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Premium Rate for Private Health Insurance

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***Abstract*— Premium rating like every other insurance has to consider the liabilities that are expected to be incurred by members. In respect of Health Insurance the liabilities will be mainly determined by demographic conditions, incidence of sickness and the distribution function of medical claims. We have derived the functional relationship between premium and there variables, making allowance for expected expenses and contingency reserves. Sicknesses are of various categories, sickness of long duration and heavy medical bills, medium duration and short duration with light bills.Premium rates are designed to follow each category unlike the straight deductions from salaries to cater for all types of sickness. The expected medical expenses is obtained by taking account of the incidence of sickness, age of the individual, medical expenses incurred and the life table of the population. Health Insurance is categorized into three different packages, high, medium and heavy medical bills and their corresponding premium is calculated.**

***Index Terms*— Life Table, incidence of sickness, medical bills, normal distribution, premiums, expected insurance liabilities.**

I. INTRODUCTION

Over the past decade, the insurance industry in Nigerian has grown steadily and the can be shown in the total premium which have gone from about #75 billion in 2005,to over #300 billion currently (African Insurance trends; 2015). The research conducted by Philips Consults (2017) indicate that Nigeria generates a pluralistic health system comprising of the public and private health sectors. Public health sector is organized into primary, secondary and tertiary levels.

Health care providers are critical in Health Insurance business and often attrite reputations of HMOs, (Philips consulting 2017). They argued that there is a need for backward integration by health insurance business to improve customer experience. It is against the background that this paper.

The current Nigerian Health Insurance has been designed for the public sector. The public sector contributes directly from salary by monthly deduction. In this paper we are deriving the premium fate for health insurance, not based on salaries but based on actuarial relevant factors.

We assume that the population is stationary and the life table conforms to the English Life Table No 10 and the incidence of sickness and the distribution function of medical bills both follow a normal distribution. The expected health insurance liabilities are derived taking into consideration the expected sickness bills and making allowance for Expenses. Expenses are of two main types, operational expenses and overload expenses such as buildings and equipment's which are amortized over ten years.

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II. LITERATURE REVIEW

Kelly Montor Merry (2008) states that "Community rating of health insurance policies is a method of setting premiums that spreads evenly across the entire community. Everyone pays the same rate regardless of age, health status, or claims history. Thus, under community rating a health 20 years-old student would pay the same premium for the same coverage as a 63 years-old with diabetics or cold.

Community rating is controversial in the health policy community. Some feel that it drives premiums higher, forcing lower-income individuals to go uninsured.Others believe that it offers a crucial opportunity for those with expensive health problems to obtain affordable coverage."

Alkenbrack (2011). Examined commonly based health insurance and social health insurance using a conceptual frame work that was developed based on theoretical and empirical literature in London. She employed a cross sectional case comparison design with the use of econometric and qualitative methods in the analysis. She found that, the schemes had a positive effect on utilization and finance. The potation implications were describe in the context of the intentional debate regarding the potential contributing of community based health insurance financing strategies as countries progress toward universal coverage.

Insure.com (2009), in their paper "How does the health insurance company determine our group's premium". States that 'Health insurance companies use one of three methods to calculate your group's premium: medical underwriting, adjusted or modified community rating or rating bands. Medical underwriting is used primarily in the individual and small business health insurance markets. It is used in the large group market only at the time of purchase and rates are based on the number of employees participating in the plan, and a review of the Company's claim history. The second Method, adjusted or modified community rating is the standard for rating health insurance premiums in some states and eliminates health status from the list of factors insurers consider when setting the premiums. The rate is charged on limited factors such as ages, gender mix, and lifestyles.

III. METHODOLOGY

Let l_x be the number of people aged x in the population which we assumed is stationary.

The proportion at age x sick is P_x and is normally distributed with mean μ_{1x1} and variance $\delta_1{}^2{}_x$, N (μ_{1x}, $\delta^2{}_{1x}$)

The medical bills M_x for a life aged x is normally distributed with mean μ_{2x} and variance $\delta^2{}_{2x}$, N (μ_{2x}, $\delta^2{}_{2x}$).

The overhead expenses incurred that enabled commencement such as buildings is taken as H. and yearly operating expenses including staff salaries is taken as S.

The expected cost of medical bills for a life age x is P_xM_x and for all the lives age x it will be $\Sigma \; l_xP_xM_x$

Let $(P_1M_1, P_2M_2\ldots\ldots\ldots\ldots P_nM_n)$ denote a random sample of six n from a bivariate normal distribution with probability density function (P, M) and parameters μ_1, μ_2, δ_1^2, δ_2^2 and *P* the correlation between variable P and M.

Let Þ be the mean of P_1, $P_2\ldots\ldots\ldots\ldots P_n$ and M be the mean of M_1, $M_2\ldots\ldots\ldots$..

$\bar{P} = \sum_{x=1}^{n} P_x /n \quad \bar{M} = \sum_{x=1}^{n} \bar{M_x}/n$

Using the principles of moment generating function of bivariate normal distribution, P,M have a bivariate normal distribution with mean μ_{1x1} μ_{2x2} and correlation coefficient Þ.

The cost of medical bills for all ages = $\sum_{x=0}^{\infty} l_x E(P_n) E(M_x) = \sum_{x=0}^{\infty} l_x\mu_{1x}.\mu_{2x}$

Overhead expenses which is taken as G is amortized over 10 years. Hence yearly cost is 0.1H. Operating expenses taken S is yearly which can be subdivided among the age groupings x. k percent is loaded to cater for reserves and profit and f percent for contingencies.

Expected liability =

$(1 + k + f) \{\sum_{x=0}^{n} l_x\mu_{1x}\,\mu_{2x} + S + 0.2H\}$

Let PREM be the required premium paid per age group x

$$Prem_x = (1 + k + f)\frac{\{\mu_{1x}.\,\mu_{2x} + l_x(S + 0.1H)\}}{\Sigma\; l_x}$$

If the same premium is to be paid by all the age groupings

$$Prem = (1 + k + f)\frac{\{\sum_{x=0}^{\infty} (l_x\mu_{1x}\mu_{2x} + S + 0.1H\}}{\Sigma\; l_x}$$

When we introduce the variations in proportion risk and medical bills, $P_x\mu_{1x} = \mu_{1x} + Z\,\delta_1^2{}_x$ and μ_{2x}: $\mu_{2x} + Z\,\delta_2^2$

Hence Premium per age x

$$Prem\ x = (1 + k + f)\frac{\{(\mu_{1x}\mu_{2x}Z_1\,\delta_1^2{}_x) + (\mu_{2x} + Z_2\,\delta_{2x}^2) + (l_xS + 0.1H)\}}{\Sigma\; l_x}$$

One equal premium for each person

$$Prem = (1 + k + f)\frac{\Sigma \{l_x(\mu_{1x} + Z_1\,\delta_1^2{}_x) + l_x(\mu_{2x} + Z_2\,\delta_2^2) + S + 0.1H\}}{\Sigma\; l_x}$$

Where Z is the z score of the normal distribution for each confidence level.

If it is with 95% confidence z = 1.96.

IV. CASE STUDY

Population is grouped into the following age groups 0-9, 10-29, 30-49, 50-69 and above 70 years of age.

Table 1: LIGHT MEDICAL BILL

Age group.

	0-9	10-29	30-49	50-69	>70
L_x	90069	86969	80935	63620	18700
Proportion sick per week μ_{1x}	.003	.002	.004	.004	.003
Standard deviation of proportion sick δ_{1x}	.00036	.0005	.00035	.00052	.00041
Medical bill per week μ_{2x}	1700	2000	2000	2200	200
Standard deviation of medical bill δ_{2x}	250	280	195	235	45

For example from the table, we deduce that the expected medical bill for a person age 30-49 is N2000 per week and 4 out of 1000 in this age group is sick.

Total population = 340293.

Current expenses is taken as 0.05 of the liabilities mainly made up of administrative expenses and expenses to collect the contributions, overhead expenses is taken as N5, 000, 000 amortized over 10 years k.Loading = 10% of liabilities.

Liability equation is taken per age without standard deviation

$$\frac{(1 + k + f)(\mu_{1x}\mu_{2x} + 0.1H)}{\sum_{x=0}^{\infty} l_x}$$

Table 2 Light Bills

Age group	PREMIUM	TOTAL CONTRIBUTION
0-9	7.554	680381
10-29	6.2893	546978
30-49	10.889	881301
50-69	11.809	751289
>70	5.889	110124
		2, 970, 073

Single Premium = 8. 278 for the group
Total Contribution by single premium for everyone = 2043632 per week
(When single premium)
Total Contribution (Premium) from the population is greater than when the premiums are charged per age group.

Table 3: Medium Medical Bills

Age group

	0-9	10-29	30-49	50-69	>70
L_x	90069	86969	80935	63620	18700
Proportion sick per month μ_{1x}	.003	.002	.004	.004	.003
Standard deviation of n proportion sick δ_{1x}^2	.00036	.0005	.00035	.00052	.00041
Medical bill per week μ_{2x}	3000	40000	2500	3500	1000
Standard deviation of medical bill δ_{2x}^2	525	625	615	620	150

Table 4 Medium Medical Bills

Age group	Premium	Total Contribution
0-9	12.039	1084372
10-29	10.889	947036
30-49	13.189	1067480
50-69	17.789	1132647
>70	12.039	225136
		4, 456, 671

Single Premium = 14.22392
Total Contribution = 4, 841, 015 per week
(When it is single premium)
Total Contribution from single premium is just slightly higher than the total contributions when premiums are classified according to age groups.

Table5:Heavy Medical Bills

	Age Group				
	0-9	10-29	30-49	50-69	>70
L_x	90069	86969	80935	63620	18700
Proportion sick per month μ_{1x}	.002	.0045	.0040	.003	.002
Standard deviation of n proportion sick δ_{1x}	.0003	.00063	.00025	.00052	.00041
Medical bill per week μ_{2x}	5, 000	7, 200	5, 500	5100	2000
Standard deviation of medical bills per week δ_{2x}	750	620	515	500	320

Table6 Heavy Medical Bills

Age group	Premium	Total Contribution
0-9	13.189	1187952
10-29	14.109	1227076
30-49	20.664	1672469
50-69	19.284	1227834
>70	6.289	117611
		5432542

Single Premium = 15. 963

Total Contribution

(When it is single premium) = 5432983 per week

When the medical bills are high the single premium's contribution is almost equal to the total contributions from premium according to age groups.

The Health Insurance provider receives more total contributions from single premiums when the medical bills are light, but as the medical bills rises it makes no difference changing premiums according to age groups or one single premium for the population.

V. CONCLUSION

Health Insurance in arriving at the premiums to charge should assess the functions, rate of incidence of sickness and medicals bills for age groups, preferably for classes of ailments and the life table for the population. The premium should be renewed every year. Adequate statistical records should be kept as too given prior information for future years.

The premium rates differ for each category of package and grouping.

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