Underwriting Capacity, Carbon Footprint and Performance of Quoted Insurance Firms in Sub-Saharan African Countries

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Abstract

In this study, the effects of underwriting capacity and carbon footprint on the financial performance of listed insurance firms in selected sub-Saharan African countries was investigated. It is argued in the study that both internally controlled factors (underwriting capacity) and factors that are external to the insurance industry (carbon footprint) generate or intensify risks faced by the insurance firms. The study employs secondary data collected from the sampled insurance firms' annual audited financial statements. Data used involves forty-five (45) insurance firms in eight (8) selected sub-Saharan African countries for the period of 2010 to 2019. To present a robust outcome in the relationships, a dynamic estimation procedure was adopted based on System Generalized Method of Moments estimation technique using dependent variables (Return on Asset, Return on Equity and Tobin's Q), explanatory variables (shareholders fund, underwriting profit, reserves, earning asset ratio, gross premium, the ratio of ceded reinsurance and Carbon dioxide emission) and moderating variables of firm's size, economic growth and inflation rate. The results from the study reveal that the pattern of effects of underwriting capacity or carbon footprints differ in terms of the factors considered or the measurement used for a performance indicator. In particular, the study found that shareholders' funds, underwriting profit, reserves, earning asset ratio and gross premium written exert significant effects on the performance of the insurance firms, although the effects vary depending on whether Return on Asset, Return on Equity or Tobin's Q is used as a performance indicator. The study also finds that the level of carbon footprint in the economy exerts significant negative effects on all the performance indicators of insurance firms.

Keywords: Carbon Finance, Co_2 Emission, Global Warming, Underwriting, Insurance Sector

1 Introduction

The insurance industry contributes significantly to economic growth by reducing company risks brought on by unexpectedly catastrophic events in both developed and emerging economies. By serving as a financial intermediary through capital formation and providing business finance for economically weaker segments of the economy, it also promotes economic growth (Etale, 2019). The insurance industry's business model stands out among other financial organisations. This is because in order for risk to be accepted, its functioning depends on the projection of predicted future risk (claims cost). However, the ability of the underwriting capacity to take on the transferred risks will determine how well this duty is performed (Kwon & Wolfrom, 2016).

As a result, the insurance industry's inverse cycle nature is dependent on underwriting abilities, investment, and claim-paying capacity (Lelyveld, Leiedorp & Kampam, 2009; Kamau, 2013; Oyetayo & Abass, 2020). Effective underwriting might therefore raise investment, which would then result in a predictable claims trend, which could improve the profitability of insurance companies. Any company, whether it be an insurance company or another kind, wants to increase its profits and the wealth of its stakeholders (Gitman, 2007). But the majority of businesses struggle to achieve their objectives because of difficulties in the operational environment. In other words, an organization's effectiveness depends on its capacity to acquire resources and manage them in a variety of ways in order to create competitive advantages (Iswatia & Anshoria, 2007). However, the profitability of insurance businesses may suffer if they are unable to take on bigger unanticipated risks because of inadequate underwriting capacity. Numerous variables affect an insurer's overall ability to undertake responsibilities, or underwriting capacity. Shareholders' money, underwriting profit, reserves, earning asset ratio, gross written premium, and reinsurance usage are a few of these variables.

The ecological footprint was created in 1996 by Wackernagel and Rees, and from that came the idea of a carbon footprint. A more recent area of study of environmental implications is the ecological footprint. The ecological footprint is a gauge of how much human activity the ecosystems of the planet need. Numerous ideas, like the carbon footprint, water footprint, and land footprint, were created from this idea (Jović, Lakovi, & Jovevski, 2018). These ideas have all been researched in relation to environmental conservation. However, the carbon footprint is the main topic of this study. Over the past several years, the carbon footprint has gained favour in the finance industry as a way to measure and disclose carbon emissions from both own operations and investment portfolios.

If policyholders are appropriately and immediately informed about the effects of climate change, insurance firms can transfer altered risks to the policyholders, therefore the impact of climate change on the performance of the commercial insurance industry is unlikely to be severe (Tol, 1998). A large portion of assets in some industries will become "stranded," which means they will no longer have value or generate income, especially if countries around the world abide by the Paris Agreement of 2015 to limit global warming to 1.5 or 2 degrees Celsius. As a result, insurers are reevaluating their risk models, particularly their reliance on historical patterns. For instance, a 2018 research that was published in the journal Nature Climate Change predicted that between $1 trillion and $4 trillion in assets in the oil and gas sector will become stranded by the year 2030. The financial performance of insurance firms may be significantly impacted by such a setback.

The effect of underwriting capacity and carbon footprint on the performance of insurance firms has continued to attract the interest of researchers but its examination with the data from the chosen scope (Sub-Saharan Africa) is limited in prior literature. Hence, this study investigates the joint effects of underwriting capacity and carbon footprint on the performance of insurance firms. Little is still known about the joint effect of underwriting capacity and carbon footprint on the performance of insurance firms. Additional insight into the determinants of insurance firms' performance debate can be gained by an examination of the interactive effect of the carbon footprint on the relationship between underwriting capacity and performance of insurance firms in developing countries, particularly for Sub-Saharan African countries. Hence, we develop a model that accounts for the joint effect of underwriting capacity and carbon footprint on the performance of listed insurance firms in Sub-Saharan African countries.

Additionally, in contrast to earlier studies, this study used a System Generalized Method of Moments (System GMM) estimation technique for dynamic panel data models to deal with multiple endogenous regressors in a panel data set and to address the potential simultaneity and endogeneity problem of variables. This technique was created by Arellano and Bond (1991) and improved by Arellano and Bover (1995). The System GMM estimator utilized in this study uses both level and lag values as instruments; and addresses endogeneity bias problems inherent in data as against static OLS estimators (pooled OLS, fixed effects, and random effects) used in previous studies. The system GMM estimator is known and expected to produce less biased and more precise estimates. Thus, this study improved on previous studies in terms of techniques used in determining the effects of underwriting capacity and carbon footprint on the financial performance of listed insurance firms in selected sub-Saharan Africa countries.

Following this introduction, the rest of this paper is organized as follows. Section two presents the literature review, the research method is discussed in section three, section four presents the results of data analysis and discussion of findings while the conclusion and recommendation is presented section five.

2 Literature Review

2.1 Conceptual Clarification

2.1.1 Concept of Performance

Performance is a collection of financial and non-financial measures that reveal the extent to which goals and outcomes have been attained (Lebans & Euske, 2006). According to Brealey, Myers, and Marcus (2009), an organization's performance is a gauge of how well a business uses the resources from its core operations and produces income over a specific time frame. In current research, returns on asset (ROA), returns on equity (ROE), returns on investment (ROI), and net interest margin are among the regularly utilised performance measures (NIM). The aforementioned accounting measurements of performance are primarily used. Tobin Q, a market performance metric, is another firm performance indicator that has recently caught the attention of academics (Zeitun & Tian, 2007; Singh, Tabassum, Darwish & Batsakis, 2018). It is calculated as the ratio of the book value of all assets to the sum of the market value of equity and the book value of liabilities. We shall use Tobin's Q, ROA, and ROE as performance substitutes in this analysis.

2.1.2 Underwriting Capacity

According to Soye and Adeyemo (2017), an insurer's capacity to underwrite refers to its financial ability to establish the upper limit of accepted risk. This refers to the highest level of financial risk that an insurer is prepared to take on in the event of a single loss or over a specific time frame. There is no general agreement on the major indicators of underwriting capacity, the indicators of underwriting capacity utilised in this study include shareholders' fund, underwriting profit, investment income, reserves, earning asset ratio, gross written premium, and reinsurance utilisation - the ratio of ceded reinsurance. The ability of an insurer or the insurance sector as a whole to assume risk and/or retain it is known as underwriting capacity. In other words, underwriting capacity gauges an insurer's overall capability to take on responsibilities. The ability of insurance firms to accept, cling onto, or outright reject the risk provided by a potential policyholder has been strongly correlated with their ability to remain in business. The more premiums it can collect and then invest the more risk it will be taking on by writing new insurance policies. As a result, the insurer's capacity for profit depends on its willingness to take on risk. Finding the correct balance is crucial to preserving and enhancing the insurer's financial stability (Oyetayo & Abass, 2020).

2.1.3 Carbon Footprint

According to Grubb and Ellis (2007), a carbon footprint is a measurement of how much carbon dioxide is released into the atmosphere as a result of the burning of fossil fuels. In the context of a business organisation, it refers to the volume of CO2 released as a result of regular company operations, either directly or indirectly. It might also be a reflection of the fossil energy used to produce a good or commodity that is released onto the market. In addition, Jović, Lakovi, and Jovevski (2018) define a carbon footprint as the total amount of greenhouse gas emissions that anything causes. It helps to understand how human activity affects the temperature of the planet and may be estimated for a good, a service, a person, a nation, or even a whole continent.

2.1.4 Carbon Footprint's Impact on the Insurance Industry Performance

Based on historical loss data and probability, the insurance sector sets product prices. This historical pricing procedure becomes more complex and ambiguous as a result of climate change because previous events are no longer a good indicator of the future. With the changing global environment, insurers want greater rates (Ahmed et al., 2013). According to Webster and Clarke (2015), the insurance sector could cover all increased claims brought on by climate change by raising insurance premiums for, say, energy producers. This would be a form of insurance-led levy that recognises both the sector's current carbon emissions (carbon footprints) and its carbon inheritance. If policyholders are appropriately and immediately informed about the effects of climate change, insurance companies can transfer changed risks to the policyholders, therefore the impact of climate change on the profitability of the commercial insurance sector is unlikely to be severe (Tol, 1998).

A large portion of assets in some industries will become "stranded," which means they will no longer have value or generate income, especially if countries around the world abide by the Paris Agreement of 2015 to limit global warming to 1.5 or 2 degrees Celsius. As a result, insurers are reevaluating their risk models, particularly their reliance on historical patterns. For instance, according to a 2018 study published in the journal Nature Climate Change, between $1 trillion and $4 trillion in assets in the oil and gas sector, especially in the context of sub-Saharan African countries are predicted to become stranded by the year 2030. The financial performance of insurance firms' in the sub region may be significantly impacted by such a setback.

2.2 Empirical Review

In this section, we review some previous empirical studies that have investigated the effect of underwriting capacity on the performance of insurance firms. We could not find previous empirical studies on the link between carbon footprint and performance of insurance firms; hence we review only previous studies on underwriting capacity and performance of insurance firms.

In three mature insurance markets (France, Germany, and Switzerland), Meier and Outreville (2003) analysed reinsurance prices and the insurance cycle in the property and liability insurance industry for the years 1982 to 2001. We checked for cycles and determined their lengths using second-order auto-regressive processes. Results demonstrate that one of the elements causing changes in pricing and profits (underwriting cycle) and consequently the loss ratio of primary insurers is reinsurance price. The outcome further demonstrates that an increase in primary insurers' underwriting capability will follow a drop in the cost of reinsurance.

From 1995 through 2003, Cummins, Dionne, Gagne, and Nouira (2008) evaluated the effects of reinsurance on insurers' costs and underwriting risk for a sample of 554 U.S. property-liability insurers. The findings demonstrate that reinsurance purchases greatly raise insurer costs while significantly lowering loss ratio volatility. In order to lower their underwriting risk, insurers accept to pay higher premiums for insurance products when they purchase reinsurance.

Using a multivariate regression model over a time period spanning 2002–2012, Cummins, Feng, and Weiss (2011) investigated reinsurance counterparty relationships and company performance in the American property and liability insurance business. The purpose of the study is to ascertain if captive reinsurance use has an impact on the business performance of life insurers. Accounting measures of ROA and ROE were used to gauge financial success. The outcome demonstrates a negative relationship between captive reinsurance use and company performance. Reinsurance is a major source of interconnection within the insurance business, according to findings, which are consistent with other studies.

Mankai and Belgacem (2013) studied the interactions between risk-taking, capital, and reinsurance for property and liability insurance firms in the United States of American. The focus of the study was to analyze capitalization policy and its relationship to risk-taking. The result shows that a significant relationship subsists between the key variables (risk-taking, capital, and reinsurance) and supporting the view that they are jointly determined.

Ghimire (2014) investigate the effect of income structure on the financial performance of insurance companies in Nepal and the time frame for the study was from 2008 to 2012. The result of the correlation matrix shows that Net Premium income has a significant positive relationship with Investment, Loan and Others income (ILOI), Loan on Policyholders Income (LPI), Other income, and Provision for Outstanding Claim beginning of the year (POCBY) but not significant relationship with the income from reinsurance commission(RECOMI). The relationship between Provision for unexpected risk at the beginning of the year (PURBY) and Other Direct Income (ODI) was negative. Interesting thing is that despite the increase in net premium, reinsurance commission income is not increased in the same direction. Also, the correlation between Return on Equity with NPREM, ILOI, LPI is found significant (positive) and the rest of the variables have no significant relation with each other. Assets and income sources and profit and income sources have no significant relation.

Iqbal and Rehman (2014) carried out a study to find out whether reinsurance practices affect the profitability of non-life insurance companies in Pakistan for the period 2002 – 2011. Reinsurance practices were measure by Ratio of Ceded Reinsurance (RCR): Reinsurance Ceded (RC)/Net Premium Written (NPW) and Ratio of Reinsurance Recoverable to Policyholder's Surplus (RRPHS): [Ceded Reinsurance Recoverable (CRR) + Ceded Unearned Premium (CUP) + Ceded Commission (CC)]/Policyholders' Surplus (PHS) while profitability was proxy by ROA and ROE. Panel data in the form of pooled regression, as well as the fixed effect and random effect regression, were used to analyze the data. Findings reveal that the ratio of ceded reinsurance (RCR) has a significant positive relationship with ROE and ROA, whereas the ratio of reinsurance recoverable to policyholder's surplus (RRPHS) was found to be insignificant and had an insignificant positive relationship with ROE.

Aduloju and Ajemunigbohun (2017) explored the relationship between reinsurance, gross premium income, underwriting profit, and financial stability of insurance companies in Nigeria for the period 2014 to 2015. ROA and ROE were the surrogates for financial stability while the ratio of ceded reinsurance and reinsurance recoverable to policyholder's surplus is the measures of reinsurance utilization (surplus refers to equity capital, while, recoverable represent funds owed by reinsurers to insurance companies). The result of the correlation analysis shows that gross premium income has a positive and significant effect on profitability (ROA and ROE). Also, they found a significant positive relationship between reinsurance capacity and gross written premium, a significant positive relationship between reinsurance capacity and profitability of insurance companies, and a significant relationship between reinsurance capacity and financial stability of insurance companies in Nigeria.

Soye and Adeyemo (2017) studied the impact of reinsurance mechanisms on insurance companies' sustainability in Nigeria for the period 2009 - 2015. The dependent variable was (profitability (ROA)) and the independent variables (Net Retention ratio, Net Claim ratio, Net Commission ratio, and Ratio of Ceded Reinsurance). The outcome of the regression analysis reveals that the Net Retention ratio, Net Claim ratio, Net Commission ratio, and Ratio of Ceded Reinsurance are correlated with insurance profitability (ROA), and administrative expenses.

Sognon (2018) studied the relationship between reinsurance and financial performance of short term insurance companies in South Africa from 2007 to 2014. The panel data models, consisting of fixed and random effects were employed in the analysis. The results show that the proportion of gross premiums ceded which is the measure of reinsurance has a negative and significant effect on financial performance.

Bressan (2018) studied the effect of reinsurance on solvency, profitability, and taxes of primary insurers in the USA for the period 1994 – 2011. Findings show that the impact of reinsurance is observed to be more important for solvency, than for profitability and taxes. The outcomes suggest that insurers' capital decreases in the amount of utilized reinsurance.”

Dansu and Obalola (2018) conducted research on the impact of reliance and reinsurance use on the financial performance of non-life insurers in Nigeria. The study's time period was from 2004 to 2013. Reinsurance reliance was proxied by the Ratio of Reinsurance Recoverable to Policyholders' Surplus, whilst Reinsurance Utilization was measured by the Ratio of Ceded Reinsurance (RCR) (RRPHS). The substitutes for financial success used were the loss ratio (LR) and premium growth rate (PGR). The data were analysed using the ordinary least square (OLS) regression method. Results showed that there is a strong positive association between premium increase and reinsurance utilisation (RCR) (PGR). Similar to this, there was a positive and substantial association between reinsurance dependency (RRPHS) and loss ratio (LR).

Alani and Sani (2019) explored the impact of recapitalization on the financial performance of insurance firms in Nigeria. The period of study was divided into two: the pre-consolidation era (2000 to 2006) and the post-consolidation era (2007 to 2014). The recapitalization was proxy by shareholder's fund while performance was proxy by profit after tax. The outcome of the OLS regression shows that shareholder's fund (recapitalization) has no meaningful influence on the financial performance of insurance firms in both the pre and post-consolidation era, though the relationship was positive in both periods.

Mohamed (2019) investigated how reinsurance activities affected the financial success of Egyptian non-life insurance businesses from 2008 to 2016. While insurance and reinsurance debts, the ratio of reinsurance, local reinsurance premium ceded to local reinsurance, foreign reinsurance premium ceded to the foreign reinsurer, local claim coming from local reinsurer, foreign claim coming from foreign reinsurer, the ratio of retention, the ratio of commotion, the ratio of insurance dependence, and control variables were used as performance indicators, ROA and ROE were the measures of performance (market share, size of the company age of the company and financial leverage). The panel data results show that, according to the fixed-effect model, there is a significant and negative relationship between financial performance (ROA) and reinsurance debt, foreign reinsurer premium, the ratio of reinsurance, the ratio of retention, size, and financial leverage. However, according to the random effect model, there is a significant and positive relationship between size and ROE and a significant and contrary relationship between age and ROE.

The impact of the underwriting function on the profitability of insurance businesses in Nigeria from 2010 to 2019 is examined by Akpan, Nnamseh, Etuk, Edema, and Ekanem (2020). The underwriting function was measured by insurance premiums and underwriting profit, whereas profitability was represented by profit after tax. The results of the pooled ordinary least square (OLS) regression show that the underwriting function indicators, namely insurance premiums and underwriting profit, individually contribute considerably and favourably to the profitability of insurers. Overall, the findings show that while underwriting profit does not considerably contribute to insurers' profitability, insurance premiums do so significantly and favourably.

3 Methodology

In this study, the causal research design was utilized. The nature of the data is Longitudinal. The causal research design entails evaluating the effect/cause link between two variables, the explained and explanatory variables in order to draw statistical inferences. The variables involved are ex-post in nature which the researcher does not have the power to influence because they have already occurred. Thus, the structure of the research involves combining cross-sectional data with time-series properties to form a set of panel data. The population of this study comprised all the insurance firms listed in the eight (8) selected sub-Saharan Africa Countries Stock Exchanges as of 31st December 2019. Fifty-three (53) insurance firms listed in the Stock Exchanges of the eight (8) selected sub-Saharan African countries make up the population. Using a combination of purposive and stratified sampling technique, 45 insurance firms were selected from the total fifty-three (53) listed insurance firms in the Stock Exchanges of the 8 selected countries based on the following stratification: Botswana, one (1), Ghana, two (2), Kenya, three (3), Mauritius, four (4), Nigeria, twenty-four (24), South-Africa, eight (8), Uganda, one (1), Zimbabwe, two (2). The sample filtering technique was also utilized in the selection of insurance firms from each country based on the availability of annual reports from the insurance company's website for the period of study (that is, 2010 – 2019). The study employed secondary data that were obtained from the audited annual financial reports of the selected insurance firms under the reference period. The audited annual reports were obtained from the website of the respective companies. Data on macroeconomic variables and carbon footprint were obtained from the website of the World Development Indicator, World Bank (2019). The use of secondary data was necessitated by the fact that such data are readily and easily accessible from the website of the respective insurance firms.

3.1 Theoretical Framework

Ruin theory is the foundation of this research. Ruin theory is a stochastic process that grows continually as a result of premiums received and steps back down when claims are filed. Ruin is said to occur when the capital is negative. As a result, businesses will only provide non-life insurance if they can turn a profit or at the very least remain solvent (Gerber & Loisel, 2012).

According to the notion, an insurance firm has two opposing financial flows that come from cash premium payments and claims payments. One might conclude that disaster happens when the capital goes negative. Therefore, a high likelihood of ruin denotes instability in the shareholder's fund, underwriting profit, investment income, reserves, earning asset, gross written premium, and reinsurance; alternatively, the insurer should seek for more working capital (Kaas, Goovaerts, Dhaene, & Denuit, 2008). Because of its insufficient underwriting capabilities, an insurance firm may be having trouble with its cash flow (cash premium and claims expenses), which might affect its financial performance and lead to its being deemed insolvent (ruined). The likelihood of ruin is represented by the symbol (u), where (u) is the yearly premium and (u) is the claims procedure. The likelihood is a practical management tool that shows how well the insurer's mix of premiums and claims handling relates to the beginning capital that is available. (Mayers & Smith, 1990; Kass et al., 2008; Oyetayo & Abass, 2020).

3.2 Specification of Model

This study built a model underpinned by the ruin theory. The study utilized three models because the study is using both accounting base performance and market-based performance indicators (ROA, ROE, and Tobin's q). Also, we employed seven proxies for underwriting capacity (shareholders' fund, underwriting profit, reserves, earning asset ratio, gross written premium, and reinsurance utilization - the ratio of ceded reinsurance) and the annual tons of CO_2 emission in a country per year is the proxy for carbon footprint. The model of Oyetayo and Abass (2020) was adopted and changed in terms of variables included to proxy underwriting capability based on theoretical, empirical, and data availability considerations. Oyetayo and Abass (2020) model the influence of underwriting capacity on insurance firms' performance as follows:

$$LQ_i = \alpha + \beta_1 RS_i + \beta_2 SF_i + \beta_3 RU_i + \epsilon \quad (3.1)$$

$$ROA_i = \alpha + \beta_1 RS_i + \beta_2 SF_i + \beta_3 RU_i + \epsilon_i \quad (3.2)$$

$$SV_i = \alpha + \beta_1 RS_i + \beta_2 SF_i + \beta_3 RU_i + \epsilon_i \quad (3.3)$$

Where: $LQ_{i,t}$ (Liquidity), $ROA_{i,t}$ (Return on Asset) and $SV_{i,t}$ (Solvency) represents the performance of insurance firm i; RS_i represents a reserve of insurance firm i; SF_i is shareholders fund of insurance firm i; RU_i is reinsurance utilization of insurance firm i; ϵ_i the error term which accounts for other possible factors that could influence LQ_i, ROA_i and SV_i that are not captured in the model.

Based on the fact that the study employed different underwriting capacity indicators like underwriting profit, earning asset ratio, gross premium written in addition to the three indicators of underwriting capacity utilized in the Oyetayo and Abass (2020) model and this study also include carbon footprint as one of the independent variable; in terms of the dependent variable this study incorporates a market-based performance measure (Tobin's q) additional to ROA and ROE as performance indicators, also three control variables (firm size, economic growth and inflation rate) were also introduced to account for other factors that have been found to influence the performance of insurance firms. The above models are therefore modified to determine the link between underwriting capacity, carbon footprint and performance of insurance firms in selected Sub-Saharan Africa Countries.

The functional forms of the models are stated below;

$$ROA_{it} = f\ (SHF, URP, RES, EAR, GPW, RCR, CFP, FSIZE, GDPPC, INFL) \qquad (3.4)$$

$$ROE_{it} = f\ (SHF, URP, RES, EAR, GPW, RCR, CFP, FSIZE, GDPPC, INFL) \qquad (3.5)$$

$$TQ_{it} = f\ (SHF, URP, RES, EAR, GPW, RCR, CFP, FSIZE, GDPPC, INFL) \qquad (3.6)$$

The dynamic panel data model is specified in econometric form as:

$$ROA_{it} = \beta_0 + \beta_1 ROA_{it-1} + \beta_2 SHF_{it} + \beta_3 URP_{it} + \beta_5 RES_{it} + \beta_6 EAR_{it} + \beta_7 GPW_{it} + \beta_8 RCR_{it} + \beta_9 CFP_{it} + \beta_{10} FSIZE_{it} + \beta_{11} GDPPC_{it} + \beta_{12} INFL_{it} + \mu_{it} \qquad (3.7)$$

$$ROE_{i} = \beta_0 + \beta_1 ROA_{it-1} + \beta_2 SHF_{it} + \beta_3 URP_{it} + \beta_5 RES_{it} + \beta_6 EAR_{it} + \beta_7 GPW_{it} + \beta_8 RCR_{it} + \beta_9 CFP_{it} + \beta_{10} FSIZE_{it} + \beta_{11} GDPPC_{it} + \beta_{12} INFL_{it} + \mu_{it} \qquad (3.8)$$

$$TQ_{it} = \beta_0 + \beta_1 ROA_{it-1} + \beta_2 SHF_{it} + \beta_3 URP_{it} + \beta_5 RES_{it} + \beta_6 EAR_{it} + \beta_7 GPW_{it} + \beta_8 RCR_{it} + \beta_9 CFP_{it} + \beta_{10} FSIZE_{it} + \beta_{11} GDPPC_{it} + \beta_{12} INFL_{it} + \mu_{it} \qquad (3.9)$$

Where;

$\beta_0 \ldots \beta_{12}$ are coefficients of the parameters.

μ_{it} = the stochastic (error) term for insurance firm *i* at time t.

The a *priori* expectation: $\beta_1 > 0$, $\beta_2 > 0$, $\beta_3 > 0$, $\beta_4 > 0$, $\beta_5 > 0$, $\beta_6 > 0$, $\beta_7 > 0$, $\beta_8 > 0$, $\beta_9 > 0$, $\beta_{10} > 0$, $\beta_{11} > 0$, $\beta_{12} < 0$. From theory, it is expected that shareholders fund, underwriting profit, reserves, earning asset ratio, gross premium written, ratio of ceded reinsurance, carbon footprint, firm size, economic growth are expected to have positive impact on the performance of insurance firms while inflation rate is expected to have a negative effect on the performance of insurance firms.

The subscripts *i* and *t* refer to individual firms or country (for the macroeconomic variables) and period (2010 - 2019) respectively. ROA_{it-1}, ROE_{it-1} and $\beta_1 TQ_{it-1}$ are lagged dependent variables and their inclusion in the model is "meant to take care of potential endogeneity of the independent variable which included the likelihood of omitted variables, simultaneity, and variable measurement error in the context of dynamic panel data method.

Table 3.1: Description of variables

Variables	**Definition**	***a priori sign***
ROA_{it}	Return on asset of insurance firm *i* at time *t*	Dependent Variable
ROE_{it}	Return on equity of firm *i* at time *t*	Dependent Variable
TQ_{it}	Tobin's q of insurance firm *i* at time *t*	Dependent Variable
ROA_{it-1}	Lagged value of the return on asset of insurance firm *i* at time *t*	+
ROE_{it-1}	Lagged value of the return of equity of insurance firm *i* at time *t*	+
TQ_{it-1}	Lagged value of the Tobin's q of insurance firm *i* at time *t*	+
SHF_{it}	Shareholders' fund of insurance firm i at time t.	+
URP_{it}	Underwriting profit of insurance firm i at time t.	+
RES_{it}	Reserves of the insurance firm i at time t.	+
EAR_{it}	Earning asset ratio of insurance firm i at time t.	+
GPW_{it}	Gross written premium of insurance firm i at time t.	+
RCR_{it}	The ratio of ceded reinsurance of insurance firm i at time t.	+
CFP_{it}	Carbon footprint	+
$FSIZE_{it}$	Size of insurance firm	+
$GDPPC_{it}$	Economic growth	+
$INFL_{it}$	Inflation rate	-

Source: Author's Compilation, (2021).

3.3 Operational Definitions of Variables

The variables adopted are defined in Table 3.2 and the previous researcher who utilizes the variable in their study is also indicated.

Table 3.2: Operational Definitions of the Variables

S/N	**Variable**	**Type of Variable**	**Measurement**	**Sources**
1	Return on Asset (ROA)	Dependent Variable	$ROA = \frac{Profit\ after}{-tax\ total\ Assets}$	Aduloju & Ajemunigbohun (2017)
2	Return on Equity (ROE)	Dependent Variable	$ROE = \frac{Profit\ after}{-tax\ total\ Equity}$	Aduloju & Ajemunigbohun (2017)
3	Tobin's Q (TOQ)	Dependent Variable	$\frac{Market\ capitalization + Total\ liabilities - net\ cash\ flow}{total\ asset}$	Zeitun & Tian (2007)
4	Shareholders' Fund (SHF)	Independent Variable	Measured as the logarithm of total shareholders' fund of the insurance firm	Oyetayo & Abass (2020)
5	Underwriting Profit (URP)	Independent Variable	The underwriting profit of an insurance firm is measure by the logarithm of the total underwriting profit	Soye & Adeyemo (2017)
6	Reserves (RES)	Independent variable	Measured as the logarithm of reserve of the insurance firm	Oyetayo & Abass (2020)

S/N	Variable	Type of Variable	Measurement	Sources
7	Earning Asset Ratio (EAR)	Independent Variable	Measured as premium earned/total asset	Soye & Adeyemo (2018)
8	Gross Premium Written (GPW)	Independent Variable	Measured as the logarithm of gross premium written by the insurance firm	Akpan et al., (2020)
9	The ratio of Ceded Reinsurance (RCR)	Independent Variable	Measure as reinsurance ceded (RC)/net premium written (NPW))	Abbas (2019)
10	Carbon footprint (CFP)	Independent Variable	measured as the annual tons of CO_2 emission in a country	Grubb & Ellis (2007)
11	Firm Size (FSIZE)	Independent Variable	Size is measured as logarithm of total assets of the insurance firm	Kazeem (2015)
12	Economic Growth – GDP per capita (GDPPC)	Independent Variable	measured as real GDP/Population	Aigbovo & Uwubanmwen, (2014)
13	Inflation Rate (INFL)	Independent Variable	measured as the annual change in the CPI; (CPIt – CPIt-1) / CPIt-1	Aigbovo & Uwubanmwen, (2014)

Source: Author’s Compilation, (2021).

3.4 Data Analysis Techniques

In this paper, statistical and econometric methods are used to perform the data estimation. The descriptive statistics include descriptive and correlation analysis. In terms of the inferential statistic, we employed the System Generalized Method of Moments (System GMM) estimation technique for dynamic panel data models developed by Arellano and Bond (1991) and augmented by Arellano and Bover (1995). However, before we proceed with system GMM estimation, the data was subjected to various preliminary and diagnostic tests to ensure the reliability and validity of results obtained from the empirical analyses. These preliminary and diagnostics tests include; the panel unit root test and cointegration test. In conducting all our data analysis, we utilized the Econometric View Software (EVIEW) version 10.0.

4 Empirical Analysis

4.1 Statistical Evaluation

4.1.1 Descriptive Statistics

The basic charactisation of the datasets is performed using the descriptive statistics to summarise the data. The annualized summary statistics for all the variables in the study are presented for the sampled companies over the 10 years period. For the performance indicators, average return on assets (ROA) is 2.60, although there are large extreme patterns for the different companies considering the minimum of -78.32 and a maximum of 21.4. The standard deviation is much higher than the mean value, indicating that ROA across the insurance firms for the countries is extremely divergent (this is validated in Figure 4.1a). For return on equity, the average value is 10.08, and the standard deviation is 19.57, which again shows that the ROE values are very divergent across the countries in the study. Average Tobin Q ratio is 1.46, indicating that insurance firms are performing well in the market among the sub-Saharan African (SSA) countries. For each of the performance measures, the minimum values are essentially low (with ROE and ROA having negative minimum values) which suggests that some of the sampled companies did not perform well over the period. The standard deviations for each of the performance measures is relatively high (compared against the mean respective values). This also indicates that performances across the firms are highly varied, with some of the firms performing well and others performing quite poorly. The J-B values of the variables are also respectively significant at the 1 percent level, suggesting a high level of heterogeneity among the firms in the sample.

Table 4.1a: Descriptive Statistics

	Mean	**Max**	**Min**	**Std. Dev.**	**Skew**	**Kurt.**	**J-B**	**Prob**
ROA	2.60	21.40	-78.32	7.77	-3.66	33.13	1705.46	0.00
ROE	10.08	142.18	-158.00	19.56	-1.28	23.47	7874.25	0.00
TBQ	1.46	34.08	0.02	3.99	6.70	48.39	377.62	0.00
SHF	7.07	8.96	4.25	0.85	-1.05	4.58	128.70	0.00
URP	0.42	2.90	0.02	0.37	3.03	16.20	3928.37	0.00
RES	6.55	7.89	3.95	0.80	-1.33	4.31	164.65	0.00
EAR	0.29	1.58	-0.02	0.23	2.36	11.42	1736.81	0.00
GPW	6.55	7.91	3.89	0.76	-1.24	4.57	160.30	0.00
RCR	0.36	28.70	-22.87	1.99	1.31	149.08	3972.80	0.00
FSIZE	5.29	7.81	3.41	0.83	1.07	4.26	103.84	0.00
GDPPC	3.82	15.45	-7.67	5.30	-0.04	2.67	1.89	0.39
INFL	10.09	255.30	-2.40	17.97	12.59	172.07	493.70	0.00
CFP	2.24	9.01	0.11	3.09	1.46	3.37	163.06	0.00
ΔCFP	0.01	0.26	-0.20	0.06	1.01	5.90	233.95	0.00

Source: Author's computations, (2021) using Eviews 10.0.

The standard deviation for the shareholders' fund is low relative to the mean value. This indicates that the shareholders funding of insurance companies is essentially standard and similar across the countries in the study. Similar outcomes are shown for underwriting profits, reserves and gross premium written. Thus, it is seen that much of the insurance activities and indicators are stable over time among African countries and the values are also generally standardised across the countries. Average earnings-asset ratio is 0.29, indicating that average annual earnings in relation to total assets of the insurance firms is about 29 percent. This is a relatively high value and suggests the need for expanded asset base for the insurance companies in the selected countries. The ratio of ceded reinsurance (RCR) is also at 36 percent, showing the higher levels of risks involved in the insurance sector in Africa. Average annual carbon footprint per capital for the countries is 2.24 metric tonnes, while the average growth rate of carbon emission for the countries is low at 0.01. Given a maximum annual growth rate of 0.26 in the carbon footprint for the countries, it is clear that the sub-Saharan African region does not contribute significantly to global carbon footprints.

For the control variables, average GDP per capita growth rate among the countries is 3.82 percent. This is a relatively low growth rate among the economies, given that growth rate in the economy in the first decade of the 21st century was as high as 6 percent for the region (African Center for Economic Transformation, 2014). This means that growth in the economies has declined since the middle of the 2010 decade. The skewness value of -0.04 for the GDPPC variable suggests that the countries in the study experienced quite similar growth rates over the period. The average size of the insurance firms is 5.29 percent. This is relatively low. Average inflation rate is high on average for the economies at 10.09 percent, although the high rates in a country like Zimbabwe (reaching 255.3 percent) may have contributed to the relatively high average value. The Jarque-Bera statistics for all the variables (except growth in GDP per capita) are all significant at the 1 percent level, which shows the absence of normality. This outcome is to be expected since a pool of different countries and different companies was adopted for the datasets. Hence, the result shows that firm-level characteristics may be exerting strong heterogenous influences for the datasets. This is a strong basis for providing a panel-form analysis in the regression process for the study.

Both the company-specific and country-specific factors are likely to vary across the countries in the study, given the highly significant J-B test values for the variables. Thus, descriptive statistics for the variables for each of the countries considered in the empirical analysis are also presented on country basis in Table 4.2b (means and standard deviations). On average the performance indicators of ROA, ROE, and Tobin Q are larger for insurance firms in Mauritius (average ROE of 157.23), South Africa and Botswana. Ghanaian companies also performed well in terms of the Tobin Q ratio which indicates that these firms are better performed in the financial markets. Essentially, insurance firms in these countries are more efficient and profitable. Nigerian companies performed the least in all the indicators, highlighting the difficulty faced by Nigerian insurance companies in terms of financial performance.

Average shareholders' funds in the companies are higher in Uganda and Kenya, while South Africa recorded the highest average underwriting profits, indicating the level of development of the South African insurance market. In terms of reserves, Ugandan companies recorded the largest reserve values, while South African and Ghanaian companies indicated the largest earnings ratios. South Africa (474.87 units) and Nigeria (92.4 units) were the highest producers of carbon footprint per capita among the countries, clearly suggesting that industrial capacity relates well with the amount of carbon dioxide (CO_2) and other greenhouse gases emitted in a country. The average annual change in per capita carbon footprint is highest for Botswana and Ghana at 5.93 percent and 5.48 percent respectively, suggesting that these countries are quickly catching up in terms of carbon pollution on the continent. On the other hand, South Africa with an average annual change of 0.88 percent appears to be slowing down considerably in its carbon generation. It appears that countries that experience better economic prospects are also linked with increased carbon footprint generation. As expected, South Africa has the highest carbon footprint per capita on the continent, although it is the only country with an average negative growth in per capita carbon footprint among the selected countries in the SSA region. Moreover, Kenya is the clear leader in terms of growth in per capita income among the countries in the sample.

Table 4.1b: Descriptive Statistics for Individual Countries

Variable	*Botswana*		*Ghana*		*Kenya*		*Mauritius*		*Nigeria*		*South Africa*		*Uganda*		*Zimbabwe*	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
ROE	18.79	4.96	12.58	13.86	12.60	27.53	157.29	393.91	10.01	83.28	18.58	18.42	10.12	16.87	13.28	15.37
ROA	3.07	0.66	5.50	5.84	4.90	3.85	3.02	2.31	0.81	9.14	5.16	7.14	2.78	4.72	4.30	4.04
TBQ	2.69	0.83	0.81	0.18	0.92	0.24	0.94	0.13	0.68	0.30	1.37	0.58	0.89	0.14	1.20	2.06
SHF	7.16	0.04	5.57	0.32	7.56	0.28	7.14	0.45	7.20	0.33	7.23	1.36	7.96	0.05	5.20	0.47
URP	0.27	0.03	0.37	0.13	0.17	0.06	0.25	0.22	0.39	0.27	0.68	0.63	0.56	0.10	0.58	0.35
RES	6.38	0.12	5.17	0.32	6.96	0.43	6.05	0.40	6.85	0.32	6.48	1.03	7.46	0.16	4.64	0.50
EAR	0.14	0.01	0.36	0.11	0.21	0.09	0.14	0.06	0.30	0.17	0.39	0.40	0.09	0.01	0.29	0.14
GPW	6.33	0.06	5.23	0.29	7.01	0.28	6.41	0.31	6.75	0.41	6.66	0.97	7.05	0.15	4.63	0.56
RCR	0.03	0.02	0.37	0.25	0.76	6.23	0.41	0.38	0.32	1.55	0.41	0.79	0.38	0.21	0.13	0.34
FSIZE	6.21	0.06	5.12	0.23	5.59	0.26	5.64	0.44	4.89	0.32	6.20	1.35	4.49	0.04	5.11	0.34
GDPPC	3.61	5.95	4.04	6.49	7.92	2.75	4.75	1.76	4.04	6.49	1.16	1.53	1.11	4.57	5.06	6.32
INFL	4.85	2.18	11.28	4.14	7.11	2.76	2.97	1.66	11.28	4.05	5.17	0.73	6.14	4.25	27.44	78.01
CFP	6.20	1.53	14.90	1.70	16.21	2.75	4.03	0.27	92.40	4.13	474.87	13.59	4.69	0.44	11.71	0.92
ΔCFPPC	4.02	14.32	3.08	7.05	2.44	5.70	2.17	3.69	0.01	5.44	-0.43	2.12	0.88	4.11	1.75	11.95

Source: Author's computation, (2021) using Eviews 10.0.

4.1.2 Correlation Analysis

The patterns of relationships among the independent variables in the study are evaluated with the correlation analysis shown on Table 4.2. Strong negative correlations are seen to exist between EAR and all the other underwriting capacity variables, including firm size which is also a firm specific variable, indicating that earnings among the insurance firms move in opposite direction with other firm specific characteristic indicators of the companies. However, earnings ratio is shown to be positively correlated with carbon footprint, suggesting that insurance companies in countries with higher carbon emissions are more likely to receive greater earnings. Positive relationships also exists between carbon footprint and all the other underwriting capacity variables, which clearly shows that insurance firm generally thrive better for countries that generate more carbon emissions. The correlation coefficients between reserves and both the gross premium written by the insurance firms and the shareholders' funds in the firms are positive and indicate that reserves, funds level and premium of the insurance firms are all factors that improve together among insurance firms. Underwriting profits are also slightly positively correlated with shareholders' funds and reserves of the companies.

Table 4.2: Correlation among the explanatory variables

Variable	EAR	GPW	RCR	RES	SHF	URP	CF
GPW	-0.219 (0.000)						
RCR	-0.012 (0.799)	-0.003 (0.951)					
RES	-0.379 (0.000)	0.881 (0.000)	-0.006 (0.899)				
SHF	-0.500 (0.000)	0.912 (0.000)	-0.022 (0.649)	0.887 (0.000)			
URP	-0.233 (0.000)	-0.095 (0.044)	-0.027 (0.572)	0.046 (0.336)	0.096 (0.042)		
CF	0.242 (0.000)	0.144 (0.002)	0.005 (0.914)	0.060 (0.206)	0.135 (0.004)	0.324 (0.000)	
FSIZE	-0.500 (0.000)	0.913 (0.000)	-0.022 (0.650)	0.888 (0.000)	0.931 (0.000)	0.096 (0.043)	0.134 (0.005)

Source: author's computation, (2021) using Eviews 10.0. (Probabilities in parentheses below each coefficient)

The distribution of the density functions for the data used in the study are further tested since the aim of observing the study is to examine the patterns of probability and normality distributions. This is done by plotting the quantiles using the Quantile-Quantile (Q-Q) theoretic plot, shown in Figure 4.6. If the residuals are normally distributed, the points in the QQ-plots should lie alongside a straight line. The plots of all the variables (including dependent variables) exhibit strong non-normal distribution given that their plots are widely off the diagonal lines. For Most of the variables, the plots of the Quantile-Quantile distribution show that both large negative and positive shocks are driving the departure from normality in each of the variables. This further confirms the results from the descriptive analysis presented above that most of the data sets are non-normally distributed.

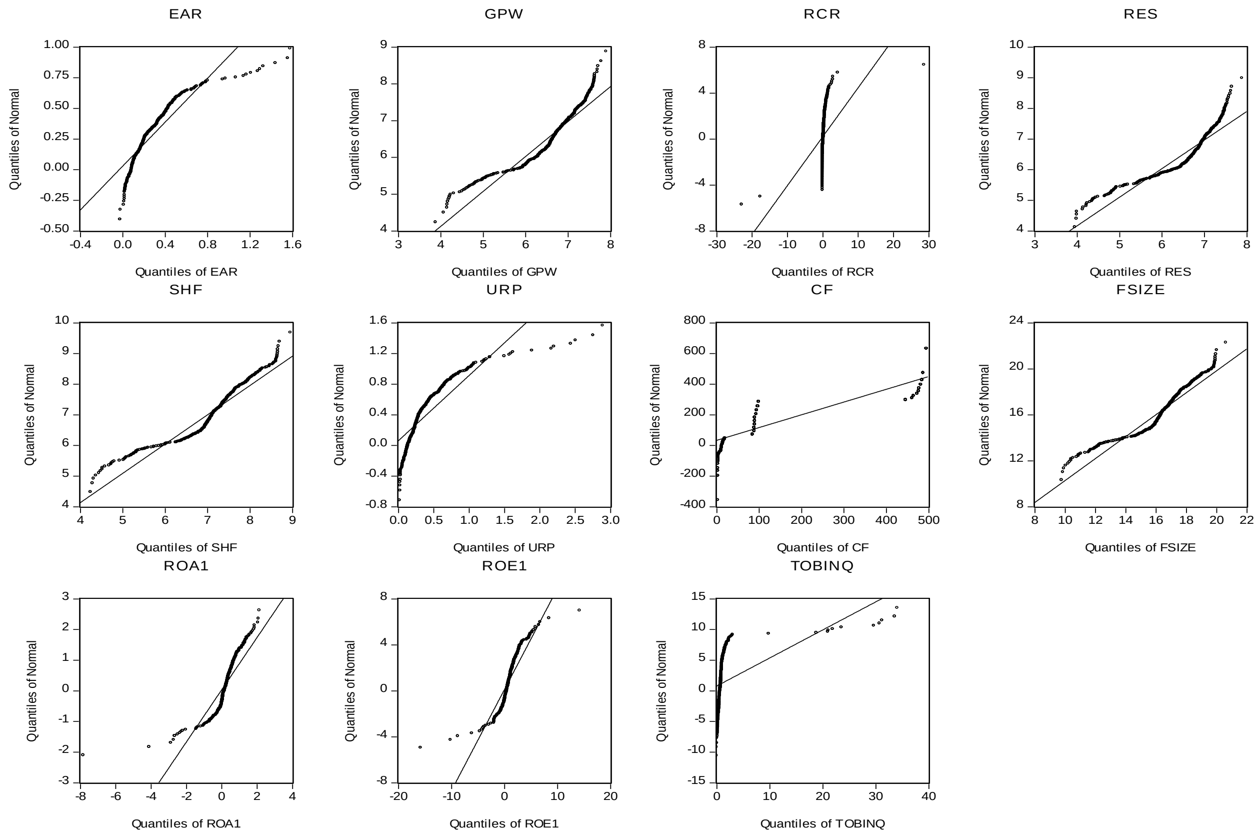

Fig. 4.1: Quantile-Quantile Distribution Charts for Variables

Source: Author's computations, (2021) using Eviews 10.0.

The concentration of the distribution of the datasets is also demonstrated by the functions of the density distribution of the variables. The plot of the density functions in histograms (shown in Figure 4.2) presents the results of the quantile test in another dimension. From the chart, it is seen that none of the datasets appears to be condensed in the middle and represents a relatively normal distribution system. This show that all the series is clearly non-normally distributed as also demonstrated by the J-B tests.

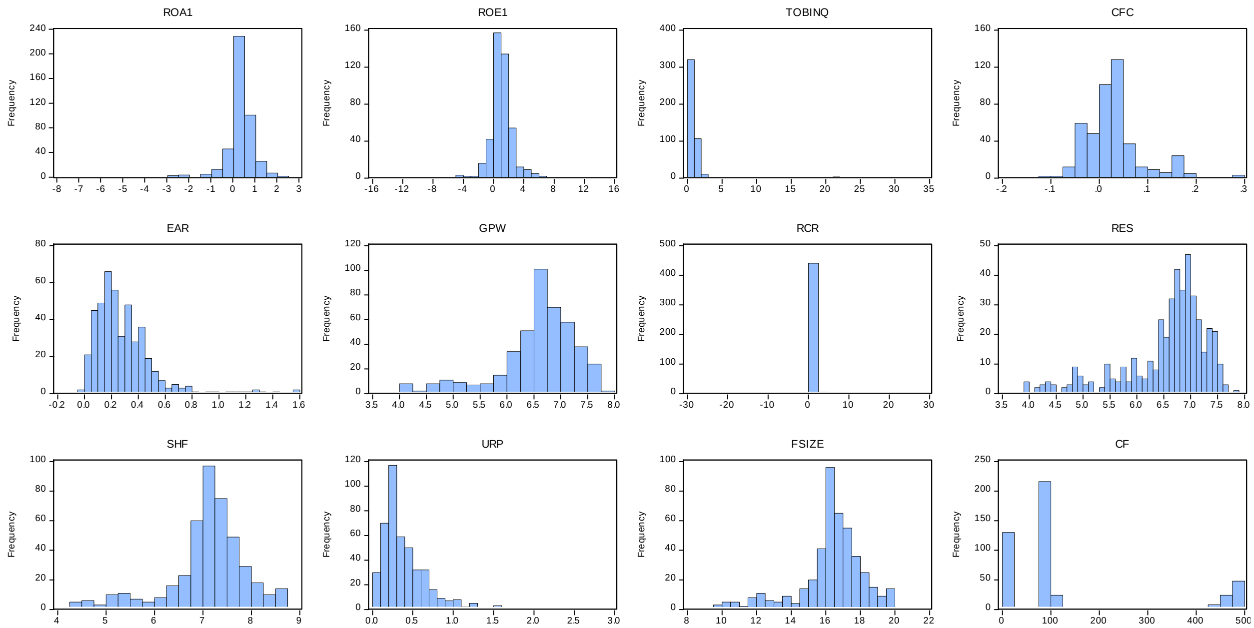

Fig. 4.2: Distribution plot for series

Source: Author's computations, (2021) using Eviews 10.0.

4.2 Cross-section Dependence Test

As noted above, it is necessary to disentangle the cross-sectional features of the relevant variables in order to observe the pattern of dependence. This is because, the insurance firms in the sample are all SSA companies and may therefore likely exhibit similar responses to overall patterns of macroeconomic and firm-specific factors. This can present certain levels of interdependencies that are related to spatial autoregressive processes among the variables (Adegboye, 2020). In the dataset, the number of cross-sectional units (45 companies) in this study is more than the time period (10 years). This means that the Breusch and Pagan (1980) LM test may not provide the needed efficiency in terms of measurements. Hence, the cross-sectional dependence (CD) test developed by Pesaran (2004) is used since it is more applicable for a large number of cross-sectional units (N) observed over T time periods. The test reported in Table 4.3 is implemented for the three equations estimated in the study for the Peseran cross-sectional dependence (CD) procedure.

Table 4.3: Cross-section Dependence Test Results

Model series tested	Pesaran CD	P-value	Abs corr
ROA	0.24	0.81	0.11
ROE	0.82	0.41	0.17
TBQ	1.94	0.11	0.15

Source: Author's computation, (2021) using Eviews 10.0.

From the result in Table 4.3, it is seen that the Peseran CD test fails to reject the null hypothesis of absence of cross-sectional dependence in the block of variables. This implies the absence of cross-sectional dependence for the estimation structure. This outcome further contributes to the efficiency of the estimation procedure especially as the estimation also allows for slope heterogeneity across panel units (Beqiraj, Fedeli & Forte, 2018). We thus proceed by testing for unit root and for the presence of cointegration among the variables in the study.

4.3 Panel Unit Root Tests

The data utilised for this analysis reflects both the common (homogeneous) qualities of the companies included in the study as well as the country - and firm-specific characteristics (individual heterogeneity). For the purpose of preventing the occurrence of "spurious" inference, it is necessary to utilise panel unit root tests to determine whether the data are stationary. It is necessary to test for stationarity because of the time series component of the data. In this work, the homogeneous panel's stationarity qualities were investigated using the test created by Levin, Lin, and Chu (LLC) (2002). These tests presuppose that the nations' co-integration vectors are equal. However, it is expected that each of the study's participating nations, along with the enterprises, will demonstrate variations in their economic and financial policies, as well as institutionally unseen traits. Given that the common unit root assumption may not be sufficiently realistic, the homogeneous unit roots alone may not be adequate to capture the stationarity status of the data sets. Im, Pesaran, and Shin (2003) and the Augmented Dickey-Fuller test (which accounts for heterogeneity in the panel's cross-section and assumes a null hypothesis of no cointegration in the panel data) are also used to circumvent this ostensibly implausible assumption for the chosen datasets. Table 4.4 displays the results of all unit root tests. Because the variables are basically ratios, only the tests for initial differences (Xt-Xt-1) are presented in the findings.

Table 4.4: Panel Data Unit Root Tests Results *in first difference

Variable	**Homogenous Unit Root Procedure**	**Heterogeneous Unit Root Procedure**		**Remarks (order of integration)**
	Trend and Intercept			
	LLC	**IPS**	**ADF-Fisher**	
	X_t-X_{t-1}	X_t-X_{t-1}	X_t-X_{t-1}	
ROA	-10.24**	-5.51**	196.89	I[1]
ROE	26.69**	-13.52**	353.74**	I[1]
TBQ	-16.63**	-7.85**	252.84**	I[1]
SHF	-3.07**	-1.77*	129.82**	I[1]
URP	-17.49**	-5.81**	195.54**	I[1]
RES	-11.53**	-3.44**	165.68**	I[1]
EAR	-9.28**	-3.79**	161.65**	I[1]
GPW	-14.49**	-4.96**	190.49**	I[1]

Variable	Homogenous Unit Root Procedure	Heterogeneous Unit Root Procedure		Remarks (order of integration)
	Trend and Intercept			
	LLC	IPS	ADF-Fisher	
	X_t-X_{t-1}	X_t-X_{t-1}	X_t-X_{t-1}	
RCR	-7.12**	-3.17**	146.28**	I[1]
SIZE	-11.66**	-4.66**	174.49**	I[1]
GDPPC	-5.81**	-1.94*	110.98	I[1]
INFL	-637**	-1.33	134.12**	I[1]
CFP	-18.22	-8.12	234.42**	I[1]

*Note: ** and * indicate significant at 1% and 5 % levels respectively; IPS = Im, Pesaran & Shin; LLC = Levin, Lin & Chu*

Source: Author's computation, (2021) using Eviews 10.0.

Only the differenced results of the tests are presented in the Table. It can be seen that the coefficients of the test for all the variables in first difference indicate that all the variables are stationary (given that the critical test values are higher than the test statistic). Given this condition, it is shown that the variables are all integrated of the same order one (i.e., I[1]), therefore a co-integrated analysis can be performed for the variables with meaningful outcomes.

The unit root results strongly indicate that the stationarity status of the variables are equal with each of the variables being I[1].

4.4 Panel Cointegration Test

However, it is possible to create the long-term circumstances of the variable interactions to provide a more solid foundation for a dynamic relationship between the variables. The results of the Pedroni and Kao panel cointegration tests on the panel and group assumptions are shown in Table 4.5, together with the corresponding variance ratios and rho statistics (non-parametric tests).

Table 4.5: Panel Cointegration Test Result

ROA equation	Panel Statistics	Group Statistics	Kao (ADF)
Variance ratio	-3.33		
Rho	7.99**	11.15**	-3.89**
IPS	-13.16**	-21.12**	
ADF	-2.84**	-3.93**	
ROE equation	**Panel Statistics**	**Group Statistics**	**Kao (ADF)**
Variance ratio	-6.10		
Rho	8.58**	10.75**	-5.584**
IPS	-9.34**	-17.74**	
ADF	-2.27**	-4.03**	

Tobin's Q ratio equation	Panel Statistics	Group Statistics	Kao (ADF)
Variance ratio	-1.99		
Rho	6.18**	11.20**	-1.705*
IPS	-4.11**	-20.15**	
ADF	-2.05**	-3.95**	

Note: **, * indicates the rejection of the null hypothesis of no cointegration at the 0.01 and 0.05 level of significance respectively

Source: Author's computation, (2021) using Eviews 10.0.

For both the panel and group assumptions, the coefficients of the IPS and Augmented Dickey Fuller test statistics are significant at the 5% level. In light of this, panel cointegration is well supported by both the ADF-t and non-parametric-t statistics. Another residual-based (Kao) panel cointegration test is used to supplement these findings. The null hypothesis of no cointegration may be rejected at the 5% level for each of the equations based on the Kao residual-based cointegration test presented in Table 4.5. As a result, the results of the cointegration tests indicate that the variables in the research have a significant long-term link. Thus, the empirical study may make use of the dynamic panel data estimation approach.

4.5 Regression Results for Underwriting Capacity, Carbon Footprint and Insurance Firms Performance

In this section, the equations specified in Chapter Three are estimated and the results are presented and interpreted for the goal of drawing relevant policy and academic conclusions. The estimated equations in this section are based on the dynamic panel data (DPD) estimations using the system GMM. In order to improve on the robustness of the estimations, two sets of estimations are performed for each equation. The first set employs only the relevant variables related to underwriting capacity and carbon footprint. The second estimation includes control variables (firm size and macroeconomic factors – economic growth and inflation rate) into the equation. This is to help observe whether economic environment or firm characteristics influence the relationships between insurance companies' performance and either underwriting capacity or the rate of carbon emission in the economies.

In Table 4.6, the results of the dynamic estimates of the relationships with respect to return on asset (ROA) of the insurance firms are reported. The diagnostic tests in the result is generally impressive, given that the coefficients of the over-identifying restriction test statistic (J-statistic) for the GMM estimates (controlled and non-controlled estimates) possess the expected values (i.e., they are greater than 0.1). The value of the J-statistic value therefore indicates that the instruments used in the estimation are valid and that the models were appropriately specified. The Arrelano and Bonds (AR) tests are used to identify any form of serial correlations among the errors in the estimates based on the instruments employed in the estimation. The second order coefficient needs to be insignificant in order to satisfy the AR condition. From Table 4.6, the coefficient of the second order statistic is not significant (in line with *a priori* expectation), suggesting that the model error terms are serial uncorrelated in levels. The coefficients of the lagged dependent variables are significant at the 1 percent level – which also justifies the use of a dynamic form for the relationship. Since the coefficients are all positive there is evidence of mean reversion and long run stability within the insurance sector in terms of efficiency of operations. The coefficients of the lagged dependent variables are however low at 0.181 for the baseline estimates. This shows that that adjustment to long run equilibrium in ROA is slow following the process of movements in the independent variables.

Table 4.6: Results for determination of ROA

	Baseline estimates		*Controlled estimates*	
Variable	**Coefficient**	**Prob.**	**Coefficient**	**Prob.**
ROA_{t-1}	0.181**	0.00	0.177**	0.00
SHF	-11.957**	0.00	-10.376**	0.00
URP	0.517**	0.00	0.668**	0.00
RES	-2.510**	0.00	-2.458**	0.00
EAR	-1.568**	0.00	-1.652**	0.00
GPW	1.769**	0.00	2.191**	0.00
RCR	0.005	0.17	0.004	0.42
CF	-0.037**	0.00	-0.036**	0.00
FSIZE	-3.198**	0.00	-2.508**	0.00
LGDPPC			-0.727**	0.00
INFL			-0.001	0.46
Hansen J (prob)	0.31		0.252	
AR(1) (prob)	2.19*		2.03*	
AR(2) (prob)	0.478		0.511	

Note: * and ** indicate significance at 5% and 1% level, respectively. Source: Author's computation

Source: Author's computation, (2021) using Eviews 10.0.

The relative contribution of the underwriting capacity and carbon footprint variables to ROA for the insurance firms is determined by observing the coefficients of the explanatory variables in terms of signs and significance. From the baseline estimate in Table 4.6, it is seen that all the coefficients passed the significance test at the 1 percent level (except for ratio of ceded reinsurance - RCR which also fails the test at the 1 percent level). In particular, the result shows that the coefficient of shareholders fund (SHF) is negative, suggesting that increased shareholders' funds tend to reduce ROA among the companies. It implies that as more shareholder funds are introduced to the companies, operational efficiency tends to drop significantly. The result also shows that though shareholders' funds are pivotal in controlling other underwriting systems and capacities among the companies, excessive funds may act as an inhibitor to improvements in financial efficiency among the insurance firms. The coefficient of earnings-to-assets ratio is also negative and indicates that rising earnings in terms of assets may not be an efficiency enhancement factor, especially in the short term for insurance companies from the sample.

The coefficients of all the other significant variables are positive, which show that underwriting capacity in terms of increased underwriting profits, and better gross premium written by the insurance firms, will lead to better operational efficiency in the of insurance firms. It is therefore shown that while shareholders' funds may boost premium, the main direct factors that drive performance of financial efficiency among the insurance companies are the reserves, underwriting profits and premiums for the companies. An insurance company with less shareholders' fund but with better management of premium receipts and underwriting will be better in terms of ROA than a firm with large funds without due consideration for the other underwriting capacity factors. On the other hand, it is seen that improved reserves in the companies leads to lesser ROA. Thus, retention systems for insurance companies are strong deterrence to financial efficiency among the firms.

The coefficient of carbon footprint is negative and significant at the 1 percent level. This implies that the impact of carbon footprint is negative and effective on the ROA of the insurance firms. Thus, increased environmental degradation through more carbon emission tends to reduce ROA among the insurance firms. The process of this negative impact follows the fact that increased degradation also increases the risks for insurers and if not appropriately measured and considered, this may pose strong setback for operational activities in the companies, especially those in developing countries (Grimaldi, 2021). The results of the controlled estimation are similar to that of the baseline estimates, which indicates that the estimated coefficients are robust to given circumstances in the economies. This implies that the effects of the underwriting capacity factors and carbon footprint on ROA do not change irrespective of the size of the insurance companies or the prevailing macroeconomic situations. In the controlled results, the coefficient of firm size is significant and negative. Essentially the result shows that the bigger the firm, the smaller the ROA, and a greater leverage relative to asset structure of the firm, the lesser the ROA.

The result for the effects of the underwriting capacity and carbon footprint on return on equity (ROE) is presented in Table 4.7. This estimation is performed because the relationships may differ for the firms in terms of financial performance relating to operational efficiency or efficiency of shareholders' resource use. The diagnostic tests are also impressive, given that Hansen J-value is insignificant and the AR(1) and AR(2) possess the expected signs. The coefficient of lagged dependent variables for both estimates of ROE fails the significance test although they possess the expected positive value. This poses a strong mark on the long run stability of the ROE estimates based on the effects of the underwriting capacity factors. This also suggests that adjustment to equilibrium may be too slow to be significantly different from zero in the insurance sector for the companies.

Table 4.7: Results for determination of ROE

Variable	*Baseline estimates*		*Controlled estimates*	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**
ROE_{t-1}	0.002	0.75	0.005	0.48
SHF	2.016	0.22	3.152	0.11
URP	2.129**	0.00	1.763**	0.00
RES	-0.486**	0.01	-0.620**	0.00
EAR	4.471**	0.00	3.882**	0.00
GPW	1.135**	0.00	2.008**	0.00
RCR	-0.010	0.56	-0.005	0.81
CFP	-0.059**	0.00	-0.065**	0.00
FSIZE	-1.693**	0.03	-1.761*	0.04
LGDPPC			-2.020**	0.00
INFL			-0.005	0.17
Hansen J (prob)	0.702		0.621	
AR(1) (prob)	-2.27*		-2.79*	
AR(2) (prob)	-0.83		-0.51	

Note: * and ** indicate significance at 5% and 1% level, respectively. Source: Author's computation using Eviews 10

Source: Author's computation, (2021) using Eviews 10.0.

In terms of the effects of the explanatory variables, a close look at the coefficients in Table 4.7 reveals that the coefficient of shareholders' fund is positive but fails the significance test at the 5 percent level. This implies that shareholders fund does not lead to changes that will generate improvements in return on equity for the insurance companies. Essentially, the funding of insurance companies does not promote the performance of the companies for the shareholders. On the other hand, the coefficients of URP, EAR and GPW all pass the significance test at the 1 percent level and are all positive. This implies that increasing the underwriting profits as well as earnings ratio will boost shareholders' value in the firm, as is to be expected. Companies with better underwriting efficiency as well as earnings and premium yields always perform better in terms of return on equity. Reserves however have a significant negative coefficient in the estimates, indicating that larger reserves in the company's lead to lesser ROE for the firms.

Given the nature of reserves, the result suggests that companies with more forceful attempts in the market in terms of risk taking appear to perform better. The controlled results are similar to those of the baseline estimates, which show the robustness of the estimates.

The results for Tobins' Q estimates are presented in Table 4.8. For this result, the Arellano-Bond AR(2) is insignificant at the 5 percent level, indicating the absence of serial dependence among the errors in their levels. Also, the Hasen J-statistic has probability values that are greater than 0.1, which indicate that the instruments used in the GMM estimation were well defined and appropriate. The coefficient of the lagged dependent variable ($TOBINQ_{t-1}$) is significant at the 1 percent level, and it is positive as expected. The coefficient is also sufficiently large to suggest that persistence is low in the system – any disequilibrium in the short run can be quickly adjusted in the long run given the influences of the underwriting capacity factors as well as the carbon emission effects.

In terms of the individual effects of the explanatory variables on Tobins' Q, the result shows that the coefficient of SHF is positive and significant in the baseline equation, which shows that shareholders' funds are essential in promoting the market performance of the insurance companies. It should be noted that this is the only equation where the SHF coefficient is both positive and significant. This shows that the relevance of the insurance companies in the market among investors consideration is the main aspect where larger shareholders' funds are reflected among insurance companies. Firms with more funds are shown to demonstrate better influences in the market than firms with fewer funds. This is one important area where shareholders' funds play significant roles in directly influencing the performance of insurance companies. All the other coefficients (except reserves) are positive and significant at the 1 percent level. This result therefore indicates that underwriting profits, earnings to assets ratio, gross premium written, and the ratio of ceded reinsurance all exert positive effects on the market performance of the firms. On the other hand, the levels of reserves in the companies limit the market performance. Given that reserves are related to the retention policy of the companies, the result indicates that higher retention inhibit the market performance of the firms. This result indicates that the positive impact of underwriting capacity on the performance of insurance companies is better observed through the market performance of the firms. This outcome is essentially plausible because, the weight of the insurance company is heavily dependent on the pattern of trust that is reposed on them (Cummins et al., 2011; Koc, 2016).

Table 4.8: Results for determination of Tobin's Q

Variable	*Baseline estimates*		*Controlled estimates*	
	Coefficient	**Prob.**	**Coefficient**	**Prob.**
$TOBINQ_{t-1}$	0.787**	0.00	0.783**	0.000
SHF	6.708*	0.02	2.828	0.142
URP	1.376**	0.00	0.937**	0.000

RES	-1.262**	0.00	-1.540**	0.000
EAR	1.166**	0.00	3.976**	0.000
GPW	2.094**	0.00	0.142	0.685
RCR	0.002**	0.00	0.008	0.220
CFP	-0.018**	0.00	-0.003	0.508
FSIZE	-3.773	0.00	-0.533	0.555
LGDPPC			0.856**	0.000
INFL			-0.008**	0.000
Hansen J (prob)	0.376		0.384	
AR(1) (prob)	-3.47**		-2.91*	
AR(2) (prob)	0.26		0.24	

Note: * and ** indicate significance at 5% and 1% level, respectively. Source:

Source: Author's computation, (2021) using Eviews 10.0.

The results also demonstrate the impact of carbon footprint on the market performance of the insurance companies. The coefficient of CFP in the result is negative (like in other estimates) and significant at the 1 percent level. This shows that higher carbon footprints in emission lead to lesser market value of the firms. Thus, carbon emission or environmental degradation also tends to limit the performance of the insurance firms in the market. Thus, the result demonstrates an unambiguously negative impact of carbon footprint on all indicators of financial performance of the insurance companies within the sub-Saharan African region. The impact of firm size is also negative in this result, indicating larger companies do not perform better than smaller ones in terms of market value. The results of the controlled estimation are only slightly different from those of the baseline regression especially in terms of the signs of the coefficients. This also demonstrates the robustness of the estimates in the study.

In order to further examine the intensity of the role of carbon footprint on insurance market activities, an interactive model is estimated where carbon footprint variable is interacted with all the other underwriting capacity variables and the results are presented in Table 4.9. In the results for ROA, the coefficient of all the variables in interaction with carbon footprint is negative, except for RES and GPW (which is not significant). This indicates that countries with increased and larger carbon footprint will experience lower impacts of the underwriting capacity variables on ROA for the firms. However, higher footprint for the countries renders the effect of reserves to be positive, which is the reverse of the initial negative effect. This also supports the fact that carbon footprint is inimical to the financial performance of insurance firms. Similar results are observed for both ROE and Tobin's Q estimations. There is therefore clear evidence that when carbon footprint (carbon dioxide (CO_2) and other greenhouse gas emission) is rising for a country, insurance firms in the countries need to operate more efficiently in terms of underwriting activities in order to generate performance outcomes when compared with companies in countries with lesser carbon footprint. Thus, carbon footprint is seen to act as an additional constraint on the efficiency and performance of insurance companies.

Table 4.9: Results for interaction relationships

Variable	*ROA equation*		*ROE equation*		*TOBINQ equation*	
	Coeff.	**Prob.**	**Coeff.**	**Prob.**	**Coeff.**	**Prob.**
lagged dependent variable	0.055**	0.00	0.042**	0.00	0.793**	0.00
*SHF*CFP*	-0.01**	0.00	-0.017**	0.00	-0.009**	0.00
*URP*CFP*	-0.003**	0.00	-0.005**	0.00	0.001**	0.00
*RES*CFP*	0.013**	0.00	0.010**	0.00	0.001	0.63
*EAR*CFP*	-0.017**	0.00	-0.021**	0.00	-0.024**	0.00
GPW&CFP	-0.000	0.86	-0.008**	0.00	-0.007**	0.00
*RCR*CFP*	-0.000	0.60	0.000	0.49	0.000	0.54
CFP	-0.015	0.13	-0.055*	0.01	-0.024**	0.00
FSIZE	0.282*	0.01	0.537*	0.01	0.681**	0.00
Hansen J (prob)	0.60		0.25		0.44	
AR(1) (prob)	-1.36				-2.43*	
AR(2) (prob)	-0.54				-0.55	

Note: * and ** indicate significance at 5% and 1% level, respectively.
Source: Author's computation, (2021) using Eviews 10.0.

4.6 Discussion of Findings

The study finds that shareholders' funds have significant negative impact on ROA, non-significant effect on ROE, but a significant positive impact on Tobins Q. This outcome is similar to previous findings by Soye and Adeyemo (2017), Alani and Sani (2019) and Oyetayo and Abass (2020) who also found varied impacts of shareholders' funds on the performance of insurance companies in Nigeria. These results therefore appear to highlight the presence of an optimal shareholders' fund input for insurance firms in terms of boosting operational efficiency. This implies that acquisition and use of shareholders' funds may need to be more efficiently controlled. Although shareholders' funds are pivotal in controlling other underwriting systems and capacities among the companies, excessive funds may act as an inhibitor to improvements in financial efficiency among the insurance firms. The coefficient of earnings-to-assets ratio is also negative and indicates that rising earnings in terms of assets may not be an efficiency enhancement factor, especially in the short term for insurance companies from the sample.

From the results, underwriting profits have clear and unambiguous positive impact on all the measures of financial performance of the companies. Thus, efficiency in underwriting (which ultimately leads to more profits) is expected to boost insurance companies at all levels. Soye and Adeyemo (2017) also found similar results for Nigeria, where underwriting profits are considered as an integral aspect of the drive by insurance companies to improve overall efficiency and market performance.

Moreover, reserves in the companies were also shown to negatively affect all measures of performance of the insurance companies. This result demonstrates the inefficiency-enhancing role of retention policy among insurance firms. Though retention may act as a risk aversion strategy, the result from the study has shown that it does not provide enough effects to improve the performance of the companies. The results follow the outcomes of previous studies and corroborate the findings of Oyetayo and Abass (2020) for Nigeria (where they found a weak negative effect). In the same vein, the study is in consonance with findings that show that increased retention generally limits performance of insurance companies, especially in terms of market value and return on equity (Soye & Adeyemo, 2017; Mohamed, 2019).

In general, the results from the study show that the positive impact of underwriting capacity on the performance of insurance companies is better observed through the market performance of the firms. This implies that it is Tobin’s Q measure of performance that better reflects how underwriting capacity contributes to firm performance. This outcome is important because it shows that boosting underwriting capacity in terms of operational efficiency, funding activities and revenues is directed at stimulating the market performance of the firms. Apparently, the result indicates that investors are quick to consider the underwriting systems of insurance companies in valuation of the firms. This result is in line with pure textbook propositions about insurance firms and is also supported by previous studied (Mankai & Belgacem, 2013)

Another important outcome in the study is the clear negative impact that carbon footprint was found to exert on all performance indicators. Thus, there is a clear negative effect of carbon footprint on performance indicators of insurance firms. This result has strong implications given that, like Grimaldi (2021) noted, the environment plays significant roles in activities of modern insurance companies, especially in developing countries. In particular, both investors and regulatory agencies has begun to increase pressure on the industry to provide appropriate mechanisms for responding to risks associated with climate change since more and more segments of the society are being affected. This can lead to depletion of premium and profit pools even for more stable market segments since insurance will become difficult to operate by the affected companies. As Croson and Kunreuther (2000) has noted, increased risks in the environmental degradation imposes additional moral hazards that are related to information limitation on the insurance company, thereby increasing costs and reducing efficiency. This has necessitated recent aspects of the insurance industry that focuses on environmental liability which is aimed at reducing the information asymmetry problems generated by environmental demands. Similar outcomes are demonstrated in Doherty and Richter (2002) in an earlier research for advanced economies.

5 Conclusion and Recommendation

5.1 Conclusion

The insurance sector appears to be on an upward movement in sub-Saharan African countries and has started to play a significant role the in developing economies. Thus, proper focus on its main activities from both the policy and operational perspectives are essential. The major foundation for the processes in this study is that the insurance market is an integral aspect of the financial market and needs concrete empirical evaluations, especially with respect to factors that explain its dynamic behaviour overtime. This study primarily set out to address these issues by explaining the main internal and external factors that drive the performance of the insurance companies in Sub-Saharan African countries. Essentially, the focus is on the operations of the companies in terms of underwriting capacity as well as the recently growing role of the environment in insurance business. The study has shown that while internal factors (which the firms can easily control) tend to steadily improve performance when effectively deployed, environmental factors (captured by carbon footprint) may be playing a role that tends to impose more constraint on efficiency performance of these companies among Sub-Saharan African countries.

The broad-based perspective taken by this study in terms of number of companies and countries included provides a significant background for evaluating the broad influences that the insurance sector may be facing among Sub-Saharan African countries. In the same vein, this current study is very relevant for both policy directions and operational dimensions within the insurance markets. This is better demonstrated in the type of data employed – firm-specific which can better capture internal aspects of performance and functions. Moreover, the factors considered in the study are mostly non-extraneous to the internal operational workings of the insurance firms.

5.2 Recommendations

The following policy recommendations are made in accordance with the outcomes of this research:

(i) First, there is need for a strategy to manage shareholders' funds in an optimal manner among insurance firms. Although shareholders' funds are pivotal in controlling other underwriting systems and capacities among the companies, excessive funds may act as an inhibitor to improvements in financial efficiency among the insurance firms. Thus, the companies need not overemphasis the role of shareholders' funds in the effective promotion of performance among the insurance firms.

(ii) Given the negative effects of climate change (measured as the carbon footprint in the economy) on insurance performance, there is the need for insurance companies in Sub-Saharan African countries to adopt revised business models that can provide safety nets both to support customers and enhance business efficiency. This should be done by making climate risks as part of their strategic management decisions. In this direction, the strong participation of the companies in the field of risk needs to be combined with climate science in order to help provide mitigation systems against the influences of climate risks.

(iii) Finally, given that modern systems are interconnected in terms of operations and resources, the concentration of risk are likely to increase as climate degradation leads to losses spreading across different types of coverage among the countries in the study. Thus, a single event may generate an increase in multiple claims filing leading to aggregation risk arising from effects that are beyond geographic bounds. There is therefore need for insurance companies to adopt more innovative means of addressing the risks posed by climate change, either by helping to mitigate the risks or gearing up measures to help activate global climate change minimization.

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