ANALYSIS OF THE MARKET EFFICIENCY OF NIGERIAN STOCK MARKET: EVIDENCE FROM POST COVID-19 LOCKDOWN

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Goal: to assess the efficiency of the Nigerian stock market after the COVID-19 lockdown which had substantial impacts on African countries, including their local stock markets. **Methodology:** the empirical study was conducted by employing the GARCH models with three different error distributional assumptions with data covering the timeframe from June 2020 to December 2022. **Findings:** the results indicate that during the post COVID-19 period, the Nigerian stock market demonstrates inefficiency in the weak form but efficiency in the semi-strong form. **Originality and contribution of the authors:** this is the first empirical study in Nigeria that presents the comprehensive overview of market efficiency in the post COVID-19 period. The authors' emphasis in the study that the levels of market efficiency are independently determined forms; the semi strong form efficiency can be attained without week form efficiency. The study emphasise the importance of implementing strict oversight, restrictions, and regulations to discourage excessively negative noise (rumour) traders and investors from engaging in short selling for profit especially in equities held by institutional investors.

Keywords: Nigeria, market efficiency, stock market, COVID-19, GARCH.

JEL: C58, G01, G14.

INTRODUCTION

On December 31, 2019, the Wuhan Municipal Health Commission first reported the emergence of the novel coronavirus (COVID-19) in Wuhan City, China. The virus quickly spread worldwide, prompting the World Health Organization (WHO) to declare it a global pandemic on March 11, 2020 [WHO, 2020a]. Despite numerous countries implementing strict measures, the spread of COVID-19 persisted, resulting in a significant toll on human lives. As of January 27, 2021, the virus had affected a large number of people and caused a substantial number of deaths [WHO, 2020b].

Apart from its devastating impact on human lives, the COVID-19 pandemic

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caused significant harm to the global economy and financial markets. Stringent quarantine measures resulted in reduced economic activity in the short term, and the long-term consequences involved widespread unemployment and the closure of many businesses [Zhang, Lyles, Wu, 2020]. Respected organizations such as the International Monetary Fund, the World Bank, and the Organization for Economic Cooperation and Development released reports forecasting substantial contractions in the global economy due to the pandemic [Abu et al., 2021].

According to E. Emenyi and S. Effiong COVID-19 has been characterized as one of the most disruptive events in history, surpassing even other natural and human-made crises such as climate change [Emenyi, Effiong, 2020]. Financial markets, especially stock markets, were profoundly affected by the pandemic, experiencing more significant impacts than any previous infectious disease outbreak. Comparisons with the 2008 global financial crisis highlight the unprecedented nature of COVID-19's immediate and widespread disruption of the global economy, with lockdowns causing simultaneous disruptions to both demand and supply chains worldwide [Erdem, 2020].

In summary, the emergence and rapid spread of COVID-19 have led to a global pandemic with far-reaching consequences. Not only has it caused immense loss of life, but it has also left a lasting effect on the world economy and financial markets, demonstrating the unprecedented scale of its effects when compared to other crises in history [Bello, Adekunle, Nwachukwu, 2022]. As a result of COVID-19 digital transformation and infrastructural development with emphasis on technology as an interaction avenue for innovation has been at the forefront policies of the Nigerian Exchange Group (NGX).

The concept of stock market efficiency revolves around the relationship between stock prices and available information. In the words of L. Oyelami, M. Ogbuagu and O. Saibu [Oyelami, Ogbuagu, Saibu, 2022], E. Fama [Fama, 1970] this classification comprises three distinct forms: strong-form efficiency, semi-strong form efficiency, and weak-form efficiency. The weak form suggests that stock prices are random and historical patterns cannot be used to predict abnormal profits. The semi-strong form indicates that all publicly available information is reflected in stock prices. The strong form implies that even private information is already incorporated into stock prices, leaving no room for insider trading [Alzyadat, Asfoura, 2021].

Various factors can impact stock market efficiency, including corporate actions such as splits and economic events like pandemics [Alade, Adeusi, Alade, 2020]. The COVID-19 pandemic triggered a momentous impact on the global economy and financial markets, resulting in unparalleled volatility, panic, and deviations from fundamental values [Liu, Zhang-Zhang, Ghauri, 2020; He et al., 2020; Baig, Ahmed, Najmi, 2021; Al-Awadhi et al., 2020; Zhang, Lyles, Wu, 2020; Mensi et al., 2022].

According to [Mazur, Dang, Vega, 2021] the crude petroleum sector was the hardest hit loosen over 60% of market value and the price even became negative at a time. There was improvement in market valuation and returns of more than 10% in the Natural gas and Chemical sectors firm. At the industry level, the best performing include healthcare, software, technology and food, while crude petroleum, hospitality and entertainment, and real estate experienced declined market capitalization of more than 70%.

The findings of [Takyi, Bentum-Ennin, 2021] indicates that stock markets in African countries were negatively impacted by the COVID-19, for example the Namibia stock market plunged by 17%, Ghana — 6.5%, Nigeria — 13%, Kenya — 15%, Botswana — 2.7% and Tanzania by 11%, with an overall plunge of between 2.7 and 20% for the whole continent.

Against this backdrop, the study aims to assess the efficiency of the Nigerian stock market in the weak form, semi-strong form,

and strong form during the post-COVID-19 lockdown. The research objectives are to evaluate market efficiency under these three forms and test corresponding hypotheses [Kelikume, Olaniyi, Iyohab, 2020]

This study's significance lies in understanding the impact of the COVID-19 lockdown on the Nigerian stock market, considering both short-term economic consequences and long-term effects like unemployment and business failures [Zhang, Lyles, Wu, 2020]. The findings will be valuable for policymakers at organizations like the Stock Exchange Commission in making informed decisions regarding the stock market after the pandemic.

The research utilizes daily data from the Nigerian Exchange Group, specifically the All Share Index (*ASI*), for the period from June 2020 to December 2022. This period is considered as post-COVID-19 lockdown.

The manuscript is partitioned into four distinctive sections. First section presents a literature review on market efficiency and stock market studies. Second section contains research methodology, data analysis. Third section describes the results of the analysis and discussion.

Fourth section contains the conclusion, recommendations, and future research directions. Through its investigation of the Nigerian stock market's efficiency after the COVID-19 lockdown, this study adds valuable insights to the current literature on stock market performance and its economic ramifications.

LITERATURE REVIEW

Market efficiency refers to the alignment of commodity values with their projected values in a market. It evaluates how well current prices reflect all relevant information about the underlying assets. The informational or price efficiency is one of the most widely discussed concepts in financial markets [Lawal, Osinusi, Badmus, 2020]. It measures how readily accessible relevant information is to all market participants, and market prices serve as indicators of how well they incorporate reliable data [Mohammed, 2023]. The more accessible information is to participants, the more efficient the financial market becomes, allowing both buyers and sellers to transact and profit while reducing transaction costs. In such an efficient market, trading cannot consistently outperform the market since all traders have equal access to the same data.

The Nigerian stock market plays a crucial role in the country's financial system, facilitating various economic tasks such as raising financing for businesses and providing a platform for investors to trade stocks. While there are several definitions of the capital market, none have achieved widespread approval. D. Okorie and B. Lin defines the stock market as a place where buyers and sellers come together to exchange intrinsic commodities like shares, stocks, or bonds, raising long-term capital for the modernization and expansion of projects by governments, businesses, and related parastatals [Okorie, Lin, 2021].

According to [Kumari, Rai, Pandey, 2023] the capital market is an organized marketplace that allows the government and private investors to secure long-term loans for their expenditures and the expansion or modernization of enterprises. It facilitates the quick liquidity recovery of capital providers and offers businesses access to operating and fixed capital. The capital market is recognized as a catalyst for socioeconomic expansion and advancement in both developing and developed countries. It plays a vital role through financial intermediation, connecting surplus cash owners with cash users in the economy, supporting financial sector modernization reforms, resource channelling, and allocating savings among competitive users crucial for the efficiency and development of the economy [Badmus, Ojelade, 2022].

In a capital market deemed weak form efficient, investors face challenges in consistently outperforming the market due to cur-

rent share prices already reflecting historical data and past share price movements, making predictions less effective. In a semi-strong form efficient capital market, the prices of shares are presumed to swiftly and accurately assimilate newly available information, ensuring that market participants are well-informed in a timely manner, rendering it ineffective for making abnormal gains based on publicly available information like company accounts, industry conditions, and announcements. A strong form efficient capital market indicates that asset prices accurately represent both historical and non-public information, including insider knowledge. However, it has been observed that some nations struggle to fully meet these requirements, leading to stricter regulations against acting on insider knowledge, as seen in instances where investors profited from such information, leading to indictments [Bhama, 2022].

In summary, market efficiency is about the correspondence between commodity values and projected values. The Nigerian stock market is essential for raising capital and trading stocks, and the capital market plays a vital role in socioeconomic growth. Various degrees of capital market efficiency, including weak, semi-strong, and strong forms, govern the behaviour of financial markets and shape how they incorporate information and react to new developments and are based on how well prices reflect historical and available information, with some nations implementing stringent regulations to prevent the use of insider knowledge for gains [Eleftheriou, Patsoulis, 2021].

The efficient market theory, as proposed by [Fama, 1970], asserts that asset prices should accurately represent all available information, both historical and new, at any given time. This theory is linked to the random walk model, suggesting that future share price changes are likely to be random departures from past prices. It argues that the only way for an investor to achieve average market returns is by trading shares while considering all available information. This research aims to peruse the legitimacy of the efficient market theory by evaluating evidence for and against it. The theory categorizes market efficiencies based on the accessibility of information.

According to the efficient market hypothesis (EMH), security prices adjust rapidly to new information. Technical analysis, often used by investors, operates on the belief that new information disseminates to different groups of investors in stages, resulting in trends in stock price movements that persist over time. On the other hand, fundamental analysis seeks to evaluate the intrinsic value of a firm to achieve superior risk-adjusted returns. However, EMH contends that fundamental analysis is also likely to be invalid, as analysts' recommendations based on publicly available information are not significantly more accurate than those of competitor analysts. EMH suggests a passive investment strategy, where investors buy and hold, rather than active portfolio management.

The Dow theory, introduced by Ch. Dow more than a century ago, combines trend analysis with the efficient market paradigm [Mensi et al., 2022]. Though it holds true for contemporary US market indices, there is limited scholarly research to fully justify the theory's profitability. Evidence suggests that capital markets are at least weak-form efficient based on serial correlation tests and filter tests. However, for a market to be efficient there must be a large number of investors who think it is inefficient. Some experts believe that testing the strong-form efficient market model is challenging because of the unknown "insider knowledge". Empirical research by I. Kelikume, E. Olaniyi and F. Iyohab has found that announcements of planned mergers based on "insider knowledge" quickly assimilate into share prices, preventing investors from earning abnormal gains [Kelikume, Olaniyi, Iyohab, 2020].

The EMH, introduced by E. Fama [Fama, 1970], is closely related to the Dow Theory. It suggests that investors can make money in an efficient market because they have

access to all necessary information without incurring high transaction costs. This diminishes arbitrage opportunities and above-market gains in a competitive and liquid market. The current value of an asset or security is influenced by various factors, such as financial news, research, social, political, and economic considerations, which are quickly reflected in its price in an efficient market. The market may seem inefficient due to constant engagement from portfolio managers, but it is, in fact, efficient in reflecting available information.

Studies have shown that events such as financial crisis, that cause changes to market conditions [Kim, Shamsuddin, 2008; Lim, Luo, Kim, 2013; Kim, Lim, Shamsuddin, 2011; Smith, 2012] can affect the level of market efficiency. The effect of those events, including epidemics [Okorie, Lin, 2021; Wang, Wang, 2021] can in turn affect the market participants' psychology and the way information is incorporated into prices and can lead to variation in the ability to predict return [Charles, Darné, Kim, 2015].

In [Nageri, 2021] investigation, the primary objective was to examine how the Nigerian Exchange Group responded to the COVID-19 pandemic, with a particular focus on analysing the risk-return relationship and volatility. The study employed panel data analyses of GARCH-in-mean and Threshold GARCH, considering three different error distributional assumptions. The results revealed a positive risk-return relationship for the ten stock market indices during the pandemic, and surprisingly, bad news had no significant impact on return volatility. This suggested that the policy response effectively mitigated the negative effects of COVID-19 on the stock market.

M. Alade, S. Adeusi and F. Alade undertook a distinctive statistical analysis to assess the efficiency of the Nigerian stock market, with a particular focus on investigating the presence of long memory properties in financial variables [Alade, Adeusi, Alade, 2020]. They used Time Varying Hurst Exponent and Rescaled-range method (R/S) to test market efficiency. The results showed evidence of serial correlation and long memory persistence in asset return series, the outcomes of the study suggest that the Nigerian stock market exhibits inefficiency, pointing to potential areas for improvement and further research in this domain.

In their research, N. Abu with colleagues [Abu et al., 2021], examined the efficiency of the Indian stock market amidst the COVID-19 pandemic, employing the event study methodology. Their findings highlighted variations in the impact of news on different sectors, indicating diverse levels of efficiency within the semi-strong form of the market. This suggests that certain sectors responded differently to new information during the pandemic, offering valuable insights into market behaviour and information incorporation.

W. Mensi with colleagues [Mensi et al., 2022] analysed asymmetric multi-fractality in Middle East and North Africa stock markets under various turbulent periods, including the COVID-19 pandemic. Their findings indicated varying patterns of multi-fractality during upward and downward trends, with efficiency behaving differently during different crises. I. Kelikume, E. Olaniyi and F. Iyohab evaluated the weak axiom of the efficient market hypothesis for fifteen leading African stock markets, taking into account market imperfections [Kelikume, Olaniyi, Iyohab, 2020]. The study highlighted those institutional constraints and limitations affected market efficiency and investments in African stock markets, negating the efficient market hypothesis.

In their research, A. Al-Awadhi with co-authors delved into the impact of COVID-19 on stock market returns, employing panel data analysis [Al-Awadhi et al., 2020]. Their study uncovered compelling evidence of significant negative effects of COVID-19 cases and deaths on stock returns. This provides valuable insights into the relationship between the pandemic's health impact and its consequences on financial markets.

In their comprehensive research C.-L. E. Liu, Y. Zhang-Zhang and P. Ghauri conducted an event study to investigate the immediate repercussions of the COVID-19 outbreak on 21 prominent stock market indices in affected countries [Liu, Zhang-Zhang, Ghauri, 2020]. Surprisingly, the study revealed that Asian countries witnessed more pronounced abnormal returns compared to other regions during the initial phase of the pandemic. This distinctive finding sheds light on the differential effects of COVID-19 on various global markets and regions.

In an intriguing exploration into the connection between countries' level of freedom and stock market performance during the COVID-19 outbreak [Erdem, 2020]. Remarkably, the study uncovered a notable trend wherein less free countries experienced a pronounced negative impact on their stock market performance as a consequence of the pandemic. This distinct finding provides valuable insights into the interplay between political and economic factors during times of crisis.

In their ground-breaking research by H. Baig, W. Ahmed and A. Najmi conducted a comprehensive investigation into the impact of the COVID-19 pandemic on the microstructure of the US equity markets [Baig, Ahmed, Najmi, 2021]. The study revealed compelling evidence of adverse effects on market volatility and liquidity at the individual level. This unique finding sheds light on the intricate dynamics of the financial markets during times of unprecedented global crises.

K. Eleftheriou and P. Patsoulis assessed the impact of social isolation and COVID-19 lockdown on stock market indexes across 45 countries [Eleftheriou, Patsoulis, 2020]. Their analysis showed a negative correlation between changes in COVID-19 containment measures and stock market returns.

While all these studies provided valuable insights into various aspects of the stock market during the pandemic, none of them specifically addressed market efficiency. Therefore, this research endeavours to bridge this gap by meticulously assessing market efficiency during the post COVID-19 lockdown period. The study uniquely examines the weak, semi-strong, and strong forms of efficiency in the stock market, providing valuable insights into how it responded to the pandemic's impact.

METHODOLOGY AND DATA

The model specification, variable measurement, data sources, and estimating methodology are covered in this section.

The all-encompassing expression for the conditional variance, which encompasses (p) lags of the residuals, is depicted as follows:

$$\sigma_t^2 = C + \alpha_1 \varepsilon_{nt-1}^2 + \cdots\cdots\cdots\cdots\cdots + \alpha_p \varepsilon_{nt-1}^2. \quad (1)$$

According to [Engle, 1982], equation (1) is referred to as the linear ARCH (p) model (Auto-Regressive Conditional Heteroskedasticity) because of the inclusion of the (p) lags of the ε_{nt-p}^2 in the variance equation. σ_t^2 is the variance or error term derived from the mean equation, ε_{nt-p}^2 is the previous day variance or error term derived from the mean equation and ε_{nt-p}^2 is the "p" previous day various or error term.

Equation (1) is known as the linear ARCH (p) model due to its incorporation of (p) lags of the squared ε_{nt}^2 term in the variance equation. Consequently, an ARCH (1) model is derived as a specific case with just one lag of the squared ε_{nt}^2 term in the variance equation. This unique approach allows for a precise understanding of how past squared residuals impact the current conditional variance in the model.

Therefore an ARCH (1) model is:

$$\sigma_t^2 = C + \alpha_1 \varepsilon_{nt-1}^2. \quad (2)$$

Equation (2) model mentioned earlier suggests that during a crisis, the persistence of significant residuals observed at the crisis's onset diminishes by the end of the crisis. The variance of returns in the sub-

sequent period, based on the mean equation residual, is determined solely by the squared residual from the previous periods (representing shocks in the return mean equation). In the empirical investigation, the study employed three distinct conditional distributions — the student's *t*-distribution, the Generalized error distribution, and the Gaussian distribution — for the standardized residuals of return innovations. To estimate the conditional return equation, the Ordinary least square regression model was utilized in the mean equation, while the GARCH model was applied to the return variance equation. This unique combination of methodologies allowed for a comprehensive analysis of the return dynamics and volatility in the study.

Mean equation is:

$$ASI_{rt} = C + \alpha\, ASI_{rt-1} + \mu_t. \qquad (3)$$

Return variance equation ARCH model is:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2. \qquad (4)$$

Equation (3) presents a thorough analysis of the *ASI* return series, exploring its relationship with αASI_{rt-1}, the mean (C) value of *ASIrt* and the error term (μ_t) from previous periods. Rigorous testing is conducted on the error term to assess the presence of ARCH effect and volatility clustering. Consequently, the conditional variance is derived to explain the squared error term from the mean return equation for the past period. The GARCH term $\left(\beta\sigma_{t-1}^2\right)$ is used to represent the current period's return variance, offering valuable insights into the return series dynamics and volatility patterns.

This approach allows for a detailed examination of how past and current return values interact with their associated volatility. In the GARCH model, the current return variance is determined by a combination of a constant, the squared residual from the mean return equation, and past return variance values. The phenomenon of volatility clustering indicates that periods of high volatility are followed by periods of low volatility, and vice versa, leading to fluctuating patterns of volatility. Moreover, the concept of mean reversion in volatility suggests that volatility tends to return to a normal level over time. This tendency remains consistent, regardless of the observed time frame, as long-run volatility eventually converges towards this baseline level [Lawal, Osinusi, Badmus, 2020]. This particular trait offers valuable insights into the dynamic nature of volatility and its propensity to stabilize over extended periods. The mean equation is represented by:

$$ASI_{rt} = C + \alpha ASI_{rt-1} + \mu_t. \qquad (5)$$

Return variance equation GARCH model is:

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 + \beta_1 cov. \qquad (6)$$

In this particular research, the focus lies in analysing the connection between the *ASI* return series and its reliance on past values of αASI_{rt-1}, the mean/constant (C) value of *ASIrt*, and the error term (μt). To gain deeper insights into the dynamics of the *ASI* return series, rigorous testing on the error term for ARCH effect and volatility clustering was conducted. This pivotal step enables the study to derive the conditional variance equation for the GARCH models employed. This unique approach allows for a comprehensive examination of the *ASI* return series and its underlying volatility patterns and the COVID-19 daily cases in order to provide valuable contributions to the existing body of knowledge in this domain.

The Nigerian Exchange Group serves as the primary target market for the research, and the study concentrate on utilizing returns on the *ASI* as the key performance measures during the post-COVID-19 lockdown period, spanning from June 2020 to December 2022. This specific timeframe allows for an insights into the market's response and efficiency in the aftermath of the pandemic-induced lockdown, providing a unique perspective on the Nigerian stock

Table 1

Description of variables

Variable	Description	Unit of measurement
COVID	This represents the daily cases of COVID-19 pandemic in Nigeria in the post lockdown period	Daily cases of COVID-19 reported for Nigeria in the post lockdown period
Return	This is generated from the All Share Index of the Nigerian Exchange Group and calculated as shown in the Unit of measurement	$\frac{\left(ASI_t - ASI_{t-1}\right)}{ASI_{t-1}}$

market's behavior during a critical period in recent history. The return series is explained through the aforementioned factors, shedding light on the interplay of these variables within the stock market context. The *ASI* return is calculated by:

$$ASI_{rt} = \frac{\left(ASI_t - ASI_{t-1}\right)}{ASI_{t-1}}, \qquad (7)$$

where ASI_{rt} represents the *ASI* at the particular time (current day), while ASI_{t-1} signifies the *ASI* at time $t-1$ (current day minus 1 day).

For the *ASI* data in Nigeria, secondary data was obtained from the website of the Nigerian Exchange Group which is the Nigerian stock exchange and Worldometer an international team of developers, researchers, and volunteers making world statistics available based in the United States, completely independent and self-financed[1]. The data covers the time period from June 2020 to December 2022, offering a comprehensive and detailed record of the *ASI*'s performance during the post-COVID-19 lockdown period. Utilizing this data source ensures accuracy and reliability in the analysis, allows for meaningful conclusions about the behaviour and efficiency of the Nigerian Exchange Group market during this critical timeframe. The summary of the data used in the study and the source of the data is shown in Table 1.

To assess the data's suitability for ARCH variant models, various tests are conducted and analysed, including unit root tests, ARCH effect tests, and volatility clustering analysis on the ASI return series. The model adeptly captures the volatility clustering phenomenon and considers asymmetry, the ARCH effect, and other relevant characteristics of the series [Engle, 1982]. These comprehensive analyses ensure that the model is well-equipped to account for the dynamic behaviour and heteroskedasticity present in the data, providing a robust framework for further investigation. The return series data used in the study was computed as follows:

$$ASI_t = \frac{\left(ASI_t - ASI_{t-1}\right)}{ASI_{t-1}},$$

where ASI_t, *ASI* denote at time t and ASI_{t-1} is *ASI* at time $t-1$.

The histogram and normality tests, serial correlation LM test, and heteroskedasticity test are all used in this study as diagnostic test.

ANALYSIS AND DISCUSSION

Table 2 shows that COVID-19 has the highest mean with a value of (384.8369) while All Share Index Return (*ASIR*) has a mean of (0.001427). The standard deviation of

[1] Nigerian Exchange Group. URL: https://ngxgroup.com/(accessed: 14.10.23); Worldometer. URL: https://www.worldometers.info/(accessed: 14.10.23).

Table 2

Descriptive analysis of *ASIR* with COVID-19 daily cases

Statistics	*ASIR*	COVID-19
Mean	0.001427	384.8369
Median	0.000220	231.0000
Maximum	0.062345	4035.000
Minimum	–0.035637	49.00000
Std. dev.	0.009325	419.8339
Skewness	1.676595	3.105467
Kurtosis	12.01566	19.91751
Jarque-Bera	1441.863	5061.119
Probability	0.000000	0.000000
Sum	0.533584	143929.0
Sum sq. dev.	0.032432	65745159
Observations	374	374

Note: $p < 0.05$.

Table 3

ADF and PP Unit Root Test Result of *ASIR* post COVID-19 lockdown

***ASIR* post COVID-19 lockdown**	***t-statistics***	***p-value***	***ASIR* post COVID-19 lockdown**	***t-statistics***	***p-value***
ADF test statistics	–25.41153	0.0000	PP test statistics	–43.23462	0.0001
Critical values:			Critical values:		
1%	–3.440370	N/A	1%	–3.440354	N/A
5%	–2.865852	N/A	5%	–2.865845	N/A
10%	–2.569124	N/A	10%	–2.569121	N/A

Note: $p < 0.05$; N/A — not determined.

COVID-19 and *ASIR* follows the same pattern as the mean, with COVID-19 (419.8339) having the highest standard deviation and *ASIR* (0.009325) has the lowest standard deviation. The probability of Jarque-Bera statistics shows that COVID-19 and ASIR are not normally distributed because their corresponding *p-values* are all less than 0.05.

In Table 3, the results of the unit root test conducted on the All Share Index return series during the post-lockdown pandemic period are presented. The Augmented Dickey Fuller (ADF) test statistics show a *p-value* of 0.0000, leading to the rejection of the null hypothesis. Therefore, the post-pandemic return series is determined to be stationary, signifying that it does not possess a unit root. This finding indicates a crucial characteristic of the series and provides a solid foundation for further analysis and modelling of the data.

In Table 4 presents the results of the unit root test for the All Share Index returns series during the post COVID-19 lockdown period, considering the daily cases. The Augmented Dickey Fuller (ADF) test yields a *p-value* of 0.0428, and the Philip Perron (PP) test statistics show a *p-value*

Table 4

ADF and PP Unit Root Test Result of *ASIR* during COVID-19 lockdown with COVID-19 daily cases

***ASIR* during COVID-19 lockdown**	***t-statistics***	***p-value***	***ASIR* during COVID-19 lockdown**	***t-statistics***	***p-value***
ADF test statistics	–2.931007	0.0428	PP test statistics	–6.959115	0.0000
Critical values:			Critical values:		
1%	–3.447770	N/A	1%	–3.447627	N/A
5%	–2.869113	N/A	5%	–2.869050	N/A
10%	–2.570871	N/A	10%	–2.570838	N/A

Note: $p < 0.05$; N/A — not determined.

Table 5

Conditional return / Mean equation of *ASI* return estimate post COVID-19 lockdown

Variable	**Coefficient**	**Std. error**	***t-statistic***	**Probability**
C	0.002071	0.001051	1.969714	0.0493
ASIR(-1)	–0.402280	0.036286	–11.08628	0.0000

Note: $p < 0.05$.

of 0.0000. These findings lead us to reject the null hypothesis, indicating that the return series after the pandemic is stationary. This signifies the absence of a unit root and highlights a crucial characteristic of the data, providing important insights for further analysis and interpretation of the stock market's behaviour during the post-lockdown period.

Table 5 displays the results of the conditional mean/return equation for the All Share Index return before the COVID-19 pandemic. On the other hand, Table 6 presents the findings from the ARCH effect test conducted on the residual of the mean equation of the All Share Index return series following the epidemic. The calculated *R-square*, *p-value*, and *F-statistics* all have corresponding values of 0.9437 and 0.9438. The analysis indicates that there is no significant ARCH impact in the residuals of the mean equation of the All Share Index return series on the Nigerian Exchange Group after the lockdown period. Hence, we accept the null hypothesis, which suggests the absence of an ARCH effect. These results provide valuable insights into the behaviour of the stock market during and after the COVID-19 lockdown period, indicating that the volatility patterns do not exhibit significant clustering in this context.

The ARCH effect of the residuals of the mean equation in Table 5 is presented in Table 6 as follows.

In Table 7, the outcomes of the GARCH model highlight a positive relationship between the mean of past daily returns and the current day returns, as demonstrated by the mean equation. The *p-values* for the mean return are observed to be 0.0022, 0.0057, and 0.0000, respectively. These low *p-values* signify that the positive historical mean daily return holds significant predictive power for the current return on the Nigerian Exchange Group, even at a stringent 5% significance level. This finding emphasizes the influence of past returns in shaping the current market behaviour and provides valuable insights into the relation-

Table 6

ARCH mean / Return equation of *ASI* return series of post COVID-19 lockdown

F-statistic	0.004979	Prob. F (1,636)	0.9438
Obs R^2	0.004994	Prob. χ^2 (1)	0.9437

Note: $p < 0.05$.

Table 7

***ASIR* post COVID-19 lockdown (June 2020 — December 2022)**

Parameter	Gaussian distribution		Student's *t*-distribution		Generalized error distribution	
	Estimate	*p-value*	Estimate	*p-value*	Estimate	*p-value*
μ	0.116345	0.0022	0.117648	0.0057	0.036830	0.0000
ω	0.000954	0.0000	0.013703	0.8900	7.24E-05	0.0000
α	0.222460	0.0828	488.9557	0.8900	1.187776	0.0109
β	–0.545554	0.0000	0.115673	0.0107	–0.001010	0.9510
AIC	–4.526319		–7.108685		–7.134647	
SC	–4.491422		–7.066808		–7.092770	
HQ	–4.512773		–7.092429		–7.118391	

Note: $p < 0.05$.

ship between historical and present-day stock performance on the NGX.

Furthermore, the analysis reveals a noteworthy positive correlation between the current day's All Share Index return on the Nigerian Exchange Group and the variance equation. This equation is derived from the residual of the mean equation, incorporating the ARCH and GARCH terms alongside the constant. Notably, the results demonstrate that both the ARCH term (past day return squared residual) and the GARCH term (past day return variance) exhibit statistical significance at the 5% level in accurately predicting the present day variance of return on the Nigerian Exchange Group. This observation highlights the importance of considering both historical squared residuals and return variances in understanding the present-day volatility patterns of the stock market, providing unique insights into the underlying dynamics of the NGX.

The presence of the constant term in the model indicates that, in the absence of the ARCH and GARCH components, present day changes in return would be minimal. This suggests that by observing past-day stock return movements on the Nigerian Exchange Group, an investor could potentially forecast present-day stock returns and achieve returns higher than the market return. As a consequence, the stock market is currently perceived as inefficient, implying that there are exploitable opportunities for investors to make superior predictions and outperform the overall market. This unique insight sheds light on the existing inefficiencies in the stock market and highlights the potential for skilled investors to capitalize on them for better investment outcomes.

In the evaluation of the model's predictive capability, all three criteria — the Akaike Information Criterion, Schwarz Criterion, and Hannan-Quinn Criterion — display closely aligned values with no significant disparity.

However, interestingly, the student's t distribution demonstrates the lowest values across these criteria. This observation sug-

Table 8

***ASIR* post COVID-19 lockdown with COVID-19 daily cases (June 2020 — December 2022)**

Parameter	Gaussian distribution		Student's *t*-distribution		Generalized error distribution	
	Estimate	***p-value***	**Estimate**	***p-value***	**Estimate**	***p-value***
μ	–0.000948	0.8913	–0.000169	0.9650	–5.98E-06	0.5080
ω	3.94E-05	0.0000	0.011015	0.9927	3.09E-05	0.0007
α	0.827977	0.0000	382.4818	0.9927	0.912903	0.0080
β	–0.031855	0.0009	0.155614	0.1075	0.117248	0.3904
AIC	–6.801779		–7.167357		–7.216506	
SC	–6.738698		–7.094200		–7.142910	
HQ	–6.776730		–7.138316		–7.187282	

gests that the GARCH model's predictive accuracy, when assuming the student's t distribution, yields the most accurate estimation of daily returns on the Nigerian Exchange Group. This unique finding highlights the importance of choosing an appropriate distribution assumption for the GARCH model, as it can significantly impact the model's predictive performance and the reliability of its estimations in the context of stock market returns.

In the analysis of the GARCH model for the *ASI* return after the pandemic lockdown, the results, as shown in Table 8, revealed a positive correlation between the mean of past daily All Share Index return and the present-day return, as evidenced by the mean equation. The *p-values* associated with the mean of the previous daily return are 0.8913, 0.9650, and 0.5080. These values indicate that the statistical significance of the mean prior daily return in forecasting the present day return on the Nigerian Exchange Group is relatively low, particularly at the 5% level. This unique finding suggests that the past daily returns have limited predictive power in explaining the present-day returns, thereby providing insights into the complexities of market behaviour during the post-lockdown period and underscoring the need for further investigation into the factors influencing daily returns in the Nigerian Exchange Group.

Moreover, the variance equation was formulated using the mean equation's residual, encompassing the ARCH and GARCH terms, along with the constant. The results from the variance equation demonstrate a positive relationship between the ARCH term (past day return squared residual) and the GARCH term (past day return variance). Remarkably, both of these terms are found to be statistically significant in predicting the present day variance of return on the Nigerian Exchange Group after the pandemic lockdown. Notably, the *p-values* associated with these findings are below 5% for only one distributional assumption, indicating a unique relationship between past and present-day variances and underscoring the importance of considering distributional assumptions in GARCH modelling for accurate volatility predictions in the post-lockdown market scenario.

The presence of the constant term in the variance equation implies that, without the ARCH and GARCH components, the changes in the *ASI* for the present day would be minimal, almost close to zero. This observation suggests that investors can analyse the current day's return movements on the Nigerian Exchange Group to predict present day share returns and potentially outperform the overall market returns after the pandemic. This unique insight emphasizes the

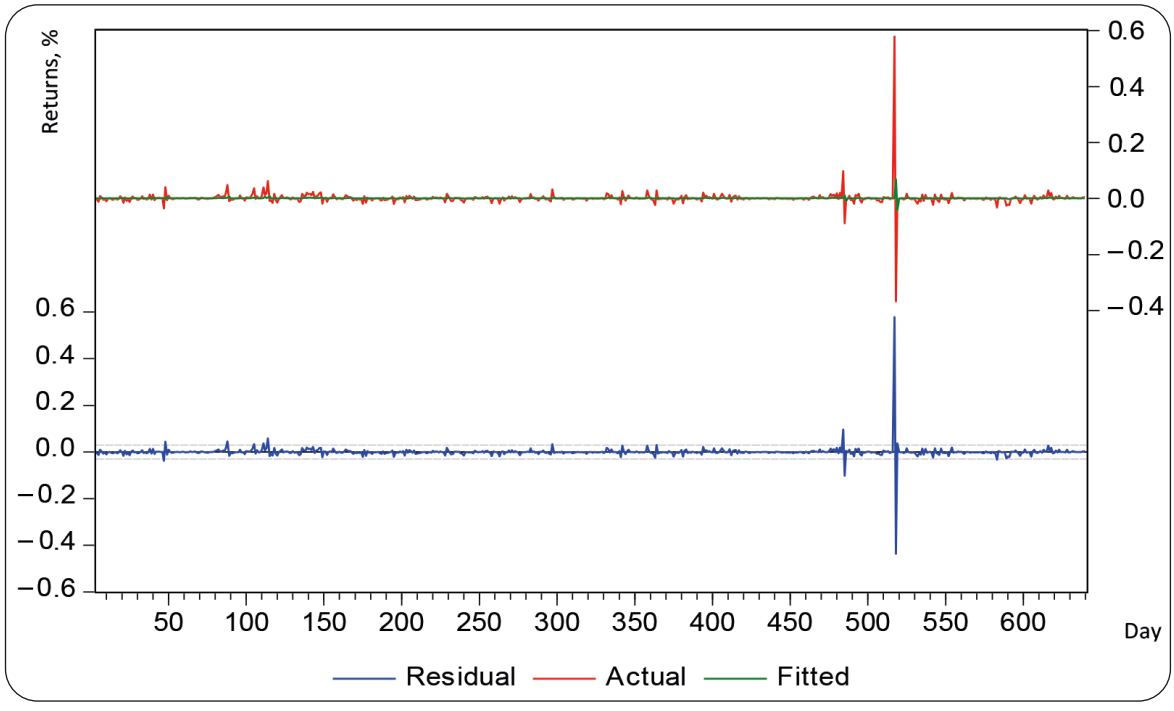

Fig. 1. Volatility clustering for daily *ASI* return post COVID-19 lockdown

opportunities for investors to make well-informed decisions based on past return patterns and capitalize on the market's behaviour for improved investment outcomes in the post-lockdown period.

The results suggest that the market is currently experiencing inefficiencies. Based on the information criteria, the Generalized error distribution emerges as the most suitable choice for the GARCH model to accurately forecast the daily return of equities on the Nigerian Exchange Group after the pandemic. Furthermore, the study also assessed the semi-strong form efficiency of the Nigerian Exchange Group, considering the pandemic period as the event window. This unique analysis sheds light on the market's efficiency levels during this critical time, providing valuable insights into its behaviour and dynamics in response to the pandemic's impact.

As per the findings in Figure 1, the stock return volatility during the post-pandemic lockdown period exhibited a pattern of sustained low volatility, indicating a continuous period of low volatility followed by extended periods of the same. This long-term characteristic of return volatility persisted throughout the analysed timeframe, the evidence implies that the Nigerian Exchange Group market was not efficient in its weak form following the COVID-19 lockdown period. This suggests that the market did not fully reflect all available information in the stock prices, potentially leading to trading opportunities for investors to exploit market inefficiencies and achieve abnormal returns. This unique observation provides insights into the market's behaviour during the post-lockdown era and highlights the importance of studying factors that influence market efficiency in times of significant global events.

The residual of the mean equation reveals a notable volatility clustering phenomenon. In Figure 2, the return series displays a swinging pattern around the mean value, indicating a mean-reverting behaviour. This implies that the stock return volatility was high during a certain period leading up to

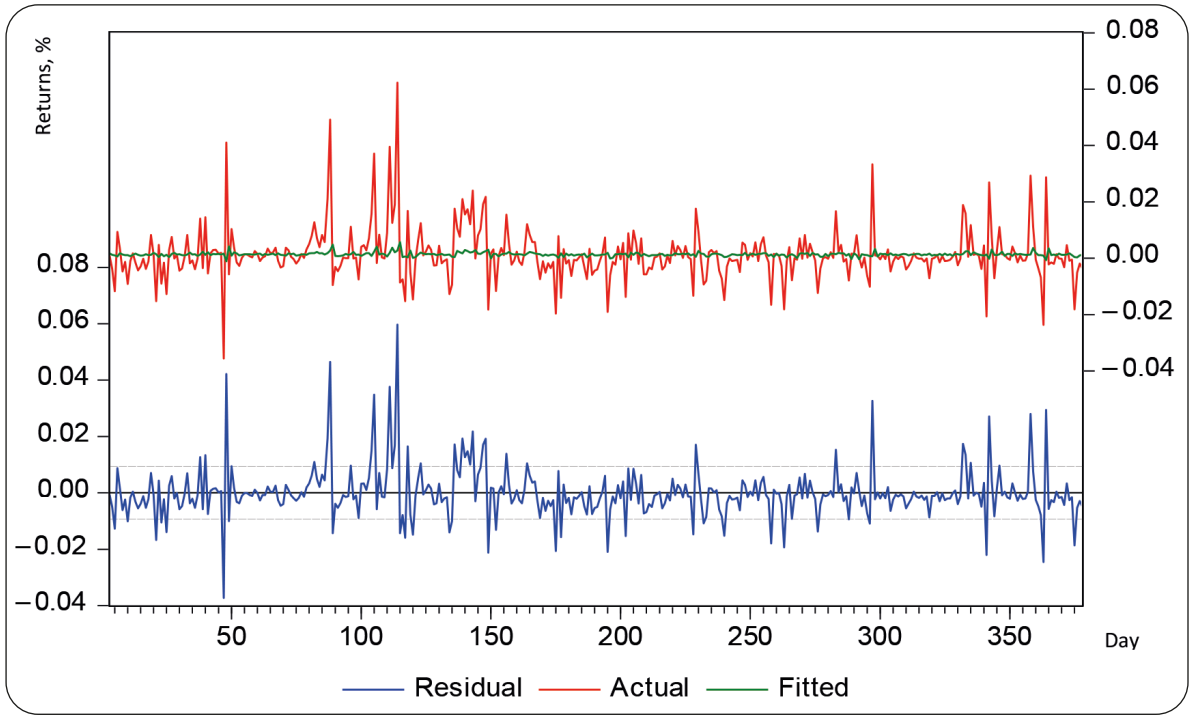

Fig. 2. Volatility clustering for daily *ASI* return post COVID-19 lockdown with COVID-19 cases residual

the third quarter of 2020 (characterized by prolonged periods of high volatility), followed by a subsequent period up to the third quarter of 2022 with low volatility (characterized by prolonged periods of low volatility). This pattern persisted throughout the post-lockdown period, with alternating phases of high and low volatility. The presence of the ARCH effect in the All Share Index return series of the Nigerian Exchange Group indicates that the variance of returns was not constant throughout the entire time span. The presence of volatility clustering, a characteristic often observed in financial time series, further validates and supports the use of ARCH variant models for analysis.

CONCLUSION AND RECOMMENDATIONS

The primary aim of this research is to evaluate the performance of the Nigerian Exchange Group market in the aftermath of the pandemic lockdown. The study centres on analysing the returns of the All Share Index between June 2020 and December 2022 to assess the level of volatility persistence using the mean reverting and half-life version of the GARCH model. The initial section offers background information on the Nigerian Stock Market and outlines the implications of the post-COVID-19 lockdown period. The results indicate that stock returns exhibit greater responsiveness to positive news in comparison to negative news.

The study poses several questions, objectives, and hypotheses based on these findings. It contributes to the discussion of market efficiency from a Nigerian perspective and examines the efficiency of the Nigerian Stock Market using the COVID-19 pandemic as an event window. Additionally, it offers insights to regulators for potential changes in regulations.

Section 2 focuses on the *ASI*, employing the GARCH model and the mean reverting

version of the GARCH model. The stationarity of the return series is assessed using unit root statistics (ADF and PP tests). The data, analysis, and discussion of empirical findings are presented in Section 3. It is essential for the samples to be stable at level [I(0)] in the econometric analysis with the GARCH model. The presence of volatility clustering and the ARCH effect in the residuals of the mean equations both before and after the pandemic return series validates the use of GARCH family models.

The conclusions drawn from the data suggest that during the sample period (June 2020 to December 2022), volatility is very persistent compared to the post-lockdown pandemic era when it is low. The *ASI* return volatility is significantly low persistent and quickly dying before the pandemic, but it is significantly high persistent and slowly dying for the entire sample period and after the pandemic, according to the results of the mean reverting and variance form of the GARCH model. The return is found to be mean-reverting and not following a random walk after the COVID-19 lockdown, and it takes about 10 days for volatility to return to its long-term average level.

The study's findings suggest that investors on the Nigerian Exchange Group tend to exhibit herding behaviour, reacting to unexpected news, leading to over and undervaluation of equities. The stock prices fluctuate around the mean price for a day with the pandemic, but for the whole study period and the post-lockdown pandemic era, it takes about 8–10 days before stock prices move up or down. This implies considerable risk and uncertainty in the Nigerian stock market, with potential long-lasting effects on future results. As such, the findings of this study is inline or supported the findings of K. Nageri who ascertained that the impact of bad news was found to have no significant impact on return volatility on the Nigerian Exchange Group [Nageri, 2021].

To address these findings, the research recommends implementing stringent oversight, limitations, and regulations to discourage excessively pessimistic noise traders (investors) from shorting the market for profit. Short selling should be limited to equities held by institutional investors with long-term goals that are not likely to be adversely affected by liquidity constraints. Large-cap stocks should be the focus of short selling, as they are easier and cheaper to borrow than smaller-cap stocks with lower institutional ownership. This approach aims to prevent inflated equities' prices from rising and potentially exacerbating market bubbles. The NGX should also promote professional development among market participants, particularly stockbrokers and registrars, to enhance public understanding of the stock market's significance of digital transformation leveraging on technology.

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Анализ эффективности фондового рынка Нигерии после завершения локдауна COVID-19

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Цель исследования: оценка эффективности фондового рынка Нигерии после отмены локдауна, введенного из-за пандемии COVID-19, оказавшей существенное влияние на африканские страны, в том числе на их фондовые рынки. **Методология исследования:** эмпирическое исследование проведено при помощи моделей GARCH. Авторы выдвинули три предположения о распределении ошибок в модели. Были использованы данные, охватывающие период с июня 2020 г. по декабрь 2022 г. **Результаты исследования**: установлено, что в период после пандемии COVID-19 фондовый рынок Нигерии демонстрирует слабую форму неэффективности, но при этом эффективен в умеренной форме. **Оригинальность и вклад авторов:** работа представляет собой первое полноценное эмпирическое исследование эффективности фондового рынка Нигерии после пандемии COVID-19. Авторы акцентируют внимание на том, что разные уровни эффективности рынка определяются независимо

друг от друга. Так, эффективность в умеренной (semi-strong) форме может быть достигнута без эффективности в слабой форме. В исследовании подчеркивается важность внедрения строгого надзора, правил и регулятивных мер, способных ограничивать участие трейдеров и инвесторов в коротких продажах с целью получения прибыли, особенно в отношении акций, которыми владеют институциональные инвесторы.

Ключевые слова: Нигерия, эффективность рынка, фондовый рынок, COVID-19, модель GARCH.

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