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ANALYSIS OF IMPLICIT TRUST BETWEEN THE INSURER AND THE INSURED A CASE STUDY OF ZAMBIA STATE INSURANCE CORPORATION (ZSIC):

INNOVATION AND BUSINESS MANAGEMENT

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Abstract-The past two to three decades have witnessed a significant increase in the number of players in the insurance industry in Zambia such as general and life insurers, insurance brokers, loss adjusters and insurance agents. This has inevitably resulted in a rise in the number of professionals working in the insurance industry. But it is doubtful how many of these insurance professionals understand the scientific basis for the work they do, particularly in the evolution of insurance claims for the insured to have trust in their insurers. This study used a mathematical model to determine the degree of implicit trust between the insurers and the insured. Meta-analysis design was used in identifying the model which was based on the classical risk process or the Cramér-Lundberg (C-L) model. The study was conducted as a case study of Zambia State Insurance Corporation (ZSIC) because it is the only parastatal insurance company in Zambia and is the oldest of all the players in the insurance industry in Zambia. A simple regression analysis was applied to show the impact of premiums and claims on the reserves. It was found that the relationship between reserves and premiums is always positive while that between reserves and claims is always negative. The rate at which the premiums were contributing to the ZSIC reserves was 72.46%, while claims reduced the reserves at a rate of 31.29%. It is therefore expected that ZSIC's policyholders will have implicit trust in ZSIC since the company's reserves are stable, as evidenced by the rates at which premiums increase the reserves and at which claims reduce the reserves.

Keywords*: Implicit Trust, Insurer, Insured, Reserves, Premiums, Claims*

Background

The Insurance industry in Zambia has been steadily growing since 1971. The industry was essentially a monopoly with ZSIC which was established in 1968 as the country's only insurance provider until 1991 when the industry was liberalized through the privatization programmes implemented by the government. Since 1991 the number of players in the insurance industry in Zambia has significantly increased to 27 insurance companies and 49 brokers as at the end of July 2014. The industry now has two local reinsurance companies, 260 agents and a number of other players (Kawesha, 2014). Players in the insurance industry are also being constantly challenged to be innovative and come up with new products that can meet the demands of Zambians.

The Insurance Act No. 27 of 1997 as amended in 2005 prohibited insurance companies from conducting both life and non-life insurance business. The amendment saw the birth of companies such as Madison Life, Professional Life and ZSIC Life. In line with the provisions of the Insurance Act No. 27 of 1997 as amended by Act No. 26 of 2005, ZSIC Limited underwent a restructuring and compliance exercise which resulted in the birth of three separate business entities, namely ZSIC Limited, which is the Holding Company, ZSIC General Insurance Limited and ZSIC Life Insurance Limited as subsidiary companies (Kawesha, 2014). ZSIC has been restructured, re-energized and rebranded into ZSIC Limited, a diversified investment company with a wealth of experience that is poised for phenomenal growth. With its two subsidiaries, ZSIC Limited continues to be part of the lives of the people of Zambia.

The problem statement of this study is that the increase in the number of players in the insurance industry in Zambia has inevitably led to a rise in the number of professionals working in the insurance industry most of whom do not understand the scientific basis for the work they do, particularly in the evolution of insurance claims. The evolution of insurance claims comprises two processes, namely, the claim number process and the aggregate claim amount process, the latter being modelled by a compound Poisson process and the former by a homogeneous Poisson process with intensity λ. This study seeks to explore the role of the Poisson process in insurance modelling, with particular reference to the insurance industry in Zambia, in order to provide a scientific basis for implicit trust between the insurer and the insured which is at the core of the relationship between these two parties.

The study whose aim was to identify a model for the degree of trust between the insurers and the insured sought to achieve the following specific objectives:

a) To model the claim numbers and inter-arrival times of claims for ZSIC;
b) To determine a model for implicit trust between the insurer and the insured; and
c) To apply the determined trust model to realistic data pertaining to ZSIC.

Some key terms and their definitions

A ***claim*** is a demand made by the insured, or the insured's beneficiary, for payment of the benefits as provided for in the insurance policy (Kasumo, 2011:3).

Reserves are the amount of money that remains after all liabilities have been met. In other words, an insurance company accumulates a surplus when the premiums collected over a given period of time exceed the claims that have been paid over that period (Kasumo, 2011:4).

Methodology

The study attempted to determine the relationship between reserves and premiums, as well as between reserves and claims. Meta-analysis design was used in the formulation of the model to determine the degree of trust between the insurers and the insured. This study was quantitative, exploratory and confirmatory.

Secondary data relating to ZSIC for two years (2013 and 2014) were used for analysis. The data included in the study were the evolution of motor claims which amounted to a combined total of 1625 entries for the years 2013 and 2014. The data were summarized into monthly numbers of claims, monthly total claim amounts and arrival dates in terms of days over the two-year period. Pensions Insurance Authority (PIA) data from the available PIA annual reports were also used to validate the formulated model. The PIA data had three variables as shown in the data presentation and analysis as, reserves, premiums and claims. The data were for the years 2001, 2002, 2009, 2010, 2011, 2012 and 2013.

In the formulation of the model, the exponential distribution was used to model the claim inter-arrival times and the homogeneous Poisson process was used to model the claim numbers. Mikosch (2009) argues that the homogeneous Poisson process combines the claim sizes and the arrival times and come up with a C-L model or the classical risk process. From the C-L model, the general risk model was derived by dropping down the initial capital which was finally used to derive the implicit trust model. Simple Regression analysis was used in this study to regress the reserves depending on premiums and claims. Reserves were the dependent variable and the premiums and claims were the independent variables. Both multiple and simple regression methods of analysis were used in the application of the implicit trust model.

The *t*-statistic was used in this study to test for the significance of the inference parameters. The analysis of variance (ANOVA) was used to test the significance of the regression models. In all the applied tests the significance level was 5%. The coefficient of determination R^2 was used to determine the extent to which the dependent variable was being explained by the variations in the independent variable. The adjusted R^2 was used to determine whether the model is the best. For the data analysis, Microsoft Excel, Minitab and the Statistical Package for the Social Sciences (SPSS) were used.

Results

Modelling of the inter-arrival times of claims ZSIC

The claims in an insurance company arrive almost every day. It is easy to analyze them using number of days in a year as time. The inter-arrival time or inter-occurrence of claims, say $0 < t_1 < t_2 < \cdots < t_n$, are modelled by $T_n = t_n - t_{n-1}$. The inter-arrival times for the years 2013-2014 are shown in

Table 1. ***Table 1****: Inter-arrival times*

Time (t_n)	No. of claims $N(t)$	$T_n = t_n - t_{n-1}$
31	59	31
59	115	28
87	176	28
116	234	29
147	309	31
176	379	29
207	436	31
237	506	30
266	583	29
297	648	31
327	701	30
358	756	31
389	838	31
415	903	26
446	996	31
476	1071	30
506	1155	30
536	1221	30
567	1289	31
596	1353	29
625	1416	29
656	1483	31
683	1551	27
713	1625	30

Modeling of claim number process

$N(t) = N\{i \geq 1 | T_i \leq t\}$, $t \geq 0$ is the total number of claims received by an insurance company up to time *t* (Mikosch, 2009:2).

Probability Density

The results in *Table 2* below show the output obtained using Minitab statistical software computed with the homogeneous Poisson process.

Table 2*: Claim number process probabilities*

$N(t)$	$P(N(t) = x)$
59	0.027796
56	0.017243
61	0.035117
58	0.024117
75	0.032474
70	0.046259
57	0.020570
70	0.046259
77	0.025659
65	0.046209
53	0.009121
55	0.014200
82	0.011394
65	0.046209
93	0.000673
75	0.032474
84	0.007557
66	0.047609
68	0.048320
64	0.044170
63	0.041572
67	0.048320
68	0.048320
74	0.035817

In *table 2* above the intensity or mean λ was 68 which imply that on average ZSIC was receiving 68 motor claims in a month for the period January 2013 to December 2014. The probabilities in the second column of *Table 2* are the probabilities of receiving *N*(*t*) motor claims. Thus, for example, the probability of receiving 59 motor claims in the first 31 days was 0.027796.

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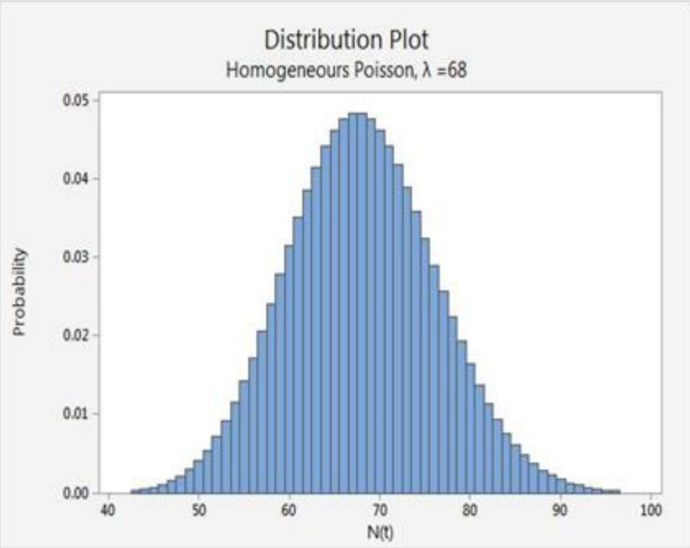

***Figure 1**: Probability distribution plot of the Homogeneous Poisson Process with intensity λ=68.*

Figure 1 shows the distribution plot between the number of claims and their probabilities of occurring in a month. It also shows that on average ZSIC was receiving 68 claims in a month from 2013 to 2014 and the probability of receiving 68 claims was 0.048320 or 4.832%. The minimum number of claims ZSIC received was 53 representing 0.9121%. The maximum number of claims ZSIC received was 93 representing 0.0677%. This means the company was approximately budgeting for 68 motor claims in a month for 2013 to 2014 even when the claims are stochastic. The claim number process resulted into a model that combined claim sizes and claim arrivals. This model was seen as a Cramér-Lundberg model. As noted above, the total claim amount process in the Cramér-Lundberg model is a compound Poisson process.

Formulation of an implicit trust model

According to Cramer (1930) the risk reserve model is given by

$$X(t) = \mu + P(t) - S(t)$$

where $X(t)$ represents the surplus or reserves at time t, μ is the initial capital of the company, $P(t)$ represents the total premiums received by the company up to time t and $S(t)$ is the total claim amount paid by the company up to time t. The risk reserve model is called the Cramér-Lundberg (C-L) model if the claim number process is specified as the homogeneous Poisson process which combines the claim sizes and the arrival times. In this model, $S(t) = \sum_{i=1}^{N(t)} Y_i , t \geq 0$

Therefore, the C-L risk model can be expressed as

$$X(t) = \mu + P(t) - \sum_{i=1}^{N(t)} Y_i , t \geq 0$$

If the initial capital μ is not considered then the risk model by Mario (2013) is called a *general* risk model expressed as

$$X(t) = P(t) - S(t), t \geq 0$$

Since an insurance company depends on the premiums $P(t)$ as the main source of income, and it pays the claims $S(t)$ to its customers, then the difference between the premiums and the claims is called the reserves, which can also be written as

$$X(t) = P(t) - \sum_{i=1}^{N(t)} Y_i , t \geq 0$$

The higher the surplus of an insurance company, the more trust the customers will have in that insurance company and the more new customers would be willing to be insured by that insurer. But surplus $X(t)$ depends on premiums and claims, therefore trust can be measured or determined by the reserves of an insurance company.

Let trust Tr be equal to reserves $X(t)$ of an insurance company. Then we can say that trust is equal to premiums less claims of an insurance company and it can be written as:

Trust = premiums – claims

or, mathematically,

$$Tr = P(t) - \sum_{i=1}^{N(t)} Y_i \,, t \geq 0$$

Therefore, the higher the reserves or surplus, the more trustworthy the company is, and if the reserves $X(t)$ of an insurance company increases monotonically over time, then the insurance company will be highly trusted and will attract more new customers. That is,

$$X(t) = P(t) - \sum_{i=1}^{N(t)} Y_i \,, t \geq 0$$

In other words, the model above tells us that the trust between the insurer and the insured can be measured or determined by the level of risks the company is incurring. Now that the risk model has been developed, it will be applied to the ZSIC data.

Application and statistical analysis of the developed implicit trust model

The insurance trust model was used to compute the surplus $X(t)$ using the annual PIA data drawn from the PIA annual reports for the years 2001, 2002, 2009, 2010, 2011, 2012, and 2013 for ZSIC (Kawesha, 2009, 2011 & 2014).

The results in *Tables 3, and 4* were produced from the implicit trust model developed in the previous section based on ZSIC data.

Zambia State Insurance Corporation data

Year	$P_z(t)$	$S_z(t)$	$X_z(t)$
2001	24,774,000	17,810,000	6,964,000
2002	31,198,000	24,331,000	6,867,000
2009	160,181,000	153,450,000	6,731,000
2010	190,073,000	58,650,000	131,423,000
2011	201,092,000	55,281,000	145,811,000
2012	220,024,521	49,709,000	170,315,521
2013	177,488,000	54,904,000	122,584,000

Table 3*: ZSIC annual data (2001-2, 2009-13) PIA Reports*

The missing data for the period 2003 to 2008 in table 3 above was projected to come up with table 4 below. The data for $P_z(t)$ for 2003 to 2008 was projected using the following model with r=0.080943;

$$P_{oz}(t) = \frac{P_{tz}(t)}{(1+r)^n}$$

The data for $S_z(t)$ for 2003 to 2008 was projected using the following model with $r = -0.06108$:

$$S_{tz}(t) = S_{oz}(t)(1+r)^n$$

where,

t = 2003, 2004, 2005, 2006 and 2008

$P_{oz}(t)$ are the premiums for the past year

$P_{tz}(t)$ are the premiums for a current year

$S_{oz}(t)$ are the claims for the previous year

$S_{tz}(t)$ are the claims for the current year

n is the number of years being projected

r is the average rate

Zambia State Insurance Corporation data

Year	$P_z(t)$	$S_z(t)$	$X_z(t)$
2001	24,774,000	17,810,000	6,964,000
2002	31,198,000	24,331,000	6,867,000
2003	*100,413,994*	*22,844,977*	*77,569,017*
2004	*108,541,803*	*21,449,713*	*87,092,091*
2005	*117,327,503*	*20,139,665*	*97,187,838*
2006	*126,824,343*	*18,909,629*	*107,914,714*
2007	*137,089,885*	*17,754,717*	*119,335,168*
2008	*148,186,352*	*16,670,343*	*131,516,010*
2009	160,181,000	153,450,000	6,731,000
2010	190,073,000	58,650,000	131,423,000
2011	201,092,000	55,281,000	145,811,000
2012	220,024,521	49,709,000	170,315,521
2013	177,488,000	54,904,000	122,584,000

***Table 4**: ZSIC annual projected data (2001-2, 2003-8 & 2009-13)*

To draw inferences from the trust model, a simple regression analysis was used to test for the strength and reliability of the model. Since surplus $X(t)$ is the amount of money that remains after subtracting the claims from the premiums, the surplus $X(t)$ depends on premiums $P(t)$ and claims$S(t)$. In this study surplus $X(t)$ was dependent on premiums $P(t)$ and claims $S(t)$ which were the independent variables.

Simple regression results where $S_z(t)$ is dependent on $P_z(t)$.

Model Summary

$X(t)$	R^2	R^2 (adj)
35,410,149	61.8%	58.3%

***Table 5**: Model summary*

Regression equation

The simple linear regression equation was

$$\mathrm{X}(t) = X(t) = -3{,}980{,}137 + 0.7246P_z(t).$$

The simple linear regression clearly indicates that for any amount of premium received ($P_z(t)$), reserves were increased by 72.46% of that amount of premiums received. As at 2014, ZSIC should at least receive a minimum premium amount of K5, 492, 924.37 per year for it to sustain its services and remain trusted by its customers. Any amount of premiums received in any of the years indicated in *Table 4* below K5, 492, 874.69 would have resulted in the ruin of the company. This figure of the premium could have helped ZSIC to determine the minimum premium rates that help the corporation to avoid the ruin problem after 2013.

Term	Coeff	SE Coeff	*Tr-* value	*P-* value	*VIF*
Const	-3,980,137	36,041,278	-0.58	0.5864	
$\boldsymbol{P_z(t)}$	0.7246	0.2223	3.44	0.0184	1

***Table 6**: Coefficients*

The P-value for the constant from the coefficient figure above was given as 0.5864, which is greater than the significance level α=0.05. This means that the constant term $B_0 = -3{,}980{,}137$ is insignificant. The insurance company cannot operate without premiums. The P-value for $P_z(t)$ of $B_1 = 0.7246$ was 0.0184, less than α=0.05 significance level, which means that B_1 was significant. For any amount of claims paid, surplus was increasing by 72.46% of the premiums received, which was good for the company. The existing customers could even be motivated to remain insured with ZSIC and new customers could be attracted to obtain insurance cover from ZSIC. Therefore ZSIC can maintain and improve its market even when there is high competition with private insurance companies such as Madison, Goldman and Professional to name but a few.

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	2.310E+16	2.310E+16	11.84	0.0184
$\boldsymbol{P_z(t)}$	1	2.310E+16	2.310E+16	11.84	0.0184
Error	5	9.755E+15	1.951E+15		
Total	6	3.286E+16			

***Table 7**: Analysis of variance*

The P-Value for the regression model was 0.0184 which was less than α=0.05 as shown in the ANOVA table above (*Table 7*). This means that the model was significant and the insurance company was performing well enough to attract new customers and maintain the existing ones.

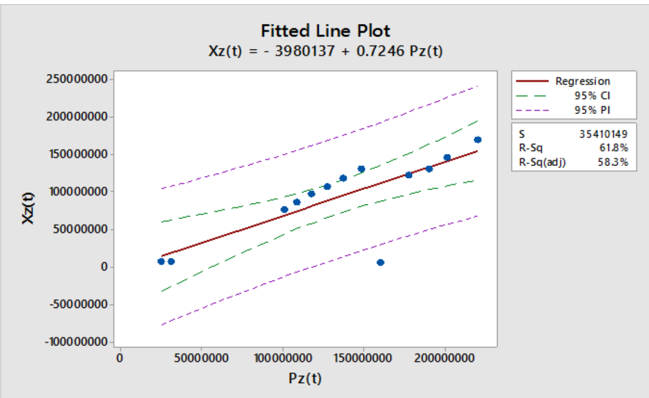

***Figure 2**: Line of best fit*

Simple Regression where $X_z(t)$ is dependent on $S_z(t)$

Model summary

$S_z(t)$	R^2	R^2 (adj)	R^2 (pred)
K55,926,599	4.61%	0.00%	0.00%

***Table 8**: Model summary of surplus and claims*

Coefficients

	Coeff	SE Coeff	T-value	P-value	VIF
Const	105,980,332.83	23,417,647.29	4.53	0.0009	
$S_z(t)$	-0.3129	0.4288	-0.73	0.4808	1

***Table 9**: Coefficient of surplus and claims*

Regression Equation

$X_z(t)$ = 105,980,332.83− 0.3129$S_z(t)$

As shown in *Table 8* above, 4.6% of variations in the surplus are explained by the claims. This means that the claims only account for a very small reduction in the surplus. In other words, about 95.4% of variations in the surplus are explained by other factors than the claims.

Analysis of variance

The P-value for the regression model was 0.0184 which was less than α=0.05 as shown in the ANOVA table below (*Table 9*). This means that the model was significant and the insurance company was performing well enough to attract new customers and maintain the existing ones.

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	1	5.918E+14	5.918E+14	0.09	0.7742
$\boldsymbol{P_z(t)}$	1	5.918E+14	5.918E+14	0.09	0.7742
Error	5	3.227E+16	6.454E+15		
Total	6	3.286E+16			

***Table 10**: Analysis of Variance*

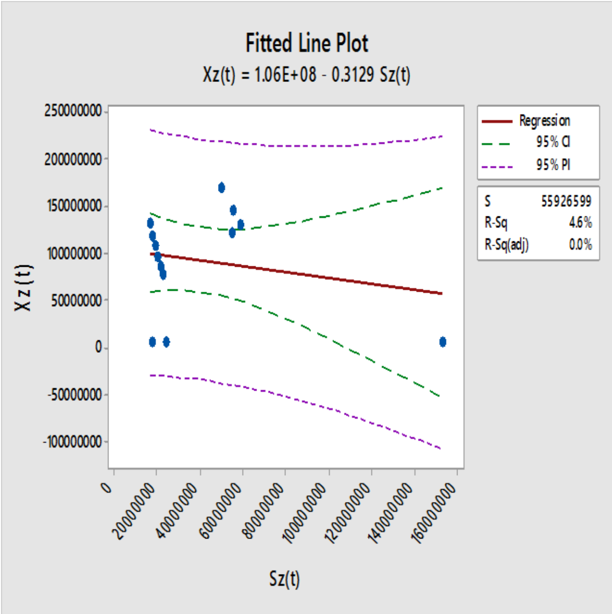

***Figure 3**: Line of best fit*

Summary results of the regression

Premiums	Claims
$X_z(t) = -20{,}928{,}491 + 0.7246P_z(t)$	$X_z(t) = \text{K}105\ 980\ 332.83 - 0.3129S_z(t)$
72.46% increase in surplus	31.29% decrease in surplus
P-value=0.0184 (model significant)	P-value=0.742 (model insignificant)
P-value for const=0.5864 (insignificant)	P-value for const=0.1124 (parameter insignificant)

***Table 10**: ZSIC summary results from the implicit trust model [$X(t) = P(t) - S(t)$]*

It is clear from the findings that there is a positive relationship between surplus and premiums and a negative relationship between surplus and claims. The Poisson process is used to model the claim number process while inter-arrival times of claims in an insurance company are exponential. And finally the degree of trust between the insurer and the insured can be determined by the surplus of the insurance company. The Poisson regression can also be used to analyze the degree of trust between the insurer and the insured.

Main Learning outcome

The insurance industry in Zambia is growing at a fast rate and comprises several players. But so far there is only one parastatal insurance company in Zambia, ZSIC, while the rest are privately owned and operated. From the foregoing analysis, it is possible to come up with the baseline to use when determining the premium rate that is reasonable for a given insurance company using the model identified in this study. This base line can help insurance companies to come up with premium rates that can go a long way in preventing ruin from occurring. The baseline can also help insurance companies to come up with premium rates that are affordable to their customers, thus leading to an improvement in the policyholders' trust in the insurance companies.

For an insurance company to sustain its services, its reserves should always be positive and monotonically increasing. Whenever, the insurance company's reserves are negative, then ruin or bankruptcy is said to have occurred. The higher the surplus of an insurance company, the more trustworthy it becomes both to existing and new customers. This means that the level of trust can be determined by the surplus of the company. When surplus increases, the level of trust of the customers increases as well. The opposite happens when the surplus reduces. On average, claims received from

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policyholders are paid within 21 days of being reported.

Conclusion

In conclusion, the model to determine and improve the degree of trust between ZSIC and its insured was identified. The model was formulated based on the classical risk model from which the general risk model was derived. The model can help ZSIC to monitor its financial status. It can also help to determine the degree of the scientific trust of the existing policyholders and those willing to be insured by ZSIC in future. The model shows that premiums play a very important role in insurance modelling. This model does not take into account the initial capital. In other words, it is a 'memoryless' model as far as the initial capital of the company is concerned.

Recommendations

1. ZSIC should use the identified trust model to determine the bench-mark to use when coming up with the premium rate.
2. ZSIC should keep up-to-date data about premiums, claims and surplus to ease the process of checking or ascertaining its financial status.
3. ZSIC can use the determined trust model to sensitize the general public about the importance of being insured in order to attract new customers.

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