UNIVERSITY OF CAPE COAST

TESTING THE VALIDITY OF THE CAPITAL ASSET PRICING MODEL AND EXISTENCE OF MARKET VOLATILITY: AN ANALYSIS OF THE GHANA STOCK EXCHANGE

GODWILL BRUCE NYARKOH

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BY

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Thesis Submitted to the Department of Economic Studies of the School of Economics of the College of Humanities and Legal Studies, University of Cape Coast, in Partial Fulfilment of the Requirements for the Award of Master of Philosophy Degree in Economics.

AUGUST 2020

DECLARATION

Candidates Declaration

I hereby declare that this thesis is the result of my original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature ……………………… Date …………………….………

Name: Godwill Bruce Nyarkoh

Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Supervisor's Signature………………………. Date ……………………….……

Name: Dr. William Brafu-Insaidoo

Co-Supervisor's Signature……………………. Date ………………………..

Name: Prof. William Godfred Cantah

ABSTRACT

Volatility and the risk-return trade-off of equities or stock market play essential role in investment, decision making and financial stability among others. This study proposes to test the validity of the capital asset pricing model and existence of market volatility in the Ghana Stock Exchange (GSE). An investigation of eight companies listed on the GSE and market returns of GSE was done through a secondary data collected on daily basis from 4th January 2010 to 31st December 2018. The CAPM is tested on portfolios by adopting the Fama and Mcbeth (1973) two-stage regression methodology using GARCH (1,1) model in estimating the time series regressions present in the study. The study however found that in as much as the use of portfolios addresses the flaws associated with individual securities in testing the validity of CAPM, it is invalid in the GSE, as market and firm-specific risk have significant effect on the average portfolio returns of investors. The findings also revealed the GSE is mean reverting and takes a longer period (35 days) for the market to be stable overtime. The study recommends that the Central Bank of Ghana must ensure risks, which are almost inevitable, are properly priced by considering the impact they have on the economies. Also, with GSE being volatile, investors must consider day trading to avoid too many losses.

KEYWORDS

Capital Asset Pricing Model

Ghana Stock Exchange

Portfolio

Security

Volatility

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DEDICATION

To my family and friends

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LIST OF ABBREVIATIONS

ADF	Augmented Dicker Fuller
AIMS	Alternative Investment Market Segment
APT	Arbitrage Price Theory
AR	Autoregressive
ARCH	Autoregressive Conditional Hetereoscedasticity
ARIMA	Autoregressive Moving Average
ASEA	African Security Exchange Association
ATS	Automation Trading System
B-G	Breush-Godfrey
BLUE	Best Linear Unbiased Estimators
BoG	Bank of Ghana
CAL	Cal Bank Limited
CAPM	Capital Asset Pricing Model
EGH	Ecobank Ghana Limited
ETI	Ecobank Transportation Incorporation
FIMS	Fixed Income Market Segment
FM	Fama-Macbeth
GCB	GCB Bank Limited
GED	Generalised Error Distribution
KPSS	Kwiatkowski, Phillips, Schmidt And Shin
LM	Lagrange Multiplier
LSE	London Stock Exchange
MA	Moving Average

MPT	Modern Portfolio Theory
NYSE	New York Stock Exchange
RBGH	Republic Bank Ghana Limited
SCB	Standard Chartered Bank Limited
SOGEGH	Societe Generale Ghana Limited
TBL	Trust Bank (Gambia) Limited
EMH	Efficient Market Hypothesis
FTSE	Financial Times Stock Exchange
GARCH	Generalised Autoregressive Conditional Hetereoscedasticity
GDP	Gross Domestic Product
GSE-CI	Ghana Stock Exchange Composite Index
GSE	Ghana Stock Exchange
IFC	International Financial Corporation
IMF	International Monetary Fund
ISE	Istanbul Stock Exchange
JSE	Johannesburg Stock Exchange
MIMS	Main Investment Market Segment
MoUs	Memorandum of Understandings
NSE	Nairobi Stock Exchange
OLS	Ordinary Least Squared
PNDC	Provisional National Defence Council
SEC	Security Exchange Commission
SML	Security Market Line
WACC	Weighted Average Cost of Capital

CHAPTER ONE

INTRODUCTION

Considering the risk and uncertainty involved in taking up any investment opportunity, returns are always of prime concern to investors when deciding on which investments to undertake. There exist, several models, to assist investors to estimate their returns on investment pertaining to the risk associated with it and a widely accepted one is the Capital Asset Pricing Model (CAPM). Based on this, the study considers portfolios on the GSE as suggested by Fama and Macbeth (1973) to test validity of the capital asset pricing model and existence of market volatility on the Ghana Stock Exchange (GSE). This chapter then gives information on the background of the study, problem statement, the objectives, research hypothesis, the significance of the study, limitations, delimitations and organisation of the study.

Background to the study

One way in which we connect the future is through investments (Ndikumana & Boyce, 2011). Investment is the planning that secures most people from the uncertainty of the future. In finance, an investment is a monetary asset purchased with the idea that the asset will provide income in the future or appreciate and be sold at a higher price for profit realisation (Dullien, 2010). Chakravarty (2006), argued that individuals and households consistently rely on the concept of investment to provide assurance for the unforeseeable future and consumption smoothing. Investment is surely an important concept, especially for the development of every economy and so, plays a crucial role which differentiates the developed, developing and underdeveloped countries. However, one major factor that influences individuals' decision to consider or continue investing is the quantum of returns expected or earned (Dullien, 2010). In economics, the speculation that capitalist enterprises and investments are motivated by their profit has been quite evident, right from Adam Smith, who attributed the validity of the "invisible hand" to the self-love of producers, to Karl Marx who conceptualised capitalists as being conditioned on the competition to earn profits, (Dullien, 2010).

In success of this, investors have to decide on whether to invest in a physical asset (which are tangible such as precious metal or real estate) or financial assets (which are intangible such as corporate bonds and shares). The position of investment in financial assets in the development of economies continues to receive huge attention both in academia and among policy-makers (Bowman, 1979). Evidence from several literatures posit that deeper, broader, and better functioning financial market can promote higher level of economic growth (Levine, Loayza & Beck, 2000). Investors who invest in financial assets, however, aimed at achieving maximum wealth through higher yield and an increase in the price of their assets. To acquire such optimum wealth implies every investor takes into consideration all necessary factors that can affect the return from investment in the future. Malkiel (1992) asserted that the time and the risk involved in the maximisation of profit are also fundamental to decisions made by every household when considering investment opportunities.

Therefore, several economies have made conscious efforts to provide policies and avenues to ease the difficulty associated with investments related to financial assets and one of such avenues is the stock exchange. According to Fama (1970), the maximisation of expected returns of investors hugely depends on the predictability and efficiency of the stock market. He proposed that an efficient market is one that current stock prices reflect all available information and therefore rules out the possibility of investors making abnormal returns by taking advantage of any mispricing of an asset. He stated further that, this serves as a motivation for an investor to consider investment opportunities on the exchange by incurring lesser risk and maximising their returns. Hence, the presence of an inefficient market greatly hinders the activities of investors and for that matter the maximisation of their returns. Market inefficiencies exist due to information asymmetries, high transaction costs, market psychologies and human emotions, among other reasons (Giouvris, 2014). As a result, some assets may be over or undervalued creating opportunities for excess profit for some few investors on the exchange.

Is no doubt that this has been evident in some stock exchange around the world. Especially with the arrival of the 2008 global financial crisis, there existed the fall of Africa's portfolio investment which led to a huge fall in the African stock market returns (Macias & Massa, 2009; World Bank, 2012). As a result, a large number of African stock market did not only suffer from the systematic effect however, also faced a great divestments and capital flow reversal (International Monetary Fund, 2009). The former has been a result of over-valuation of stocks whilst the latter has been attributed to the increased uncertainty on expected returns. Trading occurred in only a few stocks in a number of these stock exchanges, which led to reasonable proportion of the total market capitalization (International Monetary Fund, 2009). Outside these actively traded shares, there are serious informational and disclosure inefficiencies for other stock. Mispricing and price volatility on the market are some of the prominent inefficiency characteristics have accounted for the huge divestment after the global financial crises of 2008/09. This contributed to reduced investors' confidence in equity market. Some of these mostly include; the Zimbabwe Stock Exchange, Ghana Stock Exchange, Nairobi Stock Exchange, Mauritius Stock Exchange and Nigeria Stock Exchange (International Monetary Fund, 2009).

On the premise of inefficiencies on the market, Appiah-Kusi and Menya (2003) and Frimpong, and Oteng-Abayie (2008), commonly argued that the Ghana Stock Market (GSE) is mostly characterised by some up and downtrends in the presence of good and bad news released over the period before the event announcement date. As such illiquidity and the dearth of instruments traded dominate the GSE specifically with the financial stocks. Nevertheless, with all these indications of imperfections, countries in Africa, especially Ghana, has sought for mechanisms and policies to help reduce inefficiencies (mispricing) and motivate the integration of the stock exchange market to benefit from the possible international cross-border portfolio investment flows and diversification opportunities. Some key policies adopted include; integration, automation of the stock exchange market and the stock exchange-led sustainability initiative (Schwab, 2018; Giouvris, 2014).

Apparently, with all these evidences of inefficiencies and mechanism put in place to help reduce inefficiencies on the stock exchange, investors are always in search for an appropriate model or tool to help measure mispricing and volatility/risk associated with securities and the returns earned, and also study the nature of the market they trade-in. Is no doubt that there exist several models and approaches for the determination of investors' return on the market amidst price changes and volatility on stock exchange market. Some of these include; the Arbitrage price theory, deductive models and the capital asset pricing model (CAPM). The African Valuation Methodology Survey (2014/2015) once confirmed the CAPM as the primary model, with 86% of respondents in Africa endorsing its usage over APT and deductive models. Therefore, this then gives this study the edge to investigate the CAPM instead of any other.

The capital asset pricing model (CAPM) as originally introduced by Sharpe (1964) and Lintner (1965), has impacted deeply on investors' knowledge on the relationship between price and risk of capital assets. The CAPM in simple terms indicates that the systematic variations in security returns can be understood by a single measure of risk, beta. With CAPM, the expected return on any risky security or portfolio of risky securities can be estimated by the risk-free rate and the market risk premium multiplied by the beta coefficient (beta). One of the most acceptable concepts in finance is the beta. Financial economists and practitioners use it to measure a stock's sensitivity to the whole market, to locate mispricing of stock, to estimate the cost of capital and to evaluate the performance of asset managers. In the view of the capital asset pricing model (CAPM), beta is considered constant over the period. Indeed, literature has proposed that, taking time scale into consideration, the measure of systematic risk is not fixed over time therefore the predictive power of beta to testing CAPM and some extent the nature of the market remains in question.

Problem Statement

While not disputing the fact that the CAPM as proposed by Sharp–Lintner (1964) was a linear model based on unconditional/static beta, it primarily ignores the effect of time variations on the stock market. Time scales of measurement closely follows the investment horizon of varying classes of investors. Fama and French (1992), indicated that with most financial time series data, the variance of the errors changes with time and so testing the CAPM on Ordinary Least Squared (OLS) technique leads to heteroscedasticity, which makes the estimates inefficient for a credible conclusion.

For this reason, several studies have made a conscious effort to incorporate the effect of time variation in testing the model and so call it the conditional CAPM.

Especially in Africa, some studies have tested the validity of CAPM using the GARCH model on individual securities (see; Maina & Ishmeal (2014) In NSE; Abonongo, Oduro, Ackora-Prah & Luguterah (2016) in GSE). However, Fama and Macbeth (1973) asserted that using individual securities, two problems quickly become apparent. First, estimates of beta for individual assets are inaccurate, leading to a measurement error problem when they are used in explaining average returns. Again, the regression residuals have similar sources of variation, such as industry effects in average returns. Therefore, to deal with such defects they developed a two-pass regression approach in which the portfolio betas are estimated in a first-pass time series regression, and estimated betas are then used in second-pass cross-sectional regression to estimate the risk premium of the factor for the market.

Besides, in an attempt to extend the knowledge of investors on the model's validity, there is the need to inform investors in Ghana on the type and nature of the market they trade in, so as to aid them in planning their entry and exit strategies on the market.

Hence, this study is to therefore, bridge literature gap by testing the validity of the conditional CAPM on portfolios and existence of market volatility in the Ghana Stock Exchange (GSE) to aid investors in trading on the stock exchange.

Purpose of the Study

The purpose of the study is to test validity of the conditional CAPM and existence of market volatility in the Ghana Stock Exchange (GSE).

Research Objectives

Specifically, this study seeks to:

1. Determine the effect of market risk (conditional CAPM beta) on portfolio returns.
2. Find the existence of a firm's abnormal returns/gains on GSE.
3. Evaluate the linearity of the conditional CAPM.
4. Find the effect of a firm's specific risk on portfolio returns.
5. Examine the nature of stability in the Ghana Stock Exchange

Hypothesis of the Study

H_0: Market risk does not affect and portfolio returns.

H_0: There exist no abnormal gains on the GSE.

H_0: The conditional CAPM does not show a linear relationship between market risk and portfolio returns.

H_0: Firm's specific risk does not affect portfolio returns.

H_0: There exist no stability in Ghana stock exchange.

Significance of the Study

This study is of relevance to various classes of people in the finance and investment world. Investors will use it to make sound investment decisions. The CAPM is widely used as a measure of performance. For this reason, once its validity is determined on the market, investors can use it to evaluate the securities to invest in, hold or sell. This research helps these investors make informed decisions.

Financial analysts can also use information from this study to determine the value of companies during acquisitions and mergers. For each firm in a merging or acquisition agreement, the cost of equity and the Weighted Average Cost of Capital (WACC) are calculated. These values are then compared to the cost of equity and WACC of the merged firm to determine the effect of conducting business jointly.

In addition, to determine the appropriate level of efficiency, this study is useful in providing investors with information on how volatile or stable a market can be, to aid them plan on the appropriate time to enter or exit a market. Researchers and academicians will also find this study useful as it extends literature as it points out several flaws in other methods used.

Delimitations

The study was delimited to some selected listed firms on the Ghana Stock Exchange (GSE). Specifically, the study focused on 30 listed firms on the GSE and NSE. However, for the sake of the inaccessibility of data on the GSE, the study used 8 individual securities from 8 actively trading firms on the GSE for the sampled period classified under the Financial and Insurance sector for testing the validity of CAPM.

Organisation of the study

The study will be divided into five chapters where chapter one details the above. Chapter two will contain the literature review which will further be subdivided into the theoretical literature and empirical literature. Chapter three will deal with the research design, the source of data, theoretical and empirical model specifications, measurement and justification variables and model diagnostics. Chapter four will look at the presentation and discussion of findings and lastly, chapter five will include a conclusion, recommendations, limitations and area for further studies if any.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This section reviews the relevant literature on this study. It begins with a brief overview of the GSE. Also, continues with a discussion of the theoretical literature of the CAPM and volatility on the stock exchange. This is then followed by a review of the empirical literature on related works.

Overview of the Stock Exchange

The Ghana Stock Exchange

According to Manu (2017), history of the GSE dates back to 1968 when the Pearl report by the Commonwealth Development Finance Company Ltd suggested the establishment of a Stock market in Ghana within two years and recommended measures to help achieve it, nevertheless, this did not materialise. In February 1989, the PNDC government organised a ten-member National Committee on the setting up of the Stock market under the chairmanship of Dr. G.K. Agama, the then Governor of the BoG (Bank of Ghana). This effort resulted in the establishment and incorporation of the GSE in 1989 as a private company limited by guarantee under the Companies Code, 1963. In November 1990, the GSE voluntarily considered operational regulations namely, GSE Membership Regulations L.I.1510, Listing Regulations L.I. 1509 and Trading and Settlement Rules and thus commenced trading on November 12, 1990. The GSE was the sixth-best performing index emerging stock exchange, with a capital increment of 116% in 1993 (Manu, 2017). In addition, the Federation Internationale des Bourses de Valeuer's in 1994 declared the GSE as the best index performing stock exchange among all emerging stock exchanges, earning about 124.3% in its index level.

In 1998, the GSE was one of the World's best performing stock market, top IFC (International Financial Corporation) Frontier equity market in local terms. Within this same year, the GSE converted into a public company limited by guarantee (Manu, 2017).

The period 2008/09 saw the automation of the GSE to enable it to be incorporated into the world financial market through the facilitation of real-time online trading. The automation also allowed brokers to trade on their clients' behalf always whilst considering both day and margin trading, as well as the borrowing and lending of securities on the exchange (Manu, 2017).

January 2013 saw the inauguration of the West African Capital Market Integration Council, tasked to supervise and implement the establishment of an integrated capital market in West Africa, in a bid to establish a harmonised regulatory setting for issuing and the trading of financial securities across the region. As well as to develop a common platform for cross-border listing and trading of such securities in the sub-region. In 2015, the GSE upgraded the existing trading platform, allowing the exchange to further expand, innovate and attract international investors as well as a platform for regional integration in West Africa according to the proven industry standard. Moreover, in the 2017 fiscal year, the government exempted gains from the realisation of securities listed on the GSE or publicly held securities approved by the Security Exchange Commission (SEC) (Manu, 2017).

Market capitalisation, which refers to the total cedi market value of all companies' outstanding shares, was GHS 3.05 million in 1990 for the GSE. The capitalisation of the GSE has grown amidst fluctuations in some years to GHS 52.69 billion (US$12.54 billion) (31% of GDP) in 2016 and a further

GHS 58.80 billion (US$13.31 billion) (29% of GDP) by 2017. As of March 2018, GSE's market capitalisation has increased by 11% to GHS 64.38 billion. However, the market capitalisation decreased 316 points or 12.54 percent since the beginning of 2019. It reached an all-time high of 3553.60 points in April 2018 and recorded a low of 1528 points in December 2016 (Manu, 2017).

Review of Theoretical Literature

Risk-Return Relationship

Most investors realise that the stock market is a risky place to invest their money. Periodic swings may be drastic but is with this volatility that often drives investor market returns. Volatility is a result of the dispersion around a security's mean or average return. The higher the standard deviation for securities the greater the dispersion of returns and the higher the risk associated with the investment. Volatility creates a risk that is associated with the degree of dispersion of returns around the average. In other words, the greater the chance of a lower-than-expected return, the riskier the investment.

The relation between volatility and market performance is strong. Volatility continues to decrease as the stock market increases and rises with the fall of the stock market. When volatility increases, risk increases and returns decrease.

Markowitz (1952) introduced the basic portfolio theory to define a linear risk-return relationship, which proved useful for portfolio asset management. Many other researches after his work are focusing their work on investigating the relationship between stock returns and volatility for developed and emerging market.

Modern Portfolio Theory (MPT)

Modern Portfolio Theory (MPT) is a theory about minimising the risk and maximising portfolio returns through diversification and adequate allocation of capital. The theory's foundation was established by Harry Markowitz's ideas published in his 1952 seminal article titled "Portfolio Selection."

Investors and scholars were already aware of the notion that risk can be minimised by diversification before the emergence of MPT. The "do not put all your eggs in one basket" proverb demonstrates the underlying idea. Markowitz actions were to provide a systematic mathematical basis for uncertainty in portfolio selection and identification (Roll, 1977). With him, the process of portfolio selection starts with specific beliefs about the future output of the security and ends with the choice of portfolio. Investors find projected returns to be desirable and variances in return to be unfavourable. This perception in much respect has affected the actions of the investors. The Markowitz model suggests that in time $t - 1$ a portfolio selected would yield a random return at time t. A basic premise of the model is that investors are risk-averse and are interested only with the mean and variance of their return on their investment for a period.

As a result, investors select portfolios that are mean-variance efficient, which lessen return variances on portfolio at a particular level of expected return and optimising expected returns at a specified level of variance. Explicitly Markowitz (1959) noted that investors could select a perfect combination of risky assets if they are aware of the relationship between expected returns on assets, variances of returns and covariance. Regardless, it will be difficult for investors and corporate managers to apply Markowitz's theory in its entirety, as they need to know the expected return, the variance of return, and covariance.

Despite the above, the theory has been heavily criticised because most of the topic investigated by the theory focused highly on the complex statistical mathematical modelling and formulas supporting the theoretical concept. Such inquiries usually report their conclusions, utilising unnecessarily complicated rhetoric and intricate formulaic expressions. In contrast, by general the least complex approaches are overly simplified, incomplete, and lacking the requisite robust requisite of serious research and practitioners.

Standard Capital Asset Pricing Model (CAPM/Static Beta)

Technically speaking Modern Portfolio Theory (MPT) consists of Markowitz' selection of portfolios which was initially proposed in 1952, while out of the flaws of MPT came, the development of contributions by Sharpe (1964), Lintner (1965) and Mossin (1966) to financial asset price theory, known as the Capital Asset Pricing Model (CAPM) (Giouvris, 2014). It is relevant to note here that Markowitz' portfolio theory is a 'normative theory. Franzoni and Galgano, (2002) define a normative theory, as "one which describes a norm or standard of behavior investors should undertake when building a portfolio. To which the CAPM generalised it into a 'positive theory', which hypothesise how investors behave in contrast to how they should behave. The CAPM of Sharpe (1964), Lintner (1965) and Mossin (1966) built the MPT further by quantifying the risk and return relationship into a simple model, which is practically and theoretically appealing and practically parsimonious.

The Standard Capital Asset Pricing Model (CAPM) is considered in finance to estimate the appropriate required return rate of an asset if such asset is to be added to an already well-diversified portfolio and if the asset is a non-diversifiable risk. The method focuses on the sensitivity of the asset to non-diversifiable risk (also termed as systemic risk or market risk), sometimes described by the financial industry as beta (β), as well as the expected return of the market and a risk-free asset. The model makes some speculations or assumptions relating to investors. Thus, all investors aim to maximise economic utility, they are rational and risk-averse, they are broadly diversified across a range of investments, they cannot influence prices, that is to say, they are price takers, they can lend and borrow unlimited amounts under the risk-free rate of interest, they trade without transaction costs, they deal with securities that are highly divisible into small parcels, they assume all information is available at the same time to all investors and finally the market is perfectly competitive.

The Standard CAPM is a pricing model for either individual security or a portfolio. To this end, we consider the Security Market Line (SML) and its relationship to expected returns and systematic risk (beta) to depict how the market pricing of individual securities or portfolios with respect to their security risk class would be. The SML assists in measuring the reward-to-risk ratio for any security relative to that of the overall market. As such, if the expected return rate for any security is deflated by its beta coefficient, the reward-to-risk ratio for any asset in the market is equal to the market reward-to-risk ratio, thus:

$$\frac{E(R_i)-(R_f)}{B_i} = E(R_i) \quad (1)$$

The market reward-to-risk ratio is the market risk premium and by rearranging the above equation and solving for E (Ri), we obtain the Capital Asset Pricing Model (CAPM).

$$E(R_I) = R_f + \beta_{im}(E(R_M) - R_f) + \varepsilon_i \quad (2)$$

Where $E(R_I)$ denotes the expected returns of individual firms stocks, R_f indicates the zero-risk beta or risk free asset, β_{im} measures the systematic risk of the market, R_M denotes the market return, $(R_M - R_f)$ is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return), and ε_i captures the specific risk or idiosyncratic of each firm.

The testable ex-post version of the CAPM is depicted mathematically as;

$$(R_t - Rf_t) = \alpha i + \beta_m(R_{m_t} - R_{f_t}) + \varepsilon_t \quad (3)$$

Where $(R_t - Rf_t)$ represents excess return of investors, αi is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, measures the systematic risk of the market, $(R_{m_t} - R_{f_t})$ is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t, and ε_t captures the specific risk or idiosyncratic risk.

Therefore, the model states that investor's risk premium equals the market risk premium and so the intercept term should be zero.

Security Market Line

Security Market Line (SML) emanating from CAPM visually shows the outcomes of the capital asset pricing (CAPM) formula. The risk (beta) is represented on the x-axis, and the y-axis is the expected return. The market risk premium is derived from the slope of the SML. The relationship between β and the required return is indicated on the market line of securities (SML) showing the expected return as a function of β. The intercept is the nominal risk-free rate available for business, whereas the slope is $E(R_M - R_f)$. This is a valuable method for evaluating whether an asset to be considered for a portfolio provides a fair expected return for risk. Within the SML graph, individual shares or portfolios are plotted. When the risk of the asset in relation to the expected return is located above the SML, it is undervalued, because the investor should expect the inherent risk to return more. And a security located below the SML is overvalued since the investor would be accepting less return for risk assumed. This is shown in figure 1.

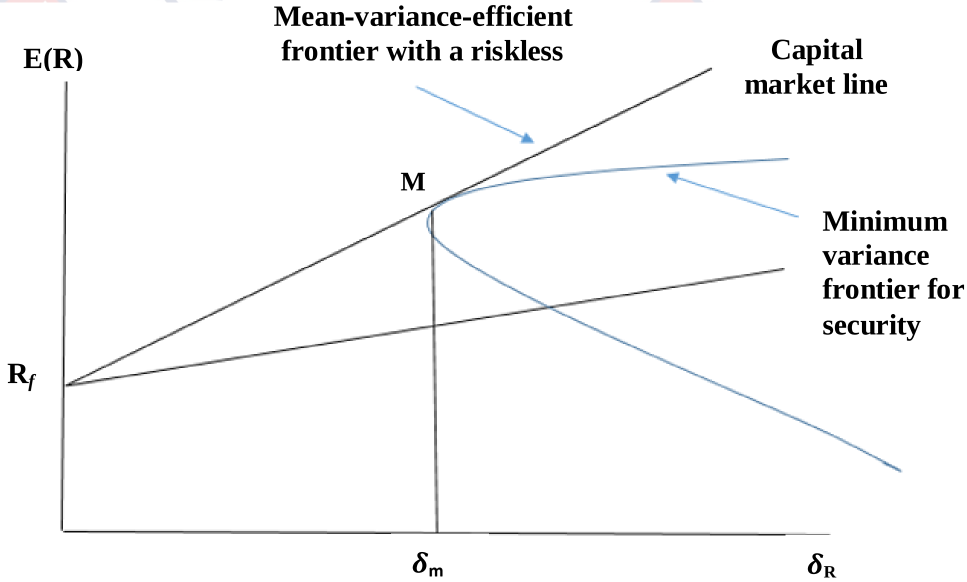

Figure 1: The investment opportunity curve

Source: Fama and French (2004)

From the figure above, once the expected/required rate of return $E(R_I)$ is been determined using CAPM, we can make a comparison between the required return rate and the estimated return rate of the asset over a given investment period to determine if it would be a suitable investment. To make this comparison, we need an independent estimate of the security or portfolio return based on either fundamental or technical analysis. Therefore, in principle, an asset is priced correctly if its average price is the same as the appropriate rates of return determined using the CAPM. The CAPM provides the asset appropriate return or discount rate, that is, the rate at which future cash flows generated by the asset should be discounted given the relative risk of that asset. Betas, which exceed one, mean more than average "riskiness", betas below one indicates lower than average. Thus, a riskier-stock will have a higher beta and will be discounted at a higher rate; less-sensitive stocks will have lower betas and be discounted at a lower rate. Given the accepted concave utility function, the CAPM is consistent with intuition-investors (should) require a higher return for holding a more risky asset.

Since beta indicates the asset-specific vulnerability to non-diversifiable, i.e. market risk, by definition the market as a whole has one beta. Stock exchange indexes are also used as local market indicators-and, in that case, have a beta of one. Consequently, an investor in a large diversified portfolio (such as a mutual fund) expects performance to conform to that of the market.

Moreover, Sharpe (1964), Lintner (1965) and Mossin (1966) considered this theory as a static one and so assumed beta is stable over time. However, from the early 1980s, the efficiency of CAPM has been doubted.

For instance, Scheicher, (2000) questioned the stability of beta and the linear relationship between return and return rate of assets. Also, Fama and French (1992) provided a strong evidence and so argued the theory on the premise that the unconditional/ static CAPM does not account for time-variation in conditional moments.

Conditional CAPM (Dynamic Beta)

Fama and French (1992) offered convincing proof that the unconditional/ standard CAPM fails to compensate for returns on the chosen portfolios. From then, literature on asset pricing has established alternative theories, which vary in many dimensions from the initial model. Well-articulated areas of research, which still keeps the single factor structure, have been the conditional versions of the standard CAPM.

The key distinction between Conditional CAPM and standard CAPM is in variables such as possible variations and investment performance problems that investors find to be worthy and relevant in some of their financial transactions to avoid bankruptcy. This framework demonstrated that not all investors have identical expectations and the main explanation for CAPM as the unconditional /standard model Conditional. CAPM stated that all investors have similar conditional expectations for their return on investment. In this situation, we cannot forecast the market conditions using standard CAPM. The concept underlying this approach is that while CAPM can hold information on time "t" conditionally, it does not hold this information unconditionally, as we have earlier stated.

Allied to the above, this technique implicitly assumes, in the scope of Conditional Asset Pricing Models, investors value stocks in reference to the risk of the asset class to which they belong. And for that beta which represents the risk of the market must be captured in its varying form or nature. Based on this argument, Fama and French (1992) suggested to adequately estimate the returns of investors in relation to risk of market, there is the need for an appropriate volatility model to estimate the dynamic beta of the market. Barra affirmed that this dynamic beta is superior to the historical and static beta in predicting future risk and return relationships. So is based on this that the study considers the conditional CAPM in its analyses.

The Concept of the Efficient Market Hypothesis

Closing on the heels of the CAPM was the emergence of the Efficient Market Hypothesis (EMH) as a main concept in finance. Undoubtedly, no other concept or theory has caught the attention of finance practitioners as well as economists other than the EMH. It is an information efficiency concept and refers to the capacity of the market to respond immediately to news or information that converts it into price. The concept of the EMH has its origins as early as the beginning of the 20th century. Nevertheless, Fama (1970) did not review the theoretical and empirical literature in EMH until the 1960s.

Fama (1970), who is regarded as the main proponent of EMH, formalized this theory and proposed that a market is called effective unless the prices of a financial asset represent all available knowledge incomplete and instantaneous form. In other words, any information that could be used to predict the output of stocks has already been priced in the current level of stock. We may explain it this way: if there is information that alerts us that a stock is under-priced and as such provides a profit opportunity, investors would usually rush to buy the stock based on this information immediately. In doing so, they drive the stock price to a reasonable value at which only the normal rate of return is obtained (Bodie, Kane & Marcus, 2003).

In recent times, Malkiel (1992) expands the concept of Fama further by stating that firstly, in an efficient market, stock prices would not be influenced by disclosing information to all parties on the market and secondly, by trading on this collection of information, it is difficult to make excess returns. Jensen (1978) discusses the efficient market hypothesis in three dimensions: Weak, semi-strong and strong forms.

First, a market is a weak-form efficient, if the current stock price represents all the knowledge about past prices and volumes of trading. This means that the only set of available information in this type is the stock's historical prices and that there should be no hint of potential price adjustments. Second, a market is semi-strongly efficient, if the stock price represents all publicly available knowledge. An investor cannot produce excess returns by taking advantage of already available information, because when new information is made public, it is automatically converted into the price of a security. Third, if current security rates are instantly and completely representative of all known information, including within or private information, a market is called strong-form efficient. Since the CAPM thrives in an efficient market, this study adopts the EMH in its analyses.

Volatility of Asset Returns

The return on assets is volatile. Measured by the standard deviation or variance in a stock return, volatility is a reliable indicator of risk, much like the beta. Volatility occurs in clusters, which grows over time. It also fluctuates within a given range. It reacts to good and bad news differently. The stock market is hugely characterised by volatility in asset prices and for this, Fama and French (1992) posited a suggested risk and returns relationship on such a market should be measured by a proper volatility model. Several ARCH (Autoregressive Conditional Hetereoscedasticity) style models have been used to estimate stock return volatility. Of these models, the ARCH models are the simplest. Simple ARCH models have many drawbacks, which is why they developed the GARCH models. Such models have proved to be very useful in modelling volatility and predicting returns on stocks. Indeed, studies have shown that GARCH models are more reliable than the normal linear regression models for predicting expected stock returns (Groenewold (1997); Scheicher (2000)). Franzoni and Adrian (2005) also found that GARCH models are more robust in predicting stock returns.

Mean Reversion in Volatility

It is a common valid phenomenon that every financial asset has a volatility level that underlies it. Thus, high volatility periods of a rise in volatility or low volatility periods die off over time, and volatility slowly returns to its normal level. It is one of the characteristics of asset return known as Mean Reversion. Mean reversion suggests that current information has no long-term volatility effect. Available empirical evidence clearly shows that while the mean volatility reverts, it also exhibits clustering, in that large changes in an asset's price tend to be followed by large changes, and small changes in asset prices seem to be followed by further minor changes. This was first noted by Mandelbrot (1963). This is then connected to another stylized fact about returns on assets, called persistence on volatility. Volatility is said to persist if today's volatility shock has a significant effect on future volatility. The persistence of volatility has an essential role in the forecasting and prediction of volatility and thus has a huge effect in portfolio and risk management. Persistence in volatility indicates that shock(s) to volatility does not diminish immediately rather its effect stays for some time. The higher the level of persistence the weaker the mean-reverting process of the asset or market. Since volatility mean reversion incorporates volatility clustering and persistence, this paper again hinges on modelling volatility mean reversion of stock prices in GSE to determine the stability of the market.

Review of Empirical Literature

The development of new stock market in developed countries is important for the diversification of portfolios. Therefore, the presence of these financial market made it imperative for research to examine the characteristics of risk and returns in investment. Since the mid-1990s, quite many literatures have been focused largely in the Asian and Eastern European exchanges with very little attention on Africa. This section reviews firstly, some of these specific studies in Market around the world and secondly in some parts of Africa.

Empirical Reviews on CAPM

Around the World

Claessens, Dooley and Warner (1995) provide evidence on the nature of asset returns by investigating cross-sectional returns in 19 emerging market. Using data from IFC emerging market database, they examine the effects of other risk factors on asset returns in addition to beta. Following a regression similar to that of Fama and French (1992), they find that in addition to beta, size and trading volume have a significant influence in explaining asset returns in most of these markets. The evidence provided in most of these countries contradicts existing evidence documented in developed capital market. This implies that evidence gathered in developed market alone should not be used to determine the way asset pricing theories are.

In addition, Akdeniz, Atlay-Salih, and Aydogan (2000) examined the impact of beta on monthly asset returns in Turkey from 1992 to 1998. They followed Fama and French (1992) regression approach. Beta coefficients are estimated by regressing monthly returns of assets on the contemporaneous and one-month lagged return on the value-weighted Istanbul Stock Exchange (ISE) Composite Index, which is made up of 100 equities. Evidence shows that the market beta is insignificant in explaining realised asset returns for Greek Stocks.

Moving forward, Pereira (2005) examined the challenges of applying traditional valuation techniques and asset pricing model(s) adopted by practitioners in emerging capital market with emphasis on Argentina, an important capital market in Latin America. He interviewed corporate executives, financial advisors, private equity funds, banks and insurance companies using a written questionnaire. Pereira found that the capital asset pricing model (CAPM) is the most popularly used asset pricing model to discount cash flows, yet is often adjusted to take account of country risk premium. Country specific risks such as asset expropriation by regimes, fluctuation in exchange rate, political instability, etc., need to be considered in calculating the cost of capital or discount rate for investment inflows.

Jamil (2018) also investigated the validity of CAPM on the London Stock Exchange (LSE) from 2004 to 2016. Considering the ordinary least square (OLS), Fama and Macbeth (1973) methodology, the study specifically examined the relationship between average stock returns and market risk. Using daily share prices of 70 most traded companies held in FTSE 100 index and total observation is 3370. These tests are given significant results. Therefore, concluded that the CAPM holds for LSE.

In Some Parts of Africa

So particularly in Africa, Hearn and Piesse (2009) proposed and tested size and CAPM focussing on emerging African Market. Their sample includes Johannesburg Stock Exchange (JSE), Nairobi Stock Exchange (NSE), Swaziland and Mozambique. Their results showed that size illiquidity augmented CAPM performs better than the Sharpe-Lintner CAPM and Fama-French Model as they found that size and illiquidity is a priced factor in South Africa and Kenya but less significant in Swaziland and Mozambique. 'Illiquidity for a given stock on a given day is measured as the ratio of the absolute value of the percentage price change per US$ of the trading volume.

Otieno, (2009) tested CAPM on 48 listed firms at the NSE. Using monthly adjusted stock returns of the 48 companies from 1998 to 2010. He adopted the Black et al (1972) testing methodology of the CAPM. His findings were that while the linear structure of CAPM is supported at the NSE, the higher beta did not give higher returns, as CAPM asserts. The study thus negates the CAPM, so concluded the CAPM is not valid on the NSE

In a similar quest, Clarke, Quaz, Reddy and Thomson (2011) investigated the CAPM with the aim of testing whether it provides a reasonable basis for actuarial modelling in South Africa. They went on to use data from 2000 to 2009 to separately regress excess returns on sector indices and excess return returns on the market portfolio for individual years as well as for all periods combined against their corresponding estimated betas. Unlike numerous others found in the literature, data used by Reddy and Thomson in their study are of yearly interval. Their results show that, with the exception of 2001, the CAPM was rejected and the performance of the beta was quite weak for regression on sectoral indices.

Accordingly, Were (2012) tested the CAPM on weekly returns at the NSE and negated Otieno's findings. She used weekly NSE data for 20 companies which formed the NSE 20 share index then from January 2005 to June 2012. The companies were grouped into 4 portfolios, each having 5 stocks. The CAPM was tested on each of these portfolios and the findings were that the portfolio with the lowest beta had the lowest return and vice-versa. The study thus supported the validity of CAPM, amid the presence of the size, value, and momentum anomalies of beta estimates.

Acheampong and Agalega (2013) had tested the standard CAPM with constant beta and found it to be invalid in the Ghana Stock Exchange. The test was based on a regression model. After performing several statistical tests based on the standard CAPM formula, Acheampong and Agalega could not reject the null hypothesis that the difference between the expected and actual returns was statistically insignificant. This led to the conclusion that the CAPM is not valid for the GSE.

Coffie and Chukwulobelu (2015) also studied the Application of CAPM to individual securities rather than portfolios on the same Exchange. They used 19 individual companies listed on the exchange from January 2000 to December 2009. The results rejected the application of the strictest form of

CAPM but uphold the validity of Jensen (1968) and Jensen, Black, and Scholes (1972) versions of the CAPM.

However, in a bid to improve the applicability of the CAPM on stock market, various modifications and variations have been put forward and yielded better reports. For instance, Maina and Ishmail (2014) challenged the normality assumption of the distribution of returns in the CAPM on the NSE. He estimated Beta using the GARCH model, which captures skewness, heavy tails and peaked of financial data, unlike the normal distribution. He used the NSE-20 share index, Mumias Sugar Company and Safaricom as a representative sample of the entire market. His results were that with more precise beta estimates, the CAPM is applicable on the NSE.

In a similar vein, Abonongo, Oduro and Ackora-Prah (2016) considered the volatility and risk-return trade-off of equities on the GSE. This study used secondary data of 35 equities from the Ghana Stock Exchange (GSE) and Annual Report Ghana databases comprising the daily closing prices from the period 02/01/2004 to 16/01/2015. Using the univariate GARCH-M (1, 1), EGARCH-M (1, 1) and TGARCH-M (1, 1) models, the results indicated the existence of positive risk premium meaning investors were compensated for holding risky assets.

Empirical Reviews on Market Stability (Volatility)

Around the World

Targeting the persistence of volatility shocks at the aggregate market level in the New York Stock Exchange (NYSE), Chou (1988) applied the GARCH (1, 1) model on the data from 1962–1985. He found volatility shocks to be highly persistent, having a half-life of volatility equal to one year.

Khan, Rehman, Khan and Xu (2016) investigated the Pricing of risk and volatility dynamics on the Pakistani stock market by employing aggregate (aggregate market level) and disaggregate (sectoral level) monthly data for the period from 1998 to 2012. Three generalized autoregressive conditional heteroscedasticity models were applied: GARCH (1, 1) for various volatility dynamics; EGARCH for asymmetric and leverage effect and GARCH-M for pricing of risk. The outcomes of the study were that; first, the volatility shocks are quite persistent but with varying degrees across the sectors. Further, overall volatility process is mean reverting and however, the speed of mean reversion varies across the sectors.

In Some Parts of Africa

In Africa, Ogunm, Beer and Nouyrigat (2005) apply Nigeria and Kenya stock data on the EGARCH model to capture the emerging market volatility. The result of the study differed from Jayasuriya (2002). Though volatility persistence is evidenced in both market; volatility responds more to negative shocks in the Nigeria market and the reverse is the case for Kenya market. The study failed to examine the contribution of innovation assumptions. Okpara, and Okpara and Nwezeaku (2009) also randomly selected forty-one companies from the Nigerian Stock Exchange to examine the effect of the idiosyncratic risk and beta risk on returns using data from 1996 to 2005. By applying EGARCH (1, 3) model, the result shows less volatility persistence and establishes the existence of leverage effect in the Nigeria stock market, implying that bad news drives volatility more than good news.

Emenike and Aleke (2012) examined the volatility of Nigerian Stock Exchange return series for evidence of asymmetric effects by estimating GARCH (1, 1), EGARCH and GJR- GARCH models. Their results showed evidence of volatility clustering and volatility persistence in Nigeria. The estimates from asymmetric models also indicated that the Nigerian equity market is asymmetric in that the stock returns and conditional volatility are negatively correlated.

Abonongo, Oduro and Ackora-Prah (2016) considered the volatility and risk-return trade-off of equities on the GSE. This study used secondary data of 35 equities from the Ghana Stock Exchange (GSE) and Annual Report Ghana databases comprising the daily closing prices from the period 02/01/2004 to 16/01/2015. It was revealed that volatility was persistent (explosive process) in most of the selected equities with the three distributional assumptions. The persistence in volatility was extended in investigating the half-life measure of the selected equities. It was revealed that most of the equities had strong mean reversion and short half-life measures.

Literature Gap

Therefore, it can be well noticed that these pieces of literature presented above provide varying and conflicting results. However, a key point established in the diverse results especially in the testing of the CAPM is the appropriate technique to reflect the actual behaviour of financial data. It is as well noted that some of the literature considered a valid model such as the GARCH, however, the problem lies in the approach. As most studies in the developing economies, such as Ghana, based their analysis on individual securities, this is completely flawed by some scholars such Fama and Macbeth (1973). As such, they proposed the use of portfolios in their two-pass regression approach, which this study considers. So, this study provides the basis for testing the validity of the conditional CAPM and examines the market volatility in the GSE to aid investors in planning their entry and exit strategies on the exchange.

Chapter summary

In all, this chapter indicates that it would very necessary to consider time variations in the determination of risk and return relationship on the stock exchange market. For this reason, with the first four objectives, this study affirms the fact that conditional CAPM is much superior to the standard CAPM and by that, this study seeks to test the validity of the conditional CAPM using the Fama and Mcbeth (1973) two-pass regression approach on portfolios. Also, by adopting the mean reversion and half-life method, the study will examine the stability in GSE.

CHAPTER THREE

RESEARCH METHODS

Introduction

In testing the validity of the conditional CAPM and analysing volatility in the GSE, this chapter sets out the approaches for conducting the study. First, the research design is presented, and then followed by the theoretical model, which considers the two-pass regression approach. The chapter later identifies the empirical model specifications estimation techniques, mean reversion and half-life period measure, measurement and justification of variables and expected signs, model diagnostics, estimation technique and data source.

Research Design

Given the purpose and objectives of this study, the causal research design through a positive philosophy was used to assess the validity of the conditional CAPM and the market volatility in the GSE. This is considered to conclude the cause-effect relationship between the variables used for the study. The study followed a quantitative approach which allows the researcher to maximize objectivity, generalize the results and replicate other research findings. This study, which attempts to investigate conditional CAPM and the market volatility in the GSE is descriptive since it is measured once. Therefore, the variables relevant to the stated objectives of the study are valid and accurately presented.

Theoretical Model

Two-Pass Regression

This section explains the methodology of the regression approach of Fama and MacBeth (1973). The Fama-MacBeth regression analysis is relevant for this thesis as it gives a widely used approach to analysing relationships between stock return and risk. The Fama-MacBeth methodology will be applied in the empirical analysis of this thesis.

Fama and MacBeth (FM) (1973) represents a landmark contribution toward the empirical validation or refusal of the basic implications of the Capital Asset Pricing Model. A relevant portion of the available financial literature (see for example Roll, 1977) devoted its attention to the issue of determining the mean-variance efficiency of the market portfolio. FM first interpreted the CAPM as implying a basic linear relationship between stock returns and market betas that should completely explain the cross-section of returns at a specific point in time. To test the effectiveness of the CAPM in justifying that observed cross-sectional variability of returns, FM designed and implemented a basic two-step regression methodology that eventually survived the first set of empirical results that it generated, to become a standard approach in the field.

The basic theoretical model described in FM and resulting from the Sharpe-Lintner version of the CAPM simply states that variability in market betas accounts for a significant portion of the cross-sectional variability of stock returns at a certain point in time, or for a specified sample period. However, Jensen (1968) earlier tested the valid of CAPM in time series and argued that consistently the intercept which represents the risk-free rate is greater than the average risk-free rate (typically proxied as the return on a one-month Treasury bill), and the coefficient on beta is less than the average excess market return. So, to mitigate this, he proposed the excess return expression of the model where the risk-free is then subtracted from the average return on the right-hand side and the new intercept term captures the abnormal returns on the market. Moreover, called this term Jensen's Alpha. This is shown below:

$$(\mathrm{R_t} - \mathrm{Rf_t}) = a_0 + \beta_m(\mathrm{R}_{m_t} - \mathrm{R}_{f_t}) + \varepsilon_t \quad (4)$$

Where $(R_t - Rf_t)$ represents excess return of investors, a_0 is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, β_m measures the systematic risk of the market, $(\mathrm{R}_{m_t} - \mathrm{R}_{f_t})$ is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t and ε_t captures the specific risk or idiosyncratic risk.

In order to make this proposition empirically testable, Fama and Mcbeth (1973) adopted equation 5 and used its estimated betas as a basis for ranking securities for their two-pass regression. Therefore, equation 4 is simplified as;

$$r_t = a_0 + \beta_m \mathrm{R}_{m_t} + \varepsilon_t \quad (5)$$

Where r_t represents excess return of investors, a_0 is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, β_m measures the systematic risk of the market, R_{m_t} is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t, and ε_t captures the specific risk or idiosyncratic risk.

Allied to the above, Fama and Macbeth (1973) argued that in estimating the CAPM with individual securities, two problems quickly arise. First, estimates of beta for individual assets are imprecise, creating a measurement error problem when they are used to explain average returns. Second, the regression residuals have common sources of variation, such as industry effects in average returns. So, to deal with such defects and to test the model on the whole market, portfolios are to be formed out of the beta estimates from individual securities (equation 5). Forming portfolios, Fama and Macbeth (FM) (1973) asserted the beta estimates from the individual securities are to be ranked from the highest to the least beta. For equal proportion, then assets with the highest 10% or 20% betas are group into the first portfolio. Therefore, this is done until the last portfolio is formed. In addition, the portfolios are formed based on the simple average because betas from the individual securities are assumed to give weights to portfolios formed. Below shows, the formulae used:

$$R_{pt} = \frac{\sum_{i=1}^{n} R_{it}}{n} \qquad (6)$$

Where R_{pt} returns on portfolios and 'n' is the number of securities under study.

The portfolios formed are then considered in the first-pass time series regression and so its betas are estimated in the equation specified below:

$$R_{pt} = a_0 + \beta_p R_{m_t} + \varepsilon_t \qquad (7)$$

Where R_{pt} represents excess portfolio average return of investors, a_0 is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, β_p measures the systematic risk of the market, R_{m_t} is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t, and ε_t captures the specific risk or idiosyncratic risk.

According to Fama and Mcbeth (1973), these estimated betas from the portfolio are then considered as the only determinant to estimate the risk premium of the factor for the market in the second-pass cross-sectional panel.

However, they asserted four hypotheses as indicated in chapter one of this study are to be tested based on the second-pass regression shown below:

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \varepsilon_{it} \quad (8)$$

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \gamma_2\beta^2{}_{it} + \varepsilon_{it} \quad (9)$$

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \gamma_2 B_i^2 + \sigma^2{}_{eit} + \varepsilon_{it} \quad (10)$$

Where $\bar{r}_{it}$ is the average excess returns of each portfolio at time t, β_{it} captures the systematic risk of each portfolio at time t, $\sigma^2{}_{eit}$ measures variance of residual returns of portfolio at time t, ε_{it} denotes the firm specific risk, γ_0 and γ_1 represent abnormal returns of firms or investors, and risk premium respectively, whilst $\beta^2{}_{it}$ is used to determine the linearity of the CAPM.

From the equations above FM can test some of the major implications of the CAPM simply through basic statistical analysis of the estimates for the various coefficients, under the assumption that both the returns and (consequently) the parameters describing their stochastic processes are normally distributed and temporally IID. As the ordinary least square method assumes that the disturbance term is *white noise*, that is, conditions of normality with zero mean, finite and constant through time (homoscedastic) variance, and universal uncorrelation holds. Many studies have raised questions on the validity of the market model to estimate the systematic risks of financial assets using the OLS technique for time series data. It has been shown that some of the assumptions such as homoscedasticity do not always hold. The most important implications of heteroscedasticity are:

1. The OLS estimators will be inefficient since they will not have the minimum variance in the class of unbiased estimators. This fact can partly explain the non-stability of beta estimates and makes it impossible to use past

values of betas for forecasting their future values. Therefore, the accuracy of beta estimates also cannot be evaluated accurately (Levy, 1971).

2. Significance hypothesis tests of the estimates will be performed with a higher type I error than it is assumed since the estimated covariance matrix will be biased. Similarly, other tests, based on homoscedasticity, e.g., the Chow test for parameter stability will no longer be valid.

3. The coefficient of determination R-squared will decrease, which means that systematic risk will be understated, while diversifiable risk will be overstated. As Fisher and Kamin (1985) state errors in beta estimates are the equivalent of extra non-systematic individual risks.

For these reasons, it is necessary to take heteroscedasticity explicitly into account by considering a proper volatility model.

Empirical Model Specification

This section of the chapter discusses how variables used for this particular study are to be estimated. Therefore, to achieve the objectives of the study, we adopt a proper volatility model such as the GARCH model.

Since financial market data often exhibit varying volatility, autoregressive (AR) and moving average (MA) models, that assume the conditional variances are constant, cannot capture the nonlinear dynamics. Linear models are unable to explain characteristics like volatility clustering, leverage effects, leptokurtosis and long memory in financial series (Zivot (2009). Thus, we employ an econometric method that allows modelling non-linear patterns as non-constant volatility.

The Autoregressive Conditional Heteroscedasticity (ARCH) model by Engle (1982) and its generalization, GARCH by Bollerslev (1986) are the major and widely used methodologies in modelling and forecasting volatility of financial time series. GARCH (q,p) model includes both the information about volatility observed in the previous period, that is short-run volatility (ARCH term), and forecasted variance from the last period, that is long-run volatility (GARCH) term. To predict the current period the GARCH (q, p), it comprises of two equations and thus the mean and variance equations. The mean equation is given as;

$$y_t = x'_t B + \varepsilon_i \qquad (11)$$

Where y_t is the dependent variable, x'_t is the independent variable, B is the slope and ε_t is the error term.

This describes the observed data as a function of other variables plus an error term. It holds that error term has a zero mean, a constant unconditional variance thus $\varepsilon_t^2 = \sigma^2$ and is not autocorrelated. However, the variance is allowed to be autocorrelated and has one ARCH term, a GARCH term and a constant term. This is expressed as:

$$\sigma_t^2 = \omega + \rho\sigma_{t-1}^2 + \theta\varepsilon_{t-1}^2 \qquad (12)$$

Where σ_t^2 indicates the conditional variance (which is the dependent variable), ω is a constant term, σ_{t-1}^2 is the GARCH term, ε_{t-1}^2 represents the ARCH term while θ and ρ represent the lagged squared error term (ARCH Effect) and conditional volatility (GARCH Effect) respectively.

Moreover, in the variance equation, both θ and ρ measure the market volatility. A large error coefficient θ means that volatility reacts intensely to market movements, while a large value of the GARCH coefficient ρ suggests that shocks to conditional variance take a long time to die out, which means that volatility is persistent (Lean & Tan 2010). If the sum of ARCH and

GARCH coefficients (i.e. $\theta + \rho$) is very close to one, that means high persistence in volatility and implies inefficiency in the market and close to zero means the market is quite stable and depicts efficiency. So, to satisfy the non-explosiveness conditional variance, $\theta + \rho < 1$. Secondly, to satisfy the non-negativity of the conditional variance ($\sigma^2_{t-1} \geq 0$), $\omega > 0, \theta \geq 0, \rho \geq 0$ (i.e. ω, θ, ρ) should be positive (Alagidede, 2007).

So, for the first four objectives, the study adopts the Fama and Macbeth (1973) two-pass regression approach for testing the validity of the conditional CAPM in the GSE. This approach comprises two important stages thus; the beta of each portfolio is estimated in a first-pass time series regression, and estimated betas are then used in second-pass cross-sectional regression to estimate the risk premium of the factor for the market.

In computing daily stock return, the study uses the formula proposed by Brooks(2008) as:

$$R_{it} = \ln\left(\frac{P_t}{P_{(t-1)}}\right) * 100 \qquad (13)$$

Where: t =present day, R_{it}= continuously compounded returns on day t, P_t is the stock price on day t, $P_{(t-1)}$= stock price in previous day t-1 and ln= Natural logarithm.

Therefore, in estimating the systematic risk betas from the individual securities for portfolio formation, the study adapts Jensen (1968) ex-post excess return model, expressed as:

$$(R_t - Rf_t) = a_0 + \beta_m (R_{m_t} - R_{f_t}) + \varepsilon_t \qquad (14)$$

Where $(R_t - Rf_t)$ represents excess return of investors, a_0 is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, β_m measures the systematic risk of the market, $(R_{m_t} - R_{f_t})$ is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t, and ε_t captures the specific risk or idiosyncratic risk.

Equation 14 is modified to suit the variables from the GSE as;

$$(R_{stocks_{it}} - TB_{G_{it}}) = \alpha i + B_m(GCI_{it} - TB_{G_{it}}) + \varepsilon_{it} \qquad (15)$$

Where t, and G represent time period and Ghana stock exchange respectively. R_{stocks_t} denotes the average security returns from Ghana stock exchange, αi is intercept or Jensen alpha, TB_{Gt} is the risk-free rate or zero-Beta assets proxied by Treasury bill rate from the Central Bank of Ghana, $GSE.CI$ is the market indexes measured by the GSE Composite Index for Ghana stock exchange B_m is estimated beta for each security which measures the systematic risk of the market and ε_t denotes the error term.

This is then simplified as;

$$r_t = a_0 + B_m R_m + \varepsilon_t \qquad (16)$$

Where r_t represents excess return of investors, a_0 is the intercept also called the Jensen's Alpha and measure abnormal gains on the market, β_m measures the systematic risk of the market, R_{m_t} is sometimes known as the market premium or risk premium (the difference between the expected market rate of return and the risk-free rate of return) at time t, and ε_t captures the specific risk or idiosyncratic risk

Moreover, according to Fama and French (1992), the poor empirical performance of the unconditional CAPM is not allowing the betas to vary over time. However, in real life, financial data for instance, stock market return data, variance changes with time hence there is a need for studying models that accommodate this possible variation in variance. As earlier indicated Studies such as Fabozzi and Francis (1978) have suggested that volatility of returns in stock market world over can be modelled and forecasted using the GARCH type models.

Therefore, this study will employ the GARCH (p,q) model in addressing the objectives of this study; the mean and variance equation takes the form of equation 16 and 12 respectively. Beta estimates from equation (16) are estimated with GARCH (p, q) and portfolios will be formed, with each portfolio formed comprising 20% or 10% of betas estimated from the individual securities of equation (16).

Moving forward, portfolio betas will then be estimated in the model specified below using the GARCH (p, q) model and this represents the first-pass regression.

$$\left(R_{pstocks_t} - TB_{G_t}\right) = \alpha i + B_p\left(GCI_{it} - TB_{G_{it}}\right) + \varepsilon_{it} \qquad (17)$$

Where 't' represents the period. $R_{pstocks_t}$ denotes the average portfolio's returns from Ghana stock exchange, αi is intercept or Jensen alpha, TB_{Gt} is the risk-free rate or the zero-Beta assets proxied by Treasury bill rate from the Central Bank of Ghana, $GSE.CI$ is the market indexes measured by the GSE Composite Index for Ghana stock exchange, βp is estimated portfolio beta, which measures the systematic risk of the market and ε_t denotes the error term.

The second-pass cross-sectional regression model; where the portfolio beta will now serve as the independent variable is depicted below;

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \varepsilon_{it} \qquad (18)$$

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \gamma_2{\beta^2}_{it} + \varepsilon_{it} \qquad (19)$$

$$\bar{r}_{it} = \gamma_0 + \gamma_1\beta_{it} + \gamma_2 B_i^2 + \sigma^2{}_{eit} + \varepsilon_{it} \qquad (20)$$

Where $\bar{r}_{it}$ is the average excess returns of each portfolio at time t, β_{it} captures the systematic risk of each portfolio at time t, $\sigma^2{}_{eit}$ measures variance of residual returns of portfolio at time t, ε_{it} denotes the firm specific risk, γ_0 and γ_1 represent abnormal returns of firms or investors, and risk premium respectively, whilst $\beta^2{}_{it}$ is used to determine the linearity of the CAPM.

In addition, to achieve the fifth objective of the study, the nature of stability of the GSE is investigated by using daily closing price indices, thus GSE Composite Index (GSE-CI). Here daily stock return was computed based on the formula in equation 13 as proposed by Brooks(2008).

However, any inquiry into the stock returns volatility and the possible causes of such volatility ought to account for the complex non – linear dynamics in the variables at hand, failure to which could lead to misspecification of the conditional characterization of the data and consequently drawing of vague conclusions.

So partly following Takaendesa (2006) and Aziakpono (2009), this study employs the following equation:

$$R_t = \mu + \varepsilon_t \qquad (21)$$

Where R_t is the logarithmic daily returns for each of the market, μ is a constant and ε_t is the residual term.

The estimated model is tested for autocorrelation using the Breush-Godfrey Serial Correlation LM test. If the test ever confirms the presence of autocorrelation, the lagged one values of the dependent variables for both market will be added to the right-hand side of Equation 21 to eliminate the autocorrelation. This is because the mean equation should be white noise series, that is it should have a finite mean and variance; constant mean and variance, zero auto-covariance, except at lag zero and this is shown in equation 22 below;

$$R_t = \mu + \lambda_1 R_{t-i} + \varepsilon_t \quad (22)$$

Where R_t is the current daily return series, R_{t-i} represents the lagged independent value of daily return series for the market and $\lambda_1$is its coefficient and ε_t is the error term.

Therefore, equation (22) can be modified and specified as;

$$R_t = a_0 + \lambda_1 R_{t-i} + \varepsilon_t \quad (23)$$

Where R_t represents the current daily return series of GSE, R_{t-i} is the lagged values of daily returns series of GSE, $\lambda_1$is its coefficient and ε_t is the error term.

Fama and French (1993) and others posit that there is the tendency for stock prices to revert to their mean in the long run thus violating the principle behind the random walk hypothesis and the efficient market hypothesis in general. As a result, the variance of stock returns will not be constant hence there is the need to model for heteroscedasticity. The appropriate mean equation will then be tested to ascertain if ARCH effects were captured before estimating volatility models. Given that stock returns are non-normally distributed, Autoregressive Moving Average (ARIMA) Model may not appropriately capture stock volatility.

The study, therefore, adopts the Generalised Autoregressive Conditional Heteroscedastic (GARCH) models, which allow variances of errors to be time-dependent. Moreover, the mean equation used for the GARCH model estimation will be the form of equation (23). And the variance equation which will be used to capture and thus determine the nature of stability in the GSE will be of the form;

$$\sigma_t^2 = \omega + \rho\sigma_{t-1}^2 + \theta\varepsilon_{t-1}^2 \quad (24)$$

Mean Reversion

In determining the nature of volatility in the GSE, the study specifically focused on estimating how stable and revertible the market is. Mean reversion means that current information on volatility does not affect the future forecast of volatility. Generally, the GARCH coefficient(s) of a stationary GARCH model captures persistence dynamics in volatility. In stationary GARCH models, the volatility mean reverts to its long-run level, at a rate given by the sum of ARCH and GARCH coefficients, which is usually close to one (1) for financial time series. The mean-reverting formula for the general GARCH (1, 1) model is given by;

$$(\varepsilon^2 - \sigma^2) = (\alpha_1 + \beta_1)(\varepsilon_{t-1}^2 - \sigma^2) + X_t - \beta_1 X_{t-1} \quad (25)$$

Where $\sigma^2 = \frac{\alpha_0}{(1-\alpha_1-\beta_1)}$, the unconditional long-run level of volatility and $X_t = (\varepsilon^2 - \sigma^2)$. The magnitude of $\alpha_1 + \beta_1$ controls the rate of the mean reversion.

Half-Life Period (L)

In addition, to find the number of days it takes the market to be stable, the study continues with the estimation of the half-life period of the market. The half-life τ is a measure of volatility persistence, Engle and Patton (2001) defined Half-Life as the time required for the volatility to move halfway back towards its unconditional mean. If, τ is the least value of k such that;

$$|\sigma_{t+k|t} - \sigma^2| = \frac{1}{2}|\sigma_{t+k|t} - \sigma^2| \quad (26)$$

Where k is the number of days, $\sigma_{t+k|t}$ is the conditional expected value of volatility k days into the future and σ^2 is the mean level to which the unconditional variance eventually reverts.

Also, the GARCH (1, 1) process is mean-reverting if $\alpha_1 + \beta_1 < 1$ since if this condition is satisfied, $\sigma_{t+k|t} \rightarrow \sigma^2$ as $k \rightarrow \infty$. Thus, the forecast conditional variance reverts to the unconditional variance as the forecast horizon increases.

For k ≥ 2 and a GARCH (1, 1) process, the value of $\sigma_{t+k|t}$ is given by;

$$\sigma_{t+k|t} = \sigma^2 + (\alpha_1 + \beta_1)^{k-1}\left(\sigma_{t+k|t} - \sigma^2\right), K \geq 2 \qquad (27)$$

From the above equations, thus 26 and 27, the number of days k for a GARCH (1, 1) Process is given by;

$$|\sigma^2 + (\alpha_1 + \beta_1)^{k-1}(\sigma_{t+1} - \sigma^2) - \sigma^2| = \frac{1}{2}|\sigma_{t+1} - \sigma^2| \qquad (28)$$

This is the same as;

$$(\alpha_1 + \beta_1)^k = \frac{1}{2}(\alpha_1 + \beta_1) \qquad (29)$$

Taking the logarithmic form of equation 29 gives;

$$K = \frac{\log(\alpha_1+\beta_1)/2}{(\alpha_1+\beta_1)} \qquad (30)$$

Therefore, the half-life for a basic GARCH (1, 1) model is given by;

$$\tau = \frac{\log(\alpha_1+\beta_1)/2}{(\alpha_1+\beta_1)} \qquad (31)$$

Measurement and Justification of Variables

Average Excess Return

The average excess return used in this study serves as a dependent variable for the first four objectives of the study. It is measured as the daily expected return of each equity or portfolio minus the risk-free of the market. This approach follows Black, Jensen and Scholes (1972) and Fama and

MacBeth (1973), who found out that this relationship as suggested by Sharpe-Litner (1964) is too “flat” and cannot describe the efficient portfolios chosen by investors. Jensen (1972) therefore measured abnormal performance by introducing the intercept term, or Jensen’s alpha, in the time series regression, to mitigate the shortcomings of Sharpe-Litner version.

Market Risk Premium of the Model

The market risk premiums of the model would be deduced from the relation (Rm- Rf). Where; Rm is the average market return for the year and Rf, is the average risk –free rate of return for the same period. The market return will be estimated from the daily closing stock market prices of the GSE-CI. The GSE-CI was used as the proxy for the entire market and the market return. The risk-free rate is the yield on government Treasury bill; which is relatively deemed to be risk-free. Thus, the monthly yields on the government T-bill were collected and the average risk- free rate deduced from it. The coefficient of this variable will then be used in determining the systematic beta of the market. Hence, the study expects a positive coefficient.

Systematic risk/ Market Beta

Systematic risk is defined as the risk to which all firms operating in a country or a market are exposed. Because this kind of risk is stemmed from the fundamentals of a market, it cannot be eliminated. The systematic risk of a security is determined by its beta coefficient, as such, Bowman (1979) defines the beta coefficient of individual security as simply a “measure of its volatility relative to the market rate of return”. William Sharpe also defines the beta coefficient as “the slope term in the simple linear regression function where the rate of return on a market index is the independent variable and a securities rate of return, the dependent variable" (Bowman, 1979). Hence, the systematic beta is expected to have a positive coefficient. This is to ensure the assumption that "only market risks are priced" is met and as such, investors are compensated for any risk they take on the market.

Stock Market Return

This is measured as the natural logarithmic difference in daily prices. Concerning the data, the study used the Ghana Stock Exchange Composite Index. The Ghana Stock Exchange Composite Index (GSE-CI) is a major stock market index, which tracks the performance of all companies traded in the Ghana Stock Exchange. It is a capitalization-weighted index with a base value of 1000. This will serve as a dependent variable; however, the lagged value of this return is then used as an independent variable to determine the nature of volatility on the GSE. Hence, the study is expecting a negative or positive coefficient, depending on the nature of the market.

Source of Data

The study used secondary data. Concerning the objectives, the data for the individual stocks and the Ghana Stock Exchange Composite Index (GSE-CI) are obtained from the Ghana Stock Exchange database spanning from 2010 to 2018 for Ghana. These individual stocks include the actively trading stocks on the GSE as at 2018 and they are; CAL Bank Limited (CAL), Ecobank Ghana Limited (EGH), Ecobank Transportation Incorporation (ETI), GCB Bank Limited (GCB), Republic Bank Ghana Limited (RBGH), Standard Chartered Bank Limited (SCB), Societe Generale Ghana Limited (SOGEGH) and Trust Bank (Gambia) Limited (TBL). The Treasury Bill Rate will be compiled from various issues of the Monthly Statistical Bulletin published by the Central Bank of Ghana and thus the market return will be proxy by GSE Composite Index (GSE-CI).

Estimation Techniques

The research used the Maximum Likelihood Estimation (MLE) adopted by Aigner, Lovell and Schmidt (1977) in testing the validity of conditional CAPM and the market volatility in GSE to estimate the GARCH (p, q) model and Ordinary Least Square (OLS) for the cross-sectional panel.

For this study, the MLE technique is used because of its relative strength in the GARCH (p, q) model estimation. It can estimate the upper and lower limits, making the GARCH (p, q) more appropriate for the time series estimation part of the study compared to the conventional OLS technique. The Maximum Likelihood Estimation method was found to be significantly better than the Ordinary Least Square (OLS), where especially there is the tendency for errors to correlate and their variances not being constant.

Moreover, on the part of the cross-sectional panel considered in the second-pass regression, the study seeks to achieve a common effect of the efficient beta (market risk) on investors' returns, therefore, the OLS estimation technique is found appropriate. Given the assumptions of the classical linear regression model, the OLS estimator has minimum variance in the class of linear estimates, that is, the OLS estimators are Best Linear Unbiased Estimators (BLUE). The use of the OLS method comes with it the following underlying assumptions, Koutsoyiannis (1977).

The assumptions are as follows;

1. μ_t– is a real random variable
2. μ_t ~N (0,)
3. E (μ_t) = 0

4. Var $(\mu_t / X_t) = \sigma^2$

5. E $(,\mu_t, \mu_j) = 0$, (t=j)

6. E $(\mu_t, X_t) = 0$

Stationarity/Unit Root Test

It is paramount to establish the existence or non-existence of unit root in the time series under study to be able to ascertain the nature of the process that produces the time series. A variable exhibits covariance or weakly stationary if the mean and auto-covariance are finite and do not change with time (time-invariant). That is;

$E(X_t) = E(X_{t-1}) = \mu$, which is a constant and $\text{cov} = (X_t, X_{t-1}) = \mu$

For a covariance stationary series, the time series fluctuates around a constant long-run mean with a finite variance, which is time-independent. This study employs two quantitative stationarity tests namely; the Augmented Dicker Fuller (ADF) test and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test.

Model Diagnostics

It is very essential to undertake a pre and post-diagnostic check on the model, after determining the best model and its corresponding distribution for the error term to establish whether the chosen model and its distribution are correctly specified. The study, therefore, employs the Breusch-Godfrey test, Ljung-Box test and ARCH- Lagrange Multiplier (LM) test, Breusch-Pagan/Cook-Weisberg test and Wooldridge autocorrelation test, before and after the estimations in the study to validate the findings.

Distributional Assumptions of Error Term

In the GARCH model specification, it is more appropriate to consider the choice on the distributional assumption of the error term. Following

Kovacic (2012), this study assumed one distributional assumption; Generalized Error Distribution (GED), to cater to fat tails that are common in most financial data.

Nelson (1991) proposed the use of the GED to account for fat-tails observed commonly in financial time series. It is given by;

$$l_t = -\frac{1}{2}\log(\frac{\Gamma(\frac{1}{r})^3}{\Gamma(\frac{3}{r})(\frac{r}{2})^2} - (-\frac{1}{2}\log\sigma_t^2) - (\frac{\Gamma(\frac{3}{r})(y_t - X_t'\theta)^2)}{\sigma_t^2\Gamma(\frac{1}{r})}) \quad (32)$$

Where r > 0 is the tail parameter. The distribution has a fat tailed if r < 2 and becomes Gaussian distribution if r = 2. The contribution to the likelihood for observation t for the Gaussian distribution is given by;

$$l_t = -\frac{1}{2}\log 2(\pi) - \frac{1}{2}\log\sigma_t^2 - (1 + (\frac{(y_t - X_t'\theta)^2)}{2\sigma_t^2}) \quad (33)$$

Chapter Summary

The chapter presented an overview of the theoretical foundations of the Capital Asset Pricing Model and the Generalised Autoregressive Conditional Heteroscedastic (GARCH) models. Moreover, in satisfying the first four objectives of the study adopts the Fama and Macbeth (1973) two-pass regression approach which considers portfolios to mitigate the problems associated with individual securities in testing the validity of the conditional CAPM in the GSE and follows Takaendesa (2006) and Aziakpono (2009) empirical model in analysing the nature of stability in the GSE. A Breusch-Godfrey test, Ljung-Box test and ARCH-Lagrange Multiplier (LM) test, Breusch-Pagan/Cook-Weisberg test and Wooldridge autocorrelation test is employed before and after the estimations to prove the validity of the results.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

To address the flaws in testing the validity of the conditional CAPM using individual security, this study considers portfolios on GSE. As suggested by Fama and Macbeth (1973), the study adopts the two-pass regression approach as well as the GARCH model to cater for the effect of time variations in financial time series data. Also, in examining the stability in the GSE, the study again adapts Takaendesa (2006) and Aziakpono (2009) empirical model in its estimations. This chapter, therefore, evaluates and analyses the empirical estimations of the model in the previous chapter.

Summary Statistics of Security Returns

Critically examining the typical features of the time series financial data, the observed extreme values, temporal clustering, and fat-tail (leptokurtosis) in the graph and summary statistics are critical. Furthermore, examining the distribution of features of stock returns and/or stock prices is vital to the behaviour of stock prices and returns, accurate model specification, estimation and forecasting. Therefore, to begin, this study considers inspection of the trends of daily and yearly returns, normal distributions and volatility tests on the sampled equities on the GSE and market returns of the GSE. However, the summary statistics of daily returns is also presented in Appendix D (Table 1) to inform readers about its distribution as it is considered for the subsequent sections of the analysis made in this chapter.

Relationship between Yearly Average Returns and Risk

For Securities on GSE

To make a comparative case for just this part of the analysis, the study focuses on the trends in yearly distributions of daily returns of firms. To begin, it can be observed over the 9 years (2010 to 2018) that investors on the Ghana Stock Exchange (GSE) saw gains from investing in CAL, EGH, ETI, GCB, RBGH and SOGEGH equities since their average returns were positive, with CAL giving investors the highest return of approximately 0.10 percent on the market, followed by GCB (0.08%), EGH (0.05%), ETI (0.02%), SOGEGH (0.03%) and RBGH (0.01%) and thus exhibiting a bullish market over the 9 years. Whereas investors of SCB and TBL recorded losses (negative average returns) of approximately 0.08 and 0.01 percent respectively over the sampled period, indicating a bearish market.

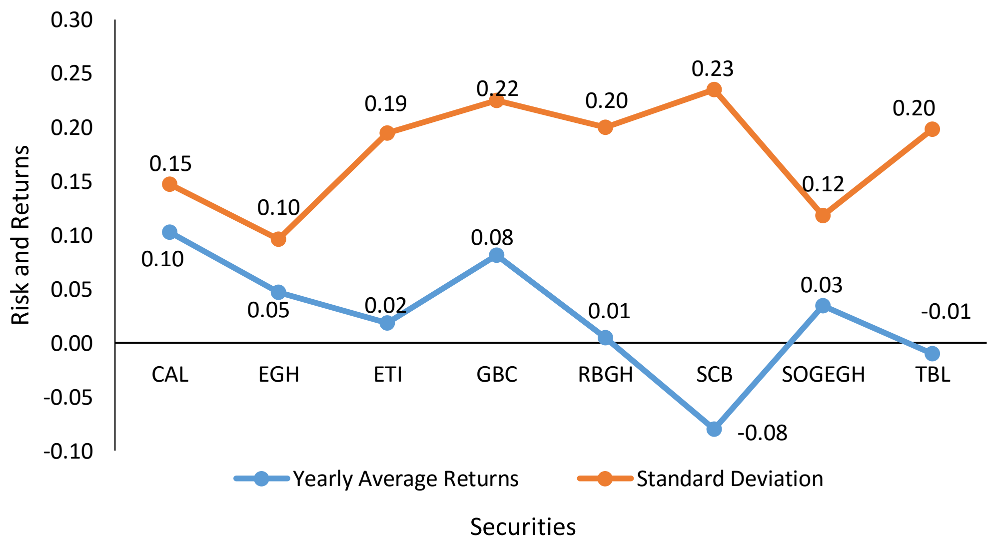

Figure 2: Relationship between Risk and Returns of Securities

Source: Nyarkoh (2020)

Moreover, risk or volatility (Standard deviation) associated with these equities, informing how their actual returns deviate from their average returns on the GSE was positive for all equities traded on the GSE. Investors who considered the purchase of SCB bore the highest risk of approximately 0.23 percent, followed by RBGH (0.20 percent), with EGH having the least risk of 0.10 percent. Theories like CAPM and APT suggest that potential return rises with an increase in risk and thus if volatility is a common priced factor, we would expect the highest average returns to be compensated by a high risk (standard deviation).

However, the figure indicates that even equity with the highest average return is not commensurate with its associate high risk. Therefore, it can be noticed that CAL recording the highest average return to investors is associated with a lesser risk of 0.10 percent compared to SCB with the highest risk recording a loss of 0.23 percent to investors in the GSE. Taking a critical observation from the information presented above, there exists no plausible relationship between risk and returns on the GSE. Moreover, as shown in Appendix D (Table 1), the maximum and minimum yearly returns on the exchange are between 0.54 to 0.17 percent and -0.04 to -0.53 percent respectively, with GCB having the maximum daily returns whilst TBL has the minimum daily returns. This shows the extent of investors' gains or losses on the exchange, and thus the investing with equity GCB had the maximum gains of approximately 0.54 percent whilst those with TBL recorded the highest loss of approximately 0.53 percent.

Nevertheless, a mere relationship between standard deviation and average return does not give concrete evidence to conclude a clear relationship between risk and return on the GSE, therefore this study will proceed formally by conducting hypothesis tests using the CAPM.

For GSE Market Returns

For the sake of objective five, the study again proceeds with an inspection of the trends of yearly market returns and risk of GSE. With a focus on the yearly averages presented in appendix D (Table 2), one can see that the NSE recorded a mean return of 2.73 percent This then implies the Ghana stock exchange experienced a gain of 2.73 percent in the market returns and depicting a bullish market, however relatively low. Moreover, volatility (risk) as measured by standard deviation is 3.26 percent, while recording a maximum and minimum returns of approximately 10.65 and -9.81 percent on the Ghana stock exchange respectively.

The above results especially on the securities seemingly depict that the risk-return trade-off, known in the finance theory is not applicable in this instance and thus indicates that as much the exchange realise or expect higher returns with more risk, the higher risk may also be indicative of higher potential loss on the market.

Normality Test

In real terms, history indicates that financial market behaviour suggests its distribution to exhibit fatter tails (leptokurtosis) than traditionally predicted and some level of skewness, which shows the probability of gains and losses to investors on the exchange. So, to achieve this, the study continues with an inspection of the normal distributions of all equities and market returns considered for the study.

For Securities on GSE

As shown in Appendix A (Figure 1 to 8), equities EGH, ETI, GCB, and RBGH, SCB, SOGEGH, TBL recorded a probability of gains and losses respectively for investors, since they depicted a positive and negative skewness respectively. Specifically, equities EGH, ETI, GCB had skewness of 1.17, 0.08 and 0.24 respectively. That means investors who considered these equities have 1.17%, 0.08% and 0.24% chance of attaining profit and thus investors of EGH has the highest probability of gaining profit on the GSE over the sampled period. This could be as a result of less risk associated with trading in such equity and evidently, it conforms to the results in table 1 as EGH recorded the least standard deviation among the others. Conversely, RBGH, SCB, SOGEGH, TBL were negatively skewed with values of -1.14, -36.42, -0.32 and -29.55. Therefore, investing in these equities has 1.14%, 36.42%, 0.32% and 29.55% chances of incurring a loss on the exchange respectively. And as such investing in SCB has the highest chance of making no profit and for that matter incurring losses on the GSE. This is also consistent with the information from table 1 as SCB recorded the highest standard deviation that makes it much riskier to trade it.

The distribution of return series of equities traded on the Ghana Stock Exchange quite conforms to the important stylist facts of the financial market data. The data from all the return series show that the returns are not symmetric and the distributions mostly have long left and right tails. In addition, as shown in the appendix the kurtosis is way over 3 suggesting that the underlying time series data is heavily tailed and sharply peaked when compared to a normal distribution. The Jarque-Bera test statistics and corresponding probability values reinforce the excess kurtosis and skewness value suggests evidence against normal distribution for all the equities.

Considering this implies that, in determining the probable gains and losses when making decision investors should consider the formation of portfolios on the GSE. Thus, because most equities exhibiting both positive and negative skewness, the potential gains and losses are large. As such, in this type of market diversifying risk by forming portfolios to reduce the risk burden would be much suitable for young investors and those who have sufficient time to invest until retirement. This is all because young investors have much time to engage in market trading activities and so have ample to recover from a significant trading loss. On the other hand, investors closer to retirement may be better off with a portfolio that is less likely to lose very much. In this sense, considering equities such as EGH would be more preferable since they have fewer chances of losing on the GSE.

For GSE Market Returns

In testing the normality of the data from GSE market returns, the results as shown in the Appendix A (Figure 9) indicates that the kurtosis of the exchange exceeds the normal distribution threshold of 3, with the exchange recording a value of 15.57 while. The Jacque-Bera and skewness from the distribution emphasize on the non-normality of financial data from both exchange and thus conforms to the stylist facts of being heavily tailed and peaked. To add on, the exchange depicts a negatively skewed distribution of -0.29. This means that there are 0.29% probability of incurring losses on the Ghana stock exchange. This implies that to be successful investors in the market, it takes a greater deal to be able to absorb risk and so portfolio formation or diversify is key for all investors. Moreover, such market type would be suitable for young investors.

Hence not disputing the fact that the distribution of these return series was done based on their logged values and so called a lognormal distribution, this distribution is much suitable for financial assets in the sense that asset prices cannot be negative. Therefore, not being normally distributed is vivid evidence of the stock price movement on the financial stock market.

Volatility Graph Analysis

Is of the general norm with stock returns to fluctuate thereby exhibiting volatility clustering, so larger returns are usually complemented by large returns. To confirm this, the study continues with an observation of volatility of the daily returns of sampled equities in the GSE.

For Securities in GSE

Taking a critical look at Appendix B (Figure 11), volatility in CAL equity could be seen to be much high within the periods of 2010 through to 2013 and experience some level of calmness afterward up to 2016, when volatility rose again in 2017, then was low in 2018. Information from the Sikasem Personal Finance(2019) indicates that the fall in the equity's risk levels and profit in 2016 was accompanied by a fall in dividends to investors. Touching on performance the bank recorded a profit after tax of Ghc 162.9 million in 2018, an increase of 12.2% over the previous year's profit of Ghc 145.2 million. Despite this, the share price of CAL bank equity dropped from GHc 1.08 at the end of 2017 to Ghc 0.98 at the end of 2018. This, therefore, confirms the fact that as volatility (risk) in 2018 was low dividends decreased and as such, demand for the equity fell leading to the fall in the share price compared to 2017 when volatility was high (Sikasem Personal Finance 2019).

Moreover, equity EGH (Figure 12) does not experience much volatility on average. However, as of 2018 volatility had increased compared to 2017. According to GSE Market Report (2019), the share price of EGH in 2018 was Ghc 7.96 which was a rise compared to the shares price of Ghc 7.5 in 2017. Once again, this proves that as volatility increases yield to investors rise and as such demand for the equity increases causing an increase in demand and so leading to a rise in share prices. Notwithstanding, this fact, dividend yield to investors of EGH was recorded to be 0% and this according to the report is attributed to the change in profit levels of the firm for that year. Similarly, investors of ETI (Figure 14) recorded a 0% in dividend yield accompanied by a fall in share price from Ghc0.16 in 2017 to Ghc 0.09 in 2018. Nevertheless, its volatility is quite high for all periods. This shows the theoretical relationship volatility and investors yield is defied (GSE Market Report 2019).

On the other hand, volatility in GCB (Figure 13) is low compared to ETI. With this low volatility, however, volatility was quite high in 2017 until it fell in 2018. Moreover, the share price in 2018 is recorded to have decreased from Ghc 4.92 in 2017 to Ghc 4.6. This quite confirms the fact that a rise in risk leads to increase investors, thereby increasing the share price of an equity and vice versa. Moving on, equity RBGH (Figure 15) and SOGEGH (appendix 17) exhibit similar volatility fluctuations over the sampled period. With both recording a fall in volatility as of 2018 after high volatility in 2017, RBGH recorded a fall in share price from Ghc 0.69 in 2017 to Ghc 0.55 in 2018. This conforms to the volatility and share price relationship however, investors' dividend yield was 0% which is attributed to some firm operational losses in 2017 (GSE Market report, 2018).

In the same manner, SCB (Figure 16) and TBL (Figure 18) shows a familiar trend in the volatility. Both experienced the least volatility over the sampled period. This shows there was less risk in trading in this equity and as such should be accompanied by less returns and dividends for investors. This, however, contradicts the results from table 1. GES Market Report (2018) showed that share price for equity SCB and TBL in 2018 fell from Ghc 21 to Ghc 16.76 and Ghc 0.4 to Ghc 0.23 respectively. In addition, investors of SCB recorded a dividend of Ghc 6.21 whilst TBL recorded 0% dividend in 2018.

To sum up, the theoretical relationship between volatility, share price and dividends are contradicted by figure CAL, GCB, RBGH and SOGEGH. These pieces of information are inconsistent with the study Nazir, Nawaz, Anwar, and Ahmed (2010), argued that the stock price volatility is significantly impacted by dividend policy of which dividend yield is positively related to stock price fluctuation, whereas the payout ratio is negatively linked to share price movement. However, this is in contrast with results from figure EGH, ETI, SCB, and TBL. Studies such as Shah and Noreen (2016) also investigated the Pakistan market and find that both dividend payout ratio and dividend yield are significantly, negatively associated with stock price volatility. Therefore, these variations in results could be attributed to some other market or firm specific factors.

For GSE Market returns

The research continues with a visual inspection of the plot of daily returns on Ghana stock exchange as shown in Appendix B (Figure 19) respectively. In reference to this, one can observed that returns continuously oscillate around their mean values on both exchange and that means larger fluctuations tend to cluster together followed by periods of calmness. As such, Ghana Stock Exchange exhibits many fluctuations within the sampled period.

Therefore, this returns series tend to conform to the stylized fact of financial market data as noted by Fama (1990), in the sense that large returns are complemented by larger returns.

Unit Root Test

From here on, the study concentrates on the first four objectives. For modelling purposes, the daily returns of each security were subject to stationarity tests. In confirming stationarity of the return series, two stationarity tests were conducted namely the ADF and KPSS tests. All these tests shown in table 1 below reveals that the ADF p-values were very significant at the 1% and therefore the null hypothesis of non-stationary or unit root was rejected. In the case of the KPSS test, the study failed to reject the null hypothesis of stationary since the test was not significant at the 5% significance level. Therefore, the returns series were all stationary at the 5% level of significance for all the tests. This information obtained also gives the study the edge to consider a volatility model such as ARCH or GARCH family for the testing the conditional CAPM in the GSE.

Table 1: Stationarity Test

Note: *** *p<0.01*, ** *p<0.05*, * *p<0.1*

	ADF-TEST		KPSS- TEST			
	Constant Only	With Trend	Constant Only		With Trend	
Variables	t-stats	t-stats	t-stats	Critical val. (5%)	t-stats	Critical val. (5%)
CAL	-25.391***	-25.391***	0.177	0.463	0.065	0.146
EGH	-15.707***	-15.707***	0.086	0.463	0.054	0.146
ETI	-53.338**	-53.338**	0.066	0.463	0.054	0.146
GCB	-26.530***	-26.530***	0.357	0.463	0.081	0.146
RBGH	-31.841***	-31.841***	0.149	0.463	0.134	0.146
SCB	45.782***	45.782***	0.059	0.463	0.045	0.146
SOGEGH	-21.677***	-21.677***	0.076	0.463	0.049	0.146
TBL	-46.698***	-46.698***	0.142	0.463	0.048	0.146

Source: Nyarkoh (2020)

ARCH-LM and Autocorrelation Test

The observation that the magnitude of current residuals for much financial time series tends to be non-linearly related to the magnitude of their past residuals forms the reasoning behind the ARCH-LM and Autocorrelation test, which are presented in Appendix E (Table 3 and 4) respectively. These tests are based on the null hypothesis of no heteroskedasticity and autocorrelation respectively. Though the presence of heteroskedasticity/ARCH effects in the data does not invalidate standard inference, ignoring it may result in a loss of efficiency (Harvey, 1976). The selected equities from the GSE were then subjected to the ARCH-LM test since it forms the basis for volatility modelling.

The test was performed at lags (1 7 14) across all the sectors. The study followed Arowolo (2013) and Abonongo, Oduro and Ackora-Prah (2016) in the lags selected for both ARCH-LM and autocorrelation test. Moreover, the 14-period lags are considered because, the equities were all significant at 5% alpha level. It is, therefore, evidence from the Appendix E (Table 3) that all return series from the respective equities are exhibiting ARCH effects at 1% significance level with the exception of SCB, which was significant at 10% and thus indicates there is the presence of heteroskedasticity, which makes the coefficients inefficient when not taken care of.

Moreover, all these equities that exhibited ARCH effects had autocorrelation checks performed on them. Results in the Appendix E (Table 4) indicates that the Ljung-Box statistic was used in checking the presence of autocorrelation with a maximum lag of 14. Moreover, it proved that the returns series were all statistically significant at the 1% level of significance, which therefore shows the null hypothesis of no autocorrelation in the levels of the returns series is rejected. This indicates that there was no clear probability of investors earning above or below average for the mere fact of using historical data from the stock exchange.

So, securities; CAL, ETH, ETI, GCB, RBGH, SCB, SOGEGH and TBL are all considered for fitting the GARCH models since they exhibited the presence of ARCH effects and autocorrelation. The information from the test, therefore, implies there exists volatility clustering and so a volatility model would be appropriate for estimations.

Model Selection Criteria

The study continues with the selection of the appropriate GARCH-lag model. From the results presented in Appendix E (Table 5), one can notice that among all the GARCH lag models considered, the GARCH (1, 1) model had the lowest criterion. Arowolo (2013) and Abonongo, Oduro and Ackora-Prah (2016) indicated that the best GARCH lag model should be based on the information with the least criterion. Hence, the study concludes that GARCH (1, 1) is the best model to capture stock returns volatility. The study considered the Generalised Error Distribution (GED) in estimating the GARCH (1, 1) model for all equities. According to Mills (1995), in financial time series data, distributions are mostly normal and as such, models have been developed to deal with these departures from the Gaussian distribution, like stable symmetric distributions for stock returns and one of such relevant models include the Generalised Error Distribution (GED). So evidently, from the normal distribution shown in the appendix, the distributions are negatively skewed which makes the use of the normal Gaussian distribution inappropriate for the GARCH (1, 1) estimation.

Discussions of Results

This section presents findings on the five objectives and hypotheses considered for the study. However, with the first four objectives, the study seeks to test the validity of the conditional CAPM in the GSE. Based on these four objectives, the first step of the empirical analysis was estimated using the method of ordinary least squares (OLS). Although the ARCH-LM test guaranteed the use of GARCH (1, 1), the OLS is also estimated to back the evidence that considering OLS estimation technique for financial time series data from the stock exchange is inappropriate as the residual variance is not constant, violating one of the assumptions of the Classical Linear Regression Model (CLRM), leading to the problem of heteroscedasticity. Estimations are therefore shown in table 2.

Table 2: Beta Estimates with OLS Technique

Variables	Beta Estimates	White Test (F-Stats)
CAL	0.00	7.28*
	(-0.02)	
EGH	0.03	15.58**
	(-0.56)	
ETI	0.02	10.76**
	(-0.14)	
GCB	0.2**	80.21***
	(-3.16)	
RBGH	0.1	14.44**
	(-1.11)	
SCB	0.2	3.07*
	(-1.22)	
SOGEGH	0.02	14.37**
	(-0.28)	
TBL	0.26*	10.42**
	(-2.21)	

Notes: t-values are shown in parenthesis *** *p<0.01*, ** *p<0.05*, * *p<0.1*
Source: Nyarkoh (2020)

The results summarized in table 2 indicate that coefficient betas from using ordinary least squared estimation on security return series from the GSE are only significant for GCB and TBL at 5% and 10% alpha levels respectively. It is also evident that the study rejects the null hypothesis of homoscedasticity and so concludes the variance of the error term of the return series are not constant since the white test suggests the p-values of each of the securities returns are significant, indicating the presence of heteroscedasticity, making the beta coefficients of the estimates inefficient. As such, it would not be appropriate for forecasting and making inferences. Therefore, this study ignores using OLS and considers the GARCH (1, 1) model to mitigate this problem.

GARCH Estimations

On this premise, the study adopts the GARCH (1, 1) model in testing the conditional CAPM in the GSE. For the purpose of portfolio formations, this section is to aid the study to obtain conditional CAPM beta estimates/efficient betas, which reflect the behaviours of the GSE. Information is therefore presented in table 3.

Table 3: GARCH (1, 1) Estimations on Securities

MEAN EQUATIONS Dependent Variable: Average Security returns			**VARIANCE EQUATION**		
Variables	Beta estimates	Z-stats	α	*β*	α+*β*
CAL	0.14** (0.07)	2.11	0.16***	0.79***	0.94
EGH	0.01*** (0.00)	29.17	0.13***	0.83***	0.96
ETI	0.01*** (0.00)	32.93	0.11***	0.75***	0.86
GCB	0.26*** (0.01)	28.04	3.34***	0.26***	3.60
RBGH	1.05*** (0.02)	45.77	0.12***	0.95***	1.06
SBC	3.40*** (0.03)	104.33	2.03***	0.12***	2.15
SOGEGH	0.12** (0.04)	3.01	1.29***	0.20***	1.49
TBL	1.65*** (0.01)	1079.53	2.41***	0.01*	2.41

Notes: std. errors are shown in parenthesis *** *p<0.01*, ** *p<0.05*, * *p<0.1*
Source**:** Nyarkoh (2020)

To attain efficient beta estimates from securities that capture the effect of time variations on the GSE the GARCH (1, 1) model is adopted. The Results present two informations thus estimates form the mean and variance equations. From the mean equation, it can be noticed that all beta coefficient estimated ranges from 3.40 to 0.01, and are all significant. In detail, equities such as ETI, GCB, RBGH, SCB, EGH and TBL are significant at 1% alpha levels whilst CAL and SOGEGH are significant at 5% alpha levels. Therefore, with SBC and EGH having the highest and lowest coefficient respectively means, with any change in the market return, investors of security SBC earns the highest change in premium by 3.40% when purchased while security EGH attains the least change in premium by 0.01% when purchased.

Moreover, results from the summary statistics of yearly average returns (Figure 3) showed that equity SBC and EGH have the highest and lowest risk (standard deviation) respectively to which the risk-return theory suggests should commensurate the highest and lowest returns. This is consistent with the results from the GARCH (1, 1). The findings, however, contradicts the evidence from the volatility graph, as trends in volatility (risk) of EGH in 2018 had increased compared to 2017 whilst that of SCB fell within the same period, leading to an increased price from Ghc 7.50 in 2017 to Ghc 7.96 in 2018 for EGH. While the share price of SCB fell from Ghc 21 in 2017 to Ghc 16.76 in 2018 (GSE, 2018).

In all, the results are consistent with the findings of Abonongo, Oduro and Ackora-Prah (2016) and, Coffie and Chukwulobelu (2015) but contradict the findings of Acheampong and Agalega (2013), and this could be attributed to the variations in periods considered, the types and number of actively trading equities considered for the study.

Moving forward, results from the variance equation also indicate significant ARCH and GARCH term for all equities. The "α" and "β" represent the lagged squared error term (ARCH effect) and conditional volatility (GARCH effect) respectively. Together, they measure the volatility of each equity. A large error coefficient indicates that volatility reacts to market shocks intensely, while a large GARCH coefficient indicates that shocks to conditional variance take a long time to disappear, implying persistent volatility (Dowd, 2002). If the summation of the ARCH and GARCH term (α and β respectively) are very close to one, that means volatility is highly persistent and implies inefficiency in the market and otherwise suggests stability in the volatility of such equity.

So, from the results, it can be noticed that relatively all equities exhibit high level of volatility persistency in their trading. As we assume risk is priced on the exchange, these results imply how unstable prices of equities on the GSE can be. According to Abonongo, Oduro and Ackora-Prah (2016), such events may emanate from the inefficiency of the market as a whole largely because of information asymmetry and illiquidity of the market and as such affecting firms and so giving room for investors who have information to capitalize on for higher gains on the market.

Testing of CAPM on Portfolios Returns

As suggested by Fama and Mcbeth (1973), estimates of beta from individual securities are imprecise, creating a measurement error problem when they are used to explain average returns. They suggested in their approach that, to mitigate the problem of error-in-variance associated with the use of individual securities in estimating the CAPM relationship, portfolios should be considered instead. So, they proposed portfolio formation and ranking of significant and efficient betas of individual securities by considering 20% or 10% of the highest and least beta estimates to form the first and last portfolio respectively. Information on the beta ranking is presented in table 4 below.

Table 4: Conditional CAPM Beta Ranking (Descending Order)

Variable	Beta Stocks	Average Excess Return	Rank
SCB	3.40	-0.02	1
TBL	1.65	-0.08	2
RBGH	1.05	0.01	3
GCB	0.26	0.08	4
CAL	0.14	0.07	5
SOEGEGH	0.12	-0.02	6
ETI	0.01	0.01	7
EGH	0.01	0.04	8

Source: Nyarkoh (2020)

Table 4 depicts the ranking of conditional CAPM beta used for portfolio formation. For this study, four portfolios are formed by considering 20% of the highest and least beta estimates to form the first to the last portfolio respectively, with each comprising two securities or equities from the GSE. The basis for considering 20% is based on the number of actively trading securities used in this study. The fewer the number, the higher the proportion, to obtain at least two equities per portfolio. The first portfolio is formed based on betas with 1st and 2nd rank and so on to the last portfolio which also takes betas with the last 7th and 8th rank. Below shows the formation of each portfolio formed;

- PORTFOLIO 1-SCB and TBL
- PORTFOLIO 2-RBGH and GCB
- PORTFOLIO 3-CAL and SOEGEGH
- PORTFOLIO 4-ETI and EGH

Once these portfolios are determined, there is the need to analyse the distribution of the data set. For this reason, the trends in the daily returns for the portfolios formed are investigated in Table 5.

Table 5: Summary of Daily Average Returns of Portfolios on GSE

Variables	Obs	Mean	Std.dev	Min	max
Portfolio 1	2233	0.01	1.70	-60.15	7.42
Portfolio 2	2233	0.03	2.05	-12.43	10.79
Portfolio 3	2233	0.04	0.18	-7.38	7.38
Portfolio 4	2233	-0.01	-0.07	-89.59	8.15

Source: Nyarkoh (2020)

Table 5 shows the trends in daily return series based on portfolios returns. Every portfolio has a positive mean excess return indicating a capital gain for holders of such security with the exception of portfolio 4. The descriptive statistics show that portfolio 3 has the highest daily average returns of 0.04, while portfolio 4 has the least daily average return of -0.01. The volatility as measured by the standard deviation shows that the deviation ranging between 2.05 and -0.07, with portfolio 2 and 4 having the highest and least deviations respectively. Here, the risk-return trade-off theory is proved as a portfolio with the least risk has the least return and vice versa.

First Pass-Time Series Regression of Portfolios Returns

In an attempt to test conditional CAPM with portfolio formation, each portfolio formed is then regressed on the excess return of the market in the first-pass time series regression to determine their beta estimates. Here again, GARCH (1, 1) estimation is considered to obtain conditional CAPM beta estimates for generating market beta or market risk. Therefore, results obtained from the mean equation in table 6 below indicate that the beta coefficients are all statistically significant at a 1% alpha level. It ranges from 0.46 to 1.47E-07. This means that the excess market return has a significant value (conditional Beta) for explaining the excess returns of portfolios. These conditional betas now represent the systematic risk or market risk. This systematic risk from the portfolios is then considered as a determinant of portfolio excess return of investor/firms on the market. However, the variance equation presented from the GARCH (1, 1) estimation is not necessary for this part of the analysis of the study so much is not talked about.

Table 6: GARCH (1, 1) Estimations on Portfolios Formed

MEAN EQUATIONS			**VARIANCE EQUATION**	
Dependent Variable: Average Portfolio returns				
Variables	Beta estimates	Z-stats	α	β
PORTFOLIO 1	0.01*** (8.05E-0.6)	26.09	0.37***	0.82***
PORTFOLIO 2	0.05*** (0.01)	269.76	0.00***	0.59*
PORTFOLIO 3	0.05*** (0.01)	29.92	0.150***	0.78***
PORTFOLIO 4	1.47E-0.7*** (9.03E-09)	16.28	0.16***	0.72***

Notes: std. errors are shown in parenthesis and *** $p<0.01$, ** $p<0.05$, * $p<0.1$.
Source: Nyarkoh (2020)

Second-Pass Regression on GSE Portfolios

To achieve the first four objectives of the study, average returns of portfolios and portfolio betas estimates from the first-pass mean equation are considered in the second (cross-sectional panel) stage of the two-pass regression. Pertaining to the first objective of the study, the results show that there exists a positive relationship between market risk and investors' average portfolio returns. This means that assuming that risk is priced, a percentage rise in the risk of the market will lead to a 0.06 percent increase in the average returns of an investor’s portfolio. In addition, this is significant at all levels of significance.

Table 7: Estimations of CAPM on GSE Portfolios Formed

Dependent Variable	Portfolio Average Returns				
Variable	Coefficient	t-stats	R-squared	F-stats	Prob(F-stats)
For obj. 1&2					
Beta	0.06***	7.17	0.37	6.14	0.000
Jensen Alpha (C)	0.01***	4.83			
For obj. 3					
Beta	0.01	0.02	0.35	0.26	0.78
Beta squared	0.85	0.36			
Constant	0.02	0.69			
For obj.4					
Beta	0.18**	2.17	0.59	2.78	0.02
Beta squared	6.60	0.14			
Firm risk	0.01***	7.47			
Constant	0.19	0.18			
Periods included:	2233		Mean dependent var.		0.0167
Cross-sections included:	4		S.D. dependent var.		0.019
Total panel observations:	8932				

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$, Obj. represents Objective
Source: Nyarkoh (2020)

The R-squared value of 37% indicates weak goodness of fit and so means the market risk is able to explain only 37% variations in the average returns of portfolio. The t-statistics proves that market risk significantly influences the average returns of portfolio at all levels of significance. Therefore, the study rejects the null hypothesis and concludes that there exists a positive and significant relationship between market risk and portfolio returns. This endorses the risk-return relationship, from the fact there exist a significant effect of market risk on portfolio returns of investors. This result, therefore, implies that macroeconomic factors such as interest rate, inflation, GDP, taxation policies and some macroeconomic shocks like the 2008 financial crises, have a huge impact on the profitability of investors in the GSE. Chakravarty (2006) indicated that macroeconomic factors such as inflation have a negative correlation with share prices and returns. He argued that rising inflation points to a recession in the economy and with this outlook, businesses start disposing their shares affecting investors' returns on the market.

This result is quite evident in Ghana, in the sense that after the financial crises, the GSE experienced huge divestments and capital flow reversal (IMF, 2009). This resulted in the decline of portfolio investment on the exchange which led to a huge fall in the GSE returns (Macias and Massa, 2009; World Bank, 2009 and Osakwe, 2010). So, risk must be appropriately priced to motivate investors in these kinds of economic times. Moreover, this result conforms to the theoretical intuition of the CAPM and is consistent with the findings of Jamil (2018) and Godeiro (2013), however, contradicts the findings of Were (2012) who all worked on portfolios and this could be attributed to area and period under study.

For objective two, the study considered determining the existence of abnormal gain on the GSE and the intercept term (Jensen Alpha) is used as a measure. The CAPM suggests there should be no abnormal gains on the market and as such, the Jensen alpha should not be significant in the model. The results, therefore, indicate that with an intercept value and t-statistics of 0.01 and 4.83 respectively, the Jensen alpha is significant at all levels of significance. Therefore, the study rejects the null hypothesis and concludes that abnormal gains do exist on the GSE.

This implies that even though there have been some policies such as automation to help with the dissemination of information to curb inefficiencies (mispricing and exploitations) on the exchange, there still exist some levels of inefficiencies which allows some investors to gain some undesirable advantages in the market, leading to abnormal gains at the cost of others.

According to Mustapha (2017) stock mispricing is crucial to successful investment on the exchange as it is caused by market specific characteristics and hugely determines the attractiveness of the stock market to portfolio investment flows, therefore, ruling out the possibility of fair pricing and with that large investors take advantage of the new ones creating abnormal gains on the African stock market. This result is consistent with the findings of Jamil (2018) however contradicts the CAPM theory.

As the CAPM stands, it suggests there exist a linear relationship between market risk and average returns of investors. The non-linearity test confirms the actual relationship between beta and average excess returns. The study extends the original CAPM model used in the first objective by adding the square of the independent variable (beta), to capture the non-linear part of the model for the third objective and thus tests the hypothesis that the squared beta is not Therefore, about this objective, a beta coefficient and t-statistics of 0.01 and 0.02 show there exist a positive but insignificant relationship between market risk and average returns of investor's portfolio.

Moreover, the result indicates that there exists a positive but insignificant relationship between expected return and beta-squared. This means that there is exist a linear relationship between beta-squared and expected return and so the CAPM is a linear one. The study fails to reject the null hypothesis that there is no linear relationship between beta-squared and average excess return. These results support the findings of Jamil (2010). Therefore, this conclusion is therefore appropriate with CAPM predictions.

Moving forward to the fourth objective of the study, CAPM suggests that there exists only one determinant of the model and thus the market beta.

Theoretically, this implies only the risk of the market (systematic risk) is priced and that investors are compensated based on the risk they bear from the market only. Thus, ruling out the effect of all other firm specific risk also know idiosyncratic risk on returns of investors. So, to capture the firm risk, the study based on Fama and Macbeth (1973) approach to further extend the equation used in objective three by considering the square of residuals of each portfolio from the first pass regression as an additional determinant in the second-pass regression. Therefore, a null hypothesis is then tested against the alternative that there exists no significant relationship between the expected return of investors and firm risk.

The estimation shows that Beta exhibits a positive and significant relationship with average returns of investors' portfolio while Beta-squared exhibits a positive but insignificant relationship with average returns. R-squared of 59% shows weak goodness of fit. Moreover, with a coefficient and t-statistics of 0.01 and 7.47 for the firm risk, the null hypothesis is rejected at all levels of significance and so concludes firm risk does influence the average returns of investors. Meaning with a percentage increase in the risk of listed firms, there is a 0.01% increase in the average returns of investors.

According to Gyan (2015), firm risks such as profitability of a business, an imminent acquisition/merger, or pending legal suit, operational strategies, investment strategies, and corporate culture of firms listed on the GSE impact on the interest of investors as well as values of shares returns on the GSE. These findings contradict the findings of Jamil (2010) as well as Khudoykulov, Alladostov and Khalikov (2016). These variations in findings can be conditioned on the nature of the market considered as well as the country. In all, this part does not conform to the theoretical underpinnings of the CAPM.

Second-Pass Cross-Section Regression (Securities Returns)

For the basis of Fama and Mcbeth (1973) argument that considering estimates of beta from individual securities are imprecise, creating a measurement error problem when they are used to explain average returns and so not giving a clear picture of the effect of risk on returns. This section then considers the conditional betas of individual securities from table 3 (first-pass regression for individual securities) as independent variables regressed on the average excess returns of these securities. This is estimated in a cross-sectional panel form to affirm the argument made by Fama and Mcbeth (1973). So, as depicted in Table 8 below, the average excess returns of securities are considered together with their respective beta coefficients.

Table 8: Estimations of CAPM on GSE Individual securities

Dependent Variable:	Security Average Returns				
Variable	coefficient	t-stats	R-squared	F-stats	Prob(F-stats)
For obj. 1&2					
Beta	-0.03	-1.44	0.46	2.07	0.15
Jensen Alpha (C)	0.04	1.54			
For obj. 3					
Beta	-0.09	-1.38	0.41	1.56	0.21
Beta squared	0.02	1.02			
Constant	0.05*	1.84			
For obj.4					
Beta	0.01	1.10	0.35	0.79	0.50
Beta squared	0.01	0.05			
Firm risk	-0.09	-1.38			
Constant	0.02	0.09			
Periods included:	2233	Mean dependent var.		0.017	
Cross-sections included:	8	S.D. dependent var.		2.629	
Total panel observations:	17864				

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$, Obj. represent Objectives
Source: Nyarkoh (2020)

Following objective one on individual securities, a second-pass cross-sectional as suggested by Fama and Mcbeth (1973) is estimated with averages an excess return of securities and their beta coefficients (market beta/risk) from table 3 (first-pass regression). Results from table 8 presented above, therefore, indicates that the slope of the estimated regression is -0.03, reflecting a reduction in average return by 0.03% as a result of a percentage rise in market risk for investors trading on the market. This is however not significant at all levels of significance with a p-value of 0.15 and so the study fails to rejects the null hypothesis that there exists no positive and significant relationship between market risk and average returns.

R-squared indicates that only 46% of variations in an average excess return of securities can be explained by the market beta. The test of the significance of the overall model as shows by the f-test indicates that the regression model is not significant at all levels. The above results, therefore, imply that individual securities are not able to predict the positive relationship between average returns and market risk as CAPM suggests. This, therefore, does not support the theoretical implications of the capital asset pricing model and the risk-trade-off theory. Therefore, investors considering only the market risk in estimating or predicting their expected return would be a fallacy. This is consistent with the findings of Oduro and Adams (2012) and Coffie and Chukwulobelu (2015) who focused on individual securities in their study.

On the second objective, the CAPM suggests that firms or investors do not enjoy abnormal returns because of the assumption of symmetric information on the market. Therefore, from the table 8 above, it can be seen that with a coefficient and t-statistics of 0.04 and 1.54 respectively, the Jensen alpha is not significant all levels and so the study fails to reject the null hypothesis and concludes that investors do not enjoy any sort of abnormal returns from trading on the GSE. This result is inconsistent with the findings of Jamil (2018) and Khalikov (2016). The non-existence of abnormal gains on the GSE can be attributed to the automation policy implemented by the exchange in 2009. This implies there has been an enhancement in the mediums through which information is disseminated to parties on the exchange and as such reducing the levels of exploitations on the exchange, leading to fair pricing and returns.

Moving on, according to the proponents of CAPM, it depicts a linear relationship between market risk and the expected return of investors. Table 8 displays the test for non-linearity in the CAPM. This part calculates a regression through average returns, betas and beta squared. So, in trying to satisfy the objective, the linearity of the cross-sectional panel was estimated as depicted in the table above. Beta is once again negative and statistically insignificant. Specifically, with a coefficient and t-statistics of 0.02 and 1.02 respectively, one can notice that the squared beta, which measures the linearity of the model, exhibits a positive relationship but insignificant at all levels of significance. The R-squared is also as low as 41%. Thus, the independent variables can explain only 41% variations security average expected returns of investors. The F-statistic test of 1.56 means that all the variables jointly do not influence the average expected returns of investors. From the results, this study fails to reject the null hypothesis and so concludes that the CAPM is a linear model. The result is consistent with the findings of Khudoykulov, K., Alladostov and Khalikov, (2016) and so conforms to the theoretical intuition of the CAPM.

To satisfy objective four, a null hypothesis is then tested against the alternative that there exists no significant relationship between the expected return of investors and firm risk (idiosyncratic risks). For this part, in the opinion of CAPM, investor's stock returns are influenced by only the systematic risk or the market beta and so idiosyncratic or firm-specific risk does not affect the company's or an investor's returns. Therefore, table 8 presents the estimation of the residual variance of security's average excess returns, beta and squared betas. The estimation indicates that Beta and Beta-squared all exhibit a positive but insignificant relationship with expected returns. R-squared of 35% shows weak goodness of fit. The f-statistics value of 0.79 also indicates that the independent variables do not jointly influence average returns.

Moreover, with a coefficient and t-statistics of - 0.09 and -1.38 for firm risk, the null hypothesis is rejected at all levels of significance and so concludes the firm's risk or idiosyncratic risk does not have any influence on average or expected returns of investors. Thus, falls in line with the theoretical intuition of the capital asset pricing model. This conforms to the findings of Reddy and Thomson (2011) and Otieno, (2009), who both concluded the CAPM is valid on the NSE and Johannesburg Stock Exchange.

So based on the first four objectives, although both approaches do not endorse the validity of CAPM on the GSE, as pointed out by Fama and Mcbeth, the use of security beta as a measure of market risk to test the validity of CAPM is a fallacy and as such does not give a clearer picture on the actual behaviour of the trading activities on the market. This is confirmed evidently in the sense that the risk borne by the market and firms have an impact on the decisions and returns of investors in the GSE (Gyan, 2015), to which the use of securities could not establish. In addition, the weak R-square values also depict that indeed there could exist some other factors which the CAPM model needs to consider, to which the use of portfolios confirmed. Using portfolios helped this study realised the full effect of all these environmental factors as well as the presence of abnormal gains on the market. Plausibly, to highlight the flaws in using securities for the test, a security market line is also predicted with the average returns and beta coefficients of securities and portfolios.

If the risk-return relationship holds, the security market line exhibits a positive linear relationship, which then makes it easier for investors to determine the most efficient assets form the inefficient ones. As shown in Figures 3 and 4, using portfolios we can accurately predict the line as suggested by the model. This means if CAPM is indeed valid all portfolios above the line are efficient for investors to trade in. However, results from using securities show a negative relationship, which is inappropriate for the CAPM theory.

Figure 3: Individual Security (Security Market Line)

Source: Nyarkoh (2020)

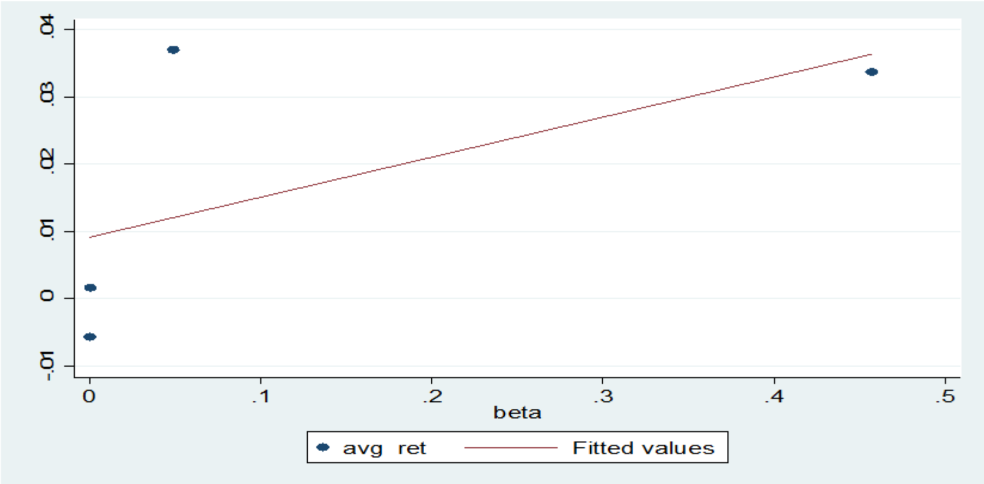

Figure 4: Portfolio (Security Market Line)

Source: Nyarkoh (2020)

For objective five, this study examined the nature of stability in the GSE using the mean reversion and half-life method. This section continues with the analysis of market index, diagnostic tests and discussions of results.

Analysis of Market Index

Considering the market index of GSE as shown in Appendix C (Figure 20). The results show GSE experienced 4 bull cycles and 4 bear phase cycles throughout the study. Commonly observed bullish periods during the study include; 2010 to mid-2011, 2013 (highest rise), start 2014 to mid-2015 and finally start of 2017 to mid of 2018 while bear periods include; 2011 to mid of 2012, 2014, 2016 (where it experienced the biggest fall) and the end of 2018.

The sampled stock price of GSE tends to experience a similar trend as can be observed in Appendix (Figure 19). The fluctuations are both in the positive and negative regions with larger fluctuations and tend to cluster together separated by episodes of relative calmness. The index series seems stationary and exhibits dependence over time.

Information from African Stock Exchange (2019) and Ghana Stock Exchange (2018), indicates that automation of the equities market has facilitated much higher trading activities and can be seen influencing the significant gains of 990.63 points on the GSE composite index in 2013. According to Business and Financial Times report (2017), the managing director of the Ghana Stock Exchange asserted that the sterling performance in 2013 after the loss in 2012 was due to improved economic fundamentals with a rapid decline in inflation, Treasury bill rates, a relatively stable cedi and investors' confidence in Ghana. Whilst in the bearish year of 2016, according to the GIS Centre (2016) report, investors' appetite for yield together with local economic uncertainties triggered by deteriorating macroeconomic fundamentals, turned many investors from the stock market and long-dated securities to the short-term fixed income treasury securities market such as the 91-day and 182-day treasury bill. The high rates of interest attracted both retail and institutional investors to chase yield inherent in those short-dated instruments. Also, information from the GSE (2018) attributed the considerable fall at the beginning of 2018 to the initiation of the financial sector clean-up exercise by the central bank of Ghana.

Unit Root Test

For modelling purposes, again the market daily returns of GSE market is subject to stationarity tests. Two unit-root or stationarity tests (ADF and KPSS) were employed which are presented in table 9. These results exhibited that all the return series are stationary at levels for the GSE. The ADF was significant at the 1% significance level and therefore the null hypothesis of non-stationary or unit root was rejected. In the case of the KPSS test, the study failed to reject the null hypothesis of stationary since the test was significant at the 5% significance level. Therefore, the returns series of the market were all stationary for all the two tests.

Table 9: Stationarity Test

	ADF-test		KPSS-test			
	Constant Only	With Trend	Constant Only		With Trend	
Variables	t-stats	t-stats	t-stats	Critical value(5%)	t-stats	Critical value(5%)
GSE-returns	-17.15***	-17.14***	0.10	0.46	0.10	0.15

Note: *** *p<0.01*, ** *p<0.05*, * *p<0.1*
Source: Nyarkoh (2020)

ARCH-LM and Autocorrelation Test

Since the stationarity of the return series has been determined, the next step is to satisfy the two pre-conditions for using the GARCH model. The first condition was to plot the graphs of the squared residual of the conditional volatility. The volatility graph demonstrates that high volatility periods follow other periods of high volatility, and low volatility periods follow periods of low volatility for the GSE market returns. Thus, the results confirmed the presence of conditional volatilities in the return series.

For the second pre-condition, in a similar approach done for the first four objectives, the study employs the ARCH-LM test on the market. The ARCH-LM test was conducted at lags 1, 7 and 14 and the null is that there exists no heteroskedasticity. The results in the Appendix E (Table 6) show that *t*-statistics for the GSE market return are significantly higher and probabilities are less than 0.01. This result indicates the presence of heteroskedasticity/ARCH effect as the study rejects the null hypothesis and therefore was considered for volatility modelling. Because these market returns exhibited ARCH effect, the study considered an autocorrelation check on them. The Ljung-Box statistic tool was used at a maximum lag of 14 and the null is that there exists no autocorrelation. The Ljung-Box statistic LB (14) used for the returns series was significant for all the series indicating the presence of autocorrelation in the series. Moreover, as such that there was no clear probability of investors earning above average gains for the mere fact of using historical data from the stock exchange. Now, both pre-conditions for using the GARCH. model have been satisfied. This is shown in table 7 in the same appendix.

Model Selection Criteria

Again, the information criteria AIC, SIC and HQ are employed in selecting the appropriate lag distribution assumption. From the results shown in Appendix E (Table 8), GARCH (1, 1) has the information criterion. According to Abonongo, Oduro and Ackora-Prah (2016), the model with the lowest information criterion value should be selected, therefore the lagged model with the least value for AIC, SIC and HQ values was selected for the GSE. Therefore, the study proceeds with using GARCH (1, 1) to determine the nature of stability of the market. Moreover, once again the study considers the Generalised Error Distribution (GED) in estimating the GARCH (1, 1) model for the market because of the negative skewness in the distributions.

Specification of Mean Equation

In Fitting the GARCH (1, 1) models for examining the nature of stability in Ghana stock exchange, it is more appropriate to specify a suitable mean equation. With OLS, the mean equation (21) in chapter 3 was estimated and tested for serial correlation using the Breush-Godfrey LM test. As the results of the mean equation in Table 10 depict, there was evidence of autocorrelation for this specification of the Mean Equation (21). Since the statistic for the Breush-Godfrey (B-G) was significant at the 5% and 1% level of significance for GSE, hence the null hypothesis of no serial correlation was rejected.

For this, a single lagged value of the exogenous variable was added to the right-hand side of Equation (21), giving rise to Equation (22) in chapter 3. This new mean equation was then tested again for serial and autocorrelation. As it is evident from Table 10, the B-G (1) had indications of no serial correlation since the p-values showed they were not significant at all levels of significance level for the GSE market returns for the Breush-Godfrey test and therefore the study fails to reject the null hypothesis of no autocorrelation. The use of Mean Equation 22 with an AR (1) component eliminates the autocorrelation hence making it more appropriate for the GARCH (1, 1) estimation.

Table 10: Autocorrelation Test

Variables	B-G	ARCHLM	B-G (1)	ARCHLM (1)
GSE-returns	0.012**	0.000***	0.78	0.000***

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Nyarkoh (2020)

Discussions of Results

Once appropriate mean equations for the Ghana Stock market have been determined, this section presents the GARCH (1, 1) estimation of these equations to help determine the nature of stability in the GSE market. Setting GARCH (1, 1) as the most appropriate model, various volatility dynamics (i.e. volatility against both last period's and previous period's shocks, its persistence, mean reversion and half-life periods) were investigated in the

GSE with market returns. The test rests on the fact that, in general, the market is quite volatile.

Table 11 shows the regression results for both mean and the variance equation that examines the nature of stability in GSE. Information from the mean equation indicates that with a coefficient of 0.06 there exists a positive relationship between the GSE current average market returns and its previous year's average returns. This indicates that the current average market returns increase by 0.06% when the previous year's average market return rises by a percentage. Apparently, with a z-statistics of 2.41 indicates its significance at 5% alpha level.

Table 11: GARCH (1, 1) Estimation on GSE Market Stability

	MEAN EQUATIONS		VARIANCE EQUATION					
On GSE								
Dependent Variable: GSE Returns								
Variables	Beta	Z-stats	α	β	α+β	ln(α+β)	ln(0.5)	L
GSE Returns (-1)	0.06** (0.02)	2.41	0.29***	0.69***	0.98	-0.02	0.69	34.50
Constant	0.01 (0.02)	0.31						

Notes: std. errors are shown in parenthesis, *** *p<0.01*, ** *p<0.05*, * *p<0.1*
Source: Nyarkoh (2020)

Moreover, the core of this section of analysis hinges on the results from the variance equation. This is used to measure the persistence of volatility in the market and as such used in determining the stability over the sampled period. So here, the variance equation has one ARCH term (ε_{t-1}^2) and one GARCH term (h_{t-1}). The dependent variable (h_t) represents the conditional variance, α and β represent the lagged squared error term (ARCH effect) and conditional volatility (GARCH effect) respectively. A large error coefficient indicates that volatility reacts to market shocks intensely, while a large GARCH coefficient indicates that shocks to conditional variance take a long time to disappear, implying persistent volatility (Gbeda & Peprah,). If the summation of the ARCH and GARCH term (α and β respectively) are very close to one, that means volatility is highly persistent and implies inefficiency in the market and otherwise suggests stability in the volatility of such equity.

To achieve objective five, the results show that both ARCH. and GARCH. effects for GSE returns is significant at 1% percent significance level, demonstrating that previous day information affects the current volatilities of Ghana stock market returns. In addition, the sum of ARCH. and G.ARCH. coefficients is less than one ($\alpha+\beta<1$) for GSE. These results confirmed the mean-reverting process, and so volatility (risk) reverts to their mean value after a certain period on the exchange. Therefore, the market is stable and so the study fails to accept the null hypothesis that there exists no stability in GSE.

Furthermore, the results provide evidence of high and persistent volatility (risk) on the GSE. A value of 0.98 is evident that the GSE has a weak mean reversion process. This means it takes long times for the GSE to be stable. Similarly, the half-life period (L) which is the speed of mean reversion was also determined and it indicates the number of days it takes volatility to get it mean value or better said the market to be stable. The result demonstrates that with the sum of ARCH. and GARCH coefficients of 0.97 for the GSE, it would take 34.50 thus approximately 35 days for volatility to revert to their mean values (stability) on the GSE. This confirms the efficiency market hypothesis and in details shows that the GSE is a weak form efficient market.

According to Emenike and Aleke (2012), the implication of weak and strong mean reversion is that, for market with strong mean reversion, the returns of those market approach their average prices very quickly whereas, for a market with weak mean reversion, their returns take a long period to return towards their average prices. That is, there is the expectation that the market with and weak mean reversion will have a high half-life period and vice versa. Therefore, the mean reversion phenomenon provides an opportunity for investors to forecast the future values of the equity returns based on past values. Whereas, the half-life period provides insights and wisdom to investors and financial experts to identify the rate at which the prices revert to their mean value. This will not only help them in the selection of strategies but also plan their entry and exit in the trade.

The Ghana has undergone a series of bull and bear phases as well as volatilities observed in the residual plots presented in the Appendix C (Figure 19). As earlier indicated the GSE returns exhibit a weak mean reversion process and as such takes 35 days for volatility to revert to their means. Abonongo, Oduro and Ackora-Prah (2016) insisted investors who like to take a long position (purchase) prefer market that have strong mean reversion since their volatility does not stay for a long time, because the risk of such market is minimum and as such, investors can easily predict their future gains on such market. However, this is not always so, the caveat here is that, in the situation where positive shocks such as innovation or discoveries increase volatility, investors will prefer to invest in equities that have high persistence measure of volatility and weak mean reversion. And even with negative shocks, investors are advised to purchase instead. This is because a stable market attracts investors and as such, a risky market will mean an increased supply of securities over demand since buyers may not be motivated to consider such a market.

Hillebrand (2003) also asserted that investors must be encouraged to take a long position on such a market because of compensation they are likely to get from price reductions on such market. With that, this study suggests that the GSE will be a perfect market for risk lovers and investors must consider taking a long position (Purchase) as an entry strategy and probably hold on to that security days till the 35th day then releases to gets even higher returns. This is because a long reversion process gives hint on the level of inefficiency of the market. Investors can, therefore, take advantage of that and thus keep securities until their prices are even higher to realise higher returns when sold. For this matter, it would not be appropriate for investors in the GSE to consider taking a short position (sell) since there is the tendency that prices will stay high or even rise when the market becomes stable.

With GSE having a high level of volatility, means the market less stable. This implies investors considering the GSE market should prefer day trading, where they take a long position in the day and later take a short position in the night. This is to avoid too many losses as it becomes difficult to estimate or forecast one's expected returns from security held.

Chapter Summary

From the above estimations and analysis, the results identified that the CAPM is not valid irrespective of individual securities returns or portfolios returns, however, the study found out that market risk and firm specific risks are major factors that affect investor portfolio returns. Also, in relation to the nature of stability, the GSE is highly volatile. This depicts that the GSE is less stable and as such depicts a weak measure of mean reversion and a long half-life period relative.

Moreover, to confirm the validity of the results, post-estimation tests are conducted. For the use of cross-sectional panel in the first four objectives, the Wooldridge autocorrelation test was tested and the results shown in the Appendix E (Table 13) justified the failure to accept the null hypothesis and so conclude there exists no autocorrelation in the models. In addition, the study employed the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity and again failed to reject the null hypothesis, concluding that there exists no heteroskedasticity in the models (shown in the same table). Moreover, for the use of the GARCH (1, 1) model, the Serial correlation test conducted by using the Ljung-box test and Heteroscedasticity test based on the ARCH-LM test were employed. So, for the analysis to be considered meaningful, the study is not expected to reject the null hypothesis of no autocorrelation and heteroscedasticity for the autocorrelation and ARCH-LM test respectively. As shown in the Appendix F (Table 9 to 12), the results indicate there is no evidence of heteroscedasticity and severe serial correlation for all objectives after estimating with the GARCH (1, 1) model, since the t-statistics and Q-statistics for the selected lags are insignificant all levels of significance. Thus, the dynamics captured in the model are adequate.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter provides an overview of the entire study. It begins with a summary of the whole study, policy recommendations and some suggestions for further research that could be used to investigate the current problem.

Summary

This research tested the validity of Capital Asset Pricing Model on the Ghana Stock Exchange; and existence of the market volatility on Ghana stock exchange using data from the Ghana Stock Exchange and the central bank of Ghana Annual Report Ghana databases spanning from 2010 to 2018. With mechanisms and policies put in place to help curb levels of inefficiencies that existed on GSE, there was, therefore, the need for an appropriate model to help investors to predict their levels of returns on the GSE as efficiency on the stock exchange suggests so. Also inform investors about the nature of stability in market, to aid them plan and assess critically their entering and existing strategies on the market.

For this, the study purposely tested the validity of conditional CAPM on GSE portfolio returns and examined the nature of stability in both market by using the mean reversion phenomenon and the half-life period method. Specifically, the study sought to determine the effect of market risk (conditional CAPM beta) on portfolio returns in GSE, find the existence of a firm's abnormal returns/gains in GSE, evaluate the linearity of the conditional CAPM in GSE, determine the effect of a firm's specific risk on portfolio returns in GSE and examine the nature of stability in the GSE.

The study adopted the two-pass regression approach which considers portfolios to mitigate the problems associated with individual securities in testing the validity of the CAPM on the GSE and also followed Takaendesa (2006) and Chinzara and Aziakpono (2009) empirical model in studying the nature of volatility in the GSE.

So, pertaining to the first four objectives, the eight actively trading equities for the sampled period were selected for the test. The trends in yearly returns and normality tests conducted showed that the data exhibited excess volatility, non-normality, excess kurtosis and skewness, which are common with financial data. It further depicted that most of the equities (CAL, EGH, ETI, GCB, RBGH and SOGEGH) made gains, while few equities (SCB and TBL) recorded losses. The volatility of the sampled equities was inspected and it was evident that on average all the sampled equities exhibited volatility clustering, indicating a period of large returns are followed by a period of larger returns.

Therefore, the validity of CAPM was then tested. However, before that, the study estimated the CAPM using OLS and the results proved that OLS is not an appropriate estimation technique to cater for the presence of heteroskedasticity in the financial data and as such, it used should be avoided in such instances. So, the GARCH (1, 1) model was then used by considering the two-pass regression approach by Fama and Mcbeth (1973). However, as some studies had concentrated on individual securities in testing the validity CAPM, Fama and Mcbeth (1973) asserted that such approach is a fallacy. The reason that, estimates of beta for individual securities are imprecise and creates measurement error problem when they are used to explain average returns and as such suggested the used of portfolios would help mitigate this problem. So based on this argument, the first objectives of the study focused on testing the validity of CAPM on the GSE using the information on individual equities collected and portfolios.

The outcome based on both individual securities and portfolios all confirm the time-varying CAPM beta (systematic beta) cannot predict the average returns of investors in the GSE. However, the test based on the portfolio further indicated that the market risk and firm risk are significant and as such key to investors when determining their average returns on the exchange. This, therefore, indicated that the CAPM which is mostly considered by most investors on the African Stock Exchange (African Valuation Methodology Survey (2014/2015) is not valid based on 2010-2018 data gathered from the GSE.

In addition, in examining the nature of stability in the GSE as the fifth objective of this study. The results revealed that on average the GSE recorded gains for the sampled period. The results also showed that data from the exchange exhibited non-normal, excess volatility and negatives skewness. Also, the outcome of the volatility test indicated that the market is characterised by fluctuations and clustering and as such GSE recorded low fluctuations in market returns.

The results indicated that the GSE return series has a slow mean reversion process as such, the GSE exhibits a lower level of stability. Again, the results further made as aware that based on the half-life period, it takes a longer period (35 days) for the GSE to be stable within the sampled period.

Moreover, in all the objectives a post-estimation test was performed to confirm the validity of the models used. For the use of the cross-sectional panel in the first four objectives, the Wooldridge autocorrelation test was employed and the results shown in the appendix justified the failure to accept the null hypothesis and so conclude there exists no autocorrelation in the models.

Also, the study employed the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity and again failed to reject the null hypothesis, concluding that there exists no heteroskedasticity in the models. But the GARCH (1, 1) model, the serial correlation test was conducted by using the Ljung-box test and Heteroscedasticity test based on the ARCH-LM TEST. The study was not expected to reject the null hypothesis of no autocorrelation and heteroscedasticity for the autocorrelation and ARCH-LM test respectively. As expected, there was no evidence of heteroscedasticity and severe serial correlation for all objectives after estimating with the GARCH (1, 1) model, since the t-statistics and Q-statistics for the selected lags were insignificant at all levels of significance.

Conclusion

As much as the use of portfolios addresses the flaws associated with individual securities in testing the validity of CAPM, the results seemed futile. The empirical results are not consistent with the theoretical Implication of the CAPM model and as such suggest the time-varying CAPM beta is unable to predict the average returns of investors in the GSE. The study, however, proved the significance of market risk and firm risk to investors in the GSE. This means that the profitability of firms, operational strategies and investment strategies other than macroeconomic factors such as inflation, interest rate, GDP are likely on the Ghana stock market. These objectives of the study reject the strictest form of the Sharpe–Lintner CAPM, hence implies that investors cannot make predictions based on historical price information from the market. This, therefore, indicates weak-form efficiency on the GSE. This conclusion on the findings does not vary much with Abonongo, Oduro and Ackora-Prah (2016), however, considering portfolios gives better prediction of the beta coefficient and proves that policies can be formulated based on the margin of the coefficients.

Again, we found that this result is confirmed by the findings from objective five, as the nature of the volatility on the GSE is examined. The findings revealed the GSE is mean-reverting, meaning there is always the tendency of the volatility on the market to be stable (return to their average values). However, it takes a longer period for the GSE to be. This implies that, it would much difficult for investors to predict future returns using past or historical prices on the GSE because of the level of riskiness and inefficiencies of the exchange. Therefore, making market entry decisions based on CAPM predictions on profits or returns to gain in the future would be inaccurate. Thus, findings from the half-life period on the market would be of greater help to investors. Therefore, a half-life of 35 days on the GSE indicates the GSE would be more favourable to investors taking long-position (purchase of securities) instead of short-selling (buying of securities).

So, in all, it can be noticed that with policies and mechanism adopted by GSE, there still exist some form of instability in the Ghana Stock Exchange. So, the CAPM does not hold in Ghana's case and the market is less stable thus, very risky.

Recommendations

- With the significant effect of market risk, which could be either interest rate, taxation policies, GDP or inflation, on portfolio returns in the GSE, the study recommends the Central Bank of Ghana to make sure investors are well compensated and protected from the severe shocks of macroeconomic risks. Here the ministry must ensure these risks, which are almost inevitable, are properly priced by considering the impact of the risk on the economy, price changes as well as earning volatilities in the pricing of risk to motivate investors to still trade on the market and recover from losses. This would help raise investors' appetite and as well boost their confidence in holding and investing in risky assets, leading to more capital inflows causing the market to be more liquid. Hence, stabilizing the market for sustainable economic growth.
- In addition, the Central Bank of Ghana must make sure policies implemented to curb the level of inefficiencies are enhanced to ensure uniform information to all parties on the exchange to prevent abnormal gains, which affect the efficiency and stability of the market. For instance, a new and improved mechanism must be adopted to enhance the automation system of the market.
- Moreover, investors in the GSE needs to consider firm specific factor (firm's decisions on financial policies, investment strategies, geographical locations, etc.) and other factors that influence equity returns like skewness (probability of gains and losses) and market capitalisation other than the risk of the market, since it does not imply

investors will always make a profit from investing in particular equity or sector.

- In addition, with the skewness and volatility (risk) of the equities in GSE, investors should consider diversification in their operations and as such portfolio formation would be a key approach to mitigate the risk involved in trading on such market.
- To mitigate the arrival of bad news on the exchange, the Ministry of Finance of Ghana, Central Bank of Ghana and the African Security Exchange Association should implement policies to help and ensure that firms trading on the exchange conform to the codes and conducts of their specific industries. This would help control all forms of inappropriate operational behaviours that would adversely affect a firm's strategies and operations, which could be bad news on the exchange. Bad news increase volatility and if volatility is not priced then investors in anticipation of this may sell their share leading to capital flight, which may increase consumption and as such cause financial instability.
- It has already been established that the GSE is less stable. Therefore, in the case where volatility (risk) is appropriately priced this study suggests investors should consider trading on the GSE market since there exists a positive relation between returns and volatility (risk).

Limitations

Due to the inaccessibility of data, the limited availability of data from the GSE imposed a constraint on the number of actively trading securities selected for the study. For instance, the 8 securities considered on the GSE made up of only two sectors thus the financial and insurance sector. However, this does not ruin the credibility of the study as the validity of CAPM is tested on the GSE.

Suggestion for Further Research

Although this study addresses the methodological weaknesses of prior studies by considering analysis on portfolios rather than individual stocks only (thus correcting measurement error problems) and using GARCH (1, 1) for efficient and time-varying betas; the approach adopted still fails to account for the validity of CAPM. As such, future studies should consider adopting methodologies that account for asset pricing anomalies such as value effects, size effects, momentum effects, and reversal effects. Indeed, this study initially sought to evaluate all the assets trading on the GSE, a majority of those assets were excluded based on the fact that they were not actively trading on the stock market for the sampled period. Future studies should consider expanding the number of assets to study. Moreover, future studies can achieve better data fit by using more observations, which can be achieved by using longer study periods.

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APPENDICES

Appendix A (Normality Tests)

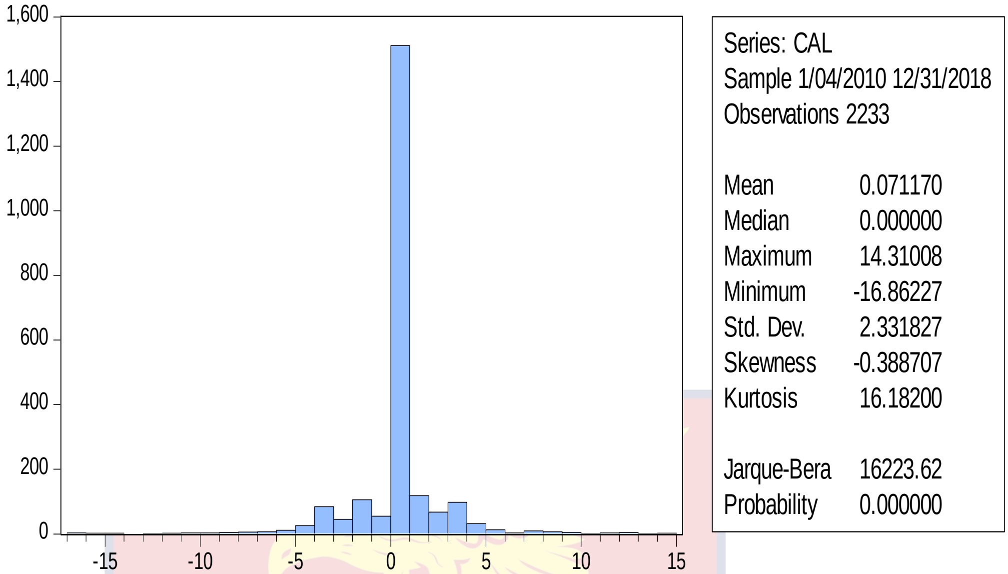

Figure 1: CAL Bank Equity

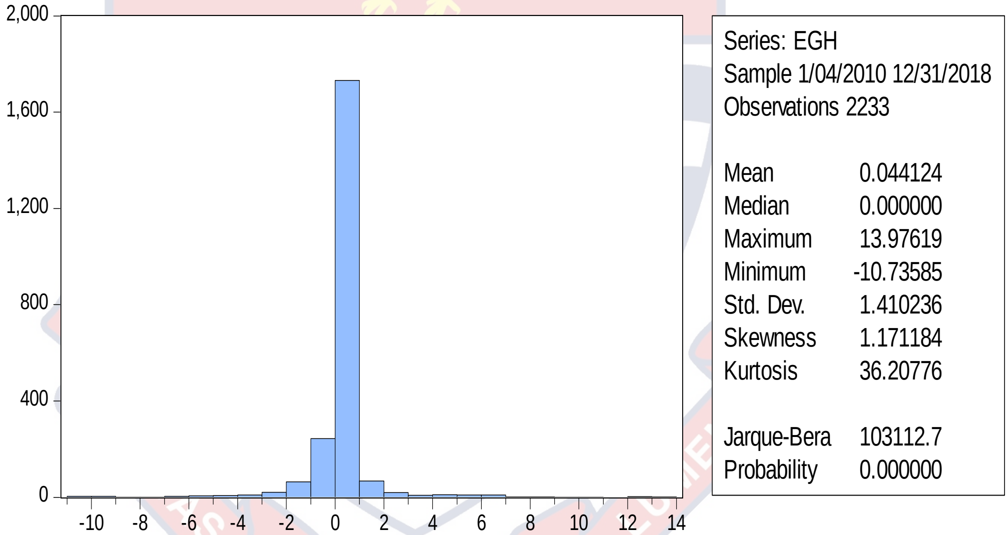

Figure 2: *ECOBANK Ghana Equity*

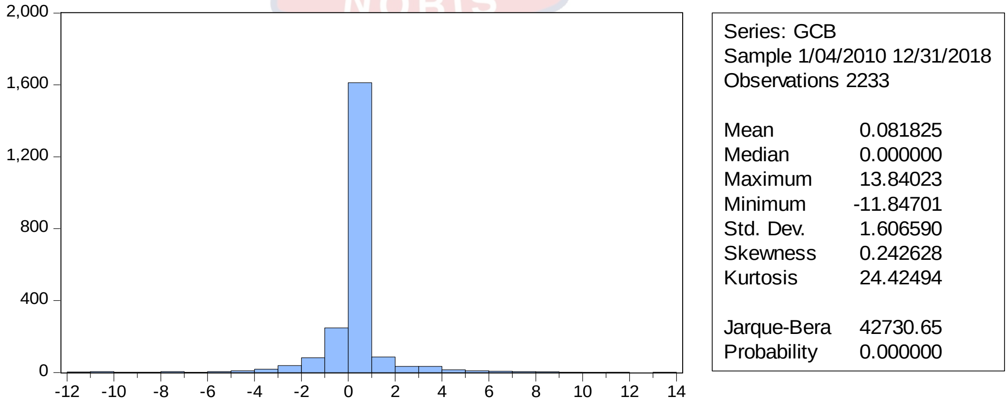

Figure 3: GCB Bank Limited Equity

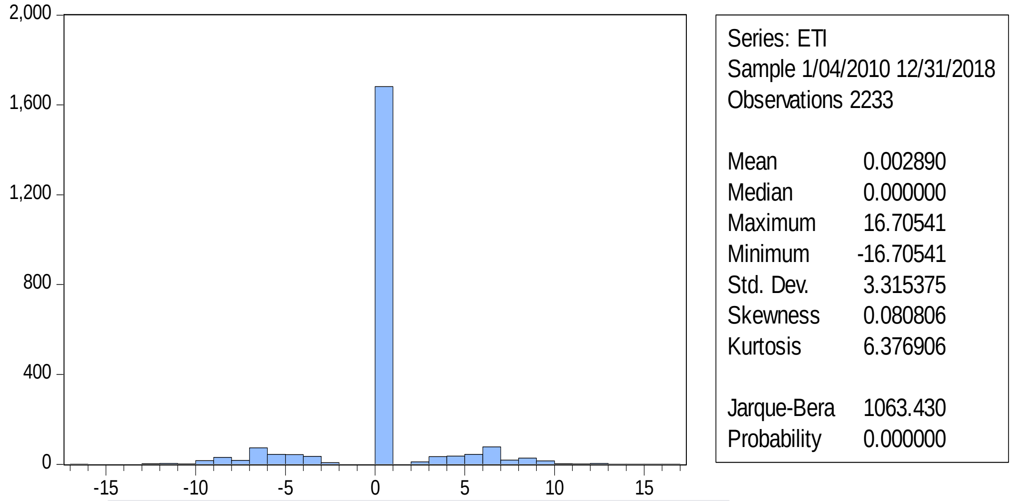

Figure 4: ECOBANK Transportation Incorporation Equity

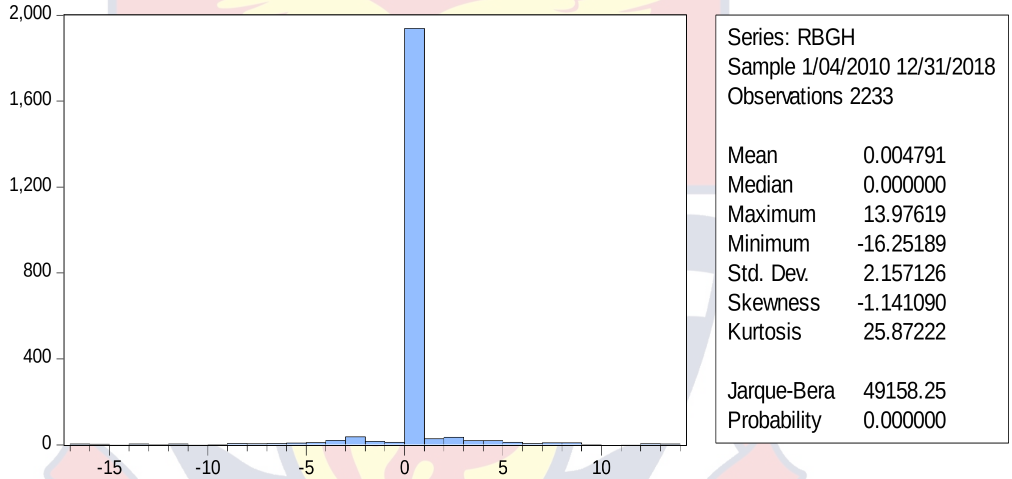

Figure 5: Republic Bank of Ghana Equity

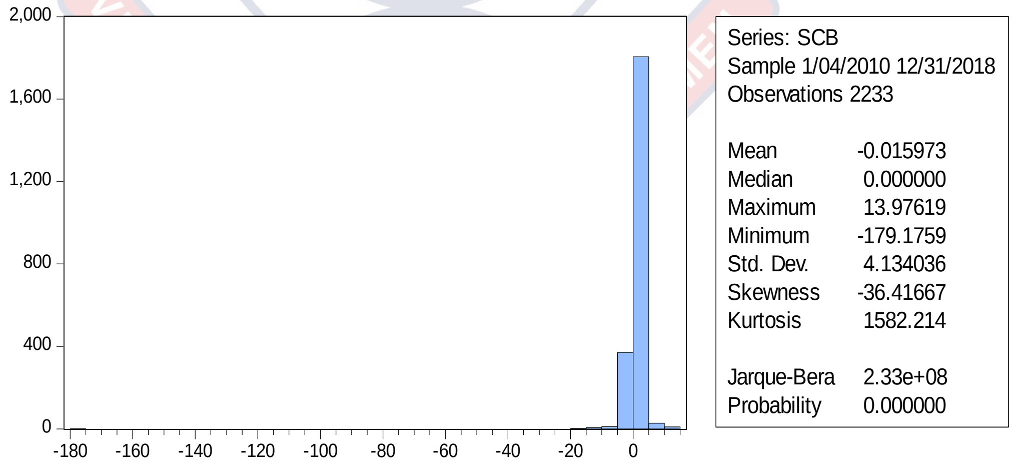

Figure 6: Standard Chartered Bank Equity

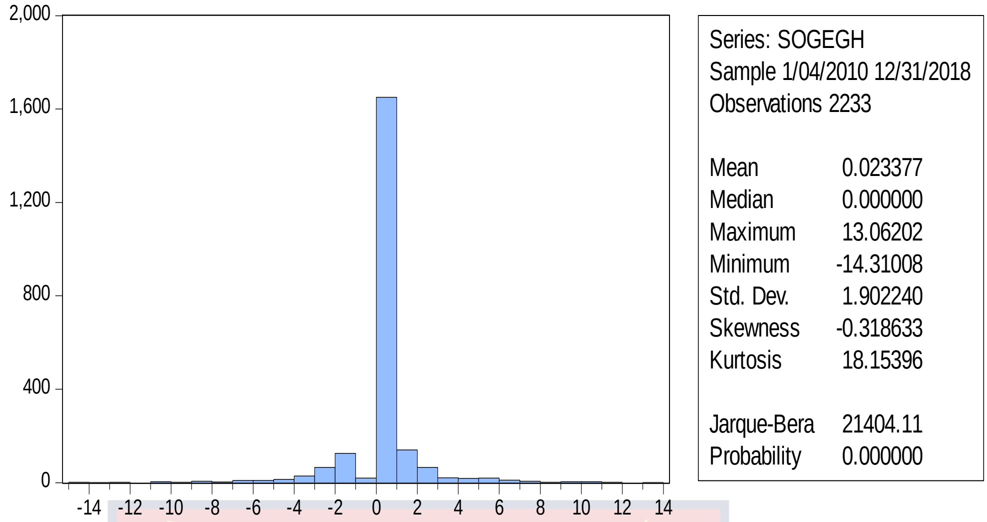

Figure 7: Societe Generale Ghana Equity

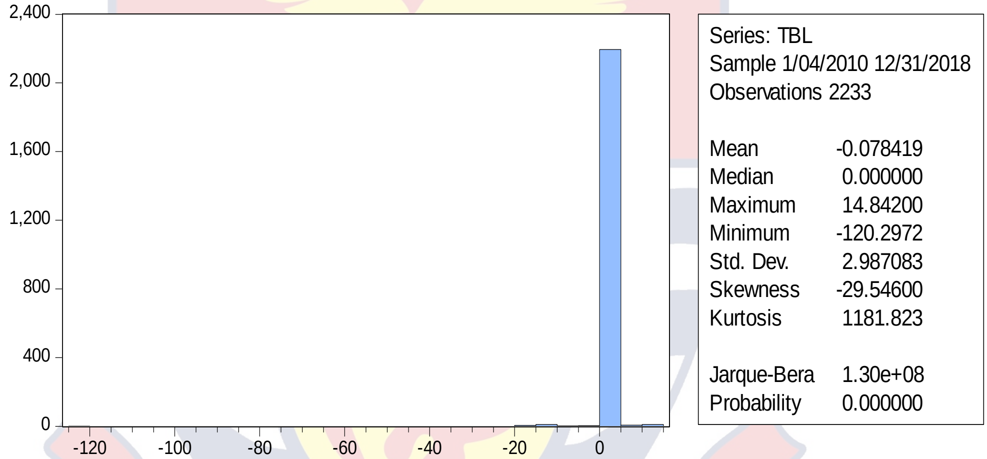

Figure 8: Trust Bank (Gambia) Equity

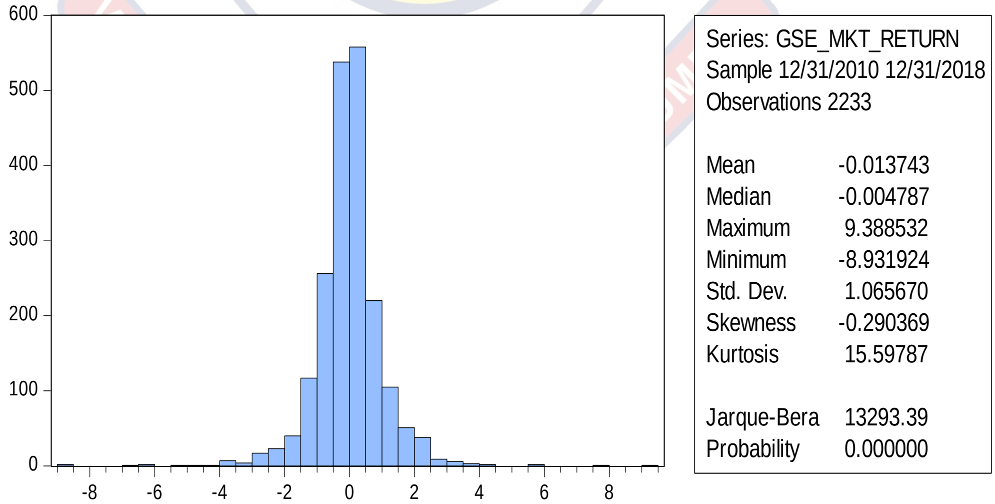

Figure 9: GSE Market Returns

Appendix B (Volatility Graph)

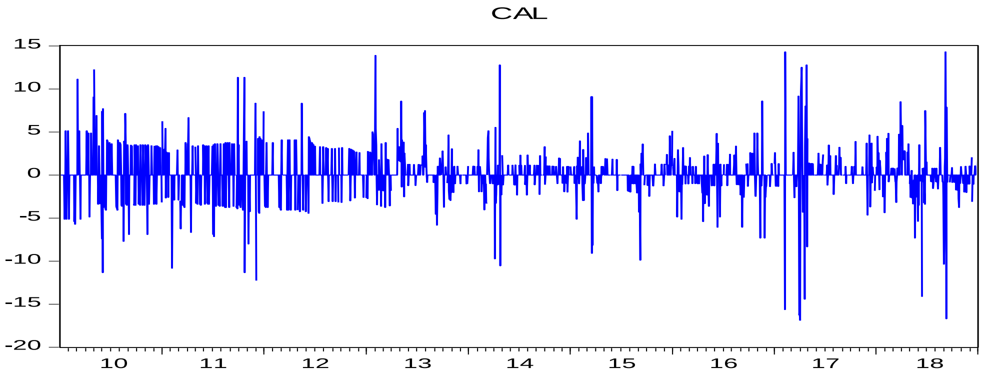

Figure 10: CAL Bank Equity

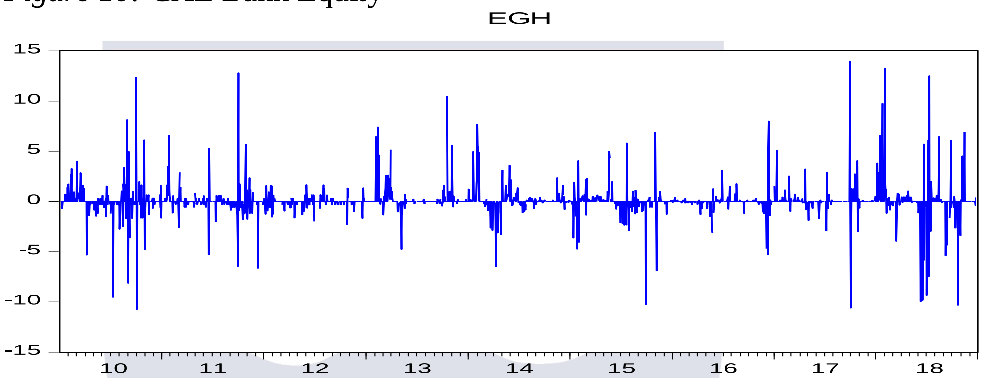

Figure 11: ECOBANK Ghana Equity

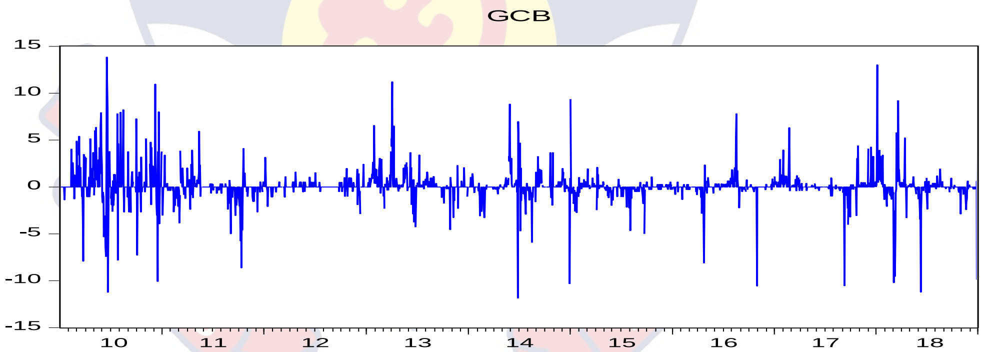

Figure 12: GCB Bank Equity

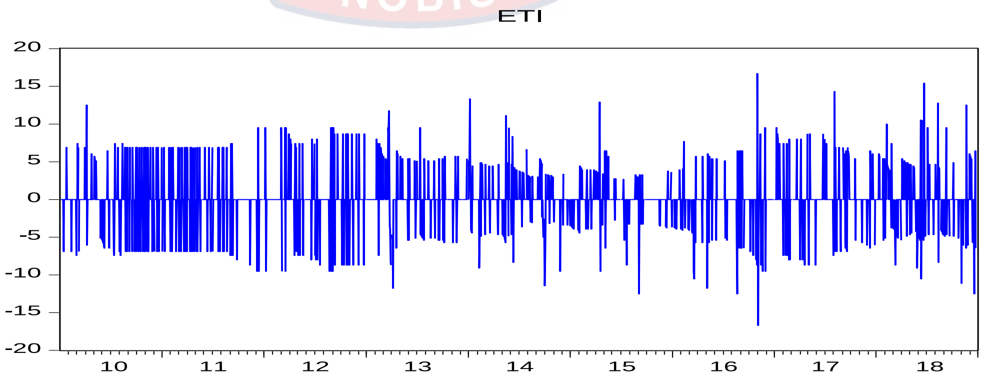

Figure 13: ECOBANK Transport Incorporation Equity

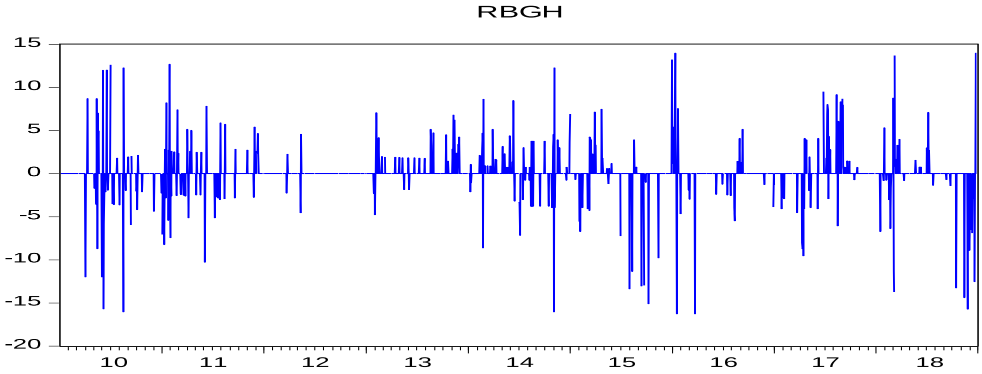

Figure 14: Republic of Ghana Bank Equity

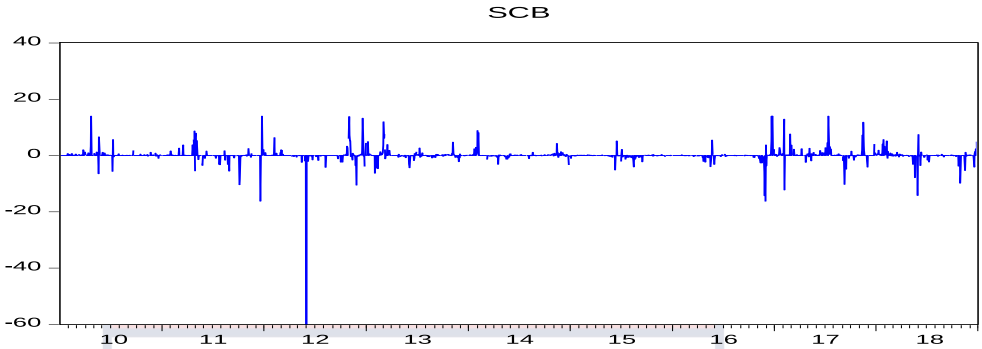

Figure 15: Standard Chartered Bank Equity

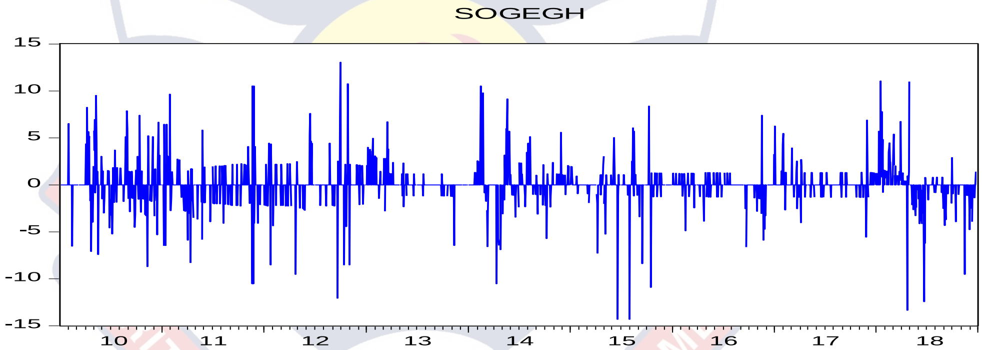

Figure 16: Societe Generale Ghana Equity

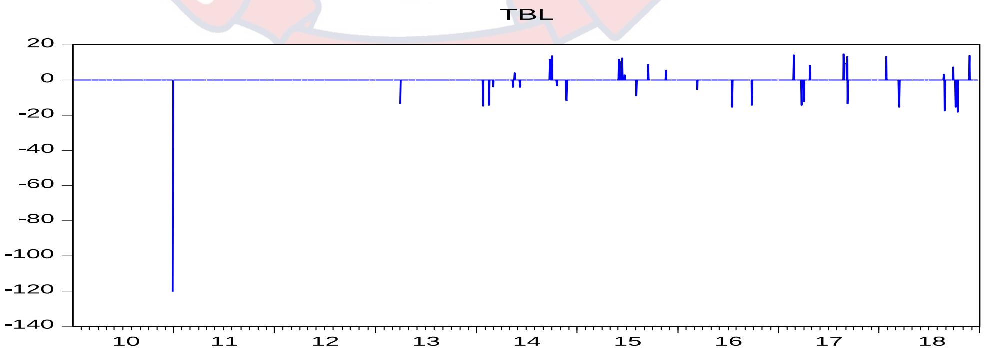

Figure 17: Trust Bank (Gambia) Equity

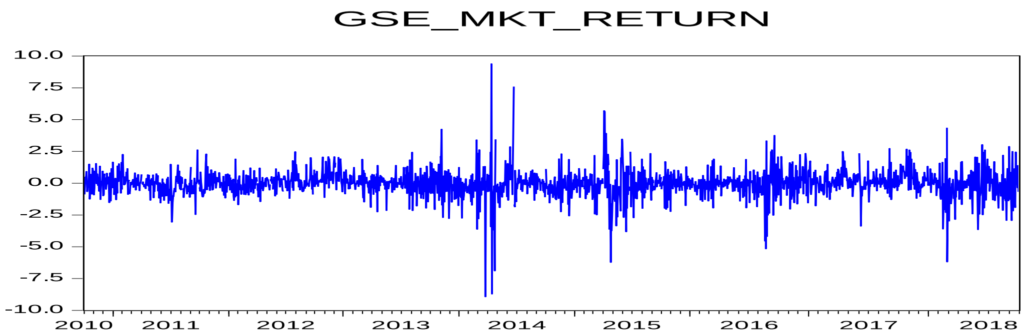

Figure 20: GSE Market Returns

Appendix C (Market Index)

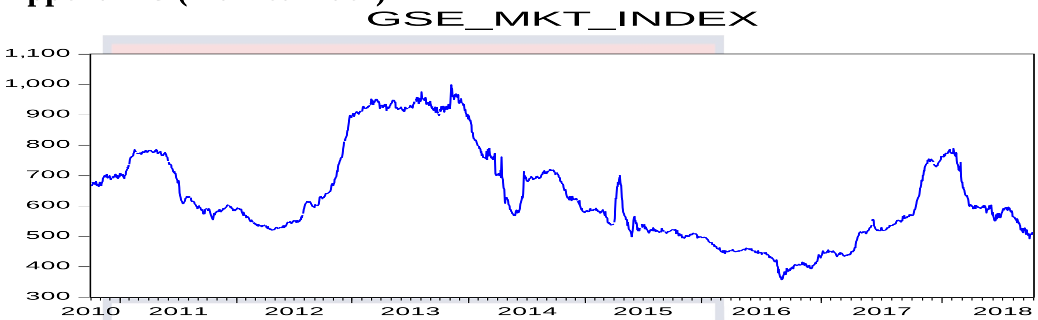

Figure 21: GSE Market Price Index

Source: Nyarkoh (2020)

Appendix D (Summary Statistics)

Table 1: Summary Statistics of Daily and Yearly Average Returns

	Daily Average Returns					**Yearly Average Daily Returns**				
Variables	Obs.	mean	Std.dev.	Min	Max	Obs.	mean	Std.dev.	Min	max
CAL	2,233	0.07	2.33	-16.862	14.31	9	0.10	0.15	-0.12	0.37
EGH	2,233	0.04	1.41	-10.736	13.98	9	0.05	0.10	-0.04	0.26
ETI	2,233	0.01	3.32	-16.705	16.71	9	0.02	0.19	-0.39	0.20
GCB	2,233	0.08	1.61	-11.840	13.84	9	0.08	0.22	-0.15	0.54
RBGH	2,233	0.01	2.16	-16.252	13.98	9	0.01	0.20	-0.29	0.30
SCB	2,233	-0.02	4.13	-179.176	13.56	9	-0.01	0.23	-0.53	0.29
SOGEGH	2,233	0.02	1.90	-14.310	13.06	9	0.03	0.12	-0.13	0.18
TBL	2,233	-0.07	2.99	-120.297	14.84	9	-0.08	0.20	-0.50	0.17

Source: Nyarkoh (2020)

Table 2: Summary Statistics of Daily and Yearly Average Market Returns

	Daily Average Returns					**Yearly Average Returns**				
Variables	Obs.	Mean	Std.dev	Min	Max	obs	mean	Std. dev	min	max
GRN	2233	0.01	1.07	-8.93	9.39	9	2.73	3.26	-9.81	10.65

and GRN indicates GSE RETURNS.
Source: Nyarkoh (2020)

Appendix E (Pre-Diagnostic Test)

Table 3: ARCH-LM Test (Objective 1 to 4)

Variables	Lags	t-stats
CAL	1	3.731***
	7	14.59***
	14	5.22***
EGH	1	4.12***
	7	3.20***
	14	7.86***
ETI	1	6.01***
	7	4.75***
	14	4.57***
GCB	1	3.68***
	7	8.03***
	14	6.83***
RBGH	1	4.11***
	7	8.35***
	14	2.13**
SCB	1	5.77**
	7	5.11**
	14	3.22***
SOGEGH	1	4.74***
	7	4.54***
	14	2.89***
TBL	1	4.36***
	7	5.12***
	14	3.68***

Source: Nyarkoh (2020)

Table 4: Autocorrelation Test (Objective 1 to 4)

Variables	**Lags**	**Q-stats**
CAL	14	620.50***
EGH	14	130.71***
ETI	14	113.77***
GCB	14	199.83***
RBGH	14	150.39***
SCB	14	85.93***
SOGEGH	14	88.67***
TBL	14	75.43***

Note: *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Source: Nyarkoh (2020)

Table 5: Model Specification (Objective 1 to 4)

Variables	(p, q)	AIC	SIC	HQ
CAL	(1, 1)	4.76	4.78	4.76
	(1, 2)	4.78	4.78	4.77
	(1, 3)	4.78	4.78	4.77
EGH	(1, 1)	3.21	3.23	3.18
	(1, 2)	3.22	3.24	3.22
	(1, 3)	3.27	3.29	3.22
ETI	(1, 1)	5.16	5.18	5.17
	(1, 2)	5.18	5.19	5.17
	(1, 3)	5.17	5.18	5.17
GCB	(1, 1)	3.26	3.27	3.24
	(1, 2)	3.26	3.28	3.27
	(1, 3)	3.28	3.27	3.26
RBGH	(1, 1)	4.74	4.75	4.66
	(1, 2)	4.75	4.77	4.74
	(1, 3)	4.65	4.67	4.74
SCB	(1, 1)	5.88	5.89	5.27
	(1, 2)	7.60	7.61	7.60
	(1, 3)	5.87	5.89	5.87
SOGEGH	(1, 1)	2.04	2.06	2.05
	(1, 2)	2.10	2.11	2.10
	(1, 3)	2.13	2.15	2.14
TBL	(11)	5.03	5.04	5.03
	(12)	5.10	5.97	5.96
	(13)	5.16	5.17	5.16

Source: Nyarkoh (2020)

Table 6: ARCH-LM Test (Objective 5)

Variables	Lags	t-stats
GSE RETURN	1	3.95***
	7	5.64***
	14	7.29***
NSE RETURN	1	1.84*
	7	3.46**
	14	2.12**

Source: Nyarkoh (2020)

Table 7: Autocorrelation Test (Objective 5)

Variables	Lags	Q-stats
GSE_RETURN	14	139.20***

Note: *** *p<0.01*, ** *p<0.05*, * *p<0.1*
Source: Nyarkoh (2020)

Table 8: Model Selection Criteria (Objective 5)

Variables	(p q)	AIC	SIC	HQ
GSE RETURNS	(1, 1)	2.47	2.50	2.49
	(1, 2)	2.48	2.50	2.49
	(1, 3)	2.48	2.51	2.49

Source: Nyarkoh (2020)

Appendix F (Post-Diagnostic Test)

Table 9: ARCH-LM Test (Objective 1 to 4)

Variables	Lags	t-stats
CAL	1	0.27
	7	0.95
	14	0.41
EGH	1	0.90
	7	0.76
	14	0.57
ETI	1	0.53
	7	0.67
	14	0.68
GCB	1	0.44
	7	0.10
	14	0.74
RBGH	1	0.28
	7	0.49
	14	0.51
SCB	1	0.99
	7	0.98
	14	0.98
SOGEGH	1	0.91
	7	0.81
	14	0.58
TBL	1	0.98
	7	0.97
	14	0.97

Source: Nyarkoh (2020)

Table 10: ARCH-LM Test (Objective 5)

Variables	Lags	t-stats
GSE_RETURN	1	0.48
	7	0.66
	14	0.67

Source: Nyarkoh (2020)

Table 11: Autocorrelation Test (Objective 1 to 4)

Variables	Lags	Q-statistics
CAL	14	0.22
EGH	14	1.20
ETI	14	1.15
GCB	14	0.97
RBGH	14	0.02
SCB	14	0.84
SOGEGH	14	0.68
TBL	14	0.98

Source: Nyarkoh (2020)

Variables	Lags	Q-stats
GSE RETURN	14	0.68

Table 12: Autocorrelation Test (Objective 5)

Source: Nyarkoh (2020)

Table 13: Post-Diagnostic test for the Second-Pass panel regression (Objective 1 to 4)

Autocorrelation -Test			**Heteroskedasticity- Test**	
Wooldridge test in panel data			**Breusch-Pagan / Cook-Weisberg test**	
Variables	F-stats.	P-value.	F-stats.	P-value.
Portfolios	0.43	0.51	0.28	0.5965
Securities	0.03	0.85	0.13	0.72

Source: Nyarkoh (2020)