EFFECT OF LIQUIDITY RISK ON LOW VOLATILITY ANOMALY IN NIGERIAN STOCK MARKET

Ph.D., Abraham Oketooyin GBADEBO
Osun State University, Osogbo, Osun State, Nigeria
E-mail: abraham.gbadebo@uniosun.edu.ng
Yusuf Olatunji OYEDEKO
Federal University of Oye-Ekiti, Km 3 Oye – Afao Road, Ekiti State, Nigeria

Abstract: *The proposition of MPT and CAPM was that the higher the risk, the higher the return and vice versa. This was premised on the assumption of rationality of market participant and efficiency of the market. However, several studies have violated this assumption, and that led to the anomaly in the market which is popularly known as low volatility anomaly. This study examines the effect of liquidity risk on low volatility anomaly in the Nigerian stock market. The population of the study is all the quoted companies in the Nigerian Stock Exchange (NSE) for the period of ten years. The purposive sampling technique was used to select forty-one companies' stocks that are frequently traded throughout the study period. The data employed for this study are secondary data which were sourced from the NSE. Risk-free rate was proxied with treasury-bill rate,–was sourced from Central Bank of Nigeria. The Ordinary Least Squares (OLS) technique was used. The study found that liquidity risk does not impact on low volatility anomaly in the Nigerian stock market. The study concludes that there is no strong relationship between liquidity risk and low volatility anomaly. This implies that liquidity risk is not an important driver of low volatility anomaly in the Nigerian stock market. The study recommends that investors and other stakeholders should maximise the opportunity of new information in the Nigerian stock market to trade in short-term investment horizon and avoid delay of the information because the market does not reward long-term investment horizon.*

Keywords: *Stocks trading, short-term investment horizon, long-term investment horizon.*
JEL Classification: *C33, G11, G12.*

1. Introduction

The sensitivity of stock return to risk and uncertainty has gained considerable efforts among researchers in the finance literatures. This is because the concept of risk and return form the basis of investment objective. In view of this, Sharpe (1964) proposed the capital asset pricing model (CAPM) which explains the influence of systematic risk exposure on expected return of a financial asset. This conforms to the assumption of Markowitz (1952) who expressed that the higher the volatility or risk of an asset, the higher the asset's return as conventional for investment decision.

However, evidence from the literatures (Oladele & Bradfieldy, 2016; Hartanto, 2019; among others) have shown that these assumptions do not hold in the stock market, due to the irrational behaviour of investors and the market structures. Similarly, Rogdeberg and Kland (2018) asserted that the CAPM-explained risk-return connection has been violated due to several anomalies that tend to dissipate or lessen over time and otherwise appear to be persistent over time.

The low volatility anomaly, discovered by Black, Jensen, and Scholes in 1972 while investigating the CAPM, is one of these anomalies. The risk-return relationship remains positive, but it is substantially flatter than projected, according to their research. They proved that the portfolio produces a greater return for a given degree of volatility and has statistically significant positive alpha.

In the same token, Harrisberg (2020) holds the ~~a~~ view that low volatility anomaly is the deviation from linearity of risk-return relationship as suggested by CAPM and other traditional finance theory such as Modern portfolio theory (MPT), efficient market hypothesis, among others. This view negates the risk-return trade-off which emphasises that all investors act rationally in terms of how they process information about stocks, and that all investors are risk averse in the process of making investment decisions.

In addition, Malkiel and Fama (1970) believe that information incorporated into financial assets is always priced correctly and it prevents the asset to be traded at undervalued rate or at inflated prices. Thus, investors cannot make abnormal returns because they adopt buy-and-hold strategy, rather than active investment strategies. Contrary to this, Sarpong (2017) believes that active investment strategy addresses how investors can make abnormal returns and beat the market because the information incorporated in the asset prices are not significantly priced correctly always. Thus, this shows the relevance of active investment strategy that investor can devise various means to influence the behaviour of financial markets.

Thus, the implementation of various active strategies has led to low volatility anomaly, and this has drawn the attentions of many researchers to acknowledge the presence of low volatility anomaly and the likely factors that can influence it.

Mamer (2015) acknowledges the existence of low volatility from both academic and theoretical perspectives. Academically, he says that low volatility anomaly occurs when testing the validity of CAPM. Evidence of this anomaly has been documented by some pioneer academics who submit that securities with high-beta have corresponding negative alphas, and low-beta securities have corresponding positive alphas. From a theoretical perception, Mamer (2015) states that low volatility occurs when monthly returns of stocks with lower risks outperform monthly return of stocks with higher risks over the long run Ching, An-Pin, and Miao-Ling (2019) claimed that in spite of this, evidence reveals low volatility anomaly in some developed and emerging countries. But more of these studies were documented in the developed economies. This justifies the importance of conducting this research.

Evidence from the literature, particularly Seppälä (2016), Huskic and Baky (2017), and Hartanto (2019), has revealed the presence of a low volatility anomaly, defying conventional theories. Meanwhile, studies like Pandey and Samanta (2016), Blitza and Vidojevic (2017); and Pandey and Sehgal (2017), among others, corroborated the conventional theories and demonstrated the lack of a low volatility anomaly.

Thus, studies on low volatility anomaly reveal~~ed~~ mixed results, and it is still unclear the extents to which assumptions hold, most especially in an emerging market like Nigeria.

More so, studies on low volatility anomaly have been debated beyond the existence of an inverse risk-return relationship to economic and behavioural explanations that justify its likely persistence. Some of these factors include but not limited to investors preferences for lottery-type payoffs, earnings shocks and earnings momentum, earnings forecasts from sell-side analysts, leverage limits and requirements to beat benchmarks short selling constraints, among others, which have been documented as the drivers of low volatility anomaly. But liquidity risk has been controlled, and interaction has not been documented (Ameni, Hasna & Mohamed 2017).

The study is distinct from the previous studies by examining the impact of liquidity risk on low volatility anomaly within the context of stock market in Nigeria. In view of this, the following research questions were stated and answered:

i.How does low volatility anomaly exist in the Nigerian stock market?

ii.What is the impact of liquidity risk on the existence of low volatility anomaly in the Nigerian stock market?

In line with the research questions, the following hypotheses were formulated:

i.There is no relationship between low volatility anomaly and Nigerian stock market;

ii. There is no linkage between liquidity risk and low volatility anomaly in the Nigerian stock market.

This study significantly contributes to the existing literature because studies on low volatility are very scanty in Nigeria.

The study is anchored on Fractal Market Hypothesis to explain impact of liquidity risk on low volatility anomaly which is different from the previous studies that adopted behavioural finance theory to explain low volatility anomaly. More so, portfolio managers, financial analysts or investment advisors would suffice to explore this study as a tool for initiating and executing decisions that could influence investment performance. Furthermore, the regulatory authorities in Nigerian stock markets could employ the findings of this study to influence their operations in respect to facilitating growth in these markets, as well as encouraging smooth trading.

The remaining sections of this paper are arranged as follow: section two presents the details of literature review, three outlines the methodology; four presents the result and discussion of findings, and section five details conclusion and recommendations.

2. Literature Review. Conceptual Review. Volatility

Volatility, according to Seppälä (2016), is the variation in price of a financial instrument that measures the risk of losing money over time. To him, an anomaly is a systematic divergence from theoretical expectation that provides anticipated opportunities for abnormal returns.

Seppälä (2016) idea of anomaly contradicts the classical CAPM, which predicts higher expected returns for higher risk stocks (Qian, & Qian, 2017).

On the other hand, Anderson and Noss (2013) posit that liquidity is the relative easiness with which an investor is able to buy or sell a security without their act of buying or selling having a substantial effect on its price. Thus, stocks with high liquidity are traded frequently, have high volumes and often perfectly mirror the estimated value and profitability of the company whose asset it represents.

According to Weimer (2015), liquidity risk is the danger of illiquidity in the market, which occurs when there is a lack of liquidity in the market, resulting in an imbalance between buyers and sellers in the market. When there are more buyers than sellers, supply and demand indicates that the price will rise; conversely, when there are more sellers than customers, supply and demand dictates that the price will fall.

And, despite the fact that several liquidity measures have been found in the literature, the Amihud (2002) measure is adopted for the purposes of this study.

Fractal Market Hypothesis

Contrary to the assumption of EMH, Buchanan (2013) is of the opinion that financial crises ranging from flash crashes to global financial meltdowns relate to waves in the socioeconomic system, which forces the economy to adapt to new circumstances which cannot be captured by the assumption of Efficient-Market Hypothesis (EMH). Market failures and crashes sometimes occur with no shifts from economic fundamentals, but as a result of herding behaviours which could lead to price changes and volatility (Moradi, Nooghabi & Rounaghi, 2019).

Accordingly, Peters proposed the Fractal Market Hypothesis (FMH) in 1991, which seeks to explain the complexity of financial markets by using mathematical laws. Following is an assumption of FMH proposed by Peter (1991): There are many different investment horizons represented in the market; information has different effects on different investment horizons; the stability of the market is largely a matter of liquidity (the balance of supply and demand); prices reflect a combination of short-term technical trading and long-term fundamental valuation; and if a security has no connection to the economic cycle, there will be no long-term trend; and trading, liquidity, and an increase in supply and demand are all important factors in the market.

Specifically, the FMH seriously undermines the rationality of investors as price takers, the use of generic information, and the stability of the market. In addition, the FMH makes the following assumptions about the situation: The market is stable because it is comprised of investors with a diverse range of investment horizons; it guarantees that traders possess adequate liquidity; the information set is more pertinent to market sentiment and technical factors in the short-run than in the long-run; prices represent a mixture of short-term fundamental valuation and long-term fundamental valuation, among other things; and prices portray a combination of short-term fundamental valuation and long-term fundamental valuation, among other things.

However, Velasquéz, (2009) identified the limitations of FMH, which are but not limited to the following: it is not a unique framework because it doesn't contain its main postulate but encompasses multiple issues in different fields; the investigation of FMH is limited to the extent of literatures which still need further development; the concepts of FMH are redefined or complemented continuously due to emerging issues and ideas.

Moradi, Nooghabi, and Rounaghi (2019) emphasise that markets are characterised with the actions of investors and availability of information at a given point. Thus, in stable times, information does not determine assets or market prices because investors in the long-run balance out the numbers of investors in the short-run; while in bearish markets, investors tend to respond to price fluctuations and information by focusing on short-term horizons.

Sarpong (2017) stresses that investors who hold illiquid assets involves in less trading because there is rarely recent information on which to trade or adjust expectations and discount rates. This could result to excess volatility in financial markets in the long run for investors. This corroborated with evidence of Fama (2016) that absence of information may signifies illiquidity that discourage investors in the short run because investors require a quick exit at a low cost. This prompts long-term investors who are rewarded for illiquidity risk in the long-run to dominate illiquid small stocks.

On the other hand, Sarpong (2017) emphasises that highly available information attracts a large number of investors with varying time horizons to take opposing sides of each exchange, resulting in high liquidity from which efficient markets will operate. This could lead rational investors to change their expectations and discount rates, resulting in high volatility with the potential of reducing returns.

This shows that the FMH explain the concept of low volatility anomaly, and the thrust of this study will be anchored on the FMH.

Empirical Review

Oladele and Bradfieldy (2016) examine the effect of low volatility on sector-based portfolios in South Africa. The study covered between 2006 and 2013. The study uses descriptive and correlation matrix in assessing range of sector-based low volatility portfolio in South Africa. It reveals that low instability portfolios outshine market capitalization-weighted index in all segments. The study concludes that coalescing low-volatility portfolios with consistent market-capitalization weighted portfolios can be a feasible and successful portfolio plan.

Jacqmin (2016) employs Sharpe ratio and regression to examine volatility effect in US stocks. It was found that the alpha for the low-volatility quintile is positive for low-volatility stocks and negative for high-volatility stocks. The study concludes ~~d~~ that low-volatility anomaly occurrence does not depend on liquidity issue.

Pandey and Samanta (2016) investigate the effect of low Volatility Anomaly on Indian Stock Market. Secondary data collected for the period January 2001 to December 2014 was employed using regression technique to analyse the data. The result shows that average excess returns rise gradually from the lowest to the highest volatility portfolio. They finalised that there is no low volatility irregularity in the Indian stock market.

Seppälä (2016) examines existence of anomaly in open mobile exchange (OMX) Helsinki stock exchange between years 2001 and 2016. Fama-Macbeth two step regression approach was adopted. Finding reveals that low-volatility stocks outdid high-volatility stocks in OMX Helsinki. The study concludes that traditional economic concepts, such as the capital asset pricing model, were ineffective in Finland's stock markets.

Li, Sullivan, and Garcia-Feijóo, (2016) investigate~~d~~ the role of market mispricing or ~~to~~ compensation for higher systematic factor risk on low-volatility stocks. Fama-MacBeth two step regression was used for the study. It founds that compensation for systemic factor risk was not the only factor that influences high returns of low-volatility portfolio, but other factors do. It indicates that excess returns were more likely to be prompted by market mispricing associated with volatility as a stock attribute than by other sources of information.

Blau and Whitby (2017) examine low volatility anomaly by comparing range-based measure of volatility with the expected return. Fama-MacBeth two stage regression was used and it was found that alphas are generally decreasing across rising range-based volatility portfolios. The study concludes that low volatility anomaly exists in both domestic and foreign markets.

Huskic and Bakøy (2017) assess the existence of low-volatility anomaly in Oslo Stock Exchange using Fama-Macbeth regression approach. It was documented that the low-volatility portfolio outperforms the high-volatility portfolio, with output decreasing monotonically as risk increases. It concludes~~d~~ that the Norwegian stock market has a low-volatility phenomenon.

Pandey and Sehgal (2017) conducted a study on volatility effect in stock returns for India. Regression analysis was used and absence of a volatility anomaly has been documented. It concludes that firm quality factor, which is based on cash flow fluctuations, explains the volatility trends in comparison to profitability.

Blitza and Vidojevic (2017) conducted a study on low volatility anomaly using Fama-French five-factor model. Fama-french five factors and regression analysis was used. It found that exposure to market beta in the cross-section is not rewarded with a positive premium. The study concludes that the low-risk phenomenon is not explained by the five-factor model.

To describe the low volatility phenomenon on the Johannesburg stock exchange, Sarpong (2017) uses the Fractal Market Hypothesis (FMH) and Chaos Theory. The study applies the Rescaled Range analysis and ordinary least square as the estimation techniques. It was discovered that domestic equity fund managers are the driving force behind the JSE's low volatility phenomena. It was concluded that a high level of liquidity and information is associated with a high level of volatility.

Nydal and Hgenhaug (2018) investigate if there is a low volatility anomaly in the Norwegian stock market and find that there is. The results of the regression study revealed that high idiosyncratic volatility stocks outperformed low idiosyncratic volatility stocks, which may be further explained by mean return reversals in the stock market. It comes to the conclusion that high volatility stocks have high returns in the short term while experiencing high volatility, but that returns have restored to normal after experiencing high volatility in the long run.

Rogdeberg and Økland (2018) employ Fama-French five-factor model to confirm whether low volatility anomaly hold or not in the Norwegian stock market. Regression analysis was used and it was found that the existence of low volatility anomaly was significant when a number of systemic risk factors were used to explain the cross-sectional return. It concludes that the assumption of low volatility anomaly holds in the Norwegian stock market.

Li and Sullivan (2018) examine the Low-Volatility Anomaly: Market Evidence on Systematic Risk vs. Mispricing The study covers a 46-year period. The results from cross-sectional analyses show that normal returns to low-volatility portfolios are gritty by mutual variations linked with the idiosyncratic-volatility typical somewhat than factor loadings.

Driessen, Kuiper, Nazliben, and Beilo (2019) assess sensitivity of interest rate to low-volatility anomaly. Fama-MacBeth regressions were employed and it was documented that low-volatility stock portfolios have negative interest rate exposure, whereas high-volatility stock portfolios have positive interest rate exposure. It concludes that interest rate exposure explains the low volatility paradox, and that interest rate premium in the stock market is much higher than the bond market premium.

In the context of Nigeria, Nageri, Lawal and Abdul (2019) examine the risk-return relationship in two distinct periods: prior to and during the economic meltdown of 2007-2009. The study discovered a negative risk-return relation in the period prior to and following the crisis, indicating that investors in the Nigerian stock market incur more risk in proportion to return. According to the findings of the study, the market was inefficient and should be effectively monitored in order to dissuade too enthusiastic noise traders from entering the market.

Hartanto (2019) examines the role of size effect on low volatility anomaly. The study uses regression as the estimation technique. It finds that low volatility anomaly holds in small stocks but not in big stocks. The study concludes that size factor is one of the drivers that drives low volatility anomaly in the US stocks market.

Hsu, Wei, and Chen (2019) investigate effect of funding liquidity risk to institutional investors on low-volatility anomaly. Fama-Macbeth two step regressions was used. It was discovered that the low-volatility anomaly is most recognised when funding liquidity risk is high; whereas the low-volatility reversal is documented when funding liquidity risk is low. The study concludes that when the selling pressure is high on high-volatility stocks, it could lead to high funding liquidity risk, resulting in the low-volatility anomaly.

Joshipura and Joshipura (2019) present details on the volatility effect from the Indian market. Regression analysis was used and it was confirmed that the portfolio comprise of low volatility stocks outperforms the portfolio consists of high volatility stocks. The study concludes that the low-volatility portfolio has a large exposure to growth stocks, as opposed to the value tilt seen in developed market low-volatility portfolios.

A study by Ching, An-Pin, and Miao-Ling (2019) examines whether the funding liquidity risk confronted by institutional investors has an impact on the negative relationship between anticipated returns and variance (the 'Low-volatility anomaly'). The Taiwan Stock Market provides evidence. The model utilised was a multivariate Markov switching model. The funding liquidity risk modelling, on the other hand, allowed for time-varying transition probabilities of the regime-switching process to reflect changes in the funding liquidity risk regime, which was captured by the funding liquidity risk modelling. According to the findings, the low-volatility anomaly is particularly noticeable when there is a large level of funding liquidity risk. When there is a minimal risk of funding liquidity, on the other hand, the low-volatility anomaly has a considerable reversal in its direction. These findings suggest that greater funding liquidity risk as a result of a financial shock conveyed from parent banks is connected with increased selling pressure on high-volatility equities held by institutional investors, resulting in the low-volatility anomaly.

Joshipura and Joshipura (2020) assess the impact of low volatility on the Indian stock market and come up with some interesting findings. In the study, 500 of the most liquid stocks on the National Stock Exchange (NSE) of India were used during a period of 14 years, from January 2004 to December 2018. The data was tested using regression analysis. The findings demonstrate that the low-risk effect is independent of the size, value, and push effects, and that it is robust even after adjusting for variables such as the liquidity and ticket-size of stocks. It is also documented that the low-risk effect is a blend of stock and sector level effects, and that it cannot be captured completely by a concentrated sector disclosure.

Harrisberg (2020) investigates whether or not the premise of a low-volatility anomaly is valid in the Johannesburg Stock Exchange (JSE). A technique based on Fama-Macbeth two-stage regression was utilised, and it was discovered that the low-volatility anomaly continues to exist on the JSE. It was gathered that the concept of risk does not adequately depict the genuine risk-return relationship that a reasonable investor would accept when deciding between assets that are high-risk but also have a high reward potential when choosing between them.

Using data from the top-500 liquid stocks listed on the National Stock Exchange (NSE) of India from January 2004 to December 2018, Joshipura and Joshipura (2020) conclude that the Indian stock market has a low-risk effect on the economy. It was determined using regression analysis that low-risk stocks outperformed high-risk ones. This was previously anticipated. According to the findings of the study, a combination of the momentum effect and the low-volatility effect can improve the performance of a low-risk investing approach.

Using data from the Nigerian equities market, Omokehinde and Olurin (2020) investigate the irrational behaviour of investors in the high-risk market. The estimate tools used in this work are the Jensen ALPHA, CAPM, Sortino, Shapre, Treynor, and Fama's return decomposition, among others. This study discovers that the excess of market and portfolio returns above risk-free returns was almost always negative. It comes to the conclusion that investors in the Nigerian equities market acted irrationally, and that they will avoid taking on further risk until the risk premium is appropriately paid by other factors.

Burggraf and Rudolf (2020) acknowledge the presence of low volatility anomaly in the cryptocurrency market. Regression was employed as tool for analysis. The study confirms absence of low volatility anomaly in the currency markets. Thus, it concludes that cryptocurrencies are more efficient and it is based on the assumption of the higher risk yields, the higher return.

Seetharam (2021) analyses the presence of low-risk anomaly (LRA) in South Africa. It finds that LRA exists on the JSE using univariate sorts but absent when multivariate portfolio sorts were used. It concludes that under conventional proxies, the risk–return relationship is negative and deterministic, but linear under a Kalman filter.

According to Hwang, Rubesam, and Salmon (2021), the influence of beta herding on the low-beta anomaly in the United Kingdom is being investigated. Estimation was accomplished by the use of regression. It demonstrates that overconfidence results in beta herding, but under-confidence results in detrimental beta herding, which may result in a low-beta anomaly. According to the findings of the study, investors' preferences for lottery-like assets, sentiment, and return reversals, as well as beta herding, cause temporal variation in betas to increase with time.

It is explicit from the reviewed literature that there are very few studies on low volatility anomaly with respect to Nigerian stock market. Thus the study investigates the volatility anomaly in Nigerian stock market. Furthermore, the study examines impact of liquidity risk on low volatility anomaly in Nigerian stock market.

3. Methodology

Research Design

The study was conducted using an ex-post facto research design. Research designs such as this one examines past occurrences to gain an understanding of the present situation. At the very least, this type of design incorporates a dependent and an independent variable into the equation. The design is chosen since it cannot be changed by the investigator at a later time.

Sources of Data

The data employed for this study are stock prices and market index sourced from Nigerian Stock Exchange (NSE), and risk-free rate proxy with treasury-bill rate sourced from Central Bank of Nigeria.

Population of the study

The population includes all companies listed on the Nigerian Stock Exchange (NSE) for the ten-year period from January 2011 to December 2020. The choice of this period is informed by the beta estimates, as the study intends to estimate 30-days beta. This was considered appropriate and is in line with the findings of Dadakas, Karpetis, Fassas, & Varelas (2016).

Sampling and Sampling Technique

The purposive sampling technique was used to select forty-one companies that are actively traded on a regular basis.

Model Specification

The Fama-MacBeth two step regression approaches were used and the models are specified below:.

$$R_{i,m(t)} = logP_{i,m(t)} - logP_{i,m(t-1)} \text{..............................}1$$

Where $R_{i,m(t)}$ denotes the return on security, say (i) and market return, say (m) at time t. $P_{i,m(t)}$ represents the current price of security, say (i) and current market price, say (m); while $P_{i,m(t-1)}$ represents the previous price of security, say(i) and the last price market, say (m).

This method of computing return followed the approach of Zubairu and Oyedeko (2017). This model is specified in both first and second-pass regression.

The first-pass regression is specified below:

$$R_t - R_{ft} = \alpha + \beta\left(R_{mt} - R_{ft}\right) + \varepsilon_t \text{......................................}2$$

Where: α is coefficient /constant of the regression, β represents the sensitivity or Beta, R_t-R_f represents the excess return of the security at time t, Rm_t-R_f is the market premium at time t, ε is the residual term.

The estimated beta, i.e., β_i is then used as the independent variable in the following two-pass regression equation:

$$\tilde{r}_i = \lambda_0 + \lambda_1 \beta_i + \varepsilon_1 \text{..}3$$

Where: $\hat{r}$ i is the average return of ith security, λ_0 is the intercept, λ_1 is the regression parameter, βi is the estimated of the Beta, and ε_1 is the random variable.

The model can be transformed into two-factor CAPM by controlling for the co-skewness and this is stated below:

$$\tilde{r}_i - \lambda_0 + \lambda_1 \beta_i + \lambda_2 \beta_i^2 + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 4$$

Where: β^2 is the co-skewness.

Also, the model can be transform to four-moments CAPM by controlling for co-kurtosis, as specified below:

$$\tilde{r}_i - \lambda_0 + \lambda_1 \beta_i + \lambda_2 \beta_i^2 + \lambda_3 \beta_i^3 + \varepsilon_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 5$$

Where: β^3 is the co-kurtosis.

The model can be augmented by introducing liquidity risk as a independent variable, e.g.:

$$\tilde{r}_i = \lambda_0 + \lambda_1 \beta_i + \lambda_2 \beta_i^2 + \lambda_3 \beta_i^3 + \lambda_4 \beta_{liq} + \varepsilon_1 \ldots\ldots\ldots\ldots 6$$

Where: β_{liq} is the beta from the liquidity risk?

The liquidity risk is computed using the Amihud (2002) illiquidity measure, as shown below:

$$Illiquidity_{i,t} - \frac{|R_{i,t}|}{Volume_{i,t}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

Where: $R_{i,t}$ is the return on stock *i* in month t, and $volume_{i,t}$ is trading volume in Nigerian stock market for stock *i* in month t.

Estimation Procedure

The portfolio was sorted equally into decile using the betas of the market premium and the liquidity premium. This procedure involves running expected return regressions before and after adding liquidity risk that may explain the outperformance of low-volatility stocks and assessing how the alpha generated by the regression model changes with the liquidity risk.

Also, the study controls for co-skewness and co-kurtosis because only beta may be inadequate to explain the variation in return, and most time assets return are not normally distributed.

Results and Discussion of Findings

Results

The result obtained based on the descriptive statistics is reported concisely in Table 1. The result reveals the average values of return, covariance (i.e. beta), co-skewness, co-kurtosis and liquidity risk for the study period from 2011 to 2020, which are 0.0117179, .4922946, .3451626, .2365402 and -.0411307 respectively. It is overt that return has a tendency to increase with covariance, co-skewness and co-kurtosis, but decrease with the liquidity risk during the sampling periods. The return value ranges from -.0055191 to .456, which implies that there were tendencies of making loses and capital gains on the market trading activities within the sample period.

The covariance ranges from -1.104066 to 1.405545. And this indicated that the securities are defensive in nature, therefore, investors can militate against this risk by holding the stock such that in good times high returns are required to compensate for the expected low returns during the bad times.

The co-skewness value ranges from .0000678 to 1.975556. And this implies that at some point in time the co-skewness tends to be less volatile than the market, but at some other times it tends to be more volatile than the market.

Co-kurtosis value ranges from -1.345813 to 2.776733, and ~~this~~ implies that co-kurtosis is more volatile than the market at some time and less volatile than the market at some time. The liquidity value ranges from -.1614433 to .7110608.

The values of standard deviation on the table indicate that co-kurtosis risk is more volatile among the variables, while the least variable among the variables is return.

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
Covariance	.4922946	.3210297	-1.104066	1.405545
Co-Skew	.3451626	.3554132	.0000678	1.975556
Co-Kurt	.2365402	.4134166	-1.345813	2.776733
Liq	-.0411307	.0935956	-.1614433	.7110608
Ret	.0027718	.0297125	-.0055191	.456

Source: Author's Computation (2021) Using E-view 10

The correlation matrix as presented in Table 2 reveals that covariance has a positive correlation with co-skewness, co-kurtosis, and liquidity in the first pair. This implies that covariance moves in the same direction with co-skewness, co-kurtosis, and liquidity.

In the second pair of the result, co-skewness has positive correlation with co-kurtosis and liquidity, and this implies that they ~~moves~~ in the same direction.

However, the result of the third pair shows negative correlation between the co-kurtosis and liquidity. This signifies that they move in negative direction.

Also the study shows that the highest coefficient of correlation is 0.8680, which is strong but not perfect. Thus, there is absence of multicollinearity among the variables.

The study proceeds to estimate the capital asset pricing model, and the results are presented in Tables 4.3, 4.4, 4.5, 4.6 and 4.7.

Table 2. Correlation Matrix

Statistics	Co-variance	Co-Skewness	Co-Kurtosis	Liquidity
Covariance	1.0000			
Co-Skewness	0.8371	1.0000		
Co-Kurtosis	0.8188	0.8680	1.0000	
Liquidity	0.0135	0.0171	-0.0809	1.0000

Source: Author's Computation (2021) Using E-view 10

Evidence is shown in Table 3 that the systematic risk-return relation does not corroborate with the assumption of CAPM. Thus, this assumption was falsified under P2, P3, P4, P5, P6, P7, P8 and P9. This shows the presence of volatility anomaly, while the P10 is in line with the convention of risk-return trade-off. In addition, the result shows some portfolios violate the apriori of CAPM. This implies that the validity of CAPM is weak in the Nigerian stock market. Thus, the study shows that low volatility anomaly exist in the Nigerian stock market, but not persistent. Also, it was observed that the coefficient of determinations of the portfolios is very low and this could be an indication of noise in the Nigerian stock market.

Table 3. Capital Asset Pricing Model of Sorted Portfolio

Statistics	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Alpha	-0.00083	-0.00091	0.010956	0.006683	-0.06724	0.000377	0.006005	0.003038	-0.00113	-0.00181
T-value	(-1.18109)	(2.519524)	(1.247157)	(0.051942)	(-0.41228)	(0.823068)	(1.281406)	(0.802448)	(-2.9243)	(-3.30582)
Beta	-0.00012	0.002654	0.000288	0.314782	0.454261	-0.00027	-0.00319	-0.00119	0.001637	-0.00157
T-value	(-0.11331)	(-1.37252)	(0.051539)	(1.16262)	(1.298872)	(-0.29389)	(-0.48684)	(-0.19944)	(2.443733)	(-1.71428)
R-Square	0.000329	0.139984	6.81E-05	0.033498	0.041464	0.00221	0.00604	0.001019	0.132791	0.070073
Adj-R^2	-0.0253	0.117932	-0.02557	0.008715	0.016887	-0.02337	-0.01945	-0.0246	0.110554	0.046228

Note: The P1-P10 represents portfolio 1 (lowest volatile portfolio) to portfolio 10 (Highest volatile portfolio) respectively, and the critical value for t-test with 39 Degrees of freedom @ 95% level is 2.023. The degree of freedom is arrived at using (n-k), where n is the number of observations and k is the number of variables.
Source: Author's Computation (2021) Using E-view 10.

In table 4 the study controls for co-skewness because it is assumed that higher volatility will have positive co-skewness, and is one of the reasons why the market is overpriced. Thus, higher skewness signifies higher probability of extreme return. Thus, controlling for the skewness in the study does not validate the assumption of risk-return trade-off among the portfolios, which implies that the assumption of low volatility anomaly holds in the market.

The introduction of skewness to CAPM results into two factor CAPM. Also, the adjusted R-square explains the variation in the two-factor CAPM as compared with single factor model. Therefore, the result from table 4 shows that the two-factor model slightly improves the explanatory power of the CAPM in the Nigerian stock market. This occurs under the P2, P6 and P10. Similarly, like the single factor model, the risk premium factors in the two-factor model are not significantly priced under some of the portfolios. And this violate a-priori stance of the model.

Table 4. Capital Asset Pricing Model of Sorted Portfolio after Controlling for Co-Skewness

Statistics	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Alpha	-0.00133	0.001339	0.029708	-0.00544	-0.15395	-0.00041	0.005373	0.002569	-0.00136	-0.00127
T-value	(-0.74827)	(0.896688)	(1.401931)	(-0.04053)	(-0.68825)	(-0.79113)	(0.616846)	(0.431787)	(-2.51313)	(-1.35701)
Beta	0.001734	-0.00721	-0.0311	0.266277	0.981127	0.005573	-0.00075	0.000269	0.002891	-0.00382
T-value	(0.286522)	(-1.20492)	(-0.94951)	(0.878184)	(0.994909)	(2.396522)	(-0.02565)	(0.017518)	(1.335359)	(-1.16512)
Co-Skew	-0.00149	0.008999	-0.00367	0.117371	-0.49517	-0.00506	-0.00195	-0.00078	-0.00101	0.001819
T-value	(-0.31067)	(1.673322)	(-0.97255)	(0.372273)	(-0.57213)	(-2.69195)	(-0.0865)	(-0.10308)	(-0.60954)	(0.715865)
R-Square	0.002862	0.199005	0.024353	0.0370	0.049651	0.162013	0.006236	0.001298	0.141188	0.034154
Adj-R^2	-0.04962	0.156847	-0.027	-0.01367	-0.00037	0.117909	-0.04607	-0.05127	0.095987	0.082447

Note: The P1-P10 represents portfolio 1 (lowest volatile portfolio) to portfolio 10 (Highest volatile portfolio) respectively, and the critical value for t-test with 38 Degrees of freedom @ 95% level is 2.024. The degree of freedom is arrived at using (n-k), where n is the number of observations and k is the number of variables.
Source: Author's Computation (2021) Using E-view 10.

Also, the study controls for co-kurtosis alongside with the co-skewness. And this transforms the single factor CAPM to four moment factor CAPM. A lower kurtosis simply implies lower chances to experience extreme return. Thus, higher volatility stocks could have a lower co-kurtosis with the market portfolio while the low volatility anomaly has higher co-kurtosis.

The result from table 5 shows the reverse relationship between the systematic risk and expected return having controlled for both skewness and kurtosis. This occurs under some of the Portfolios such as P4, P5, P6, P8, P9 and P10. This connotes an anomaly in the market. Also, the covariance, co-skewness and co-kurtosis are not significantly priced under some of the portfolio, and this violates the assumption of the model. However, the four moments pricing model slightly improves the explanatory power of the two moment CAPM, especially under P2 and P9 as reported by the adjusted R-Squared.

Table 5. Capital Asset Pricing Model of Sorted Portfolio after Controlling for Co-Skewness and Co-Kurtosis

Statistics	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Alpha	-0.00226	0.005117	0.011258	-0.17282	0.190731	-0.0005	0.000277	0.002569	-0.00183	0.001356
T-value	(-0.51072)	(2.259858)	(0.246956)	(-0.93571)	(0.638053)	(-0.88258)	(0.025187)	(0.431787)	(-2.66188)	(0.761786)
Beta	0.006992	-0.02904	0.057759	1.117213	-2.8919	0.007265	0.041222	0.000269	0.007939	-0.02104
T-value	(0.294859)	(-2.49123)	(0.293741)	(1.556194)	(-1.16276)	(1.556047)	(0.662744)	(0.017518)	(1.566591)	(-1.99963)
Co-Skew	-0.01037	0.036766	-0.08839	0.217262	8.067416	-0.00908	-0.08679	0.000269	-0.01137	0.030948
T-Value	(-0.26588)	(2.64403)	(-0.47822)	(0.67547)	(1.569653)	(-0.93053)	(-0.76608)	(0.017518)	(-1.19001)	(1.805809)
Co-Kurt	0.004623	-0.01422	1.24E-05	-0.86778	-4.66333	0.002137	0.048198	-0.00078	0.00527	-0.01379
T-Value	(0.229545)	(-2.14898)	(0.458463)	(-1.30507)	(-1.68899)	(0.419473)	(0.764307)	(-0.10308)	(1.100987)	(-1.71772)
R-Square	0.00428	0.287887	0.029864	0.079388	0.117677	0.16598	0.02249	0.001298	0.168431	0.150213
Adj-R^2	-0.07645	0.230148	-0.0488	0.004744	0.046138	0.098356	-0.08612	-0.05127	0.101006	0.081311

Note: The P1-P10 represents portfolio 1 (lowest volatile portfolio) to portfolio 10 (Highest volatile portfolio) respectively, and the critical value for t-test with 37 Degrees of freedom @ 95% level is 2.026. The degree of freedom is arrived at using (n-k), where n is the number of observations and k is the number of variables.
Source: Author's Computation (2021) Using E-view 10.

Evidence has been documented in the literature that liquidity is significantly priced, i.e., it determines the assets return. Lam and Tam (2011) posite~~d~~ that investors require higher return for less liquid assets, and accept a low return for more liquid asset. The implication is that there is positive relationship between return and liquidity, while there is a negative relationship between return and liquidity risk. And why the study examines the impact of liquidity risk alongside higher moment. .

The result presented in Table 6 shows that there is presence of low volatility anomaly. This occurs under some of the portfolios such as P4, P6 and P7. Also under P2, P3, and P5 where there is increase in abnormal return shows a corresponding decrease in the liquidity. This suggests that liquidity risk does not serve~~s~~ as an explanatory variable for the low volatility anomaly. This reveals that liquidity risk does not improve the explanatory power of the four moments CAPM, and this was reported by the adjusted R-Squared.

Table 6. Capital Asset Pricing Model of Sorted Portfolio after Controlling for Higher Moment and Liquidity

Statistics	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Alpha	-0.00286	0.005073	0.00937	-0.18689	0.147688	-0.00031	-0.00163	0.085514	0.005811	0.001069
T-value	(-0.63479)	(2.206871),	(0.199307)	(-1.00812)	(0.487448)	(-0.34631)	(-0.10366)	(1.584211)	(0.737995)	(0.578684)
Beta	0.008517	-0.02915	0.068507	1.330559	-3.07522	0.007168	0.041033	0.096856	0.007754	-0.02136
T-value	(0.356896)	(-2.46769)	(0.333569)	(1.771467)	(-1.23049)	(1.512053)	(0.650898)	(1.190867)	(1.52801)	(-2.01256)
Co-Skew	-0.01195	0.03696	-0.10065	0.203902	8.47199	-0.00901	-0.08608	-0.12649	-0.01113	0.031087
T-Value	(-0.30489)	(2.621092)	(-0.51424)	(0.632913)	(1.639682)	(-0.91221)	(-0.74927)	(-1.15695)	(-1.16421)	(0.799558)
Co-Kurt	0.005132	-0.01437	1.42E-05	-1.04123	-4.89138	0.002143	0.047768	0.03963	0.005235	-0.01376
T-Value	(0.253824)	(-2.13716)	(0.495227)	(-1.51157)	(-1.76162)	(0.415333)	(0.746922)	(1.127284)	(1.092857)	(-1.70073)
Liq	0.112272	0.028176	0.004331	-0.49091	-1.14438	0.004072	-0.05501	1.174922	0.048565	-0.0039
T-value	(0.858202)	(0.270935)	(0.215304)	(-0.97349)	(-0.93309)	(0.280698)	(-0.17252)	(1.741646)	(0.973763)	(-0.64943)
R-Square	0.024242	0.289336	0.031111	0.103001	0.138512	0.167801	0.02249	0.087614	0.189772	0.160053
Adj-R^2	-0.08418	0.210373	-0.07654	0.003334	0.042791	0.075334	-0.08612	-0.01376	0.099746	0.066726

Note: The P1-P10 represents portfolio 1 (lowest volatile portfolio) to portfolio 10 (Highest volatile portfolio) respectively, and the critical value for t-test with 36 Degrees of freedom @ 95% level is 2.028.The degree of freedom is arrived at using (n-k), where n is the number of observations and k is the number of variables.
Source: Authors' Computation (2021) Using E-view 10.

The result in the table 7 shows the interaction of liquidity with ~~the~~ systematic risk in order to examine the role of liquidity risk on the low volatility anomaly. From the analysis it is evidence that there is presence of low volatility anomaly under some of portfolio such as P2, P5 and P6. The interaction of liquidity risk with the systematic risk slightly improves the explanatory power of the model. This occurs most especially under the P2, P4, P5 and P9 and it is shown by the adjusted R-squared.

Table 7. Capital Asset Pricing Model of Sorted Portfolio and the role of Liquidity risk

Statistics	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Alpha	-0.00174	0.008023	0.009066	-0.21101	0.233281	-0.00077	-0.05136	0.092089	0.023262	-0.00053
T-value	(-0.33904)	(3.001175)	(0.849968)	(-1.13315)	(0.753204)	(-0.37021)	(-0.89662)	(0.734304)	(1.225398)	(-0.11028)
Beta	0.003856	-0.04105	0.082806	1.502549	-3.28717	0.008202	0.105861	0.076478	-0.02742	-0.01553
T-value	(0.148255)	(-3.18717)	(0.392634)	(1.962692)	(0.195575)	(1.287926)	(1.106733)	(0.212854)	(-0.77929)	(-0.79894)
Co-Skew	-0.00552	0.049328	-0.11761	0.298213	8.482656	-0.00939	-0.1057	-0.12609	-0.01324	0.03401
T-Value	(-0.13187)	(3.297621)	0.565268	(0.896198)	(1.651194)	(-0.92709)	(-0.90181)	(-1.1349)	(-1.35313)	(1.764332)
Co-Kurt	0.002038	-0.02031	1.66E-05	-1.28217	-4.99012	0.002343	0.057453	0.039518	0.006087	-0.01523
T-Value	(0.095088)	(-2.84364)	(0.561132)	(-1.77665)	(-1.80671)	(0.4429)	(0.883769)	(1.106789)	(1.251784)	(-1.66463)
Liq	-0.07736	-0.54685	-0.35606	0.397061	0.782484	-0.00603	-1.44751	1.251296	0.160452	-0.02068
T-value	(-0.18544)	(-1.76888)	(-0.3933)	(0.414902)	(0.385982)	(-0.13883)	(-0.91908)	(0.846358)	(1.321028)	(-0.44049)
Beta*Liq	0.33593	0.958281	0.400377	-2.71484	-5.39184	0.019457	1.544936	-0.23324	-0.23135	0.067556
T-Value	(0.479294)	(1.965902)	0.398183	(-1.09063)	(-1.1898)	(0.247208)	(0.902949)	(-0.05827)	(-1.01022)	(0.360444)
R-Square	0.030605	0.360006	0.035481	0.132483	0.172002	0.169252	0.044743	0.087702	0.212728	0.16316
Adj-R^2	-0.10788	0.268578	-0.10231	0.008553	0.053716	0.050573	-0.09172	-0.04263	0.10026	0.043611

Note: The P1-P10 represents portfolio 1 (lowest volatile portfolio) to portfolio 10 (Highest volatile portfolio) respectively, and the critical value for t-test with 35 Degrees of freedom @ 95% level is 2.030. The degree of freedom is arrived at using (n-k), where n is the number of observations and k is the number of variables

Source: Author's Computation (2021) Using E-view 10.

Discussion of Findings

Evidence from the analysis shows that there is presence of low volatility anomaly in the Nigerian stock market, but it is not persistence. This corroborates with the findings of Rogdeberg and Økland (2018). The explanation for the presence of other low volatility could be as a result of investors' irrational behaviour, such as over confidence, sentiment, among others. However, the study is not in line with the findings of Burggraf and Rudolf (2020), Seetharam (2020) among others.

Also it was found that the validity of the single factor, two factor, and the four moments capital asset pricing model are weak in the Nigerian stock market. This is because some of the portfolios reveals negative volatility premium, negative and significant alpha, which is an indication of anomaly in the market. This is inconsistent with the findings of Misra, Vishnani, and Mehrotra (2019). The consistency could be as a result of other factors such as size, momentum, profitability among others, which are relevant determinants of asset returns aside from covariance, co-skewness and co-kurtosis.

However, the study conforms to the findings of Leković, and Stanišić (2018), Agbatogun and Olowe (2019) among others. More so, it was discovered that liquidity risk does not prevent the low volatility anomaly. And this is inconsistent with the findings of Sarpong (2017), Hsu, et.al (2019) among others. The explanation for this is that investors do not change their holdings in response to new information in order to be compensated for liquidity risk. Contrary to this, the study conforms to the findings of Jacqmin (2016), Huskic and Bakøy (2017) among others.

Furthermore, the study finds that the coefficient of determinations of most of the portfolios is very low and this could signify price information inefficiency in the Nigerian stock market. This conforms to the findings of Bramante, Petrella and Zappa (2013). The explanation for this could be due to mispricing in the Nigerian stock market.

4. Conclusion and recommendations

The study examines the impact of liquidity risk on low volatility anomaly in Nigerian stock market. It found that that there is existence of low volatility anomaly in the Nigerian stock market, and that liquidity risk does not serve~~s~~ as the driver of the anomaly. The results are inconsistent with the preaches of CAPM. Thus, the anomalous relationship can be attributed to higher systematic risk or hidden factors as suggested by Li, et. al (2016). The study controlled for co-skewness, co-kurtosis and liquidity risk alongside with systematic risk and it was documented that there is still presence but not persistence of low volatility anomaly in the stock market. This implies that the role of liquidity risk does not explain the low volatility anomaly in the Nigerian stock market. The study concludes that liquidity risk has no significant impact on low volatility anomaly. The study recommends that the Nigerian stock market regulators should put in place communication devices to communicate news and information on stock market activities daily to investors and other market participants. Also, the investors and other stakeholders should maximise the opportunity of new information to trade in short-term investment horizon and avoid the delay of the information because the market does not reward long-term investment horizon. The study suggests that further studies should control for more factors in the capital asset pricing model when examining the low volatility anomaly. Also, studies should focus on the sectors of the Nigerian stock market.

References:

1. Agbatogun, T.O. and Olowe, A.R., 2019. Sectoral application of asset pricing models on the Nigerian stock exchange: A comparative approach. *Acta Universitatis Danubius,* 15(3), pp.402-416.
2. Ameni, G., Hasna, C. and Mohamed, A.B.O., 2017. The effects of liquidity risk and credit risk on bank stability: Evidence from the MENA Region. *Borsa Istanbul Review,* 17(4), pp.238-248.
3. Amihud, Y., 2002. Illiquidity and stock returns: Cross-section and time-series effects. *Journal of Financial Markets,* 5(2), pp.31–56.
4. Anderson, N. and Noss, J., 2013. The Fractal Market Hypothesis and its implications for the stability of financial markets. *Financial Stability Paper No. 23*. [online] Available at: <https://www.bankofengland.co.uk/-/media/boe/files/financial-stability-paper/2013/> [Accessed 4 May 2022].
5. Banerjee, A., 2016. *Low volatility anomaly in the Indian equity market, (B.Sc. Project).* [online] Available at: <https://research-advances.org/index.php/RAJMSS/article/view/289> [Accessed 4 May 2022].
6. Black, I., Jensen, M.C. and Scholes, M., 1972. The Capital Asset Pricing Model: Some empirical tests. In: Jensen M.C (Ed.) *Studies in the theory of capital markets*. New York: Praeger Publishers, pp.79-121.
7. Blau, B.M. and Whitby, R.J., 2017. Range-based volatility, expected stock returns, and the low-volatility anomaly. *PLoS ONE,* 12(11), pp.1-19.
8. Blitz, D.C. and Vliet, P.V., 2007. The volatility effect: lower risk without lower return. *The Journal of Portfolio Management*, 34(1), pp.102-113.
9. Blitza, D. and Vidojevic, M., 2017. The profitability of low-volatility. *Journal of Empirical Finance,* 43(1), pp.33–42.
10. Bramante, R., Petrella, G. and Zappa, D., 2013. On the use of the market model R-square as a measure of stock price efficiency. *Reviewed Quantitative Finance and Account*, 44(2), pp.379-391.
11. Buchanan, M., 2013. *Forecast: What Physics, Meteorology, and the Natural Sciences can teach us about Economics.* Bloomsbury Publishing USA. [online]

Available at: <https://www.abebooks.co.uk/9781608198511/> [Accessed 4 May 2022].
12. Burggraf, T. and Rudolf, M., 2020. *Cryptocurrencies and the low volatility anomaly.* [online] Available at: <https://doi.org/10.1016/j.frl.2020.101683> [Accessed 4 May 2022].
13. Ching, C.H., An-Pin, W. and Miao-Ling, C., 2019. Funding Liquidity Risk and the Low-volatility Anomaly: Evidence from the Taiwan Stock Market. *The North American Journal of Economics and Finance*, 54.
14. Dadakas, D., Karpetis, C., Fassas, A. and Varelas, E., 2016. The choice of the time horizon during Estimation of the unconditional stock beta. *International Journal of Financial Studies,* 4(25), pp.1-10.
15. Dave, B., 2015. *The low volatility anomaly: Outperformance of low risk stocks, and the role of operating performance as a driver.* (MSc. Dissertation). [online] Available at: <http://arno.uvt.nl/show.cgi?fid=138517> [Accessed 4 May 2022].
16. Driessen, J., Kuiper, I., Nazliben, K., & Beilo, R., (2019). Does interest rate exposure explain the low-volatility anomaly*? Journal of Banking and Finance* 103, pp.51–61.
17. Fama, E.F., 2016. *How the markets really work.* [online] Available at: <https://review.chicagobooth.edu/economics/2016/> [Accessed 4 May 2022].
18. Harrisberg, R., 2020. *An analysis of the low-volatility anomaly on the Johannesburg Stock Exchange* (M.Sc. Thesis). [online] Available at: <https://open.uct.ac.za/handle/11427/31727> [Accessed 4 May 2022].
19. Hartanto, A., 2019.*The size effect to low volatility anomaly, (Master Thesis)*. [online] Available at: <http://arno.uvt.nl/show.cgi?fid=150484> [Accessed 4 May 2022].
20. Haugen, R.A. and Heins, J., 1972. *On the evidence supporting the existence of risk premiums in the capital markets.* Wisconsin Working Paper. [online] Available at: <https://papers.ssrn.com/sol3/papers.cfm?abstract_id=178379> [Accessed 4 May 2022].
21. Hsu, C., Wei, A. and Chen, M., 2019. Funding liquidity risk and the low-volatility anomaly: Evidence from the Taiwan stock market. *North American Journal of Economics and Finance*, 54(C). [online] Available at: <https://doi.org/10.1016/j.najef.2019.02.010> [Accessed 4 May 2022].
22. Huskic, B. and Bakøy, M.P., 2017. *The low-volatility anomaly in the Norwegian Stock Market* (M.Sc.Dissertation). [online] Available at: <https://biopen.bi.no/bi-xmlui/bitstream/handle/11250/2483506/1732433> [Accessed 4 May 2022].
23. Hwang, S., Rubesam, A. and Salmon, M., 2021. Beta herding through overconfidence: A behavioural explanation of the low-beta anomaly. *Journal of International Money and Finance,* 111(2), pp.1-20.
24. Jacqmin, R., 2016. An analysis of the low-volatility anomaly, (M.Sc. Dissertation). [online] Available at: <https://matheo.uliege.be/handle/2268.2/1240> [Accessed 4 May 2022].
25. Joshipura, M. and Joshipura, N., 2016. The volatility effect: Evidence from India. *Applied Finance Letters,* 5(1), pp.12-27.
26. Joshipura, N. and Joshipura, M., 2019. The volatility effect: Recent evidence from Indian Markets. *Theoretical Economics Letters,* 9(2), pp.2152-2164.

27. Joshipura, M. and Joshipura, N., 2020. Low-risk effect: evidence, explanations and approaches to enhancing the performance of low-risk investment strategies. *Investment Management and Financial Innovations,*17(2), pp.128-145.
28. Lam, K. and Tam, L., 2011. Liquidity and asset pricing: Evidence from Hong Kong stock market. *Journal of Banking & Finance,* 35(1), pp.2217–2230.
29. Leković, M., 2018. Evidence for and against validity of efficient market hypothesis. *Economic Themes,* 56(3), pp.369-387.
30. Leković, M. and Stanišić, T., 2018. Capital Asset Pricing Model versus Arbitrage Pricing Theory. *International Scientific Conference* - University of Kragujevac Republic of Serbia. [online] Available at: <https://www.researchgate.net/publication/330542932> [Accessed 4 May 2022].
31. Li, X., Sullivan, R.N. and Garcia-Feijóo, L., 2016. The low-volatility anomaly: Market evidence on systematic risk vs. mispricing. *Financial Analysts Journal,* 72(1)*,* pp.36-42.
32. Malkiel, B.G. and Fama, E.F., 1970. Efficient capital markets: a review of theory and empirical work. *The Journal of Finance,* 25(2), pp.383–417.
33. Marmer, H.S., 2015. Fire! Fire! is US low volatility a crowded trade? *The Journal of Investing*, 24, pp.17-37.
34. Mandelbrot, B., 2012. *The Fractalist: Memoir of a scientific maverick*. New York: Pantheon Books. [online] Available at: <https://www.researchgate.net/publication/258757515> [Accessed 4 May 2022].
35. Markowitz, H., 1952. Portfolio selection. *The Journal of Finance*, 7(1), pp.77-91.
36. Misra, D., Vishnani, S. and Mehrotra, A., 2019. Four-moment CAPM Model: Evidence from the Indian Stock Market. *Journal of Emerging Market Finance,*18(1), pp.137–166.
37. Moradi, M., Nooghabi, M.J. and Rounaghi, M.M., 2019. Investigation of fractal market hypothesis and forecasting time series stock returns for Tehran Stock Exchange and London Stock Exchange. *International Journal of Finance and Economics,*1(1), pp.1–17.
38. Nydal, C. and Høgenhaug, M., 2018. *The low volatility anomaly: An empirical study of Oslo Stock Exchange,* (M.Sc. Dissertation). [online] Available at: <https://biopen.bi.no/bi-xmlui/handle/11250/2577007?locale-attribute=en> [Accessed 4 May 2022].
39. Oladele, O.S. and Bradfieldy, D., 2016. Low volatility sector-based portfolios: A South African case, *ORiON,* 32(1), pp.55-78.
40. Omokehinde, J.O. and Olurin, E.R., 2020. Irrational investing in a risky Nigerian equity market. *SSRG International Journal of Economics and Management Studies*, 7(1), pp.56-69.
41. Nageri, K.I., Lawal, A.T. and Abdul, F.A., 2019. Risk-return relationship: Nigerian stock market during Pre and Post 2007-2009 financial meltdown. *Academic Journal of Economic Studies,* 5(2)*,* pp.52-62.
42. Pandey, S. and Samanta, A., 2016. An investigation of low volatility anomaly in Indian Stock Market. *IRA-International Journal of Management & Social Sciences*, 4(1), pp.62-70.
43. Pandey, A. and Sehgal, S., 2017. Volatility effect and the role of firm quality factor in returns: Evidence from the Indian stock market. *IIMB Management Review*, 29(1), pp.18–28.

44. Peters, E.E., 1991. *Chaos and Order in Capital Markets*, University of Chicago Press. [online] Available at: <https: Chaos-Order-Capital-Markets-Volatility/dp/0471139386> [Accessed 4 May 2022].
45. Qian, E. and Qian, W., 2017. The low-volatility anomaly, interest rates, and the canary in a coal mine. *The Journal of Portfolio Management,* 43(4), pp.44-53.
46. Rogdeberg, P.B. and Økland, S.R., 2018. *A Five Factor approach to the Low Volatility Anomaly: An Empirical Study of the Norwegian Stock Market* (M.Sc. Dissertation.) [online] Available at: <https://openaccess.nhh.no/nhh-xmlui/handle/11250/2561270> [Accessed 4 May 2022].
47. Sarpong, P.K., 2017. *Trading in chaos: analysis of active management in a fractal market* (Ph.D. Thesis). [online] Available at: <https://researchspace.ukzn.ac.za/bitstream/handle/10413/14974/> [Accessed 4 May 2022].
48. Seppälä, J.J., 2016. *Low-volatility anomaly in Helsinki Stock Exchange,* MSc. Dissertation. [online] Available at: <https://lutpub.lut.fi/handle/10024/124466> [Accessed 4 May 2022].
49. Sharpe, W.F., 1964. Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19(1), pp.425-442.
50. Seetharam, Y., 2021. *Investigating the low-risk anomaly in South Africa*. [online] Available at: <[online] Available at: <https://www.emerald.com/insight/1940-5979.htm> [Accessed 4 May 2022].
51. Velásquez, T., 2009. *Chaos theory and the science of fractals, and their application in risk management,* (Master thesis). [online] Available at: <https://research.cbs.dk/files/58450606/> [Accessed 4 May 2022].
52. Wang, J. and Wang, X., 2012. *Structural Equation Modeling: Applications Using Mplus.* Hoboken Wiley: Higher Education Press. [online] Available at: <https://doi.org/10.1002/9781118356258> [Accessed 4 May 2022].
53. Weimer, B., 2015. The Fractal Market Hypothesis: *A critical evaluation of Efficient Theory and a new framework for financial analysis,* (Ph.D. thesis). [online] Available at: <https://www.academia.edu/14312207/> [Accessed 4 May 2022].
54. Zubairu, M. and Oyedeko, Y.O., 2017. Santa Claus rally and Nigerian stock market return: An Illusion or reality? *Net Journal of Business Management,* 5(1), pp.1-5.