ≤ 1 and the amount $\pi_A(x) = 1 - u_A(x) - v_A(x)$ is called intuitionistic index, which may require to membership value, non-membership value or both.

Again, Let A be an IFS of the set X and let R be an IF relation from X → Y, then max-min-max composition of IFS X with the IF relation R(X → Y) is defined as B = R o A with membership and non-membership function defined as:

$$u_B(y) = \max_{x \in X}\{\min[u_A(x), u_R(x, y)]\}$$

and

$$v_B(y) = \min_{x \in X}\{\max[v_A(x), v_R(x, y)]\}$$

Adlassnig [1] and Ahn [2] elaborates medical knowledge as fuzzy relation between symptoms and disease in medical diagnosis of headache.

Let F = {f_1, f_2,……………, f_m}; I = {i_1, i_2,……………, i_n};

C = {c_1, c_2,……………, c_q}; be the finite set of features, types of life insurance policies and customers respectively.

Now two fuzzy relations (FR), Q and R are defined as:

Q = {<(c, f), u_Q(c, f), v_Q(c, f) > | (c, f) ∈ C × F}

R = {<(f, i), u_R(f, i), v_R(f, i) > | (f, i) ∈ F × I}

Where u_Q(c, f) indicate the degree to which the customer c is affected by the feature f and v_Q(c, f) indicate the degree to which the customer c is not affected by the feature f.

Similarly u_R(f, i) indicate the degree to which the feature f affect the type of life insurance policy i and v_R(f, i) indicate the degree to which the feature f does not affect the type of life insurance policy i.

The composition T of IFR$_s$ R and Q(T = R o Q) describe the interest of customer c_i in terms of choosing the life insurance policy from C to I given by membership and non-membership as:

$$\mu_T(c_i, i) = \max_{f \in F}\{\min[\mu_Q(c_i, f), \mu_R(f, i)]\}$$

$$v_T(c_i, i) = \min_{f \in F}\{\max[v_Q(c_i, f), v_R(f, i)]\}, \forall c_i \in C \text{ and } i \in I$$

Then we use the Renyi's and Tsallis entropies in intuitionistic fuzzy set theory. We know that both the entropies are defined as:

$$R_\alpha(P) = \frac{1}{1-\alpha}\log\sum_{i=1}^{n} p_i^\alpha \qquad ,\alpha \neq 1, \alpha > 0$$

and

$$H_\alpha^T(P) = \frac{1}{1-\alpha}\left[\sum_{i=1}^{n} p_i^\alpha - 1\right], \quad \alpha \neq 1, \alpha > 0$$

By using these entropies we can find that which type of life insurance policy is more suitable for a customer according to his desire by using the information related to his interest obtained from the chart of given case study. This information plays a significant role in analysis when many types of life insurance policies are given.

Case Study:-

We know that there are lots of features that affect the interest of a customer like risk covered, investment, maturity benefits, saving component, cash value plan, tax beneficial, loan facilities, mortgage protection, death benefits, health protection etc. But we will study only five (risk covered, investment, tax beneficial, health protection, loan facilities) of them. We also know that there are also a lot of life insurance policies such as whole life policy, term insurance policy, limited payment life policy, fixed term endowment policy, money back policy, unit linked insurance plans, annuities etc. But again we will study only five types of policies (term insurance, whole life, endowment, money back, unit linked insurance).

Let C = {C_1, C_2, C_3, C_4,} be the number of customers (normally having same age and living standard etc.) and F = {F_1, F_2, F_3, F_4, F_5,} be the set of features that affect the interest of a customer.

Now let the IFR: Q(C→F) is given by:

Q	**F_1**		**F_2**		**F_3**		**F_4**		**F_5**	
Customer	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**
C_1	0.7	0.2	0.6	0.0	0.1	0.7	0.5	0.2	0.0	0.6
C_2	0.0	0.6	0.5	0.3	0.6	0.1	0.0	0.6	0.0	0.9
C_3	0.5	0.2	0.7	0.2	0.0	0.5	0.2	0.3	0.3	0.4
C_4	0.4	0.0	0.3	0.5	0.2	0.3	0.8	0.1	0.5	0.3

Table-1.1

Let I = {I_1, I_2, I_3, I_4, I_5,} be the types of life insurance policies that a customer wants to purchase.

Now suppose the IFR: R(F→I) is given by

R	**I_1**		**I_2**		**I_3**		**I_4**		**I_5**	
Factors	**u_R**	**v_R**	**u_R**	**v_R**	**u_R**	**v_R**	**u_R**	**v_R**	**u_R**	**v_R**
F_1	0.7	0.1	0.3	0.1	0.4	0.4	0.2	0.6	0.2	0.7
F_2	0.4	0.5	0.8	0.0	0.5	0.3	0.3	0.3	0.0	0.6
F_3	0.1	0.5	0.2	0.7	0.6	0.2	0.5	0.3	0.2	0.4
F_4	0.3	0.2	0.5	0.3	0.6	0.1	0.7	0.2	0.4	0.3
F_5	0.2	0.5	0.1	0.6	0.2	0.7	0.3	0.6	0.9	0.0

Table – 1.2

Now the composition T = R o Q is following as:

T	**I_1**		**I_2**		**I_3**		**I_4**		**I_5**	
Customers	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**	**u_Q**	**v_Q**
C_1	0.7	0.2	0.6	0.0	0.1	0.7	0.5	0.2	0.0	0.6
C_2	0.4	0.5	0.5	0.3	0.6	0.2	0.5	0.3	0.2	0.4

C_3	0.5	0.2	0.7	0.2	0.5	0.3	0.3	0.3	0.3	0.3
C_4	0.4	0.1	0.5	0.1	0.6	0.1	0.7	0.2	0.5	0.3

Table – 1.3

Now we apply the Renyi's and Tsallis entropies on the values of table three and find the results. Here we apply these entropy measures as intuitionistic fuzzy entropy measures in the form of

$$R_\alpha(P) = \frac{1}{1-\alpha}\log\left[\sum_{i=1}^{n}\{(\mu_i)^\alpha + (v_i)^\alpha + (\pi_i)^\alpha\}\right] \ , \ \alpha > 0, \alpha \neq 1$$

and

$$H_\alpha^T(P) = \frac{1}{1-\alpha}\left[\sum_{i=1}^{n}\{(\mu_i)^\alpha + (v_i)^\alpha + (\pi_i)^\alpha\} - 1\right] \ , \ \alpha > 0$$

We can take any value of α (except one) which is greater than 0 in case of both entropies. Here we take the value of α = 0.1 to 0.9 in both entropies for finding out the results. We also compare the results of both the entropies for different values of α. We apply the Renyi's and Tsallis intuitionistic fuzzy measures on the values of table 1.3 for different values of α and get the results of tables 1.4 and 1.5.

Now for **Renyi's entropy** the table values are given as:

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.463	**0.300**	0.463	0.474	**0.300**
C_2	**0.468**	0.474	0.471	0.474	0.475
C_3	0.474	**0.463**	0.474	0.476	0.476
C_4	0.468	0.468	0.466	**0.463**	0.474

Table - 1.4.1 when α = 0.1

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.449	**0.239**	0.449	0.471	0.239
C_2	**0.460**	0.471	0.464	0.471	0.472
C_3	0.471	**0.449**	0.471	0.476	0.476
C_4	0.460	0.461	0.456	**0.449**	0.471

Table – 1.4.2 when α = 0.2

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.435	**0.298**	0.435	0.468	**0.298**
C_2	**0.452**	0.468	0.458	0.468	0.471
C_3	0.468	**0.435**	0.468	0.476	0.476
C_4	0.452	0.452	0.448	**0.435**	0.468

Table - 1.4.3 when α = 0.3

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.421	**0.297**	0.421	0.464	0.297
C_2	**0.444**	0.464	0.451	0.464	0.468
C_3	0.464	**0.421**	0.464	0.475	0.475
C_4	0.444	0.444	0.437	**0.421**	0.464

Table – 1.4.4 when α = 0.4

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.395	**0.295**	0.395	0.458	**0.295**
C_2	**0.431**	0.458	0.438	0.458	0.465
C_3	0.458	**0.395**	0.458	0.474	0.474

C_4	0.431	0.431	0.420	**0.395**	0.458

Table – 1.4.5 when α = 0.5

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.408	**0.296**	0.408	0.462	**0.296**
C_2	**0.438**	0.462	0.445	0.462	0.467
C_3	0.462	**0.408**	0.462	0.475	0.475
C_4	0.438	0.438	0.428	**0.408**	0.462

Table – 1.4.6 when α = 0.6

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.382	**0.294**	0.382	0.455	**0.294**
C_2	**0.425**	0.455	0.431	0.455	0.463
C_3	0.455	**0.382**	0.455	0.474	0.474
C_4	0.425	0.425	0.412	**0.382**	0.455

Table – 1.4.7 when α = 0.7

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.371	**0.294**	0.371	0.453	**0.294**
C_2	**0.420**	0.453	0.425	0.453	0.462
C_3	0.453	**0.371**	0.453	0.474	0.474
C_4	0.420	0.420	0.404	**0.371**	0.453

Table – 1.4.8 when α = 0.8

R(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.359	**0.293**	0.359	0.450	**0.293**
C_2	**0.414**	0.450	0.419	0.450	0.459
C_3	0.450	**0.359**	0.450	0.473	0.473
C_4	0.414	0.414	0.397	**0.359**	0.450

From the above given tables we can say that for customer C_2 purchasing of life insurance policy I_1 and for customer C_4 purchasing of insurance policy I_4 is suitable while for customers C_1 and C_3 I_2 life insurance policy is good.

Table – 1.4.9 when α = 0.9

Now the values of table 1.5 for **Tsallis entropy** are given as:

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.789	**0.958**	1.789	1.856	**0.958**
C_2	**1.822**	1.856	1.836	1.856	1.862
C_3	1.856	**1.789**	1.856	1.872	1.872
C_4	1.822	1.822	1.812	**1.789**	1.856

Table – 1.5.1 when α = 0.1

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.060	**0.919**	1.608	1.726	**0.919**
C_2	**1.667**	1.726	1.690	1.726	1.737
C_3	1.726	**1.608**	1.726	1.755	1.755
C_4	1.667	1.667	1.649	**1.608**	1.726

Table – 1.5.2 when α = 0.2

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.452	**0.882**	1.452	1.608	**0.882**
C_2	**1.532**	1.608	1.559	1.608	1.623
C_3	1.608	**1.452**	1.608	1.647	1.647
C_4	1.532	1.532	1.508	**1.452**	1.608

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.317	**0.847**	1.317	1.501	**0.847**
C_2	**1.415**	1.501	1.443	1.501	1.519
C_3	1.501	**1.317**	1.501	1.547	1.547
C_4	1.415	1.415	1.385	**1.317**	1.501

Table – 1.5.3 when α = 0.3

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.200	**0.814**	1.200	1.404	**0.814**
C_2	**1.311**	1.404	1.338	1.404	1.424
C_3	1.404	**1.200**	1.404	1.455	1.455
C_4	1.311	1.311	1.277	**1.200**	1.404

Table 1.5.4 when α = 0.4

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.098	**0.782**	1.098	1.315	**0.782**
C_2	**1.220**	1.315	1.243	1.315	1.337
C_3	1.315	**1.098**	1.315	1.370	1.370
C_4	1.220	1.220	1.182	**1.098**	1.315

Table – 1.5.5 when α = 0.5

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	1.009	**0.753**	1.009	1.234	**0.753**
C_2	**1.138**	1.234	1.158	1.234	1.257
C_3	1.234	**1.009**	1.234	1.291	1.291
C_4	1.138	1.138	1.098	**1.009**	1.234

Table – 1.5.6 when α = 0.6

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.930	**0.724**	0.930	1.159	**0.724**
C_2	**1.066**	1.159	1.082	1.159	1.184
C_3	1.159	**0.930**	1.159	1.219	1.219
C_4	1.066	1.066	1.023	**0.930**	1.159

Table – 1.5.7 when α = 0.7

T(p)	**I_1**	**I_2**	**I_3**	**I_4**	**I_5**
C_1	0.862	**0.698**	0.862	1.091	**0.698**
C_2	**1.001**	1.091	1.012	1.091	1.116
C_3	1.091	**0.862**	1.091	1.151	1.151
C_4	1.001	1.001	0.957	**0.862**	1.091

Table 1.5.8 when α = 0.8

From the values of table 1.5 we also get the same results as table 1.4. For different customers, the purchasing of various life insurance policies is beneficial.

Table – 1.5.9 when α = 0.9

Conclusion:

Life insurance business needs a special attention as compared to the other business due to the change in economy and employment. In the above hypothetical case study, we have tried to know the various aspects or factors which influence the customers in purchasing the life insurance product. The above analysis can be amplified as per the national scenario with some specific modifications. On the basis of above analysis we conclude that both the entropies give same results used for decision making problems. Other entropies may also used in this form. These methods may prove effective tool for some other decision making problems and medical diagnosis of some type of diseases.

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