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Measuring Stock Market Volatility in a Less Developed Economy: Evidence from Cameroon

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Abstract: ***Over the past decades, the importance of understanding the volatility of stock markets has received significant attention among researchers and analysts. Since the stock market crash of 19th October 1987, considerable attention has been given to stock market volatility especially in emerging and less developed countries. This study was carried out to determine the causes of stock market volatility and to quantify the volatility of the stock market in Cameroon using the GARCH model. Data was collected on the daily stock prices of selected quoted companies of the stock market in Cameroon from the 2nd of August 2019 to the 17th of February 2023 and analysed using Eviews. The results show that both the ARCH and the GARCH parameters were highly significant with p – values of 0.0000. The sum of the ARCH effect and the GARCH effect was closed to one, implying that any shock experienced on the conditional variance will be highly persistent. The study concludes that the GARCH model is a better forecasting model of volatility in the stock market in Cameroon than the ARCH model.***

Keywords: GARCH Model, Stock Market Volatility, Less Developed Economy

1. Introduction

1.1 Background

Stock market volatility has been an important research area since the publication of the seminar paper "Portfolio Selection" by Markowitz in 1952 which formed the basis of the first capital asset pricing model of Sharpe (1964), Lintner (1965) and Mosin (1966). Fama (1970) developed the efficient market hypothesis and Black (1976) reported the existence of predictive asymmetry between stock returns and future volatility. Volatility since then has been considered an important concept for many financial applications like portfolio optimization, risk management and asset pricing. Over the past decades, the importance of understanding the behaviour of volatility in stock markets has received significant attention among researchers and analysts. Ever since the stock market crash of 19th October 1987, considerable attention has been given to overall stock market volatility especially in emerging and less developed economies. A common fact about less developed economies is the high volatility of their stock markets due to their critical vulnerability to exogenous shocks (De Santis 1997; Aggarwal et al., 1999; Xu 1999; Cano – Berlanga and Cano – Gimenez 2018). The volatility of stock returns in less developed countries is important to investors as it helps them to measure and manage market risk more accurately, thereby assisting them in pricing capital assets, since volatility is directly associated with the risk and return of an asset.

Volatility is a measure of the rate of fluctuation in the price of a security over time. It indicates the level of risk associated with the price changes of a security. Rajput and Kakkar (2012) interpret volatility as a measure of the difference between an asset's current price and its average past prices. This means that volatility can be measured by looking at the rate at which an asset's price varies from its average price. Wang et al (2021) explained that volatility in financial terms could be historic volatility or realised volatility. Historic volatility, also known as statistical volatility is the degree to which the price of a security changes during a given period, usually daily while realised volatility is the predictive future changes in the price of a security. Realised volatility provides a forecast of future price changes since volatility tends to be persistent. Given the importance of stock market volatility especially in an less developed economy, it was necessary to measure the degree of stock market volatility in Cameroon.

1.1.1 Overview of the Stock Market in Cameroon

Cameroon is a member of the Central African Economic and Monetary Community (CEMAC), comprising Cameroon, Congo, Gabon, Equatorial Guinea, Central Africa Republic and Chad. The origin of the stockmarket in Cameroon (Douala stock exchange market) began in a project sponsored by CEMAC with an objective to create stock exchange markets in Cameroon and Gabon. The Douala stock exchange market was created on the 1st of December 2001. The first listing of the market was the Mineral Water Company of Cameroon (SEMC), a subsidiary of the French company Castel Group. Between 2001 and 2019, the Douala stock exchange market was the official securities market in Cameroon. In October 2017, the Head of States of the CEMAC Region meeting in Ndjamena decided to merge the two stock exchanges of the region. This decision was confirmed on the 24th of March 2018. In 2019, the Douala stock exchange market merged with the stock exchange of Central Africa to form a single stock exchange market for the CEMAC Zone with head office in Douala - Cameroon.

The stock market in Cameroon engages in stock exchange transactions within the member states of CEMAC. The market trades in shares, bonds and other investment products of companies. It operates in three divisions; officially listed shares, officially listed loan notes and debts instruments and unlisted securities. The listed shares division trades in shares of companies that were voluntarily introduced into the market either by introducing new shares of by transferring part of the capital of a company to the public. This division is sub divided into two, with the shares of large companies in one section and the shares of small and medium sized enterprises in the other section. The second division of listed loan notes and debts instruments consist of trading in bonds. It is divided into two sections, with the first section trading in private bonds and the second section in government bonds and treasury bills. The third section is designed for securities of unlisted companies. Table 1 below presents the listed companies of the stock market in Cameroon.

Table 1: Listed Companies in the Stock Market in Cameroon

Name of Company	*Location*	*Sector*	*Share Capital (FCFA)*	*Date of Creation*	*Initial Public Offering*
Société des Eaux Minérales du Cameroun (SEMC)	Douala (Cameroon)	Agri food	1, 924, 730, 000	16/01/1979	30/06/2006
Société Africaine Forestière et Agricole du Cameroun (SAFACAM)	Dizangue (Cameroon)	Agri food	6, 210, 000, 000	12/01/1962	09/07/2008
Société Camerounaise de Palmeraies (SOCAPALM)	Tilo (Cameroon)	Agri food	45, 757, 890, 000	11/06/1968	07/04/2009
Investment Company for Tropical Agriculture (SIAT)	Libreville (Gabon)	Agri food / Livestock	74, 000, 000, 000	05/05/2004	19/07/2013
La Regionale	Yaounde (Cameroon)	Microfinance	10, 125, 360, 000	1993	09/02/2021
National Bank of Equatorial Guinea (BANGE) Cameroon	Yaounde (Cameroon)	Banking	20, 000, 000, 000	2006	28/09/2022
Gabonese Re insurance Company (SCG - Re)	Libreville (Gabon)	Insurance	15, 000, 000, 000	2011	26/01/2023

Source: Tayong (2023)

1.2 Problem Statement

Many studies have been carried out by researchers in an attempt to investigate the determinants of stock market volatility and to measure the volatility of the stock market of an economy. Most of these studies were done in western economies and more developed stock markets. In less developed countries, studies on stock market volatility have been far less than those in developed countries. Given the importance of volatility as a component of risk measure, it is necessary for less developed economies to analyse the performance of their stock exchanges to seek ways to improve on such performance. Rajni and Mahendra (2007) noted that while there is a general consensus on what constitute stock market volatility, there is a far lesser agreement on the causes of changes in the prices of stock in the capital market. A common problem plaguing the slow growth of less developed countries is their shallow stock markets and the inability of such shallow stock markets to play its role in the process of economic growth and development by facilitating the channelling of funds from savers to depositors. It becomes paramount for less developed countries not just to assess the determinants of volatility in their stock markets but also to measure the extent of such volatility. It is within the backdrop of this problem that this study has been carried out in order to determine the causes of stock market volatility and to measure the volatility of the stock market in Cameroon.

1.3 Research Objectives

The main objective of this study is to analyse the volatility of stock prices in the economy of Cameroon. Specify objectives include

a) To determine the causes of volatility in the stock market in Cameroon.
b) To determine and quantify the volatility of stock prices in Cameroon using the GARCH Model.

1.4 Research Hypotheses

H1: The volatility of stock prices in Cameroon can be measured using the GARCH Model

2. Literature Review

2.1 Conceptual Literature

Volatility is a measure of the rate of fluctuation in the price of a security over time. In financial markets, volatility is synonymous to risk since asset pricing, portfolio selection and risk management are centred on measuring and forecasting volatility. Volatility therefore indicates the level of risk associated with the price changes of a security. In terms of investment decision, volatility describes a situation where an investment in a security experiences periods of unpredictable price movements which could be an increase in the price of the security or a fall in the price of the security. Stock market volatility is a measure of the extent to which the stock market's overall value fluctuates up and down. Given the importance of volatility, it is necessary to measure the volatility of a stock market.

The most common measure of volatility is the standard deviation. Using the standard deviation in measuring volatility involves firstly the determination of the time frame for the returns to be measured. This could be hourly returns, daily returns, monthly return or yearly returns. Volatility is then measured using the formula as expressed below.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}(r_i - \hat{r})^2}{n-1}}$$

Where
r_i = Rate of return for the i^{th} day
$\hat{r}$ = Average rate of return for the month
i = Day identifier for the month

A low standard deviation will reflect a situation of low volatility in the stock market while a high standard deviation will imply a high volatility of security prices in the market.

Volatility can be used to measure the value of an option on the same stock market and with the same expiration date. This is done using the Black – Scholes formula below

C = S x N (d1) – K x N (d2)

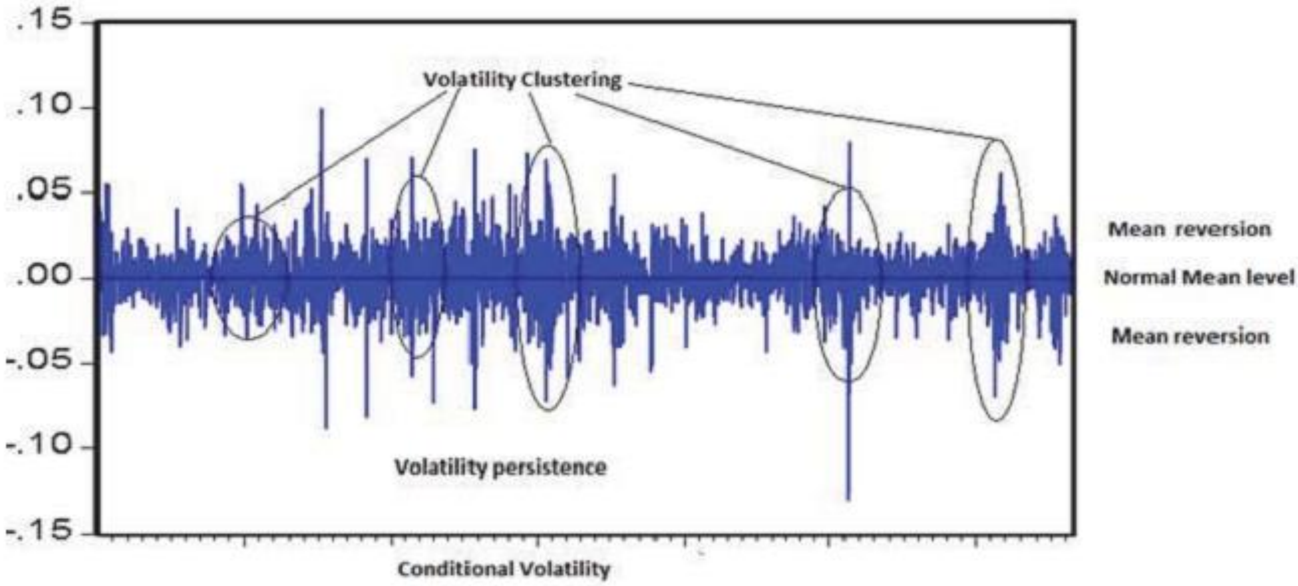
Where

$$d1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d2 = d1 - \sigma^2.\sqrt{t}$$

2.1.1 Characteristics of Volatility

Mamtha and Sakthi (2016) noted that the three main characteristics of volatility are volatility clustering, mean reversion and volatility persistence. These could be illustrated on the diagram below.



Volatility Clustering

An important aspect of volatility of asset prices is the collection of small and large movements of asset prices known as volatility clustering. Some of the earliest studies of stock market volatility such as Mandelbrot (1963) and Fama (1965) have shown that volatility in financial time series tend to cluster as large changes in the price of an asset are often followed by other large changes and smaller changes are often followed by other smaller changes. Bose (2007) examined the characteristics of volatility and suggested that large changes in the prices of securities in a stock market are more likely to be followed by further large changes, with the high volatility proceeding for a while after the initial stock, and similarly a period of low volatility is likely followed by small changes. An implication of volatility clustering is that when volatility clusters within the returns of financial assets, the random walk model of Fama (1965) will no longer be valid.

Mean Reversion

Each asset traded in the stock market has its own underlying volatility level. Mean reversion refers to the fact that shocks of volatility will affect the returns of an asset to its mean level. Mean reversion therefore explains the assumption that an asset's price will tend to converge to the average price over time. If the current price of a security is more than its average price, the security will be attractive to purchase because of the expectation that the price will rise. An implication of mean reversion is that deviations from the average price of a security are expected to revert to the average price over time. Mehta et al (2004) note that an asset model is mean reverted if the prices of the asset tend to fall after hitting a maximum value or tends to rise after hitting a minimum value.

Volatility Persistence

Volatility persistence refers to a situation where the effect of shocks for an underlying asset will take a long time to recover to its normal mean level. This means that today's return on an asset will have an effect on the unconditional variance of many periods in the future. The implication here is that the unconditional variance will tend to be infinite. Volatility persistence is therefore the strength of the volatility feedback as high persistence will mean the volatility shock will be felt further in the future. A good model used in measuring volatility must produce a constant future variance. This is because a model with an infinite variance cannot predict precisely future volatility.

2.2 Theoretical Literature

2.2.1 The Portfolio Theory of Markowitz (1952)

Instead of focusing on the risk of an individual asset, the Portfolio Theory of Markowitz (1952) demonstrated that a diversified portfolio is less volatile than the total sum of the individual investments that make up the portfolio. The theory suggest that as investors are risk averse, a rational investor will always choose a less volatile asset as long as both investments provide an equivalent expected return. This portfolio theory is based on the following assumptions:

- Investors are risk averse
- The goal of every investor is to maximize return for a given level of risk
- Risk can be reduced by diversifying a portfolio through individual and unrelated securities.

According to the portfolio theory, there are two categories of risks. These are systematic risk and unsystematic risk. Systematic risk is the market risk that cannot be reduced but unsystematic risk which is specific to an investment can be reduced by increasing the number of assets in the portfolio. The portfolio theory is based on the premise that the volatility of a portfolio is lower than the sum of volatile of the individual assets that make up the portfolio.

2.2.2 The Capital Asset Pricing Model of Sharpe (1964), Lintner (1965) and Mossin (1966)

The Capital Asset Pricing Model (CAPM) describes the relationship between systematic risk and the expected return of an asset. It is used to determine the rate of return of an asset that is required to make a decision of adding the asset to a well - diversified portfolio and less volatile portfolio. This theory is based on the following assumptions:

- Investors have identical time horizon. They buy all the assets in their portfolio at one time and will sell them at another time
- Investors are risk averse and will like to reduce their risk through diversification
- There is free access to all available information.
- There is a risk free asset and there are no restrictions on borrowing and lending at the risk free rate.

The theory was developed at a time when the theoretical foundation of decision making under uncertainty was relatively new and when basic empirical facts about risk and return in a capital market were not known. The theory therefore builds on the Portfolio Theory of Markowitz (1952). Based on this theory

$$ER_i = R_f + \beta\,(ER_m - R_f)$$

2.2.3 Efficient Market Hypothesis by Fama (1970)

This theory states that in an active market with well informed and educated investors, securities will be appropriately priced and will reflect all available information. Fama (1970) defined a market to be "informationally efficient" if prices at each moment incorporate all available information about future values. The efficient market hypothesis theory is based on the following assumptions:

- Information is universally shared
- Stock prices follow a random walk, meaning they are determined by today's news rather than yesterday's trend.

There are three forms of the Efficient Market Hypothesis

a) The weak form which suggest that the prices of securities reflect only past information. The market is efficient but anomalies can occur in the market and such market anomalies could be exploited through arbitrage, thereby restoring efficiency.
b) The semi strong form which suggest that the prices of securities reflect past and present information that is available. The semi strong hypothesis suggests that security prices will reflect publicly held information but may not incorporate privately held information.
c) The strong form which suggest that the prices of securities reflect past, present and future information that are either private or public information, formal or informal information.

2.3 Empirical Literature

Nguyen and Nguyen (2019) carried out a study with the aim of measuring stock price volatility on Ho Chi Minh stock exchange market (HSX) by applying asymmetric models (GARCH, GARCH - M) as well as EGARCH and TGARCH. Using daily stock prices from the 1st of March 2001 to the 1st of March 2019 with 4376 observations, the results of their study show that GARCH (1, 1) and EGARCH (1, 1) models are the most suitable models to measure stock price volatility. The results of the study also provided evidence to show that positive shocks have significant effect on the conditional variance (volatility), thereby implying that the volatility of stock market return in the Ho Chi Minh stock exchange market has a big impact on future market movement.

In a study by Malika (2020) on stock market volatility analysis with the aim to examine the volatility characteristics of the Tunisian stock exchange, 5 days a week stock prices for the period 1st February 2011 to 19th November 2019 giving a total of 2191 observations were used. The GARCH model was employed to estimate the volatility of the daily stock returns. The findings of the study suggest that GARCH – M and TGARCH models can capture volatility characteristics of the Tunisian stock exchange market where as EGARCH reveals no significant support for the existence of volatility.

Minimol (2021) carried out a study to examine the determinants of stock price volatility using data collected from 30 Sensex companies listed in the Bombay Stock Exchange Market in India. Using a linear regression model to establish the relationship between the variables, the study reveals that apart from dividend pay - out ratio, other variables such as dividend yield, firm size, leverage and earnings per share have significant relationship with stock price volatility. This study therefore provides an insight on the factors that contribute to a firm's decision to engage or disengage in a dividend payment policy. The study re instates the negative relationship between stock price volatility and dividend yield and firm size, while confirming the positive relationship between stock price volatility and leverage and earnings per share.

2.4 Gaps and Contributions

Previous studies on measuring stock market volatility were mostly carried out in developed countries that are governed by different policy frameworks and regulations. Such global views on the degree of volatility in stock markets cannot be generalised in the stock market in Cameroon without prior empirical investigation. A review of existing literature reveals that few studies have been done in Central Africa on measuring stock market volatility. This study was therefore aimed at bridging this literature gap by measuring the volatility of the stock market in Cameroon.

3. Methodology

3.1 Research Design

This study adopted the longitudinal research design. This is a research design that will permit the researcher to examine the same individuals repeatedly in order to detect any changes that may occur over a period of time. Since this study is aimed at measuring stock market volatility in Cameroon, the choice of this research design is therefore based on the fact that it permits the researcher to monitor changes in the variable of interest, in this case stock prices in the stock market in Cameroon. The research design also facilitates the prediction of future outcomes based upon past outcomes, and will permit the measurement of changes in the variable of interest from one period to another.

3.2 Nature and Sources of Data

This study used secondary time series data. This is data collected from specific individuals or variables over a consistent intervals of time. Specifically, 3 days a week stock prices of selected listed companies in the Stock Market in Cameroon were used. Data was collected from the selected companies from the 2nd of August 2019 to the 17th of February 2023. Data was collected from the official trading bulletin of the market published three days a week - Mondays, Wednesdays and Fridays.

3.3 Model Specification

Since financial time series data are characterised by dynamic variables which could vary with time heteroskedastic variance, the Generalised Autoregressive Conditional Heteroskedastic (GARCH) model is adopted in this study to analyse the volatility of stock market returns in Cameroon. The choice of the GARCH model is based on the premise that it allows for symmetry in the responsiveness of shocks, it does not impose the non - negative constraints on data and also that the model reduces the effects of outliers on the estimation results. The equation of the GARCH model involves the joint estimation of the mean equation and the equation of the conditional variance. The mean equation is given as

$$Y_t = X_t\theta + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where X_t is the vector of exogenous variables. The equation of the conditional variance is given as

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad \ldots\ldots\ldots\ldots\ldots(2)$$

Where ω is the constant term, $\alpha\varepsilon_{t-1}^2$ is the ARCH term and $\beta\sigma_{t-1}^2$ is the GARCH term.To ensure covariance stationarity, $\omega > 0$, $\alpha > 0$, $\beta > 0$ and $\alpha + \beta < 1$.

3.4 Diagnostic Tests

Before the estimation of the GARCH model the following tests were performed on the collected data to ensure that the data meet certain conditions to permit the results of the study to be good for analysis and interpretation.

3.4.1 Normality Test

The data used in this study was tested for normality. This study adopted the Jarque – Bera test for normality. The Jarque Bera test is a goodness of fit test used to determine whether the sample data have the skewness and the kurtosis matching a normal distribution. When performing the test, the null hypothesis is;

H0: The sample data are not significantly different than a normal population.

The test statistic for Jarque – Bera Test is given as

$$JB = n\left[\frac{(k_3)^2}{6} + \frac{(k_4)^2}{24}\right]$$

With

$$k_3 = \frac{\sum_{i=1}^{n}(x_i - \overline{x})^3}{ns^3} \quad \text{and} \quad k_4 = \frac{\sum_{i=1}^{n}(x_i - \overline{x})^4}{ns^4}$$

Where

JB = Jaque Bera Statistic, xi = each observation, n = sample size, x = mean, s = standard deviation, k3 = skewness and k4 = kurtosis. JB is calculated with the critical values of chi square at 10%, 5%, 1% level of significance. The decision rule after performing the test is based on the condition that;

If JB calculated > critical λ2, the null hypothesis is rejected and the data is not normal.

If JB calculated < critical λ2, the null hypothesis is accepted and the data is normal.

3.4.2 Stationarity Test

The data used in this study was tested for stationarity. The Augmented Dickey Fuller test was used in this study to test for stationarity. It is necessary to perform the test in order to determine the existence of unit root. Where the variables are stationary, it means that no unit root exists in the data and as such the result will be good for interpretation. When performing this test, the null hypothesis is

H_0: There is a unit root at some level of confidence.

The test statistic is a negative number which was compared to Mackinnon critical values for rejection of the hypothesis of a unit root. It is expected that the more negative the number, the greater the rejection of the null hypothesis that there is unit root in the data set. The lesser the negative number the lower the chances of rejecting the hypothesis of unit root.

3.4.3 Multicollinearity Test

This test was performed to determine whether two or more variables in our model are highly correlated, meaning one variable can be linearly predicted from another variable. This study used the correlation matrix to test for Multicollinearity. The numerical values and the signs of the correlation coefficients are used for the test. The closer the numerical value is to one, the stronger the relationship between the two variables and the closer the numerical value is to zero, the weaker the relationship between the two variables. A correlation coefficient of zero indicates the absence of a relationship while a correlation of one implies a perfect relationship between the two variables. Also a positive sign indicates a positive relationship while a negative sign indicates a negative relationship.

3.4.4 Heteroskedasticity Test

Heteroskedasticity is the condition in which the variance of the error term in a regression model varies. This study used the Breusch – Pagan test to test for heteroskedasticity. The hypothesis for conducting this test is

H_0: The residuals are homoskedastic

The hypothesis for the Breusch – Pagan test can therefore be presented as below

$\sigma_i^2 = \sigma^2 (\alpha_0 + \alpha Z_i)$ $H_0: \alpha = 0$

Where
σ_i^2 = Error variance for the i^{th} observation
α_0 and α = regression coefficients
In interpreting the results of the Breusch – Pagan test, the null hypothesis assumes homoskedasticity. If the p – value is less than 0.05, we reject the null hypothesis and infer the presence of heteroskedasticity in the data set. If the p – value is more than 0.05, we fail to reject the null hypothesis and conclude homoscedasticity.

3.5 Data Analysis

Data was analysed with the help of Eviews. Data analysis was done in two phases, the preliminary analysis and the final analysis. The preliminary analysis involves testing for various properties such as normality, stationarity and heteroskedasticity. The final analysis involves performing volatility regression using the Generalised Autoregressive Conditional Heteroskedastic (GARCH) model. The GARCH (1, 1) model was used based on the premise that previous studies have provided sufficient evidence to justify the model as the best model for measuring stock market volatility.

4. Results and Discussion

This study was carried out in an attempt to achieve two main objectives. The first objective was to determine the causes of stock market volatility in Cameroon. The second objective of this study is to measure the volatility of the stock market in Cameroon using the GARCH Model. Data was collected from selected listed companies in the stock market in Cameroon and analysed using Eviews. In this section of the work, the results of the study are presented and discussed.

4.1 Descriptive Statistics

The results of the descriptive statistics for this study are presented on table 1 below.

Table 1: Descriptive Statistics

	SAFACAM	*SOCAPALM*	*SEMC*
Mean	21125.39	28025.32	47281.29
Median	21433.00	23320.00	47000.00
Maximum	24500.00	51700.00	49999.00
Minimum	18000.00	21013.00	47000.00
Std. Dev.	1503.906	8063.521	820.5136
Observations	524	524	524

Source: Tayong (2023)

The above table shows that the average share price for SAFACAM shares during the period of study was 21, 125.39 FCFA per share, with a median amount of 21, 433 FCFA per share, maximum amount of 24, 500 FCFA per share and a minimum amount of 18, 000 FCFA per share. For the SOCAPALM shares, the average share price was 28, 025.32 FCFA, with a median value of 23, 320 FCFA, maximum value of 51, 700 FCFA per share and a minimum value of 21, 013 FCFA per share. The SEMC shares have an average share price of 47, 281.29 FCFA per share, median price of 47, 000 FCFA per share, a maximum share price of 49, 999 FCFA per share and a minimum share price of 47, 000 FCFA per share.

4.2 Normality Test Results

This study used the Jarque – Bera Test to test for normality. The results of the test is presented on table 2 below.

Table 2: Normality Test Results

	SAFACAM	*SOCAPALM*	*SEMC*
Skewness	0.040543	1.609030	2.690789
Kurtosis	2.691046	4.302254	8.457727
Jarque – Bera	2.227602	263.1304	1282.668
Probability	0.328309	0.000000	0.000000
Observations	524	524	524

Source: Tayong (2023)

The skewness for SAFACAM is closer to zero, implying that the distribution is symmetric around its mean. For SAFACAM and SEMC, the skewness is positive, implying that there will be more higher values above the mean and the distributions will have a long right tail and positively skewed. The Kurtosis of SAFACAM is approximately equal to 3, implying that it is mesokurtic, while SOCAPALM and SEMV have kurtosis of more than 3, implying that they are leptokurtic. The Jarque Bera statistics for SAFACAM is 2.227602, that for SOCAPALM is 263.1304 and that for SEMC is 1282.668. The null hypothesis for the Jarque Bera test is that the distribution is normal. For SAFACAM, the probability is 0.328309 which is greater than the critical value of 0.05. We fail to reject the null hypothesis. Hence, SAFACAM is a normal distribution. However, SOCAPALM and SEMC are not normally distributed.

4.3 Stationarity Test Results

Before performing the volatility regression using the GARCH (1, 1) model, the market returns for the stock market in Cameroon was tested for stationarity. The Augmented Dickey Fuller test was performed to test for stationarity in the data set. The results of the test could be presented below.

Null Hypothesis: RETURNS has a unit root
Exogenous: Constant
Lag Length: 6 (Automatic - based on SIC, maxlag=18)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.078199	0.9973
Test critical values:	1% level	-3.442771	
	5% level	-2.866911	
	10% level	-2.569692	

The Augmented Dickey Fuller test statistic above (1.078199) is greater than the critical values at 1%, 5% and 10% levels of significance. Also, the probability of 0.9973 is greater than 0.05, indicating that the data is not stationary. Given the fact that the data in the study was not stationary, it was transformed to become stationary by taking the first difference. The Augmented Dickey Fuller test on the transformed data. The results of the ADF test on the transformed data could be presented below.

Null Hypothesis: RETURNS1 has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=18)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.259050	0.0000
Test critical values:	1% level	-3.442771	
	5% level	-2.866911	
	10% level	-2.569692	

The Augmented Dickey Fuller test statistic of - 7.259050 is lesser than the critical value. Also, the probability of 0.0000 is lesser than 0.05, implying that the data is now stationary.

4.4 Multicollinearity Test Results

The correlation matrix was used in this study as a measure of multicollinearity. The test is based on the premise that a correlation of more than 0.7 or less than - 0.7 indicates the presence of multicollinearity. The results of the test could be presented on the table below.

Table 3: Multicollinearity Test Results.

	SAFACAM	*SOCAPALM*	*SEMC*
SAFACAM	1		
SOCAPALM	0.44415428	1	
SEMC	0.27545862	- 0.2121380	1

Source: Tayong (2023)

The correlation between SAFACAM and SOCAPALM is 0.44415428, the correlation between SAFACAM and SEMC is 0.27545862 while the correlation between SOCAPALM and SEMC is - 0.212138. Since none of the results is >0.7 or < - 0.7, it implies there is no multicollinearity in the data set.

4.5 Heteroskedasticity Test Results

This study used the Breusch Pagan test to test for heteroskedasticity. The null hypothesis of the test is that there exist homoskedasticity in the data set. The results of the test could be presented below.

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	4840.413	Prob. F(3,520)	0.0000
Obs*R-squared	505.8845	Prob. Chi-Square(3)	0.0000
Scaled explained SS	1694.245	Prob. Chi-Square(3)	0.0000

Since the probability values of 0.0000 are less than 0.5, we reject the null hypothesis that there is homoskedasticity. This implies that there is heteroskedasticity in the data set.

4.6 Volatility Regression Results

The volatility regression was performed using the GRACH (1, 1) model. Below is the presentation and discussion of the results.

Dependent Variable: RETURNS1
Method: ML ARCH - Normal distribution (Marquardt / EViews legacy)
Date: 02/22/23 Time: 11:44
Sample (adjusted): 8/05/2019 2/17/2023
Included observations: 523 after adjustments
Convergence achieved after 160 iterations
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-279.1623	99.74635	-2.798722	0.0051
RETURNS-1	0.009221	0.003178	2.901364	0.0037
Variance Equation				
C	691.0550	37.40328	18.47579	0.0000
RESID(-1)^2	0.110646	0.008741	12.65778	0.0000
GARCH(-1)	0.881356	0.005595	157.5286	0.0000

R-squared	0.020901	Mean dependent var	17.14213
Adjusted R-squared	0.019022	S.D. dependent var	184.7073
S.E. of regression	182.9421	Akaike info criterion	12.65652
Sum squared resid	17436735	Schwarz criterion	12.69725
Log likelihood	-3304.681	Hannan-Quinn criter.	12.67247
Durbin-Watson stat	1.949972		

The above results show that both the ARCH and GARCH parameters are highly significant with p – values of 0.0000. The significance of the GARCH parameter implies that any large excess return value, either positive or negative will cause the future forecast of the variance to be high for a prolonged period of time. This mean that the GARCH model is a better forecasting model of volatility in the stock market in Cameroon than the ARCH model. The results of the GARCH (1, 1) model is therefore be presented as follows;

$$\sigma_t^2 = 691.0550 + 0.110646\varepsilon_{t-1}^2 + 0.881356\sigma_{t-1}^2$$

The ARCH effect is 0.110646 while the GARCH effect is 0.881356. The sum of the ARCH and the GARCH effects (0.110646 + 0.881346) is less than 1 (0.992002). The implication of this result is that any shock experienced on the conditional variance will be highly persistent.

4.7 Causes of Volatility in the Stock Market in Cameroon

Considering the importance of stock market volatility in a less economically developed economy like Cameroon, this study was carried out with the objective to determine the causes of stock market volatility in Cameroon. The results of this study showed that there are seven main causes of volatility of stock prices in Cameroon.

1) Changes in demand and supply of securities:
In the stock market in Cameroon, the demand and the supply situations of the securities of quoted companies are not constant. Each time there is a change in the demand or the supply situation of the listed securities, there will be a change in the security price. Frequent changes in demand and supply will lead to high market volatility.

2) Changes in the prices of the output of quoted companies:
Price changes are normal business practice in Cameroon. Businesses are noted to be changing their prices frequently in an attempt to make abnormal profits. Each time there is a change in the price of the output of a company, the perception of that company will change as shareholders will view the company to be richer or poorer. This will affect the demand for the shares and also the share price, leading to volatility in share prices.

3) The payment of dividends:
While some businesses in Cameroon are noted for the regular payment of dividends, others are noted to be operating for years without paying dividend to shareholders. When dividends are paid, the demand for securities will increase, leading to an increase in security price. The non - payment of dividend will lead to a fall in the demand for the security as well as a fall in security prices.

4) Changes in the rate of dividend and interest rates of banks:
Business men in Cameroon either invest by buying securities in the stock market or may deposit their money in banks. When the rate of dividend falls, or banks increase their interest on deposit, more of the money of business men will be deposited in banks, leading to a fall in the demand for securities and a fall in security prices.

5) Key man factor:
The recruitment of a key person in a business, or the resignation of a key person in a business will affect the share prices of that business. When a key person is recruited to manage a business, the share price of that business will increase while the resignation of a key person will lead to a fall in the security prices. The frequent movement of key persons between businesses will lead to volatility in the share prices of these businesses.

5. Conclusion

This study was carried out with the objective to analyse the volatility of stock prices in Cameroon. Specifically, the study was aimed at determining the causes of volatility in the stock market in Cameroon and to quantity the volatility of stock prices in Cameroon using the GARCH model. Secondary time series data was collected from selected quoted companies in the stock market in Cameroon from the 2nd of August 2019 to the 17th of February 2023 giving a total of 524 data points. Data was analysed with the use of Eviews. The results of the study show that both the ARCH and the GARCH parameters are highly significant, implying that the GARCH model is a better forecasting model of volatility in the stock market in Cameroon than the ARCH model. The results also show that the um of the ARCH and GARCH effect is close to one, implying that any shock experience on the conditional variance will be highly persistent. Concerning the causes of volatility, the results of the study reveal five main causes of volatility in the stock market in Cameroon. These are changes in the demand and supply of securities, changes in the prices of the output of the quoted companies, the payment of dividends, changes in the rate of dividend and the interest rate of banks and the key man factor.

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