



Strathmore University

**School of Finance and
Applied Economics**

**STRESS TESTING OF INSURANCE FIRMS IN KENYA
AGAINST INTEREST RATE RISK**

PATEL, SHRUTI DINESH KURJI

Reg No: 078511

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the research proposal contains no material previously published or written by another person except where due reference is made in the research proposal itself.

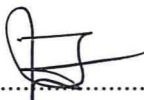
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SIGNATURE..........

DATE.....28/11/2016.....

Shruti D.K. Patel

The research project has been submitted for examination with my approval as the University Supervisor.

SIGNATURE..........

DATE.....28/11/2016.....

Dr. John Olukuru

School of Finance and Applied Economics

ABSTRACT

The study was focused on researching the impact a change in interest rates has on the fixed income portfolio, specifically the government securities. It concentrated on securities with maturities of less than or equal to five years. This was done by applying a model previously built to stress a bank against interest rate risk. The net interest income impact and the repricing impact was calculated to demonstrate the effect and the significance of the change demonstrated by the change in the solvency ratio. A change in interest rates led to an increase in the net interest income but led to a reduction in the value of the bonds. The net effect of the increase in interest rates was that the value of the portfolio reduces. However, the percentage was less than 10% for two of the companies, and therefore, interest rate risk was found to be of less significance to the Kenyan market.

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1. INTRODUCTION

1.1 Background Information

Stress testing was first thought of in the 1990s, when financial systems of many countries were unstable. This was in the form of a response to identify the various vulnerabilities financial systems of various countries faced to changes in the macroeconomic landscape. (Cihak, 2007) Moreover, innovation and diversification in the financial services' industry along with increasing cross-border capital flows has exposed the financial system to an increasing number of risks. Regulators and policy makers, therefore, have to become more innovative in their risk management approaches.

What is stress testing? Stress testing describes a range of techniques to assess the vulnerability of a portfolio to major changes in the macroeconomic environment or to exceptional, but plausible events. (Blaschke, Jones, Majnoni, & Peria, 2001) The events in question should have a low probability of occurring, but should they occur, can lead to quite high losses for the company involved.

There are two approaches to stress testing: sensitivity analysis and scenario analysis. Sensitivity analysis involves changing one risk factor and monitoring its response over the time horizon adopted. Scenario analysis, on the other hand, involves interaction of many changing risk factors. Scenario analysis, therefore, is very complex compared to sensitivity analysis, which is relatively simple to perform. The scenarios in this case differ from routine scenario analysis in that they're very pessimistic in nature. An example of a stress test involving sensitivity analysis could be a parallel shift in the yield curve, while an example of a scenario analysis could be a terrorist attack or a catastrophe such as a hurricane.

Figure 1: Levels of Stress Testing Source: (Bhatia, 2010)

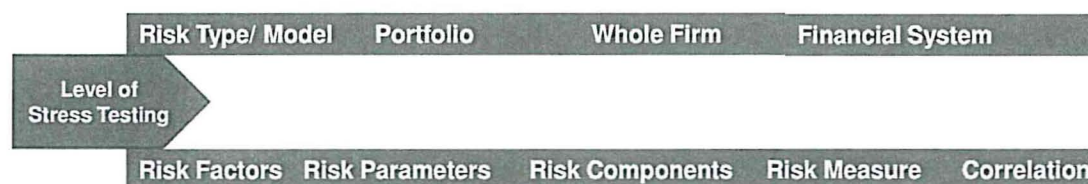


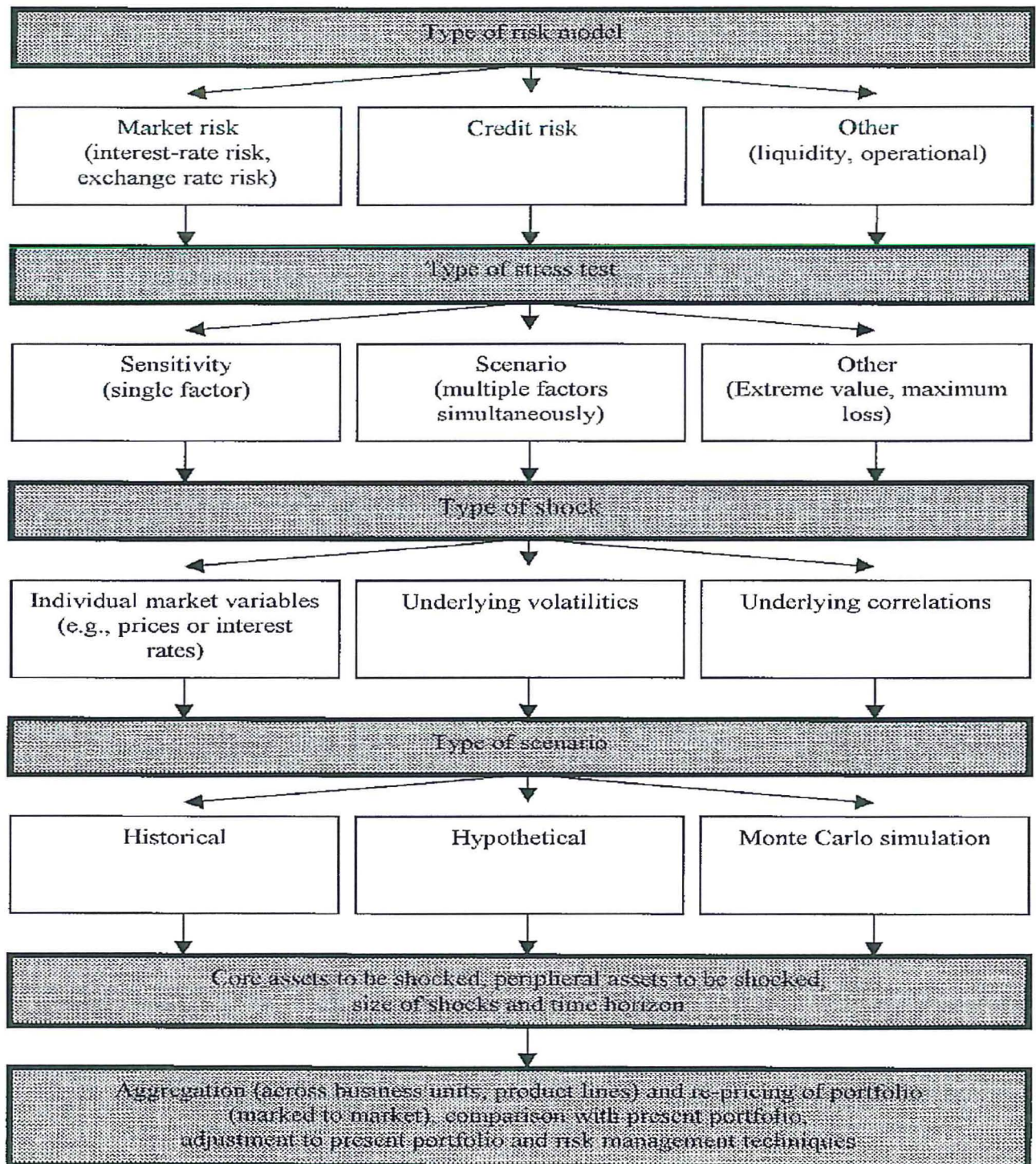
Figure 1 above illustrates the difference in levels of stress testing based on the number of risk factors and its scope. As the level of stress testing increases, the variables stressed increases as well as the scope. When dealing with just a model, it can be enough just to stress the risk factors

affecting it. When it comes to a portfolio, you have to stress its parameters and when dealing with a firm, you stress the risk components. This continues until the whole financial system is tested by stressing correlation and risk measures such as volatility. This is because during period of stress, underlying volatilities and correlations between assets change during periods of stress and therefore, these should be tested as well to predict how they might react while stressed.

Construction of the scenario requires some serious deliberation as to what type of scenario to choose: hypothetical or historical. Hypothetical scenarios have never taken place and are mostly forward looking while historical scenarios are based on past data and are backward looking. They are usually based on a significant market event in the past. (Settlements, 2009) This, however, does not capture new risks which may have come up. Alternatively, one can conduct a reverse stress test. This involves identifying scenarios that result in losses exceeding a given magnitude for a particular portfolio or firm. (Glasserman, Kang, & Kang, 2014)

There are two approaches to conducting the tests, top down and bottom up. The top down approach involves changing of the macroeconomic variables and then monitoring changes in the portfolios, such as a change in the equity market or a change in the exchange rate. The bottom up approach involves identifying vulnerabilities in the portfolio, stressing those vulnerabilities and then noting the performance. This could be the case if a portfolio is invested heavily in certain assets, which means that a change in any variable affecting these assets could significantly affect the portfolio. Below is a diagram which clearly illustrates on how to decide on what type of stress test one wants to carry out.

Figure 2: Decision Sequence for the Conduct of a Stress Test of Individual Portfolios Source: (Blaschke, Jones, Majnoni, & Peria, 2001).



Stress testing has so far been applied in various financial institutions such as banks, insurance companies and also pension plans. The most common risks affecting all financial institutions involve market risk, credit risk, liquidity risk and foreign exchange risk. Others like insurance risk are specific to certain institutions. These are broad categories and each contain their own risk factors.

This paper will stress test the sensitivity of some of Kenya's insurers to a change in the interest rate, under stressed conditions. The test carried out will be hypothetical in nature and will look at the effect of a change in the 91-day T-Bill rate on the value of the fixed income portfolio. The fixed income portfolio was chosen as this is the asset class which most insurance companies prefer to invest in as they have to ensure claims will be paid out as and when they fall due. They, therefore, have to invest in assets with relatively low risk but provide a certain level of return. The fixed income portfolio, which includes government and corporate bonds satisfy this. This paper will concentrate on government securities due to data constraints as data relating to government securities is readily available.

The insurance industry in Kenya is yet underdeveloped and has huge potential for growth. This is shown by the fact that total underwritten premiums form approximately 3% of the Gross Domestic Product of Kenya. This can be attributed to a negative image of the industry which came about when around 5 insurance companies¹ went under in a relatively short time, resulting to policyholders not being compensated for loss. The then active International Policyholders' Compensation Fund had yet to compensate policyholders as at 2012.

1.2 Problem Statement

Ideally, all insurance companies should be able to pay any claims arising from any policy within the specified period. This is done by amongst; others maintaining adequacy of funds, liquidity of assets and ensuring efficient processes within the organization. Therefore, they should invest wisely so as to maintain a considerable fund size which at least helps the company pay claims. This holds true for any financial institution such as banks, pension funds etc.

¹ <http://www.forbes.com/sites/stevedenning/2011/11/22/5086/#4eb0f27d5b56>

However, this may not be the case. A less than favorable state of financial markets may hinder financial institutions from fulfilling their promise to their customers. In the case of an insurance company, it will prevent it from paying claims to their policyholders, and eventually lead to liquidation if sufficient measures are not taken to improve their capital position. Interest rates were one of the stimuli for the global financial crisis² and therefore, interest rates are very key in risk management of a financial institution.

Internal models take into account risk faced by the firm on a day to day basis. However, it's the event which cannot be accounted for by the internal model, probably due to its inability or because it has a low probability of occurrence e.g. a financial crisis which can lead an insurance company to ruin. Therefore, additional non-routine measures such as stress testing the company, and for the case of the regulator, of the whole industry is necessary to identify potential weaknesses and avoid the company from going under.

1.3 Research Objectives

1. To determine how interest rate affects insurance companies.
2. To determine the significance of interest rate risk for insurance companies.

1.4 Research Questions

1. How does interest rate affect insurance companies in Kenya?
2. To what extent does interest rate affect insurance companies?

1.5 Justification

The value of this study is that insurance companies will now be able to determine the importance of managing interest rate risk in their risk management protocols. It is important because it affects the value of interest income received as well as value of benefits paid out in case it is linked to the interest rate. It also affects the value of assets and liabilities and this directly affects solvency, which is a key requirement for insurance companies.

Stress testing has to complement other risk management procedures of the financial institutions involved. It will provide an idea to management of whether the company will be able to stay afloat during adverse times. It will also take into account risk factors which may not be

²<http://www.forbes.com/sites/stevedenning/2011/11/22/5086/#4eb0f27d5b56>

accounted for in their respective internal models. Internal models cannot account for heavy tails in the distribution, which have the potential of driving the company to insolvency in case a certain event occurred which leads to huge losses for the company. This means that management and the Board have to take an active part in this activity as the outcomes of stress tests give valuable information about the financial status of the company.

2 LITERATURE REVIEW

Several papers have been written regarding stress testing, its application to various organizations and the different methodologies employed to put such an exercise in place.

2.1 Introduction

The International Actuarial Association³ described the fundamentals of stress testing. It identified the different types of scenarios as well as the value of the Board's participation and importance of internal models. There are many kinds of scenarios apart from the normal hypothetical, reverse or historical based. For example, some of the scenarios discussed in this paper include single event/ multi-event, company specific scenarios or global scenarios. Company specific scenarios are specific to the risks they're exposed to which the industry as a whole may not necessarily be facing. They're usually tailored to match the risk culture of the firm, e.g. if its market is highly concentrated. Single event scenarios specify a certain plausible event in the future and the firm will check if it will have adequate capital to comprehensively account for all the risk exposures. On the other hand, multi-event scenarios involve a future set of events, which can trigger others. This type of scenario usually spans over a longer period of time such as a few months or a years.

(Hirtle & Lehnert, 2015) talked about the role stress testing plays in risk management of financial institutions and its role in their supervision. It also guided supervisors on how to design stress scenarios for their industry. This includes the scope of the test i.e. system wide or just in the industry and disclosure practices. Some benefits of using stress testing as a supervisory tool include greater market transparency as results will be made public, increases credibility as well as promotes market discipline.

However, there are risks in disclosing results as well as the models. If the models are publicized, all the institutions in that industry might reverse engineer them for their risk management. This can result into all the firms having the same model, thus stifling innovation as well as all of the firms being exposed to the same weaknesses to the model. Should the results be released and a firm which displayed high post-stress capital ratios fail in reality, it can shake confidence of the industry in the supervisory regime as well as question other firms'

³International Actuarial Association. (2013). Stress Testing and Scenario Analysis, (July).

results as well. It also questions competency of the supervisor. Therefore, the supervisor should deliberate very carefully and ensure that everything is in order before deciding to publicize results.

2.2 Historical Stress Tests

This section will discuss previously done stress tests by various supervisory agencies in many countries.

(Misina, Tessier, & Dey, 2006) talked about stress testing the corporate loans portfolio of the Canadian banking sector. They followed a top down approach as the test was carried out on the whole system. They applied a vector-auto regression (VAR) model and were considering credit risk. The model incorporated probability of default, the exposure and the loss amount for each industry the banks loaned out to. They mainly considered the retail industry, construction industry, manufacturing and accommodation and food services. These were the industries which had high bankruptcy rates.

They identified key macroeconomic variables and then proceeded to formulate scenarios which consisted of:

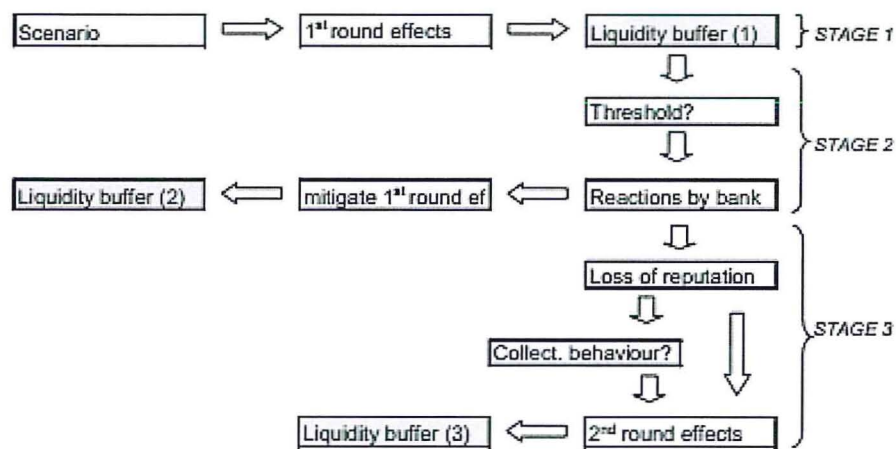
- i. a 20 per cent increase in the commodity price index,
- ii. a 4 per cent decrease in the growth rate of U.S. real GDP,
- iii. a 200 basis points increase in the U.S. real interest rate,
- iv. a combination scenario, which examines the effects of the joint occurrence of the first two scenarios.

The effect of these scenarios on the default rates was then calculated, which led to calculations of the expected loss, the 99% VaR and the 99.9% VaR for each scenario. Scenario 4 was found to be the worst-case scenario and the loss under it even exceeded the sum of scenario 1 and 2. It was also found that decrease in US's GDP was the highest source of risk in terms of losses on the loans portfolio.

(Willem, 2008) built a model and dealt with liquidity risk for banks. Models seem to be the method opted by most researchers, both individuals and organizations while carrying out stress testing. Liquidity risk has been relatively underestimated in its potential to causing distress to

the economy and therefore, not incorporated in many macroeconomic models. The author developed a model called Liquidity Stress-Tester and is as follows:

Figure 3: The Liquidity Stress-Tester Source: Wilhem (2008)



It consisted of three stages where the liquidity buffer is calculated: the initial round of effects, after mitigation of the first effects and lastly after the second round of effects. The scenario impact at the first stage was calculated from simulated weights using Monte Carlo simulations which were then transformed to lognormal distribution. This is because the lognormal distribution captures the non-linear features of extreme liquidity stress events.

The Supervisory Capital Assessment Programme (SCAP) was formed by the United States government during the financial crisis in February 2009, to stress test 19 of the largest US-owned banks, which represented two thirds of the total assets of the banking system. The goal was to ensure the banks would be able to withstand a worse than anticipated macroeconomic environment and still be able to lend. The test involved two hypothetical scenarios. The first reflected consensus expectations about the future macroeconomic environment while the second involved a deeper and longer recession than expected. The test was conducted over a two year forward horizon and would assess the impact on each bank holding company's net income and capital. The final projections of the above were a combination of those made by the individual bank holding company, those produced by the supervisor's models, comparison to historical data and benchmarks and supervisory judgment. Capital ratios were calculated for each bank under each scenario and those who fell short of the target were required to raise the amount of shortfall capital rather than increasing the capital ratio.

19 banks in total had an aggregated shortfall capital of \$185 billion. After assets were sold and capital instruments restructured, the shortfall reduced to \$75 billion. The results were made public along with the methods of deriving them, which was an integral aspect of the SCAP as compared to previous practice. Following this exercise, the move to integrate continuous stress testing into banks was taken after the formation of the Comprehensive Capital Analysis and Review which would analyze banks' internal capital planning processes and positions. This was followed by implementation of the Dodd-Frank Act stress testing (DFAST) provisions in 2013.

DFAST will be based on scenarios generated by the Federal Reserve and which consisted of a baseline scenario, adverse scenario and severely adverse scenario. Development of the scenarios involved projections of many macroeconomic variables such as inflation, GDP, unemployment rates. Capital strength of the participating banks as well as the whole system was to be tested. The results were also to be publicly disclosed. No supervisory actions are attached but it just requires the banks to take into account the results while planning their subsequent capital budgets and risk management processes. (Hirtle & Lehnert, 2015)

Chang & Kim, (2009) reported on how the Korean financial sector was tested. The securities industry, banking and non-life insurance sectors were the ones tested. The scenario they adopted was the 2003 credit card distress. Financial ratios for each firm were then calculated post-scenario. For banks, the ratio employed was the BIS capital ratio and defaulting or distressed companies were those which had a ratio of less than 85%. For the securities industry, a net capital ratio of less than 100% showed signs of distress post scenario. The non-life insurance industry was required to have a solvency ratio of at least 100% post scenario.

Broad risk categories were identified for all four industries with each having their own component variables. The 4 broad categories included capital adequacy, asset quality, liquidity and earnings. The non-life insurance sector replaced asset quality with stability while the securities eliminated it altogether. Principal Component Analysis and regression analysis was carried out and risk indices created. A composite ranking was then calculated. The banking industry was the most affected with a rating of 3.38, followed by the securities industry with 3.13 and non-life insurance industry affected the least with a rating of 3.11.

An industry wide stress test was conducted by the European Insurance and Occupational Pensions Authority in 2014. (EIOPA, 2014) describes the kind of stress testing done, what was stressed and the results. In the scenario analysis, it described a base line scenario then proceeded to describe their Core Module and a Low Yield Module. The Core Module consisted of a series of stresses on asset prices and some insurance specific stresses. It was focused on group results. The Low Yield Module was designed to check the response of individual firms to low interest rates. The results were to be determined by the firms' Solvency Capital Requirement Ratio (SCR).

First, the baseline scenario was defined. In this case, 86% of firms had a SCR of better than 100%. The Core Module consisted of two scenarios. Scenario 1 (CA1) consisted of a shock originating from the EU equity market while CA2 consisted of a shock from the non-financial corporate bond market. Post-stress SCR ratios for CA1 fell to 56% of firms having a ratio of better than 100%. Post scenario SCR ratios for CA2 fell to 73% of firms having a ratio of better than 100%.

The insurance specific stress tests included 4 major scenarios which consisted of 2 non-life provisioning deficiency scenarios, 4 life insurance risk scenarios stressing longevity and mortality, 2 mass lapse events and 7 natural catastrophe (NatCat) scenarios consisting of hurricanes, flooding, airport crash and an earthquake. In this case, what was being measured was the firms' Eligible Own Funds (EOF). On average, none of the scenarios resulted to a decrease of more than 10% in EOF after reinsurance and LAC. LAC refers to the loss absorbing capacity in Technical Provisions and Deferred Taxes.

(Chow, 2015) stress tested firms' balance sheets of various emerging economies, who have increasing levels of debt. The countries focused on include India, Thailand, Malaysia, Mexico, Philippines, Poland, South Africa, Russia, Chile, Hungary, Bulgaria, China, Argentina, Indonesia and Brazil. The corporate sector was focused on. The test was reminiscent of how the situation was during the 2008 financial crisis. The test consisted of:

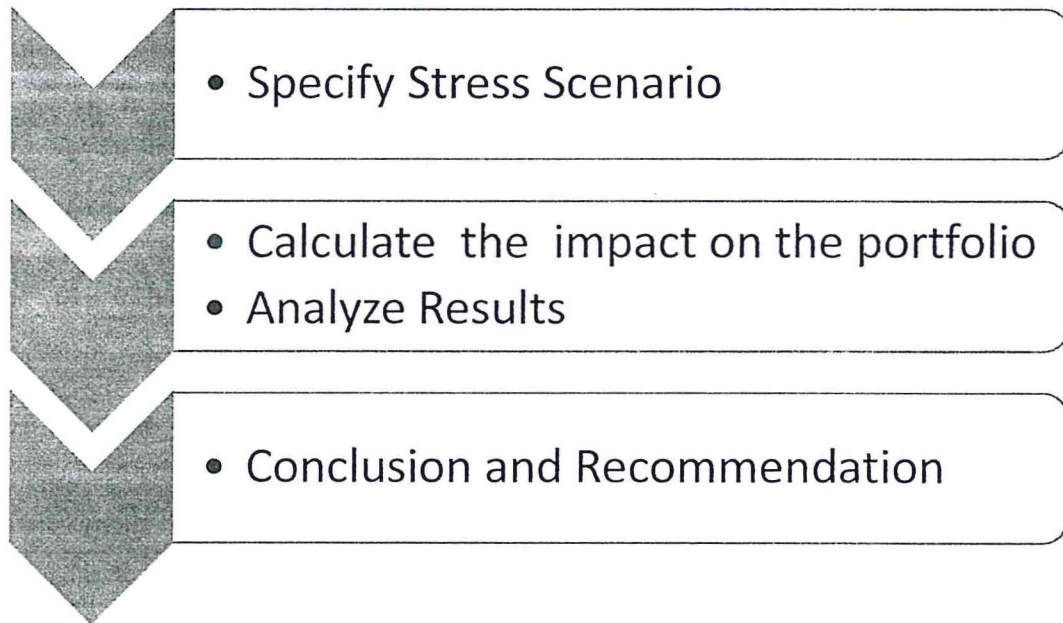
- i. A 30 percent increase in borrowing costs (similar to the average of median changes in corporate borrowing costs across countries during the global financial crisis).
- ii. A 20 percent decline in earnings (similar to the average of median changes in firms' EBIT observed across countries during the global financial crisis).

- iii. A currency depreciation against the U.S. dollar of 30 percent (similar to trends observed in late 1990s).

The results showed that should all of the above scenarios occur simultaneously, the Interest Coverage Ratio (ICR) would weaken, although the median would still remain above 1.5, and which is the minimum allowed. It was also noticed that those whose ICR was affected the most borrowed more in foreign currency with lower natural hedges. A natural hedge is the reduction in risk that can arise from an institution's normal operating procedures.⁴ It was also seen that shocks to earnings, interest rates and exchange rates could affect commodities-related firms and state-owned enterprises. The impact of this on the countries' banks would put pressure on their asset quality through increases in non-performing loans. The ability of banks to withstand them would depend on their buffer levels, which would comprise of Tier 1 capital and loan loss reserves.

⁴<http://www.risk.net/energy-risk/glossary/2040755/natural-hedge>

CONCEPTUALIZED FRAMEWORK



3 METHODOLOGY

3.1 Introduction

This section will look at data collection, sampling technique, the steps to carry out the test and data analysis. The methodology adopted has been based on (Cihak, 2007) and it will be adapted to the Kenyan market.

3.2 Research Design

A model will be used to carry out this stress test interest rate risk for Kenyan insurance companies. This model is based on (Cihak, 2007) which was looking at banks. The model will be applied to an insurance company. The stress test will focus on the fixed income portfolio only, specifically, government securities.

This will represent an economic time where interest rate will be significantly different. A change in interest rate will be assumed. The interest rate adopted will be one which falls within the 1% of the distribution, as a 99% confidence level will be adopted.

3.3 Model Description

This model will adopt the earnings simulation analysis method and the repricing impact will be calculated. These methods have been used because they are relatively easy to implement and yet capture the impact of the stress. The change in interest rate shall be parameterized so as to have different values for various changes in the interest rate.

The change in interest rate will be based on the confidence level adopted. The study shall assume a confidence level of 99%. Rates which fall in the 1% will be the ones used to stress the companies. The distribution assumed will be the lognormal distribution. The change in interest rate will be calculated as the difference between the rate assumed during the test and the latest T-Bill rate. The latest date for purposes of this study was 21 November 2016.

3.3.1 The Model

This section will discuss the various methods implemented by financial institution supervisors in conducting stress testing for their respective industries. The methodologies discussed below will concentrate on the approaches used to stress against interest rate risk as that's the risk this paper is looking at.

(Cihák, 2007) involves conducting stress testing for various risks affecting a fictional country called Bankistan. The economic conditions are specified and it's shown that the economic environment is worsening. The banking sector of Bankistan consists of 3 state-owned banks, 5 domestically owned banks and 4 are foreign owned. This paper stressed credit risk, interest rate risk, exchange rate risk and an interbank stress test. Cihak modelled all these risks and evaluated their impact on key performance ratios for all risks. For the interest rate risk, the impact on interest income was noted across instruments with maturities of less than 12 months. The impact of the stress on the capital adequacy ratio was then assessed by calculating its change post-scenario.

3.3.1.1 Repricing or Maturity Gap Model

(Blaschke, Jones, Majnoni, & Peria, 2001) stated that all financial instruments be sorted into buckets according to maturities before starting. A gap refers to the difference in flow of earnings of asset and liabilities in each bucket. The repricing is based on the difference between the interest earned on assets and that paid out on liabilities. The repricing gap ΔR_i , is used to calculate total change in net interest income in each bucket and ultimately the whole portfolio.

$$\Delta \text{Net interest income}_i = \text{GAP}_i * \Delta R_i$$

$$\Delta \text{Net interest income} = \text{Cumulative GAP} * \Delta R$$

This model provides useful information on the matching of assets and liabilities. However, it assumes that change in interest rates only affect the interest payments and not market value of assets and liabilities. It thus ignores capital gains.

There also exists the maturity gap model, which is based on the weighted average maturity of assets and liabilities.

$$M^A = \sum_{i=1}^N w_i^A M_i^A \quad M^L = \sum_{i=1}^N w_i^L M_i^L, \quad (2)$$

where M^A = weighted average maturity of assets
 M^L = weighted average maturity of liabilities
 M_i^A = maturity of asset with a maturity given by i
 M_i^L = maturity of liability with a maturity given by i
 w_i^A = weight of asset i in portfolio, measured by proportion of total market value
 w_i^L = weight of liability i in portfolio, measured by proportion of total market value

$$\text{GAP}^{\text{Maturity}} = M^A - M^L$$

If $M^A > M^L$, the firm will face a larger fall in its value of assets than liabilities, thus reducing its net worth.

3.3.1.2 Economic value of equity

This method estimates the change in the value of a bank's economic capital caused by a change in the interest rates. This model involves projecting the value of economic capital for a base scenario and then comparing it with that of a stress scenario. It captures all anticipated cash flows and is generally more effective in capturing embedded options.

3.3.1.3 The Duration Model

The duration model involves getting the duration gap. Duration refers to the interest elasticity of the price of the asset to changes in its yield. Portfolio managers can use the duration gap to immunize the portfolio against small changes in interest rate.

$$GAP^{Duration} = D^A - D^L$$

There are three types of duration: Macaulay duration, modified and effective duration. Out of these three, effective duration is the best. Effective duration estimates price sensitivity more accurately than modified duration for instruments with embedded options and is calculated using valuation models that contain option pricing components. After the value of the financial instrument is estimated, an interest rate change is assumed and the new value estimated. The percentage change between the current and forecasted values represents the instrument's effective duration. (Limits & Monitoring, n.d.)

One of the weaknesses of this model is that it assumes a flat yield curve. This is because it assumes a single discount rate throughout. Another weakness is that it only takes into account small changes in the discount rate. Stress tests typically consist of large changes in interest rate, making this model inaccurate. One can use convexity to show more accurately the sensitivity of the price to its yield. Convexity shows how duration responds to changes in interest rate yields.

3.3.1.4 Value at Risk (VaR)

Value-at-Risk (VaR) gives the worst expected loss at a given confidence level with a 95% or a 99% probability. (Snopek, 2013) The assumptions underlying VaR include data following a normal distribution and the focus on standardized returns rather than the actual returns. There are three methods for VaR computation. These include Variance-Covariance method, historical simulation and Monte-Carlo simulation.

3.3.1.5 Earnings Simulation Analysis

Earnings simulation models estimate the effect of interest rate changes for a range of different scenarios and exposures on an institution's net interest income, net income and capital. This method is effective for a time horizon of two years, as this captures important strategies and tactics, which may be hidden if considered for a shorter period of time. Management should be encouraged to measure earnings at risk for each one-year period over their simulation horizon to better understand how risks evolve over time.

Institutions can run dynamic or static simulations. Static simulations assume constant balance sheet values with zero growth and is based on current exposures. Dynamic simulations, on the other hand, allows for asset growth, changes in business lines, new business or change in management and customer behavior. (Limits & Monitoring, n.d.)

Due to the above, this model will look at the net income impact and the repricing impact.

The interest rate during the stressed conditions shall be calculated based on historical data for at least 5 years.

The impact on the net interest income shall be calculated first using the formula below:

$$\Delta \text{ Net interest income} = \Delta \text{ interest rate} * \text{the value of instrument}/100$$

The Capital after shock will then be calculated using

$$\text{Capital After shock} = \Delta \text{ Net interest income} + \text{Regulatory Capital}$$

When looking at the bonds, the repricing impact shall be considered and it will be calculated as follows:

$$\text{Repricing impact} = \text{Value of bond} * \text{duration} * \Delta \text{ interest rate}/100$$

The Capital after shock after this will sum the capital after shock for the interest income and the change in value of the bond portfolio.

The Solvency ratio will be calculated for both cases and then percentage change in the solvency ratio calculated. Solvency ratio is the size of its capital relative to all risks it has taken. The solvency ratio is a measure of the risk an insurer faces of claims that it cannot absorb.

$$\text{Solvency ratio} = \frac{\text{Net Written Premiums}}{\text{Capital} + \text{Surplus}} \quad (\text{International Risk Management Institute, n.d.})$$

Overall change in Solvency ratio = Change in solvency ratio of net interest income impact + change in solvency ratio of repricing impact

3.4 Population/ Sample

The population will involve all insurance companies in Kenya. However, due to time constraints, we shall concentrate on only 3 major firms. 'Major' here would be defined as those with the highest market share. Therefore, this is judgmental sampling as some subjects are 'fit' to be in the sample while others are not. This is advantageous because the sample is representative of your desired population.

3.5 Data

The data collected will involve financial statements of major insurance companies in Kenya, mostly balance sheets. The financial statements will be downloaded from their respective websites. This will be for the year ended 2015. Data regarding investments in government securities will be calculated, those with maturities of less than or equal to 5 years to be exact.

Historical data of interest rates will also be collected. The time frame adopted shall be 5 years. The figures shall be downloaded from the Central Bank of Kenya website. The interest rate used is the T-Bill rate, which is likened to the risk free rate.

Due to unavailability of actual data regarding the portfolios of the companies chosen, it will be assumed that the companies invest primarily in two types of bonds, a 2 year and a 5 year bond. Data regarding these two bonds will be obtained from the Nairobi Stock Exchange's website i.e. coupon rate, yield and maturity dates.

3.6 Conclusion

In conclusion, the earnings simulation analysis and the repricing impact methods will be used to measure the impact of changes in interest rates during stressed conditions. The ratio used to analyze the performance of the companies is the solvency ratio.

4 DATA AND ANALYSIS

4.1 Results

The countries chosen based on market share were Jubilee Insurance (11.39%), UAP Insurance (8.34%) and APA Insurance (7.96%).

At first, the proportion of investments in government securities was calculated for each of these companies as well as of the industry as a whole over the last 5 years (2011 – 2016).

The summary of the results are as follows:

Table 1: Proportions of Investments in Government Securities

Year	Industry	Jubilee	UAP	APA
2011	26%	27%	49%	26%
2012	28%	28%	40%	29%
2013	29%	31%	57%	26%
2014	26%	29%	53%	22%
2015	31%	36%	55%	32%
Average	28%	30%	51%	27%

We can get to know a lot about the investment strategy of these companies based on this. For example, UAP Insurance is on average risk averse and prefers to invest over 50% of its assets in government securities. This could be so as to guarantee claim payments as and when they fall due. Jubilee Insurance and APA Insurance have similar proportions to that of the industry, which ranges on average from 26-30%, with 2015 being the year where the proportions exceeded 30%.

The proportion of government securities with a term to maturity within 5 years was then calculated. The proportions were as follows:

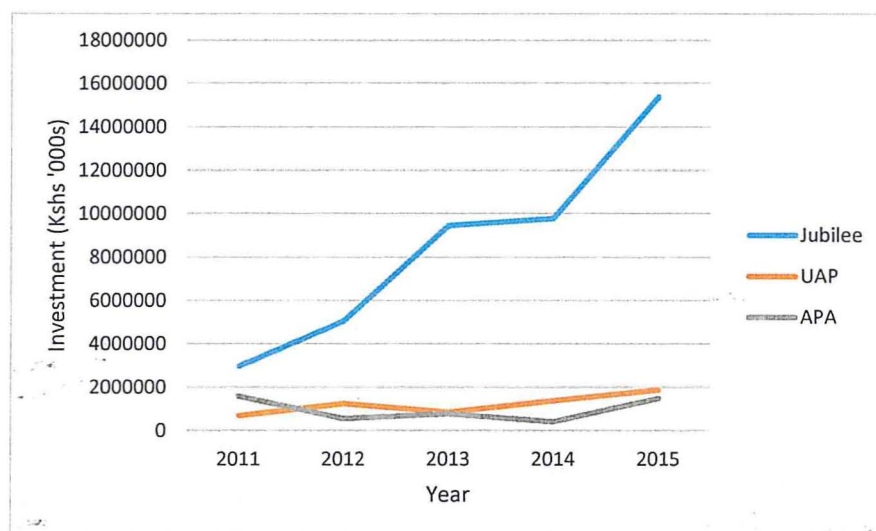
Table 2: Proportions of government securities with less than or equal to 5 years to maturity

Year	Jubilee	UAP	APA
2011	28.9%	40.28%	78.02%
2012	38.53%	38.97%	20.63%
2013	49.61%	18.86%	22.41%
2014	44.66%	23.46%	13.20%
2015	51.99%	24.95%	29.69%
Average	43%	29%	33%

The interest rate assumed was the 91-day T-Bill rate. It was fitted to a lognormal distribution and the parameters obtained. This was due to the fact that lognormal this was used because it assumes a higher volatility at higher interest rates and gives non-negative interest rates. The parameters obtained were $\mu = 2.2683$ and $\sigma = 0.26647$.

The confidence interval assumed in the stress test was 99% and hence, the rate which fell within this boundary was found. The stress test was conducted to find out how the income stream and the value of the instruments would change. The confidence interval obtained was (0, 17.96099%). This was calculated by assuming a 50bp increase beyond the upper bound. The change was calculated by getting the difference between this rate and the latest rate as at 21st November 2016, which was 8.331%. This led to a change in interest rate of 10.13%. The stress test was conducted based on the investments in 2015. This is because an average cannot be assumed as the amounts increase over the years. This is shown in the graph below.

Figure 4: Investments with maturities of less than or equal to 5 years



The net interest income impact was found to be Kshs. 1,559,105,600 for Jubilee Insurance, Kshs. 190,624,340 for UAP and Kshs. 151,659,554.3 for APA. This was added to the profits of the companies and the income after shock calculated.

Table 3: Change in Solvency Ratio of the net interest income impact

	Jubilee	UAP	APA
Solvency Ratio after shock	1.612009	1.7733238	1.485541855
Percentage Change in Solvency Ratio	11.78	1.47	2.13

The repricing impact was then calculated. This was done by multiplying the value of the government securities by the duration and the change in the T-Bill rate. The duration was calculated using the duration formula in Excel. The 2 year bond was found to have a duration of 1.820654 and the 5 year bond was 3.90501. The proportions of investments held in each bond was simulated and then an average calculated. This led to a final average duration of 2.992062 for Jubilee, 2.987893 for UAP and 3.242184 for APA.

The repricing impact due to the change in interest rate led to a change in the value of the bond portfolio of Kshs. 4,664,940,200 for Jubilee, Kshs. 569,565,130 for UAP and Kshs. 491,708,247.3 for APA.

Table 4: Change in Solvency Ratio of the repricing impact

	Jubilee	UAP	APA
Solvency Ratio after shock	0.956292	1.6230318	1.32
Percentage Change in Solvency Ratio	-33.69	-7.13	-9.15

The overall change in solvency ratio due to the stress test was therefore the sum of the change in solvency ratio of the Net Interest Income Impact and that in the Repricing Impact. The overall change in solvency ratio was therefore, -21.92%% for Jubilee, --5.66%% UAP and -7.01% for APA.

Table 5: Overall Change in Solvency Ratio

	Jubilee	UAP	APA
Overall Percentage Change in Solvency Ratio	-21.92	-5.66	-7.01

4.2 Discussions

The change in the solvency ratio due to a change in net income is 11.78% for Jubilee, 1.47% for UAP and 2.13% for APA. This means that the net interest income earned increased by that percentage. Therefore, the change in income is relatively negligible, except for Jubilee, which incorporates changes in the whole group. The portfolio value therefore increases by a relatively small percentage due to a change in interest rates. The change in solvency due to an increase in interest rates for the repricing impact was -33.69% for Jubilee, -7.13% for UAP and -9.15% for APA. The bond value reduced by those percentages for each company.

The reduction in the value of the portfolio is greater than the increase in interest income. Therefore, increase in interest rates will lead to an overall negative impact on the value of the portfolio. This therefore, answers the first research question, i.e. an increase in interest rates leads to the portfolio value reducing. The second question is also answered as the overall reduction in portfolio is small (less than 10% for UAP and APA). Therefore, we can conclude that interest rate is a factor which doesn't influence the portfolio value by a large percentage.

The findings support the theory of the inverse relationship of interest rates and the bond value. This is also in line with the findings presented by Martin Cihak in 2007. This is because in his study, all banks had an overall change in their Capital Adequacy Ratios (CAR) by -0.8%. This supports the overall negative change result as well as the significance. This is because even in that study, the change was almost negligible after a change in interest rates of 1.5%.

However, these changes are only due to the fixed income portfolio. It should be noted that interest rates do not affect fixed income securities in isolation. It also affects equities and property markets and the changes to the whole portfolio could be quite different as property and equities form a relatively substantial proportion in the whole portfolio. In addition, their sensitivities to interest rates could be different as well.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

In conclusion, a change in interest rates affects the portfolio value negatively. However, the portfolio is not particularly sensitive to changes in interest rates in Kenya. This can be due to the fact that the T-Bill rates are relatively stable. These rates are changed weekly but the difference in subsequent rates is relatively small. This is shown by the fact that it was 8.331% on 21 November 2016 and 7.96% on 14 November, a change of 0.371%.

The risk departments of these companies should therefore look at other factors affecting the portfolio values in their stress testing and risk management process. Alternatively, they could consider scenario analysis so they can examine the effect of interest rates on the whole portfolio rather than just on the fixed income segment.

5.2 Limitations of the study

This study looked into the impact of a change in interest rates on the fixed income portfolio, specifically ones with a maturity of less than or equal to 5 years. The following represents some of the limitations faced during this project:

1. Actual data regarding the portfolio was unavailable and therefore, some assumptions and simulations had to be made.
2. Extraction of data from financial statements, especially where the company operates in many segments in many countries, e.g. Jubilee.
3. Adapting the bank-related model to an insurance company.

5.3 Recommendations

The following represents a list of the recommendations one can use to improve on the accuracy of the results and can be used for further research on this topic:

1. One can use actual data in using this model, which is also more recent.
2. One can also use a more sophisticated model.
3. One can employ scenario analysis instead of sensitivity analysis to bring out the real picture in terms of the portfolio value.

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