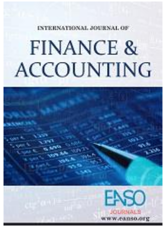

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Original Article

Pension Fund's Risk Management Investment Portfolio in Tanzania

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ABSTRACT

The study intends to assess the risk exposure of assets from the pension funds investment portfolio and suggest possible solutions of mitigating the risk of severe loss that is likely to occur over a given period of time. The study engaged secondary data of annual return series from five individual assets which are Government Securities (GSs), Fixed Deposits (FDs), Corporate Bonds (CBs), Equities and Real Estates (REs) with the total number of 18 observations. In order to achieve the objectives of the study, the author applied the Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH) model and Cornish-Fisher expansion model for data analysis to calculate Value at Risk (VaR) for individual assets in Pension Funds investment portfolio from the financial year 1998/1999 to 2016/2017. The results from both techniques employed indicated that, Corporate Bonds (CBs) has the highest Value at Risk (VaR) followed by, Fixed Deposits (FDs), Equity, Real Estates and Government Securities (GSs). There were some renovations in the social security industry in Tanzania as among the approaches to combat risk that avails with minimal effects in the operationalization of Pension Funds, therefore the findings of the study are relevant to help pension funds in Tanzania to mitigate the risk of strict loss that is likely to occur in their investment portfolio due to market fluctuations over a given period of time.

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INTRODUCTION

The study intends to assess the risk exposure of assets from the pension funds investment portfolio and suggest possible solutions of extenuating the risk of severe loss that is likely to occur over a given period of time. The study engaged secondary data of annual return series from five individual assets which are Government Securities (GSs), Fixed Deposits (FDs), Corporate Bonds (CBs), Equities and Real Estates (REs) with the total number of 18 observations.

Background Information

Before independence of Tanganyika, there were no pension benefits offered. However, there were legal requirements related to pension industry which include Master and Native Ordinance Cap 78 as amended by Cap 371 (Pension Ordinance), Provident Fund (Government Employees) Ordinance Cap 51, Provident Fund (Local Authorities) Ordinance Cap 53, and Workmen's Compensation Ordinance Cap 262 (Isaka, 2016).

After independence several activities related to pension industry in Tanzania were evolved including; enactment of the Severance Allowance Act No. 57 of 1962, amendment of the National Provident Fund Act No. 36 of 1964 amended by Act. No. 2 of 1975 which was later revoked and replaced by the National Social Security Fund Act No. 28 of 1997, enactment of the Parastatal Pensions Act No. 14 of 1978, enactment of the Public Service Retirement Benefits Act of 1999, and enactment of the National Health Insurance Fund Act No. 8 of 1999 (Isaka, 2016).

In 1997 National Provident Fund (NPF) transformed to National Social Security Fund and started to provide pensions. In 1999 there were conversion of part of civil service non-contributory to contributory Public Service Pensions Fund and the establishment of National Health Insurance Fund (NHIF). Also, there were an establishment of Community Health Insurance Fund (CHF) in 2001. In 2003 the National Social Security Policy was adopted and in 2006 there were a translation of Local Authority Pension Fund (LAPF) to become a pension fund. In 2008 the Social Security Regulatory Authority (SSRA) was established followed by amendments of laws and conversion of Government Employees Pension Fund (GEPF) to become a pension fund in 2012. In 2013 and in 2014 there were implementation of guidelines issued by SSRA and the Pension Benefits Harmonization Rules were issued respectively. Inline to that, in 2015 the Actuarial Valuation on Tanzania Pension Schemes were conducted for the first time and Reforms Options were also conducted (Isaka, 2016).

The Public Service Social Security Act, 2018 was signed into law in April, 2018 and subsequently joins all pension funds into two major entities which are the Public Service Social Security Fund (PSSSF) to wrap the public sector and the National Social Security Fund (NSSF) to encircle the private sector (URT, 2017). According to this law, PSSSF Act repeals the Public Service Pension Fund (PSPF) Retirement Benefit Act, the Local Authority Pension Fund (LAPF) Act, the Government Employees Pension Fund (GEPF) Retirement Benefit Act and the Parastatal Pension Fund (PPF) Pensions Fund Act.

During the 1990s Worldwide the strong stock markets had been supportive of the development of funded pensions, and the allocations to equities have been increased by pension funds in many countries (Inderst, 2009, p. 3). However, the study also indicated that, the burst out of the Technology-

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Media-Telecoms (TMT) bubbled in the early 2000s and the successive downturn has led to substantial funding and solvency problems for pension funds. In addition, both sides of the balance sheet have been affected whereby asset prices fall and pension liabilities rising at the same time due to lower interest rates (Inderst, 2009, p. 3)

As stated by Franzen (2010), the 2000-2003 crises have shifted concentration to pension funds' risk management in which the unexpected turn particularly of Anglo-American pension funds from surplus to deficit served as the catalyst for calls for "better risk management" of pension funds. The study state that, in 2004 the International Monetary Fund (IMF) stipulated that the policymakers should encourage better risk management practices and reduce the risk of another cycle of over and underfunding. "After several golden decades of equity investments delivering adequate returns, the topic of risk management has returned to the fore front of the pension industry given the now challenging funding and investment environment" (Stewart, 2005, p. 31).

Franzen (2010) claims that, Pension funds are inevitably active risk takers. The two most important risk categories affecting pension funds are investment and longevity risk. In defined contribution (DC), pension funds risks are redistributed to their registered members, while in defined benefit (DB) pension funds provides safe pension benefits by assuming and retaining the risks. Additionally, DB pension funds can become complex risk sharing institutions, as they may subsequently redistribute risk between the different groups of stakeholders. In recent years according to (Simons K, 2000), risk management has been of mounting interest to institutional investors, as well as to the asset management firms that manage funds on their behalf.

Traditionally, institutional investors, and particularly pension funds, emphasized measuring and rewarding investment performance by their portfolio managers. One approach to management risk was known as value at risk, has gained increasing acceptance in the last five years (Simons K, 2000), "VaR is a measure of risk based on a probability of loss and a specific time horizon in which this loss can be expected to occur. VaR estimate and forecasts the maximum portfolio loss that could occur over a given holding period with a specified confidence level" (Lopez, 1998, p. 119). However, poor VaR estimation may not reflect the actual market risk existing in the operating environment. The survey conducted in April, 2009 by the UK Financial Services Authority stated that, "a stunningly large number of companies not only experienced a sharp increase in the level of VaR, but also in the number of losses exceeding VaR" (Andersen & Frederiksen, 2010, pp. 3-4). A large number of companies experienced poor VaR estimation for the reason that there were number of violations which were not in line with the confidence level used in estimating VaR and they concluded that the most important thing to note is Risk Management units within the financial institutions are required to model the actual risk of their respective companies.

LITERATURE REVIEW

Definition of Important Variables of the Study

Portfolio Returns

Portfolio returns is well defined as the weighted average returns of its component assets, whereas asset is a resource with economic value that an individual, corporation, or country owns or controls with the expectation that it will provide future benefit. Assets are defined as resources with probable future benefits (Palepu et al. (2013).

Fixed Deposits

This[1] refers to a sum of money which is invested at the bank, financial institution, or company with the aim of receiving specified interest income within the specified time period and the principal amount at the maturity date**.**

Corporate Bonds

This refers to the debt instruments created by companies for the purpose of raising capital. According to (Mishkin, 2004) Corporate Bonds are

[1] https://www.idfcfirstbank.com/finfirst-blogs/finance (as retrieved on June, 2022)

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long-term bonds issued by corporations with very strong credit ratings where by the holder receives an interest payment twice a year and pays off the face value when the bond matures. Some corporate bonds, called convertible bonds, have the additional feature of allowing the holder to convert them into a specified number of shares of stock at any time up to the maturity date.

Government Securities

Government Securities refers to a bond or other type of debt obligation that is issued by the government with a promise of repayment upon the security's maturity date. Government Securities are usually considered low risk investments because they are backed by the taxing power of a government, argument by (Grimsley, 2003)

Equities

This refers to the amount of capital contributed by the owners or the difference between a company's total assets and its total liabilities. Equities are also known as stocks whereby the most common types of equities include common stocks and preferred stocks. According to (Graham, 2009) the stockholder bears the major risks and shares in the profits of ownership.

Value at Risk

This is the particular amount of money that is likely to be lost due to market fluctuations over a period of time and for a given probability (Gabrielsen, et al., 2012). Simons K (2000) argues that VaR is a measure of risk based on a probability of loss and a specific time horizon in which this loss can be expected to occur.

Real Estates

This[2] refers to the property comprised of land and the buildings on it, as well as the natural resources of the land. Real estate can be grouped into three main categories residential, and industrial.

Theoretical Linkage Pension Funds and Risk Management

Modern Portfolio Theory (MPT)

The Modern Portfolio Theory (MPT) refers to an investment theory that allows investors to pull together an asset portfolio that maximizes expected return for a given level of risk. The theory assumes that investors are risk-averse; for a given level of expected return, investors will always prefer the less risky portfolio. This theory implies that the return of a portfolio is a random variable and therefore it has an expected value and a variance which indicates the risk of a portfolio. However, the Value at Risk was applied to define the risk of portfolios. VaR is also commonly used by institutions for self-regulation in the manner of Benchmark Measure as a means to provide a companywide yardstick to evaluate risks across different markets. Potential Loss measures a means to give a broad idea of the worst loss an institution can incur and Equity Capitals a means to set a capital cushion for the institution. Modern Portfolio Theory models the return of an asset as a random variable and a portfolio as a weighted combination of these assets (Kaura, 2005, p. 2).

Empirical Linkage Pension Funds and Risk Management

Culp et al. (1998) argue that, to arrive at a Value at Risk measure for a given portfolio, a manager must generate a probability distribution of possible returns or changes in the value of that portfolio over a specific time horizon. The study added that the probability distribution of possible portfolio returns or future values is regarded as the VaR distribution. Again, according to (Jorion 2002) the Value at Risk provides a summary statistic of the order of magnitude of potential losses due to market risk. The study also argues that, VaR is the maximum loss over a target scope such that there is low pre-specified probability that the actual loss will be larger. Jorion (2003) claims that, in order to measure VaR, there is a need to define two quantitative parameters namely the confidence level and the horizon. The bigger the confidence level the lower the VaR. Moreover, varying the confidence level

[2] https://www.investopedia.com/terms/r/realestate.asp

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provides useful information about the return distribution and potential extreme losses. The longer the horizon the greater the VaR measure. However, the prevailing of this assumption depends on two factors, the behaviour of the risk factors, and the portfolio positions.

Furthermore, (Corkalo, 2011) claims that, there is no specific time horizon or holding period to estimate the Value at Risk. According to (Orlando & Abbott, 1998), the appropriate way of addressing Value at Risk number to the top Management is that, there is 99% chance that the organizational portfolio will lose not more than a certain amount in the next 365 days. Likewise, in this study the applicable confidence level for Value at Risk calculations was 99% with the respective holding period of 1 year.

Whilst elaborating the importance of Social Security worldwide, (Ansah, 2016) tried to show how risk management in financial sector being measured by VaR particularly in pension funds is vital. They showed how the Value at Risk was estimated through the use of Generalized Auto-Regressive Conditional Heteroskedasticity model to predict the fund level of the Social Security and National Insurance Trust (SSNIT) pension fund in Ghana. The study provides that, even though the new regulatory requirement in Ghana affected the fund level of SSNIT, the fund was managed to increase its investment income and sustainability through the VaR estimation which indicated good performance of the SSNIT. However, the study recommended that SSNIT should seek and engage in much more beneficial investment opportunities like loaning services and real estate for more sustainability.

Pedrazaet al. (2017) argues that, despite generally positive findings linking pension system development and economic growth, there have also been plenty of disappointments. In too many countries, pension fund investments remain highly concentrated in bank deposits and traditional government bonds, contributing little long-term funding for development as well as delivering disappointing investment returns and therefore pensions.

In the study conducted by (Veldhuijzen, 2014) Monte Carlo Simulations approach was applied to identify the optimal investment strategy in a Dutch pension fund. The identification of the optimal investment strategy was through the formulation, analysis, and comparison of three different investment strategies. The study concluded that, portfolio insurance investment strategies add value to a Dutch pension fund.

According to (Kusiluka and Kongela, 2020), pension funds invest heavily in fixed income securities. More recently, pension funds have also been increasing their exposure to nonconventional asset classes including real estate. Over the last two decades, pension funds in Tanzania have increased their real estate allocations to more than 18%, which is relatively higher compared to the international practice.

In the study conducted by (Franzen, 2010) Pension funds are faced with the second financial crises within less than ten years. The 2007/2008 financial crisis seems to have repeated and amplified the shock waves that the previous crisis between 2000 and 2003 sent to pension funds throughout the world. Defined Benefit pension funds, which had mostly successfully restored their funding levels after the "perfect pension storm" with simultaneously falling equity and rising bond prices, have plunged again into huge funding deficits. Risk management has stayed at the above cited forefront of the pension industry. The perfect pension storm set the stage for the risk management revolution to reach the doorsteps of pension funds. Modern risk management tools comparable to those which are used in other sectors of the financial industry such as securities firms and banks are increasingly applied by pension funds (Franzen, 2010). Recently, pension funds in many jurisdictions calculate Value at Risk, apply risk budgeting concepts, and analyse fat tails

According to (Tonks, 2005), the return earned by assets in the pension fund depends upon the investment strategy and asset allocation decisions of the pension fund. These investment decisions can be made by individual pension contributors, or delegated to professional fund managers.

Therefore, the focal point of this research study is to bridge the gap in managing the risks of the investment portfolio returns of pension funds particularly NSSF, in order to mitigate the potential loss that may occur over a given holding period.

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METHODOLOGY

In order to achieve this end, the author used secondary data which were collected from National Social Security Fund audited books from 1998/1999 to 2016/2017. However, this study employed the Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH) model and Cornish-Fisher model as analysis tools to estimate risks.

Auto-Regressive Conditional Heteroskedastic (ARCH) Effect Test

Distributions of realized returns on most assets like stocks, bonds, and real estate tend to differ from the classical normality assumption which finally affects the investors' perceptions of risk exposure. In this regard, the study will establish that, pension funds should apply risk management models like Value at Risk for modelling and forecasting volatilities and correlations of asset returns.

The time variation involves the volatility of asset returns which is usually referred to as the presence of Conditional Heteroskedasticity (Guidolin, 2013). According to Guidolin, the concept of Conditional Heteroskedasticity extends in general to all patterns of time-variation in conditional second moments, that is, not only to conditional variances but also to conditional covariances and hence correlations.

According to this study, instead of considering this key risk indicator as a problem to be corrected, Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models treat Heteroskedasticity as a variance to be modelled in order to correct the deficiencies of least squares and to compute a prediction for the variance of each error term but warnings about Heteroskedasticity have usually been applied only to cross sectional models, not to time series models because it is reasonable to assume that the variance of the error terms does not change much over time for time series unlike for cross sectional.

In this study, the ARCH effect test for return series of NSSF individual assets will be conducted by observing their respective reported p-values in order to reject or not reject their corresponding null hypothesis.

Generalized Auto-Regressive Conditional Heteroscedasticity (GARCH) Model

The GARCH model originated from a stationary non-linear model for a return series known as Auto-Regressive Conditional Heteroskedastic (ARCH) model.

The study by (Bollerslev, T, 1986) concluded by proposing that GARCH model with the aim of making ARCH model to be more realistic. Similarly, according to the study by (Aydın and Korkmaz, 2002), the GARCH model is given by the formula: -

$$R_t = \beta X_t + e_t \tag{1}$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \, e_{t-1}{}^2 + \sum_{j=p+1}^{q} \alpha_j \, h_{t-j} \tag{2}$$

However, (Aydın and Korkmaz, 2002) suggested that in order for the GARCH model to be applicable the parameters, must be α_0, α_i, $\alpha_j \geq 0$ and for the purpose of volatility process, the above equation must satisfy the condition, $\alpha_i + \alpha_j < 1$

Sjo (2011) claims that, the most typical model in empirical work of volatility forecasting is the GARCH (1). According to (Hu, 2017) the performance of Lagrange Multiplier (LM) test on the residuals of the model GARCH stipulates that, when the coefficient of asset return series is greater than zero it indicates that external shocks will make worse volatility in the respective asset returns, when it is more than 0 less than 1, it indicates that the fluctuations of an asset returns have a certain memory.

When the sum of the coefficients of the underlying asset return series ARCH and GARCH is less than 1, it indicates that the impact of the conditional Heteroskedasticity is persistent, that is, the impact plays an important role in all future predictions. Furthermore, (Aydın and Korkmaz, 2002) argues that, volatility forecasting is an important task for most of the investors, however, calculating volatility number is not sufficient for asset portfolios to control risk but it is useful in the calculations of value at risk.

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The equation for the basic GARCH model is given by the following

$$б = \sqrt{\omega + \beta б_{t-1}{}^{2} + \alpha \mathcal{X}_{t-1}{}^{2}} \quad (4)$$

Where; б = asset's volatility, ω = constant term, β = coefficient of asset return series (ARCH term), α = coefficient of asset return series (GARCH term), $б_{t-1}{}^{2}$ = news about asset's volatility from previous period, $\mathcal{X}_{t-1}{}^{2}$ = last period forecast variance

There are four different methods include Akaike Information Criterion (AIC), Shwarz Information Criterion (SIC), Hannan-Quinn Information Criterion (HQ), and Akaike's Information Corrected Criterion (AICc) commonly used for choosing the most adequate GARCH model which is the essence of data analysis in order to achieve good forecasting results.

These GARCH models include Normal Error Distribution, Student's t-Error Distribution and Generalized Error Distribution (GED). Javed & Mantalos (2010) argue that, Akaike's (1973) information criterion is the most popular since it has commonly been used and significantly known method in the model selection for decades in a wide variety of fields for analysing actual data.

Akaike's (1973) information criterion is the method which evaluates model in terms of Kullback–Leibler information based on the concept of closeness between generic distribution defined by the model and the true distribution, besides the more commonly used method of simply minimizing the prediction error. According to Javed, Kullback-Leibler information refers to the information lost when the model with generic distribution is used to approximate true distribution, therefore, the best model is the one which loses least information among others in the set.

In this study the Akaike Information Criterion was applied to measure the volatility of returns of individual asset in NSSF investment portfolio from the financial year 1998/1999 to 2016/2017. Therefore, the GARCH model equation was estimated through the use of E-Views 8 Statistical Package by selecting the model with the least Akaike Information Criterion.

Cornish-Fisher Model (Value at Risk)

The Cornish Fisher helps to consider moments of order higher than two and therefore to consider non-normality of distributions. Cornish Fisher Expansion Model has been developed by Cornish and Fisher in the year 1937, as a formula to approximate fractile of a random variable based only its first few moments (Olivier, et al., 2012).

As claimed by (Gabrielsen et al, 2012) that, Value at Risk is the particular amount of money that is likely to be lost due to market fluctuations over a period of time and for a given probability, therefore its estimation should be more accurate to be useful for an investor. In that line therefore, the more accurate Value at Risk measurements for an asset can be quickly given by the Cornish-Fisher approximation than traditional methodologies since it takes into account skewness and kurtosis (Olivier et al, 2012).

Jensen & Pedersen (2013) argue that, there is considerable evidence which shows that investor preferences go beyond mean and variance to higher moments such as skewness and kurtosis as they enable the investor to quantify more correctly the downside risk exposure, hence the relevant considerations in asset allocations.

According to Aktas & Sjostrand (2011) the risk for investment portfolio in financial institutions is measured by using Value-at-Risk with confidence level of 95% or 99% as per the regulation stipulated by Basel II. In this regard, the researcher decided to employ the Cornish Fisher Expansion Model in order to compute the Value at Risk.

RESULTS AND DISCUSSION

GARCH Model Equation Estimation

The GARCH model equation estimation conducted to determine the appropriateness in the calculation of Value at Risk (VaR). The equations were estimated by considering the model with the least Akaike Information Criterion and the coefficients of the equations were assessed if they are successfully satisfied the constraint of GARCH parameters. The aim is to assess the risk exposure of assets from the pension fund investment portfolio and suggest ways to lessen the risk of severe loss that is likely to occur

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in pension funds investment portfolio due to market fluctuations over a given holding period and for a given probability.

Table 1: The model equation for estimating Government Securities (GSs)

Conditional Error Distribution				
Information Criterion		Normal	Stud. T	GED
Akaike		-0.5224	-0.4026	-0.5634
Shwarz		-0.3246	-0.1553	-0.3160
Mean Equation (GED)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.0681	0.0352	1.9331	0.0532
Variance Equation (GED)				
Variable			Coefficient	Prob.
C			0.0122	0.0011
RESID(-1)^2			-0.3590	0.0027
GARCH(-1)			0.9331	0.0000

From *Table 1* it was observed that the Generalized Error Distribution (GED) model has the least Akaike Information Criterion-0.5634 with the coefficients of -0.3590 and 0.9331 estimated from the variance equation. These coefficients have successfully satisfied the constraint of GARCH parameters with the summation of 0.5741. This implies that it is suitable in the calculation of value at risk (VaR) for Government Securities (GSs).

Table 2: The estimation of annual return series of Fixed Deposits (FDs)

Conditional Error Distribution				
Information Criterion		Normal	Stud. T	GED
Akaike		1.6608	1.7508	1.5758
Shwarz		1.8587	1.9981	1.8231
Mean Equation (GED)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.0468	0.1127	0.4157	0.6777
Variance Equation (GED)				
Variable			Coefficient	Prob.
C			-0.0201	0.5068
RESID(-1)^2			0.0948	0.8660
GARCH(-1)			1.2219	0.0569

Table 2 indicate as follow she model with the least Akaike Information Criterion is Generalized Error Distribution (GED) is 1.5758 and its coefficients of 0.0948 and 1.2219 estimated by the variance equation. These coefficients have not satisfied the constraint of GARCH parameters with the summation of 1.3167. However, the volatility shocks are persistent which is useful in the calculation of value at risk (VaR) for Fixed Deposits (FDs) since the summation of the coefficients is very close to one.

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Table 3: The estimation of annual return of Corporate Bonds (CBs).

Conditional Error Distribution				
Information Criterion		Normal	Stud. T	GED
Akaike		3.1016	3.0940	2.5787
Shwarz		3.2995	3.3414	2.8260
Mean Equation (GED)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.2130	0.0273	-7.8146	0.0000
Variance Equation (GED)				
Variable			Coefficient	Prob.
C			0.1108	0.7637
RESID(-1)^2			-0.2619	0.0565
GARCH(-1)			1.1017	0.0082

Table 3 shows that, Least Akaike Information Criterion is 2.5787 presented by Generalized Error Distribution (GED) model having the Coefficients of -0.2619 and 1.1017 from the variance equation. These coefficients have successfully satisfied the constraint of GARCH parameters with the summation of 0.8398. This implies that volatility shocks are quite persistent which is suitable in the calculation of value at risk (VaR) for Corporate Bonds (CBs).

Table 4: estimation of annual return series of Equity

Conditional Error Distribution				
Information Criterion		Normal	Stud. T	GED
Akaike		1.4070	1.5444	1.3907
Shwarz		1.6049	1.7918	1.6381
Mean Equation (GED)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.2900	0.0944	3.0705	0.0021
Variance Equation (GED)				
Variable			Coefficient	Prob.
C			0.1137	0.5345
RESID(-1)^2			-0.4055	0.5444
GARCH(-1)			0.8114	0.1001

Table 4 indicates as follows that Least Akaike Information Criterion is 1.3907 presented by Generalized Error Distribution (GED) model.

Variance equation estimated by the GED model presents the coefficients of -0.4055 and 0.8114 which have successfully satisfied the constraint of GARCH parameters with the summation of 0.4059. This implies that there is significant volatility forecasted by GARCH model which is useful in the calculation of value at risk (VaR) for EQUITY.

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Table 5: Estimation of annual return series of Real Estates (REs).

Conditional Error Distribution				
Information Criterion		Normal	Stud. T	GED
Akaike		-0.3188	-0.0273	-0.0239
Shwarz		-0.1209	0.2200	0.2234
Mean Equation (Normal)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.1482	0.0581	2.5513	0.0107
Variance Equation (Normal)				
Variable			Coefficient	Prob.
C			0.0008	0.9505
RESID(-1)^2			-0.4688	0.4317
GARCH(-1)			1.4284	0.0315

Table 5 indicates the Least Akaike is -0.3188 presented by Normal Error Distribution model. Variance equation estimated by the Normal Error Distribution model presents the coefficients of -0.4688 and 1.4284 which have successfully satisfied the constraint of GARCH parameters with the summation of 0.9596.

This implies that there is significant volatility forecasted by GARCH model which is appropriate in the calculation of value at risk (VaR) for Real Estates (REs).

GARCH Variance and GARCH Volatility Series

This part describes how the conditional variance series can be useful to determine the conditional volatility series modelled as functions of past values of other random variables. The results from the E-views provide the conditional variance series can be generated through the option of "Make GARCH Variance Series". The conditional variance series can be useful by taking its respective square root to create the conditional volatility series. In this study, the conditional variances series were used to generate the conditional volatility series for individual assets in the NSSF investment portfolio from the financial year 1998/1999 to 2016/2017.

Table 6: Conditional variance series for individual assets in the NSSF investment portfolio.

Conditional Variance Series					
Financial Year	GSs	FDs	CBs	EQUITY	REs
1998/1999					
1999/2000	0.0221	0.0802	3.1417	0.2051	0.0203
2000/2001	0.0318	0.0795	0.7409	0.2123	0.0263
2001/2002	0.0352	0.0770	0.9242	0.1619	0.0373
2002/2003	0.0414	0.0858	0.6649	0.1428	0.0504
2003/2004	0.0358	0.0904	0.8434	0.1594	0.0291
2004/2005	0.0456	0.1031	0.9609	0.1916	0.0423
2005/2006	0.0546	0.1157	1.0433	0.0107	0.0456
2006/2007	0.0359	0.1522	1.2587	0.1146	0.0618
2007/2008	0.0008	0.1668	1.4974	0.1847	0.0866
2008/2009	0.0125	0.2186	1.7600	0.0342	0.0583
2009/2010	0.0198	0.2945	2.0482	0.1143	0.0820
2010/2011	0.0280	0.3426	2.3673	0.1911	0.1089
2011/2012	0.0032	0.4009	1.8039	0.2568	0.1535
2012/2013	0.0130	0.4724	0.2045	0.3183	0.0106
2013/2014	0.0236	0.5579	0.3228	0.3420	0.0158
2014/2015	0.0331	0.8149	0.4359	0.2987	0.0092
2015/2016	0.0217	0.9789	0.0069	0.2469	0.0122
2016/2017	0.0144	1.2414	0.1182	0.2721	0.0162

Note: GSs = Government securities, FDs = Fixed Deposits; CBs = Corporate Bonds; Res = Real Estates

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Table 6 shows the conditional variance series for annual return series such that Government Securities (GSs) has the smallest value of 0.0008 in the year 2007/2008 and the largest value of 0.0546 in the year 2005/2006, Fixed Deposits (FDs)has the smallest value of 0.0770 in the year 2001/2002 and the largest value of 1.2414 in the year 2016/2017, Corporate Bonds (CBs)has the smallest value of 0.0069 in the year 2015/2016 and the largest value of 3.1417 in the year 1999/2000, Equity has the smallest value of 0.0107 in the year 2005/2006 and the largest value of 0.3420 in the year 2013/2014 and Real Estates (REs)has the smallest value of 0.0092 in the year 2014/2015 and the largest value of 0.1535 in the year 2011/2012.

These values of conditional variance series were useful in the determination of the conditional volatility series modelled as functions of past values of another random variable shown in *Table 7*.

Table 7: Conditional volatility series for individual assets in the NSSF investment portfolio.

Conditional Volatility Series					
Financial Year	GSs	FDs	CBs	EQUITY	REs
1998/1999					
1999/2000	0.1487	0.2832	1.7725	0.4529	0.1423
2000/2001	0.1784	0.2820	0.8608	0.4607	0.1622
2001/2002	0.1876	0.2775	0.9614	0.4024	0.1931
2002/2003	0.2036	0.2930	0.8154	0.3779	0.2244
2003/2004	0.1893	0.3006	0.9183	0.3992	0.1706
2004/2005	0.2135	0.3212	0.9803	0.4378	0.2057
2005/2006	0.2336	0.3402	1.0214	0.1036	0.2137
2006/2007	0.1894	0.3901	1.1219	0.3385	0.2485
2007/2008	0.0288	0.4085	1.2237	0.4298	0.2943
2008/2009	0.1117	0.4675	1.3266	0.1850	0.2415
2009/2010	0.1407	0.5427	1.4311	0.3381	0.2864
2010/2011	0.1672	0.5853	1.5386	0.4372	0.3301
2011/2012	0.0564	0.6331	1.3431	0.5068	0.3918
2012/2013	0.1139	0.6873	0.4522	0.5642	0.1029
2013/2014	0.1537	0.7469	0.5682	0.5848	0.1256
2014/2015	0.1820	0.9027	0.6603	0.5465	0.0959
2015/2016	0.1472	0.9894	0.0832	0.4969	0.1104
2016/2017	0.1201	1.1142	0.3439	0.5217	0.1273

Note: GSs = Government securities, FDs = Fixed Deposits; CBs = Corporate Bonds; Res = Real Estates

Similar observation were noticed in *Table 7* which shows that conditional volatility series for annual return series of Government Securities (GSs)has the smallest value of 0.0288 in the year 2007/2008 and the largest value of 2.336 in the year 2005/2006. Fixed Deposits (FDs) has the smallest value of 0.2775 in the year 2001/2002 and the largest value of 1.1142 in the year 2016/2017. Corporate Bonds (CBs) has the smallest value of 0.0832 in the year 2015/2016 and the largest value of 1.7725 in the year 1999/2000, Equity has the smallest value of 0.1036 in the year 2005/2006 and the largest value of 0.5848 in the year 2013/2014 and Real Estates (REs) has the smallest value of 0.0956 in the year 2014/2015 and the largest value of 0.3918 in the year 2011/2012.

Estimation of Value at Risk (VaR) Interval and Back Testing

The Value at Risk (VaR) interval was estimated from annual return series of individual assets in the NSSF investment portfolio from the audited financial books from 1998/1999 to 2016/2017. The aim of estimating Value at Risk (VaR) interval was to calculate the risk of loss exceeding the upper boundary of the VaR interval i.e., to identify the exception as shown from *Table 8* to *Table 12* and from *Figure 1* to *Figure 5*.

However, the return series were further back tested to show their respective severity of risk of loss exceeding the upper boundary of the VaR interval as described in *Table 8*. Note that, the confidence level, of the back test was assumed as 90%, however it does not relate to the confidence level used in the

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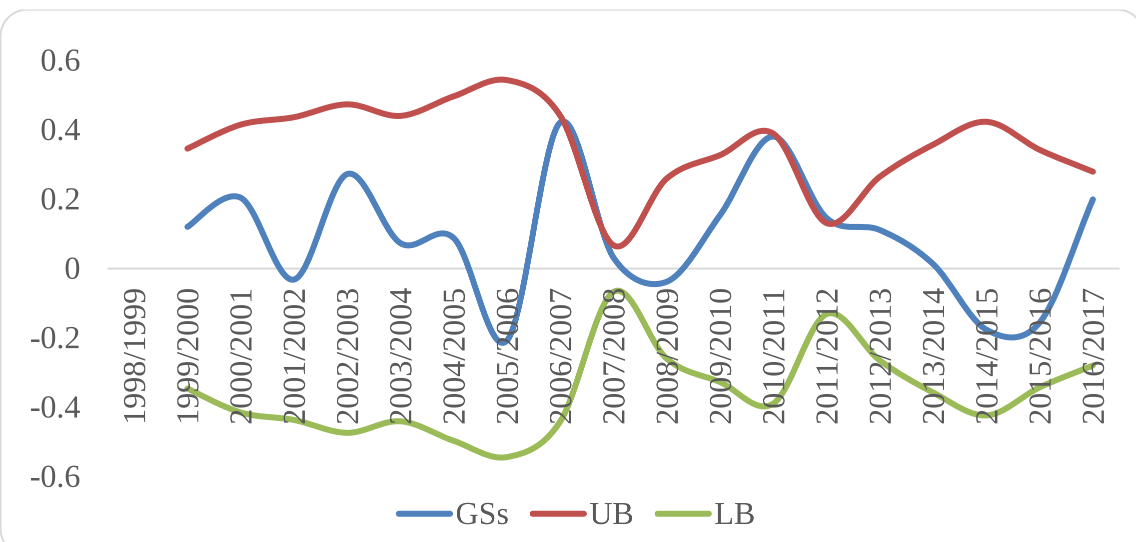
actual Value at Risk (VaR) calculations, which was 99%.

Table 8: The Value at Risk (VaR) Interval for Government Securities (GSs)

Financial Year	GSs	UB	LB	Exceptions
1998/1999				
1999/2000	0.1204	0.3459	-0.3459	0
2000/2001	0.2043	0.4150	-0.4150	0
2001/2002	-0.0317	0.4365	-0.4365	0
2002/2003	0.2726	0.4736	-0.4736	0
2003/2004	0.0733	0.4403	-0.4403	0
2004/2005	0.0879	0.4968	-0.4968	0
2005/2006	-0.2074	0.5435	-0.5435	0
2006/2007	0.4214	0.4406	-0.4406	0
2007/2008	0.0316	0.0671	-0.0671	0
2008/2009	-0.0379	0.2598	-0.2598	0
2009/2010	0.1542	0.3272	-0.3272	0
2010/2011	0.3807	0.3891	-0.3891	0
2011/2012	0.1458	0.1312	-0.1312	1
2012/2013	0.1112	0.2649	-0.2649	0
2013/2014	0.0130	0.3574	-0.3574	0
2014/2015	-0.1761	0.4233	-0.4233	0
2015/2016	-0.1557	0.3425	-0.3425	0
2016/2017	0.1995	0.2794	-0.2794	0

Note: GSs = Government securities, UB = Upper Boundary, LB = Lower Boundary

Figure 1: The graphical presentation of the Value at Risk (VaR) Interval for Government Securities (GSs)



From both *Table 8* and *Figure 1* suggest an overestimation of VaR of Government Securities as they are very close to the upper boundary.

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Table 9: The Value at Risk (VaR) Interval for Fixed Deposits (FDs)

Financial Year	FDs	UB	LB	Exceptions
1998/1999				
1999/2000	-0.0849	0.6588	-0.6588	0
2000/2001	0.0335	0.6560	-0.6560	0
2001/2002	0.4004	0.6456	-0.6456	0
2002/2003	-0.1967	0.6815	-0.6815	0
2003/2004	0.4153	0.6993	-0.6993	0
2004/2005	-0.2752	0.7471	-0.7471	0
2005/2006	0.6177	0.7914	-0.7914	0
2006/2007	-0.0575	0.9075	-0.9075	0
2007/2008	0.6531	0.9502	-0.9502	0
2008/2009	0.7549	1.0876	-1.0876	0
2009/2010	0.2195	1.2625	-1.2625	0
2010/2011	-0.1125	1.3616	-1.3616	0
2011/2012	0.2171	1.4729	-1.4729	0
2012/2013	0.1352	1.5990	-1.5990	0
2013/2014	-1.2245	1.7376	-1.7376	0
2014/2015	-0.1381	2.1000	-2.1000	0
2015/2016	-0.7837	2.3016	-2.3016	0
2016/2017	1.7698	2.5920	-2.5920	0

Note: FDs = Fixed Deposits; UB = Upper Boundary, LB = Lower Boundary

Figure 2: The graphical presentation of the Value at Risk (VaR) Interval for Fixed Deposits (FDs)

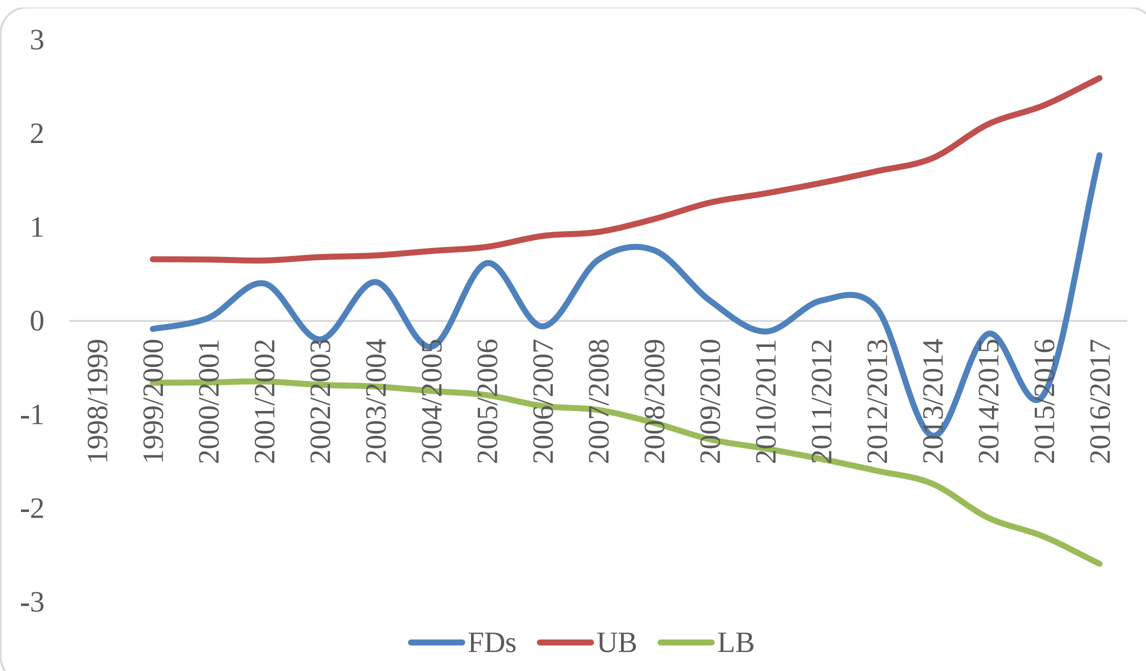

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Table 10: The Value at Risk (VaR) Interval for Corporate Bonds (CBs)

Financial Year	CBS	UB	LB	Exceptions
1998/1999				
1999/2000	3.0748	4.1234	-4.1234	0
2000/2001	-0.3190	2.0025	-2.0025	0
2001/2002	1.1183	2.2365	-2.2365	0
2002/2003	-0.2160	1.8969	-1.8969	0
2003/2004	0.3363	2.1364	-2.1364	0
2004/2005	0.4813	2.2805	-2.2805	0
2005/2006	-0.1363	2.3762	-2.3762	0
2006/2007	-0.1840	2.6100	-2.6100	0
2007/2008	-0.1660	2.8467	-2.8467	0
2008/2009	-0.2938	3.0862	-3.0862	0
2009/2010	-0.2271	3.3293	-3.3293	0
2010/2011	-2.0823	3.5793	-3.5793	0
2011/2012	2.4759	3.1245	-3.1245	0
2012/2013	0.0123	1.0520	-1.0520	0
2013/2014	0.1287	1.3218	-1.3218	0
2014/2015	-1.7065	1.5360	-1.5360	0
2015/2016	-0.1832	0.1936	-0.1936	0
2016/2017	-0.2695	0.7999	-0.7999	0

Note: CBs = Corporate Bonds; UB = Upper Boundary, LB = Lower Boundary

Figure 3: The graphical presentation of the Value at Risk (VaR) Interval for Corporate bonds (CBs)

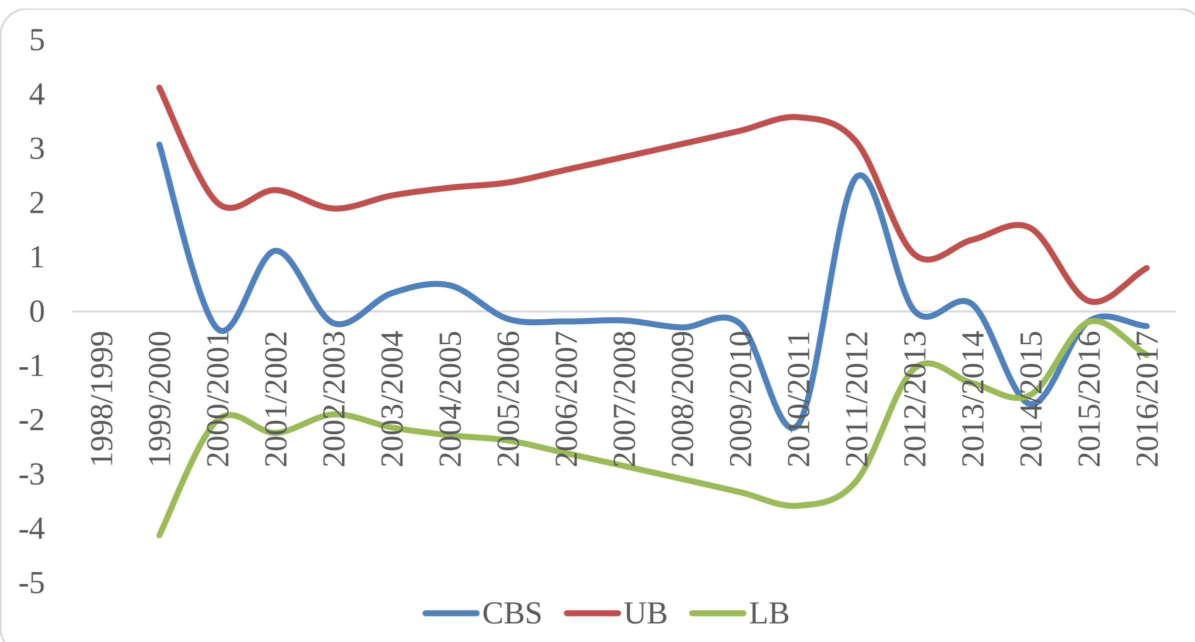

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Table 11: The Value at Risk (VaR) Interval for EQUITY

Financial Year	EQUITY	UB	LB	Exceptions
1998/1999				
1999/2000	-0.1191	0.4772	-0.4772	0
2000/2001	0.8430	0.4938	-0.4938	1
2001/2002	0.7921	0.3767	-0.3767	1
2002/2003	0.7061	0.3323	-0.3323	1
2003/2004	-0.0659	0.3707	-0.3707	0
2004/2005	1.0884	0.4458	-0.4458	1
2005/2006	0.1510	0.0249	-0.0249	1
2006/2007	0.0576	0.2665	-0.2665	0
2007/2008	-0.4621	0.4298	-0.4298	0
2008/2009	0.0313	0.0796	-0.0796	0
2009/2010	0.0956	0.2660	-0.2660	0
2010/2011	0.1182	0.4447	-0.4447	0
2011/2012	0.3863	0.5975	-0.5975	0
2012/2013	0.5619	0.7405	-0.7405	0
2013/2014	0.7676	0.7956	-0.7956	0
2014/2015	-0.2288	0.6949	-0.6949	0
2015/2016	-0.0316	0.5745	-0.5745	0
2016/2017	0.0113	0.6331	-0.6331	0

Note: UB = Upper Boundary, LB = Lower Boundary

Figure 4: The graphical presentation of the Value at Risk (VaR) Interval for Equity

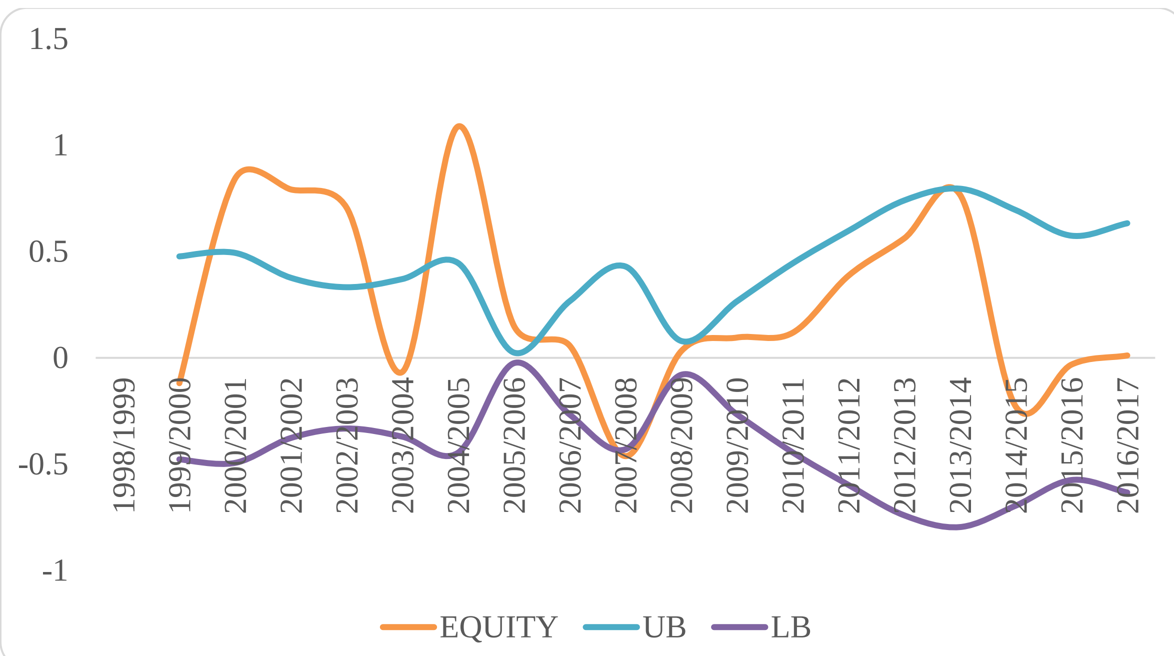

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Table 12: The Value at Risk (VaR) Interval for Real Estates (REs)

Financial Year	RES	UB	LB	Exceptions
1998/1999				
1999/2000	0.2336	0.3311	-0.3311	0
2000/2001	0.1971	0.3774	-0.3774	0
2001/2002	0.2367	0.4491	-0.4491	0
2002/2003	-0.1568	0.5221	-0.5221	0
2003/2004	0.1364	0.3970	-0.3970	0
2004/2005	0.3307	0.4786	-0.4786	0
2005/2006	0.2434	0.4970	-0.4970	0
2006/2007	0.0770	0.5781	-0.5781	0
2007/2008	0.5242	0.6848	-0.6848	0
2008/2009	0.0821	0.5617	-0.5617	0
2009/2010	0.0094	0.6663	-0.6663	0
2010/2011	0.2271	0.7678	-0.7678	0
2011/2012	0.8166	0.9114	-0.9114	0
2012/2013	0.1654	0.2394	-0.2394	0
2013/2014	-0.0255	0.2923	-0.2923	0
2014/2015	0.2093	0.2231	-0.2231	0
2015/2016	0.0828	0.2568	-0.2568	0
2016/2017	-0.0396	0.2962	-0.2962	0

Note: Res = Real Estates; UB = Upper Boundary, LB = Lower Boundary

Figure 5: The graphical presentation of the Value at Risk (VaR) Interval for Real Estates (REs)

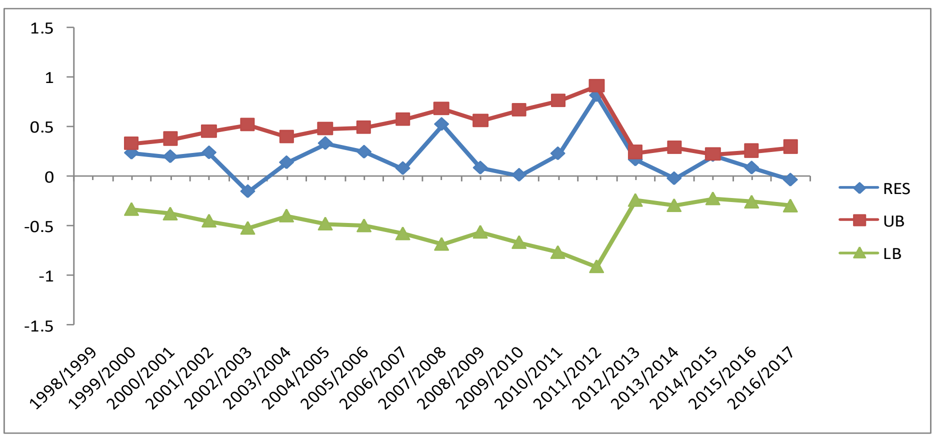

Table 13: Summary of the back testing results for the annual return series

Asset	x	T	x/T	$f(x) = \binom{T}{x} p^x (1-p)^{T-x}$
GSs	1	18	0.0556	0.0167
FDs	0	18	0.0000	0.1501
CBs	0	18	0.0000	0.1501
EQUITY	5	18	0.2778	0.0000
REs	0	18	0.0000	0.1501

Note: GSs = Government Securities, FDs = Fixed Deposits, CBs = Corporate Bonds and REs = Real Estates.

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The summary of back testing results in *Table 13* indicates potential problems that originate from severe underestimation and overestimation of risks for individual assets in the NSSF investment portfolio. Underestimation of risk is revealed from Fixed Deposits (FDs), Corporate Bonds (CBs) and Real Estates (REs) since their respective number of exceptions given by the binomial probability distribution is less than the rate of exception suggested by the confidence level.

This argument of risk underestimation for Fixed Deposits (FDs), Corporate Bonds (CBs) and Real Estates (REs) was supported by *Table 9*, *Table 10*, and *Table 12*, as well as the graphical presentations, in *Figure 2*, *Figure 3* and *Figure 5* respectively.

Overestimation of risk is observed from Government Securities (GSs) and Equity as their respective number of exceptions given by the binomial probability distribution is greater than the rate of exception suggested by the confidence level. Also, the statement of risk overestimation for Government Securities (GSs), and Equity is supported by is irregular for the exact number of exceptions suggested by the confidence *Table 8*, *Table 11* along with the graphical presentations, *Figure 1*, and *Figure 4* respectively. Therefore, the most important aspect is to check if there is a reasonable number of exceptions and whether the model is rejected or not rejected.

The Value at Risk (VaR): GARCH model and Cornish-Fisher Model

The computation of VaR based on GARCH model is given by the equation;

$$VaR_{GARCH} = W * \delta * U_\alpha * \sqrt{t/T} \quad (5)$$

Where; W = initial investment value, δ = standard deviation of the return series, U_α = critical value associated to the α% quantile of the distribution, t = specified holding period, T = total number of observations

The computation of VaR based on Cornish-Fisher model is given by the equation;

$$VaR_{CF} = W * \delta * ZCF_\alpha * \sqrt{t/T}$$

Where; ZCF_α is the Cornish-Fisher approximation of the α% quantile of the distribution Hurlimann (2014) has put forward the Cornish-fisher expansion as follows: -

$$ZCF_\alpha = U_\alpha + \frac{1}{6}*(U_\alpha{}^2-1)*Skew + \frac{1}{24}*(U_\alpha{}^3-3U_\alpha)*Kurt - \frac{1}{36}*(2U_\alpha{}^3-5U_\alpha)*Skew^2$$

Whereby; $U_{99\%}$= 2.3263

This study has involved the computation of the Value at Risk (VaR) based on the scenario of investing Tshs. 500 b in each asset in the NSSF investment portfolio based on both the GARCH model and the Cornish-Fisher model with the confidence level 99% and the holding period of 1 year. The available data involved annual return series of individual assets in the NSSF investment portfolio from the financial year 1998/1999 to 2016/2017.

Table 14: Summary of the Value at Risk (VaR) computation for GARCH and Cornish-Fisher models with the confidence level 99% and the holding period of 1 year

	GSS	FDS	CBS	EQUITY	RES
Std. Dev.	0.1752	0.6381	1.2061	0.4327	0.2202
Skewness	0.0778	0.3617	0.8302	0.3757	1.2612
Kurtosis	2.4921	4.3714	4.2533	2.0549	5.0731
$ZCF_{99\%}$	2.9638	3.5649	3.6716	3.0298	3.8410
VaR_{GARCH}(Tshs. Billion)	48.0255	174.9512	330.6513	118.6204	60.3571
VAR_{CF}(Tshs. Billion)	61.1863	268.0991	521.8719	154.4921	99.6561

Note: GSs = Government Securities, FDs = Fixed Deposits, CBs = Corporate Bonds and RE Real Estates.

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Table 14 highlights that all individual assets in the NSSF investment portfolio seem to have significant amounts of Value at Risk (VaR) as indicated by both GARCH and Cornish Fisher expansion models.

The descriptive statistics presented in *Table 14* indicated that, the average values were computed to produce the lowest amount of error from the return series values of individual assets in the NSSF investment portfolio; meanwhile the standard deviation values were computed to measure the volatility of individual assets in the NSSF investment portfolio against their respective average return. The standard deviation values indicated that, the Corporate Bonds (CBs) is the most volatile asset in the NSSF investment portfolio followed by Fixed Deposits (FDs), Equity, Real Estates and Government Securities (GSs).

The values of skewness for individual assets in the NSSF investment portfolio were computed to measure the shape of their respective return series distribution meanwhile the values of kurtosis were calculated to explain how the variance of individual assets in the NSSF portfolio are affected by the extreme deviation from the respective average return values. The kurtosis values indicated that Real Estate is an individual asset whose variance is highly affected by the extreme deviation from the respective average return values followed by Fixed Deposits (FDs), Corporate Bonds (CBs), Government Securities (GSs) and Equity.

The Value at Risk figures were computed with the assumptions that investment was made by investing Tshs. 500 billion in each asset in the NSSF investment portfolio with the confidence level 99% and the holding period of 1 year. The computation of Value at Risk for employed approaches, GARCH model and Cornish Fisher expansion indicated similar results. Both approaches have shown that, Corporate Bonds (CBs) has the highest Value at Risk (VaR) followed by Fixed Deposits (FDs), Equity, Real Estates and Government Securities (GSs) respectively.

However, the extent of VaR presented by GARCH model was different compared to those indicated by Cornish Fisher expansion. For instance, the VaR figure for Corporate Bonds (CBs) was Tshs. 330.65 billion indicated by GARCH model less than that presented by Cornish Fisher which was Tshs. 521.87 billion. Also, the VaR figures indicated by GARCH model for the remaining assets Fixed Deposits (FDs), Equity, Real Estates (REs) and Government Securities (GSs) were Tshs. 174.95 billion, Tshs. 118.62 billion, Tshs. 60.36 billion and Tshs. 48.03 billion respectively. Meanwhile, the VaR figures for Fixed Deposits (FDs), Equity, Real Estates (REs) and Government Securities (GSs) computed by Cornish Fisher were Tshs. 268.10 billion, Tshs. 154.49 billion, Tshs. 99.66 billion and Tshs. 61.19 billion respectively.

CONCLUSION AND IMPLICATIONS

Conclusively it was also observed that the Corporate Bonds (CBs) is the riskier asset in the NSSF investment portfolio followed by Fixed Deposits (FDs), Equity, Real Estates and Government Securities (GSs the computation results of Value at Risk (VaR) based on the GARCH model imply that, with the assumptions of investing Tshs. 500 billion in each asset in the NSSF investment portfolio, there is 99% chance that the Corporate Bonds (CBs), Fixed Deposits (FDs), Equity, Real Estates (REs) and Government Securities (GSs) will lose not more than Tshs. 330.65 billion, Tshs. 174.95 billion, Tshs. 118.62 billion, Tshs. 60.36 billion and Tshs. 48.03 billion respectively in the next 1 year.

However, the VaR figures based on the Cornish-Fisher expansion model imply that, with the scenario of investing Tshs. 500 billion in each asset in the NSSF investment portfolio, there is 99% chance that the Corporate Bonds (CBs), Fixed Deposits (FDs), Equity, Real Estates (REs) and Government Securities (GSs) will lose not more than Tshs. 521.87 billion, Tshs. 268.10 billion, Tshs. 154.49 billion, Tshs. 99.66 billion and Tshs. 61.19 billion respectively in the next 1 year.

The Cornish-Fisher expansion model can calculate the Value at Risk (VaR) measurements more accurately than other classical approaches as it considers the factors of Skewness and Kurtosis of the distribution. Therefore, the presented VaR figures of the NSSF investment portfolio calculated based on Cornish-Fisher are more accurate than those calculated based on GARCH model.

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REFERENCES

Adam, J., (2016). *The Research Journey: Navigating Through Obstacles*. Dar es Salaam: Dar es Salaam University Press.

Aktas, O. & Sjostrand, M., (2011). Cornish-Fisher Expansion and Value-at-Risk Method in Application to Risk Management of Large Portfolios. *s.l.: Halmstad University.*

Andersen, T. T. & Frederiksen, T., (2010). *Modeling Value-at-Risk under Normal and Extreme Market Conditions.* Copenhagen: Copenhagen Business School, Institute of Finance.

Ansah, A. Y., (2016). *Modeling of Pension Fund Using GARCH: Case Study of SSNIT,* s.l.: The Department of Mathematics, Kwame Nkrumah University of Science and Tenchnology.

Aydın, K & Korkmaz, T. (2002). Using EWMA and GARCH methods in VaR calculations: Application on ISE-30 Index. In *ERC/METU 6. International Conference in Economics* (pp. 11-14).

Bollerslev, T.: 1986, Generalized autoregressive conditional heteroskedasticity, Journal of Econometrics 31, 307ñ327.

Čorkalo, Š. (2011). Comparison of value at risk approaches on a stock portfolio. *Croatian Operational Research Review*, *2*(1), 81-90.

Culp, C. L., Mensik, R. & Neves, A. M. P., (1998). Value at Risk for Asset Managers. *Derivatives Quarterly*, pp. 21-33.

Engle, R., (2001). GARCH 101: The Use of ARCH/GARCH Models in Applied Econometrics. *Journal of Economic Perspective,* 15(4), pp. 157-168.

Franzen, D., (2010). Managing Investment Risk in Defined Benefit Pension Funds. *OECD Working Papers on Insurance and Private Pensions,* Issue No. 38, OECD Publishing, pp. 1-58.

Gabrielsen, A., Kirchner, A., Liu, Z., &Zagaglia, P. (2015). Forecasting value-at-risk with time-varying variance, skewness and kurtosis in an exponential weighted moving average framework. *Annals of Financial Economics*, *10*(01), 1550005.

Graham, B. &Dodd, D. L. (2009). *Security Analysis: Principles and Technique* .6thed.Columbia:McGrawHill.

Grimsley, S., (2003). *Government Securities: Definitions, Types and Examples. Study.com.* [Online]Availableat: https://study.com [Accessed 2018].

Guidolin, M., (2013). *Univariate Volatility Models : ARCH and GARCH.* Mypage. didattica. unibocconi. It [Accessed 21st July, 2018].

Hu, L. (2017, October). Research on Stock Returns and Volatility-Based on ARCH-GARCH Model. In *7th International Conference on Management, Education, Information and Control (MEICI 2017)* (pp. 181-184). Atlantis Press.

Hurlimann, W., (2014). Market Value-At-Risk: ROM Simulation, Cornish-Fisher Var and Chebyshev-Markov Var Bound. *British Journal of Mathematics and Computer Science,* 4(13), 1797-1814.

IHS Global Inc., (2013). *Eviews 8 User's Guide II.* s.l.:s.n.

Inderst, G., (2009). Pension Fund Investment in Infrastructure. *OECD Working Papers on Insurance and Private Pensions,* 32, 1-45.

Isaka, I. C., (2016). Presentation for Updates on Social Security Reforms. s.l., s.n.

Javed, F., &Mantalos, P. (2013). GARCH-type models and performance of information criteria. *Communications in Statistics-Simulation and Computation*, *42*(8), 1917-1933.

Jensen, J. F. B. & Pedersen, K. R. S., (2013). *Portfolio Risk: An Empirical Study to Derive an Asymmetry-Adjusted Risk Estimate.* Aarhus, Denmark: Aarhus University.

Jorion, P., (2002). *How Informative Are Value at Risk Disclosures?,* Irvine: University ofCarlifonia.

Article DOI: https://doi.org/10.37284/ijfa.1.1.712

Jorion, P., (2003). *Financial Risk Manager Handbook.* 2nd ed. Hoboken, New Jersey: John Wiley and Sons, Inc.

Kaura, V., (2005). *Portfolio Optimisation Using Value at Risk,* London, UK: Imperial College London.

Kusiluka, M. M., & Kongela, S. M. (2020). A Case for Real Estate Inclusion in Pension Funds Mixed-Asset Portfolios in Tanzania. Current Urban Studies, 8, 428-445.

Lopez, J. A., (1998). Methods for Evaluating Value-at-Risk Estimates. *FRBNY Economic Policy Review,* October, pp. 119-124.

Mishkin, F. S., (2004). *The Economics of Money, Banking and Finacial Markets.* 7th ed. Columbia: Columbia University, Longman Publishers.

Pedraza, A., Fuentes, O., Searle, P., & Stewart, F. (2017). Pension funds and the impact of switching regulation on long-term investment. *World Bank Policy Research Working Paper,* (8143).

Olivier, C., Manesme, A., & Barthélémy, F. (2012). *Cornish-Fisher Expansion for Real Estate Value at Risk.* Edinburg, s.n.

Orlando, D. K. & Abbott, M. (1998). *Introduction To Value-at-Risk.* New York, Society of Actuaries.

Palepu, K. G., Healy, P. M., & Peek, E. (2013). *Business Analysis and Valuation: Text and Cases.* 3rd IFRS ed. Cambridge Massachusetts: Cengage Learning.

Simon, M. K. & Goes, J., (2013). Assumptions, Limitations, Delimitations, and Scope of the Study. Seattle, Washington.

Simons, K., (2000). The Use of Value at Risk by Institutional Investors. *New England Economic Review*,pp. 21-30.

Sjö, B., (2011). *Estimation and Testing for ARCH and GARCH.* https://pdfs.semanticscholar.org[Accessed 24th May, 2018].

Soucik, V., (2002). *Finding the true performance of Australian managed funds.*Joondalup, Australia: Edith Cowan University.

Stewart, F. (2005). Developments in Pension Fund Risk Management in Selected OECD and Asian Countries. OECD Working Paper on Insurance and Private Pensions.

The United Republic of Tanzania (URT). (2017). Special Bill Supplement to the Special Gazette of the United Republic of Tanzania No. 8A Vol. 98. :http://www.tcme.or.tz[Accessed 20th July, 2018].

Tonks, I., (2005). Chapter 23: Pension Fund Management and Investment Performance. In: Clark & Munnel, eds. The Handbook of Pensions, 456-480.

Veldhuijzen, M. (2014). Optimal investment strategy for pension funds in the new dutch pension contract (Doctoral dissertation, Tilburg University).

Geneva, International Labor Office World Bank (2001). Social Protection Sector Strategy: from safety net to springboard. Washington, World Bank. Retrieved on 25th 2021, from http://www.nssfug.org, at 14:00 hours

