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CONTENTS

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   REVIEW OF LITERATURE

   NEED/IMPORTANCE OF THE STUDY

   STATEMENT OF THE PROBLEM

   OBJECTIVES

   HYPOTHESES

   RESEARCH METHODOLOGY

   RESULTS & DISCUSSION

   FINDINGS

   RECOMMENDATIONS/SUGGESTIONS

   CONCLUSIONS

   SCOPE FOR FURTHER RESEARCH

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   REFERENCES

   APPENDIX/ANNEXURE

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CONTRIBUTIONS TO BOOKS

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

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REDINGTON IMMUNIZATION THEORY APPROACH TO HEDGING INTEREST RATE RISK IN INSURANCE COMPANIES IN NIGERIA

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ABSTRACT

Unstable interest rates due to unstable government policies, inflations or actions of the apex bank has contributed to the inability of insurance companies in Nigeria to meet their obligations, in forms of benefits, claims or assurances as at when due, as accounted for by THE low development in the sector. By adopting Tzeng, Wang and Soo's linear programming model[1], developed from Redington's classical immunization strategy and using data from the balance sheet of insurance companies in Nigeria, this research work shows how an insurance company's assets can be immune against interest rate risk. It further reveals that the multiplier-effects of the solution to this problem on the insurance sector and the Nigerian economy at large cannot be over-emphasized.

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KEYWORDS
convexity, duration, immunization, linear-programming, stochastic.

INTRODUCTION

The origin of Insurance companies in Nigeria can be traced back to 1921, when the first insurance company, the Royal Exchange Assurance (a British company) began operations. Twenty-eight years thereafter, three other companies were registered and by independence in 1960, the "Reports on Insurance companies' operations in Nigeria" published by the Federal Office of statistics, put the number at fifty nine. Since then, the number of insurance companies operating in Nigeria has increased considerably (Ogunshola, 1980). With this growth, one would expect the insurance sector of the Nigerian economy to have developed in terms of operations and awareness. This has not been the case, and one of such factors that has inhibited this growth is the inability of insurers to meet their obligations as at when due, due to fluctuation in interest rates. Although there are other risk factors, such as credit risk, liquidity risk, business risk, operational risk, market risk and others, that can affect asset management, interest rate risk has proven to be a major factor (Doffou, 2005).

Unstable interest rate is one major problem that must be addressed in the management of assets and liabilities of an insurance company. Assets are needed to fund liabilities and if the management of the assets does not occur relative to, or in the added dimension of the liabilities, changes in interest rate may pose a threat to the solvency of the insurer and its ability to meet its obligations. With the company unable to expand or meet its obligations, its viability becomes endangered, hence the need for the management of an insurance company's' assets and liabilities (ALM). Some of the strategies involved in ALM are options, scenario models, econometric models, mean-variance optimization model and immunization (Doffou, 2005). A very important tool among these is immunization. This concept was first examined by an English Actuary for a life insurance company, named Frank Mitchell Redington (Redington, 1952). He described immunization as the process of equating the mean term of the assets to the mean term of the liabilities. This is popularly known as classical immunization and the notion has been widely used by many insurance companies in USA, United Kingdom, and worldwide (Guo, 1996). Redington's theory of immunization was generalized in the 1970's and 1980's by several authors to handle more complicated situations (Fisher and Weil, 1971; Shiu, 1987). Further area of development was in the stochastic models for interest rates (Wilkie, 1987). However, insurance companies in Nigeria are still in the dark as far as this Redington theory of immunization is concerned. Thus, a development in this area, will ultimately lead to further development in our insurance sector, so that Nigerian insurance companies can compete globally.

Several government policies meant to support and develop the insurance sector have been inactive and this has led to lack of economic growth and development. The insurance sector of any nation is a driving force for her economic stability as it not only provides funds or liquidity to financial institutions, but also provides risk management, employment opportunities and a guide for some government policies. Therefore, there is every need for insurance companies in Nigeria to grow and develop, through proper management of their assets, while fulfilling their obligations. A useful means of achieving this objective is for insurance companies in the country to immunize their assets against fluctuation in interest rate.

Redington (1959) suggested that an immune portfolio of investment can be achieved by setting the mean term (duration) of the assets equal to the mean term (duration) of the liabilities. This article portrays the relevance of this theory to asset and liability management in insurance companies in Nigeria. The impact of a rise or a fall in the interest rate on an investment portfolio is observed, thus justifying the usefulness of Redington's theory. Redington also suggested setting the rate at which the duration of the assets changes with respect to changes in interest rate (convexity) greater than that of the liabilities. This article shows the importance of this concept by revealing that whether the interest rate rises or falls, the value of the assets are always greater the value of the liabilities, once the convexity of the assets is set higher than that of the liabilities.

This article further reveals that a solution to the problem of interest rate fluctuation in insurance companies in Nigeria will aid the growth and development of the insurance sector and the economy as a whole. With prompt payment of genuine claims by insurers, Nigerians patronage will increase because of renewed and improved confidence.

Having set the broad objectives of the study, the remainder of this article is organized as follows: In the section "Trend in Immunization Theory", i examine current literatures and issues on immunization. In the next section "The Model", a linear programming model was developed using Tzeng, Wang and Soo (2000) linear programming model from Redington's immunization theory. Then the further section illustrates the applicability of the model on the balance sheet of some insurance companies in Nigeria. The last section concludes the study and offers recommendations for further study.

REVIEW OF LITERATURE

It was not until the early 1950's, that Frank Mitchell Redington (Redington, 1952) identified the two conditions for immunizing a portfolio (also called the "Redington conditions") which has been widely used and applied to managing bond portfolios in the insurance and banking industries. According to Ivanov and Hecht (2006), many savings and loans banks and other financial institutions in the US became financially stressed during the late 1980's for failing to adhere to these simple Redington conditions. These Redington conditions are as follows: The first derivative of the assets with respect to the interest rate should be equal to the first derivative of the liabilities with respect to the interest rate. Also, the second derivative of the assets with respect to the interest rate should be greater than the second derivative of the liabilities with respect to the interest rate, so that the net present value of the cash-flow remains positive within any interval of change in interest rate (Redington, 1952). A portfolio is thus shielded or "immunized" from fluctuation in interest rate, if both Redington conditions are met. This notion of equating the mean term of assets with the mean term of liabilities has been used since then, by a number of insurance companies worldwide especially the variance minimization approach (Markowitz, 1959).

Since the early 1970's, the Redington's theory of immunization has been extended to handle more complicated situations. Fisher and Weil relaxed Redington's assumption of flat yield curves and tested their model empirically (Fisher and Weil, 1971). According to the standard Fisher equation, the return on a risk-free investment includes the real rate of interest and the expected short term rate of inflation. Forgler examines the effect of both of these risks on the investor's wealth (cash-flow) evaluated at any horizon point prior to maturity (Forgler, 1984). A further extension of the Fisher-Weil immunization theorem to more general case was done by Shiu (1987), where the interest rate shocks are functions of time.

Within the framework of a stochastic model for interest rates, the concept of immunization was first examined by Vasicek (1977) and thereafter by Boyle (1978) and Wilkie (1987). Vasicek basic assumptions are that the spot rate follows a continuous Markov process, the price of a pure discount bond at a particular time which matures at a future time is determined by the assessment of the time segment between the particular time and the future time and that the market is efficient and investors act rationally. The first assumption implies that the spot interest rate can be written in the form of a stochastic differential equation, involving instantaneous drift and variance. The second assumption implies that the bond price is a function of a time segment called the spot interest rate. Since the spot interest rate is a stochastic variable, Ito's lemma can be used to differentiate the price (Mckean, 1969). Vasicek further completed his development, by invoking the third assumption to prevent riskless arbitrage by reasoning similar to that used to derive the Black Scholes Option pricing formula.

Reitano (1991) and Ho (1992) provide the Key-Rate (multivariate) immunization, where the term structure is partitioned in maturity segments. Though Redington recognized that classical immunization theory fails when shifts in the term structure of interest rates are not parallel, Fisher and Weil were seminal in situating the problem in a term structure framework.

The development of techniques to address non-parallel yield curve shifts led to the recognition of a connection between immunization strategy specification and the type of assumed shocks (Boyle,1978). Sophisticated risk measures, such as M-squared model, were developed to select the best duration matching portfolio from the set of potential portfolios. Fong and Vasicek (Fong and Vasicek, 1984) developed this M-squared model in order to minimize the immunization risk due to non-parallel (slope) shifts in the term structure of interest rates. They show in particular that by setting the duration of a bond portfolio equal to its planning horizon and by minimizing a quadratic cash-flow dispersion measure, the immunization risk due to adverse term structure shifts can be reduced.

More recently, new immunization risk measures were proposed by several authors. For example, Nawalkha and Chambers (1997) and Nawalkha, Soto and Zhang (2003) derive a multiple factor extension to the M-squared model, called the M-vector model. Being derived using a specific assumption about the stochastic process generating the term structure, these theoretically attractive models encountered difficulties in practice. For instance, Bierwag et al. (1993) shows that the minimum M-squared portfolios fail to hedge as effectively as portfolios including a bond maturing on the horizon date. This line of empirical research led to the recognition of results such as the 'duration puzzle' (Ingersoll, 1983; Bierwag et al., 1993; Soto, 2001) where portfolios containing a maturity-matching bond have smaller deviations from the promised target return than duration matched portfolios not containing a maturity-matching bond.

Shiu (1990) observes that classical immunization, following Redington (Redington, 1957) requires the satisfaction of both duration and convexity conditions. That is, duration matching is required to be accompanied with higher portfolio convexity. The convexity requirement ensures that for an instantaneous change in yields, the market price of assets will outperform the market price of liabilities. Poitras (2005) pointed out that surplus immunization involves explicit recognition of the balance sheet relationship between assets, liabilities and surplus, where the total assets held by a fund equals the sum of the fund's liabilities and the accumulated surplus. To derive the classical immunization conditions, Redington (1957) uses a zero surplus fund, where the present value of assets and liabilities are equal, at a particular time. The classical zero surplus immunization results require setting the duration of assets equal to the duration of liabilities (Poitras, 2005). This only applies for a zero surplus portfolio, where according to Poitras, immunization with a non-zero surplus requires the duration of the assets to be equal to the duration of liabilities multiplied by the ratio of the market value of assets to the market value of liabilities.

RESEARCH METHODOLOGY

According to Tzeng, Wang and Soo (2000), Redington immunization strategy can be modelled into a linear program whose solution can implement the optimal immunization objective of any insurance company. This is also applicable to insurance companies in Nigeria. Let A_t and L_t denotes the cash inflows and cash outflows of an insurance company at period t. Furthermore, let V^t represent the discounting factor of the asset and liability, such that

$V^t = 1/(1 + i)^t$

Therefore, following Redington's theory, the asset and the liability of the insurance firm can be written as,

$A = \Sigma V^t A_t$ (present value of cash inflows)

$L = \Sigma V^t L_t$ (present value of cash outflows)

These equations are general model for measuring the value of an insurance company's assets and liabilities. As earlier stated, the surplus S(t) of any insurance company is the difference between its assets and liabilities. Therefore,

$S(t) = \Sigma V^t A_t - \Sigma V^t L_t$ ……………………………… (1)

Equation (1) provides a way for the insurance company to discount its cash inflows and outflows at each period of t and further measure the value of the firm. The issue now is what immunization problem may concern the managers if the surplus of the insurance company is valued by equation (1). According to Redington, the firm's surplus is immunized against changes in interest rates, if $dS/di = 0$.

Differentiating equation (1) with respect to interest rate i gives

$dS/di = \Sigma t V^t A_t - \Sigma t V^t L_t = 0$ ……………….. (2)

The duration of assets DA and the duration of liabilities DL can be defined as

$D_A = -(\Sigma t V^t A_t / (\Sigma V^t A_t)$

and

$D_L = -(\Sigma t V^t L_t) / (\Sigma V^t L_t)$

Substituting D_A and D_L into equation (2) and re-arranging terms gives

$D_A = (L/A)\, D_L$ ……………….............................. (3)

Equation (3) suggests that the firm's surplus is immunized against interest rate fluctuation if the duration of the firm's assets is set equal to the debt ratio times the duration of the firm's liabilities (Tzeng, Wang and Soo, 2000).

Further differentiation of equation (2) gives

$d^2S/di^2 = \Sigma t^2 V^t A_t - \Sigma t^2 V^t L_t$ ………………………… (4)

Redington states that if second derivative of the surplus is positive, that is

$d^2S/di^2 > 0$

then the surplus of the firm increases whether the interest rate increases or decreases. Therefore, if the change in the interest rate is not small, maximizing d^2S/di^2 is the best strategy for immunization, when $dS/di = 0$ (Tzeng, Wang and Soo, 2000).

Since the objective of any profit-oriented insurance company in Nigeria is maximizing its profit, while discharging its responsibilities (Ogunshola, 1980), then its optimal immunization strategy can be stated as maximizing the convexity of its surplus(S) = A – L, subject to dS/di = 0. That is,

Max d^2S/di^2

Subject to $S = A - L$

And $dS/di = 0$ ……………………………………... (5)

With the minimum solvency margin for an insurance company given as N2 billion (for a life insurance company) and N3 billion (for a non-life insurance company) in Nigeria, we further have the constraints

$S(t) >= N2,000,000,000$ (life insurance)

S(t)>= N3,000,000,000 (non-life insurance), t = 1,2,3…
and the non-negativity constraint, A_t >= 0…………………………. (6)
Thus, substituting equations (1), (3), and (4) into equation (5) together with (6), we obtain a linear programming problem, similar to that of Tzeng, Wang and Soo (2000) for the case of an insurance company in Nigeria.
Max $d^2S/di^2 = \Sigma t^2V^tA_t - \Sigma t^2V^tL_t$
Subject to, $S(t) = \Sigma V^tA_t - \Sigma V^tL_t$
$D_A = (L/A)\ D_L$
S(t)>= N2,000,000,000 (life insurance)
S(t)>= N3,000,000,000 (non-life insurance), t = 1,2,3…
A_t >= 0…………………………. (7)
In equation (7), A_t is the investment decision of the insurance company for asset-liability management at each period t. It should be noted however, that when the surplus S(t) and both the liability L_t and the rate of interest i are given as parameters, equations (1), (3), and (4) are all linear functions with respect to A_t. Therefore, linear programming can solve equation (7).

RESULTS & DISCUSSION

The insurance companies selected for the purpose of this study are International Energy Insurance Plc, Crusader Insurance Plc, NEM Insurance Plc, Niger Insurance Plc, Goldlink Insurance Plc, UNIC Insurance Plc and Equity Assurance Plc. There is no particular reason for this selection as the model is applicable to all insurance companies in Nigeria. The summary pages of their various balance sheets detailing the Assets and Liabilities as at 2007 were extracted from their various annual reports and Accounts for the financial year, 2007 as shown in table 1, in the appendix. Also included is the surplus, which is the difference between the Assets and Liabilities.
It is assumed that the liabilities of the insurance companies are to be paid out in three years. Tables 2(A)-(G) in the appendix shows the liability payment schedule for the insurance companies. Although it is sometimes difficult to predict an insurance company's liability schedule under real insurance practices, recent research findings of "Effective duration of insurance liabilities by Babbel, Merril, and Planning (1997) and Briys and Varenne (1997) can help to make accurate predictions. However, this area is beyond the scope of this study.
Assuming the current interest rate of 20%, the insurance company's immunization strategy can be modelled by means of equation (7) as;
Max $d^2S/di^2 = \Sigma t^2V^tA_t - \Sigma t^2V^tL_t$
Subject to, $S(t) = \Sigma V^tA_t - \Sigma V^tL_t$
$D_A = (L/A)\ D_L$
S(t)>= N5,000,000,000 (general insurance), t = 0,1,2,3…
S(t)>= N2,000,000,000 (Life insurance)
S(t)>= N3,000,000,000 (Non-life insurance)
A_t >= 0
In this study it is assumed that the change in interest rate is non-stochastic for simplicity of demonstration. Usually, the manager of the insurance company may notice the existence of the stochastic structure of interest rate in the long run, but may only be concerned with the non-stochastic change in interest rate in the short run. Therefore, for the purpose of this analysis, we shall consider interest rate changes in the short run for periods t = 0,1,2, and 3.
From the liability schedules, the model can further be expressed as an optimization problem for each of the insurance companies. Thus, we have

INTERNATIONAL ENERGY INUSRANCE: (TABLE 2A)
Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 - 3{,}648{,}470{,}000.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 - 1{,}042{,}420{,}000.00 >= 5{,}000{,}000{,}000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 6{,}042{,}420{,}000.00$ ….. (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 - 1{,}563{,}630{,}000.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 1{,}563{,}630{,}000.00$ ….. (2)
$A_0, A_1, A_2, A_3 >= 0$ ………………. (3)

CRUSADER INSURANCE: (TABLE 2B)
Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 - 16{,}247{,}332{,}500.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 - 4{,}642{,}095{,}000.00 >= 5{,}000{,}000{,}000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 9{,}642{,}095{,}000.00$ ….. (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 - 6{,}963{,}142{,}500.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 6{,}963{,}142{,}500.00$ ….. (2)
$A_0, A_1, A_2, A_3 >= 0$ ………………. (3)

NEM INSURANCE: (TABLE 2C)
Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 - 4{,}224{,}594{,}500.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 - 1{,}207{,}027{,}000.00 >= 5{,}000{,}000{,}000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 6{,}207{,}027{,}000.00$ ….. (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 - 1{,}810{,}540{,}500.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 1{,}810{,}540{,}000.00$ ….. (2)
$A_0, A_1, A_2, A_3 >= 0$ ………………. (3)

NIGER INSURANCE: (TABLE 2D)
Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 - 25{,}402{,}695{,}500.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 - 7{,}257{,}913{,}000.00 >= 5{,}000{,}000{,}000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 12{,}257{,}913{,}000.00$ ….. (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 - 10{,}886{,}869{,}500.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 10{,}886{,}869{,}500.00$ ….. (2)
$A_0, A_1, A_2, A_3 >= 0$ ………………. (3)

GOLDLINK INSURANCE: (TABLE 2E)
Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 - 3{,}251{,}048{,}500.00$
Subject to

$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 – 928,871,000.00 >= 5,000,000,000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 5,928,871,000.00$ ..... (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 – 1,393,306,500.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 1,393,306,500.00$ ..... (2)
$A_0, A_1, A_2, A_3 >= 0$ .... (3)

UNIC INSURANCE: (TABLE 2F)

Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 – 6,648,876,500.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 –1,899,679,000.00 >= 5,000,000,000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 6,899,679,000.00$ ..... (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 – 2,849,518,500.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 2,849,518,500.00$ ..... (2)
$A_0, A_1, A_2, A_3 >= 0$ .... (3)

EQUITY ASSURANCE: (TABLE 2G)

Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 – 3,366,261,094.00$
Subject to
$S(t)=A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 – 961,788,884.00 >= 2,000,000,000.00$
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 >= 2,961,788,884.00$ ..... (1)
And
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 – 1,442,683,326.00 = 0$
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 = 1,442,683,326.00$ ..... (2)
$A_0, A_1, A_2, A_3 >= 0$ .... (3)

As stated in the earlier section, linear programming can solve the above optimization problems. Although there are different approaches at solving linear programming problems, the simplex tableau will be useful in this case. To use the simplex tableau, the models must be written in standard form, by introducing slack and artificial variables. The optimization problem, in the case of International Energy Insurance (IEI) can therefore be re-written as shown below.

Max $z = 0A_0 + 0.83A_1 + 2.78A_2 + 5.21A_3 + 0X_4 + 0X_5 + 0X_6 + 0X_7 + 0X_8 – MX_9 - MX_{10} - MX_{11} - MX_{12} – MX_{13} – MX_{14} - 3,648,470,000.00$
Subject to,
$A_0 + 0.83A_1 + 0.69A_2 + 0.58A_3 - X_4 + X_9 = 6,042,420,000.00$ ..... (1)
$0A_0 + 0.83A_1 + 1.39A_2 + 1.74A_3 + X_{10} = 1,563,630,000.00$ ..... (2)
$A_0 – X_5 + X_{11} = 0$ ..... (3)
$A_1 – X_6 + X_{12} = 0$ ..... (4)
$A_2 – X_7 + X_{13} = 0$ ..... (5)
$A_3 – X_8 + X_{14} = 0$ ..... (6)

Where z is the objective function of the linear program; A_0, A_1, A_2 and A_3 are the assets of the insurance company at period t = 0, 1, 2, and 3 respectively; X_4, X_5, X_6, X_7 and X_8 are the slack variables; X_9, X_{10}, X_{11}, X_{12}, X_{13} and X_{14} are the artificial variables while M is any large number that must be added to the artificial variables in the objective function.

Applying similar method for the other insurance companies and using the simplex tableau with the aid of Microsoft Excel software package, we have the following optimal asset allocations.

Company	A_1	A_2
IEI	N5,746,604,714.00	N1,124,913,676.00
CRUSADER	N12,042,852,775.00	N2,889,511,197.00
NEM	N8,177,251,476.00	N4,742,038,901.00
NIGER	N14,986,523,601.00	N1,478,803,952.00
GOLDLINK	N7,864,232,870.00	N4,892,048,070.00
UNIC	N8,956,716,823.00	N4,368,492,578.00
EQUITY	N3,809,911,260.00	N1,638,503,303.00

The results above are the values of the assets required by each insurance company at each particular period, to immunize its liabilities for the same period. This means that each asset manager in each of the insurance company must invest the current asset in such a way that the returns from such asset will yield the corresponding value needed to immune the company's liability for each period. For example, an asset manager at IEI, willing to generate assets that would help pay-up the liabilities as shown in the schedule in Table 2A, much invest the company's current asset in way that would yield an asset-returns of N5,746,604,714.00 at the end of period t=1 and N1,124,913,676.00 at the end of period t=2. If this can be achieved by the asset manager, then the company's surplus would be immune against changes in interest rate within that horizon. Similar explanation goes for the asset managers in the other insurance companies.
The Asset Allocations above provides immunization for the surplus of the insurance companies, in case of changes in interest rate. To demonstrate this, we shall assume there is a shift in interest rate from 20% to 22%, 25%, 17% or 15%. This is demonstrated in tables 3 for IEI insurance plc. The various impacts on the surplus of this company further reveals that the Optimal Assets Allocation provided by the solutions to the optimization model, still immunize the surplus of the insurance company. This is applicable to the other six insurance companies.

RECOMMENDATIONS/SUGGESTIONS/CONCLUSIONS

Asset and Liability Management is one of the major task any insurance company in Nigeria must perform in order to enhance performances, especially in the area of prompt payment of genuine claims. Inability by some insurance companies to meet up with obligations as at when due may not be far-fetched from the wrong choice of investment of Assets by Assets Managers. One of such factor responsible for this bane is fluctuation in interest rates. Immunization strategy is one of the tools that can be used to tackle fluctuation in interest rates. This study thus revealed that the classical immunization strategy suggested by Redington can be used to combat interest rate problems as experienced by insurance companies in Nigeria.
Although there has been several developments after Redington's work on immunization strategy, the awareness is still very poor amongst insurance companies in Nigeria, as accounted for by the level of development and awareness in that sector of the country. This study therefore sets the wheel toward an effective development in immunization strategies needed for assets and liabilities management in the insurance sector of the country. This paper has thrown light on the relevance of Redington's Immunization theory to interest rates problems in, especially in the area of Asset and Liability Management in Nigerian Insurance companies and it has further shown that linear programming can implement the insurance company's optimal immunization strategy.
The result from the data analysis has also revealed that Asset Managers in insurance companies can invest their assets in such a way that the surplus of the company is immune whether interest rate rises or falls. Whatever the effect of government policies or other economic factors on the interest rates, the fund's manager can be rest assured that the company will be able to meet up with its obligations, when the models developed in this study are properly used.
Furthermore, with prompt payment of genuine claims by insurers, Nigerians' patronage will increase because of renewed and improved confidence, thereby impacting positively on the growth of the nations' economy. The multiplicity effect of this solution is very large. For instance, with the development of the

insurance sector, more and more insurance companies will spring up, thereby leading to a reduction in unemployment rate in the country. In addition to this, the general standard of living of an average Nigerian will increased, because not only will he be encouraged to insure himself against unexpected risks or hazards but he will as well be willing to insure other properties, with the assurance that the insurance company will come to his aid, if there is any eventuality. With this, one can expect to maintain a standard of living, no matter what happens since the insurance companies would always absorb the risks.

SCOPE FOR FURTHER RESEARCH

Changes in interest rates were assumed to be non-stochastic for the purpose of this study. As a future extension of this study, it is suggested that the stochastic behaviour of interest rates should be observed. In addition, a more general term structure model related to different interest-rate-dependent portfolio situations can be considered. The data analysis only tested the model in a short horizon, because of the non-stochastic nature of interest rate that was used, although the fund manager may notice stochastic nature in a longer horizon. It is therefore suggested that further work shed more light into this.

NOTE

1. Tzeng, Wang and Soo (2000) developed a linear programming model, for immunization strategy against interest rate risk, using Redington's (1959) classical immunization theory.

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APPENDIX

TABLE 1: ASSET AND LIABILITIES OF SEVEN NIGERIAN INSURANCE COMPANIES

S/N	Insurance Company	ASSETS	LIABILITIES	SURPLUS
1	IEI Inusrance plc	12,545,069,000.00	1,041,420,000.00	11,503,649,000.00
2	Crusader Insurance Plc	13,015,675,000.00	4,642,095,000.00	8,373,580,000.00
3	NEM Insurance Plc	5,158,799,000.00	1,207,027,000.00	3,951,772,000.00
4	Niger Insurance Plc	13,641,479,000.00	7,257,913,000.00	6,383,566,000.00
5	Goldlink Insurance Plc	7,605,529,000.00	928,871,000.00	6,676,658,000.00
6	UNIC Insurance Plc	6,025,505,000.00	1,899,679,000.00	4,125,826,000.00
7	Equity Assurance plc	6,218,190,834.00	961,788,884.00	5,256,401,950.00

TABLE 2 (A): LIABILITY PAYMENT SCHEDULE FOR IEI INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	260,605,000.00	1,042,420,000.00
1	781,815,000.00	312,726,000.00	938,178,000.00
2	625,452,000.00	375,271,200.00	750,542,400.00
3	375,271,200.00	450,325,440.00	450,325,440.00

PAYMENT SCHEDULE FOR CRUSADER INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	1,160,523,750.00	4,642,095,000.00
1	3,481,571,250.00	1,392,628,500.00	4,177,885,500.00
2	2,785,257,000.00	1,671,154,200.00	3,342,308,400.00
3	1,671,154,200.00	2,005,385,040.00	2,005,385,040.00

TABLE 2 (C): LIABILITY PAYMENT SCHEDULE FOR NEM INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	301,756,750.00	1,207,027,000.00
1	905,270,250.00	362,108,100.00	1,086,324,300.00
2	724,216,200.00	434,529,720.00	869,059,440.00
3	434,529,720.00	521,435,664.00	521,435,664.00

TABLE 2 (D): LIABILITY PAYMENT SCHEDULE FOR NIGER INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	1,814,478,250.00	7,257,913,000.00
1	5,443,434,750.00	2,177,373,900.00	6,532,121,700.00
2	4,354,747,800.00	2,612,848,680.00	5,225,697,360.00
3	2,612,848,680.00	3,135,418,416.00	3,135,418,416.00

TABLE 2 (E): LIABILITY PAYMENT SCHEDULE FOR GOLDLINK INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	232,217,750.00	928,871,000.00
1	696,653,250.00	278,661,300.00	835,983,900.00
2	557,322,600.00	334,393,560.00	668,787,120.00
3	334,393,560.00	401,272,272.00	401,272,272.00

TABLE 2 (F): LIABILITY PAYMENT SCHEDULE FOR UNIC INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	474,919,750.00	1,899,679,000.00
1	1,424,759,250.00	569,903,700.00	1,709,711,100.00
2	1,139,807,400.00	683,884,440.00	1,367,768,880.00
3	683,884,440.00	820,661,328.00	820,661,328.00

TABLE 2 (G): LIABILITY PAYMENT SCHEDULE FOR EQUITY ASSURANCE PLC

t	Initial Balance	Payment	Accumulated liability
0	-	240,447,221.00	961,788,884.00
1	721,341,663.00	288,536,665.20	865,609,995.60
2	577,073,330.40	346,243,998.24	692,487,996.48
3	346,243,998.24	415,492,797.89	415,492,797.89

TABLE 3 (A): EFFECTS OF INTEREST RATE SHIFT ON THE SURPLUS OF IEI INSURANCE PLC

t	Initial Balance	Payment	Accumulated liability	At	Lt	Surplus
		interest rate = 0.20				
0	-	260,605,000.00	1,042,420,000.00	-	260,605,000.00	11,243,044,000.00
1	781,815,000.00	312,726,000.00	938,178,000.00	5,746,604,714.00	312,726,000.00	16,676,922,714.00
2	625,452,000.00	375,271,200.00	750,542,400.00	1,124,913,676.00	375,271,200.00	17,426,565,190.00
3	375,271,200.00	450,325,440.00	450,325,440.00	-	450,325,440.00	16,976,239,750.00
		interest rate = 0.22				
0	-	260,605,000.00	1,042,420,000.00	-	260,605,000.00	11,243,044,000.00
1	781,815,000.00	317,938,100.00	953,814,300.00	5,746,604,714.00	317,938,100.00	16,671,710,614.00
2	635,876,200.00	387,884,482.00	775,768,964.00	1,124,913,676.00	387,884,482.00	17,408,739,808.00
3	387,884,482.00	473,219,068.04	473,219,068.04	-	473,219,068.04	16,935,520,739.96
		interest rate = 0.25				
0	-	260,605,000.00	1,042,420,000.00	-	260,605,000.00	11,243,044,000.00
1	781,815,000.00	325,756,250.00	977,268,750.00	5,746,604,714.00	325,756,250.00	16,663,892,464.00
2	651,512,500.00	407,195,312.50	814,390,625.00	1,124,913,676.00	407,195,312.50	17,381,610,827.50
3	407,195,312.50	508,994,140.63	508,994,140.63	-	508,994,140.63	16,872,616,686.88
		interest rate = 0.17				
0	-	260,605,000.00	1,042,420,000.00	-	260,605,000.00	11,243,044,000.00
1	781,815,000.00	304,907,850.00	914,723,550.00	5,746,604,714.00	304,907,850.00	16,684,740,864.00
2	609,815,700.00	356,742,184.50	713,484,369.00	1,124,913,676.00	356,742,184.50	17,452,912,355.50
3	356,742,184.50	417,388,355.87	417,388,355.87	-	417,388,355.87	17,035,523,999.64
		interest rate = 0.15				
0	-	260,605,000.00	1,042,420,000.00	-	260,605,000.00	11,243,044,000.00
1	781,815,000.00	299,695,750.00	899,087,250.00	5,746,604,714.00	299,695,750.00	16,689,952,964.00
2	599,391,500.00	344,650,112.50	689,300,225.00	1,124,913,676.00	344,650,112.50	17,470,216,527.50
3	344,650,112.50	396,347,629.38	396,347,629.38	-	396,347,629.38	17,073,868,898.13

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