The interdependence of the JSE All Share Index and the S&P 500 Index

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DECLARATION

I, Tonderai Manyumwa, declare that this research piece is solely my own creation, except for any contributions mentioned in the references and acknowledgements. This document is presented as a partial fulfilment of the criteria for the Master of Business Administration degree at the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. This work has not been previously submitted for any academic degree or examination at this university or any other institution.

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ABSTRACT

Purpose: This paper seeks to understand if such an association exists between these two markets in recent times and to examine the extent to which it exists if the association is present.

Method: As markets become increasingly interconnected, it becomes imperative to constantly examine and monitor the evolving patterns of dependency. This entails exploring metrics such as correlation breakdowns, and other measures that capture the extent to which stock market comovements are affecting global investors. Therefore, the existence of strong interconnections and co-movements among international stock markets calls for continued monitoring and the studying of the patterns of interdependence, as this research will inform investors, policymakers, and financial institutions to better navigate the intricacies of global markets and make informed decisions to safeguard the general financial stability of the financial sector and optimize portfolio performance on a risk-adjusted basis (Moiseev and Popova, 2021).

In this research paper, empirical evidence of international stock market interdependence has been further assessed in a way that has not been evident in the literature review as follows. This paper examines the interdependence of the Johannesburg Stock Exchange (JSE) with the US stock market, using a modified GARCH model called the Dynamic Conditional Correlation model. The analysis uses weekly log returns from January 2011 to December 2022, with data sourced from Bloomberg.

Key Findings: The results indicate a strong interdependence between the two indices. Specifically, the DCC-GARCH model reveals that the previous period's residual positions and volatility significantly influence the current period's volatility for both indices. This indicates that global market shocks have a substantial impact on the South African market, diminishing the diversification benefits of including the S&P 500 in a South African portfolio.

Recommendations: Given the strong interdependence, South African investors should consider exploring alternative international markets or asset classes to achieve effective diversification. Policymakers and financial institutions should also take into account the significant influence of global market dynamics on local markets when developing investment strategies and regulations.

Keywords:

Market Interdependence; Comovements; correlation; Dynamic Conditional Correlation; S&P 500; Risk Management; Johannesburg Stock Exchange (JSE)

1. INTRODUCTION

Many market commentators and analysts have often associated foreign equity market movements, particularly the USA markets as predictors of the movements of the Johannesburg Stock Exchange ('JSE") All Share Index - "When the U.S.A sneezes, the other side of the world gets the flu" being a common expression in press and radio transcripts in over the last 5 years. This commentary from investment industry experts alludes to an association between international equity returns to that of the JSE. This paper seeks to understand if such an association exists in recent times and to examine the extent to which it exists if the association is present. Research conducted by Kim et al., (2016), further supports the USA's regnant position and influence on global stock markets.

The Standard and Poor's 500 index, or "S&P 500," is the largest stock market with a total market capitalization of USD$ 5.4 trillion (SPGlobal, 2022) and a significant component of global market indices. This article will explore the relationship between the S&P 500 and the JSE All Share Index.

The debate surrounding the interdependence among international stock markets has been extensively addressed in a multitude of academic papers. These scholarly contributions have focused on several key aspects, such as the transmission of volatility effects, instances of correlation breakdowns, and the identification of underlying trends in correlation patterns (Morana and Beltratti, 2008). The reason why this debate is important and ongoing stems from a variety of reasons and differing points of view. To begin with, global investors rely on enhanced risk adjusted returns that are achieved by increasing diversification which is achieved by low correlations amongst international markets. Therefore, the existence of interdependence within stock markets erodes any diversification benefits and increases portfolio risk measured through volatility as established by Markowitz (1952).

The nature of co-movements in the stock market is also commonly considered to be dynamic. Several scholars have really devoted their study efforts to investigating this aspect and have shown that powerful co-movements among stock markets become especially noticeable during times that are marked by market shocks and high volatility (Forbes and Rigobon, 2002). These episodes of heightened co-movements are marked by the spreading of market disruptions across various regions and countries. This phenomenon can be attributed to the influence of sentiment rather than any underlying market or stock fundamentals. The impact of sentiment, which often overrides rational market behaviour based on fundamental analysis, becomes evident during such turbulent times (Kim et al., 2019). The result of an increased interdependence as a response to market shocks leads to a further amplification of stock return volatility and ultimately portfolio risk (Bekaert and Harvey, 2000).

However, an additional noteworthy aspect within the discourse on stock market interdependence pertains to the rising trend observed in various dependency metrics among international stock markets (Morana and Beltratti, 2008). This facet calls for continuous and in-depth investigation, as it carries significant implications for understanding the evolving dynamics of interconnectedness between stock markets. As markets become increasingly interconnected, it becomes imperative to constantly examine and monitor the evolving patterns of dependency. This entails exploring metrics such as correlation breakdowns, and other measures that capture the extent to which stock market comovements are affecting global investors.

Therefore, the existence of strong interconnections and co-movements among international stock markets calls for continued monitoring and the studying of the patterns of interdependence, as this research will inform investors, policymakers, and financial institutions to better navigate the intricacies of global markets and make informed decisions to safeguard the general financial stability of the financial sector and optimize portfolio performance on a risk-adjusted basis (Moiseev and Popova, 2021).

In this research paper, empirical evidence of international stock market interdependence has been further assessed in a way that has not been evident in the literature review as follows. This paper examines the interdependence of the JSE with the US stock market, as only a few authors have examined the interdependence of an African stock market to an international market using a modified GARCH model called the Dynamic Conditional Correlation model as used by Mensah and Premaratne (2018) when they evaluated the integration of ASEAN banking sector stocks; despite the African stock markets growing importance in the global economy (Mensah and Alagidede, 2017).

However, before expanding on the overall problem statement (section 1.3), it is important to show the relevance of this study on investment portfolio management. Thus, this paper will conduct an examination of modern portfolio theory (section 1.1) which explains the importance of understanding interdependence and/or comovements of stock markets for portfolio risk optimization. Furthermore, in section 1.2 the paper will define interdependence in the context of stock markets and its explore its impact on portfolio risk management before expanding on the research conceptualisation and the study limitations.

1.1 Modern Portfolio Theory

Markowitz (1952) developed the Modern Portfolio Theory (MPT), which established a mathematical framework demonstrating that investors may decrease risk and get greater risk-adjusted returns by diversifying their investment portfolios via various assets and asset allocations. This study by Markowitz (1952) was further supported by research work done by Roy (1952) which focused largely on the covariances of returns of assets and asset classes and by so doing crystallised the effects of diversification when risks within assets are correlated (Markowitz, 1999). Diversification as a concept derived from portfolio theory can be defined as allocating wealth or assets across a range of assets that are not correlated (Koumou, 2020).

As portfolio theory focuses on correlation diversification (Koumou, 2020), many investment managers that invest in the JSE All Share Index, also invest in foreign equity markets such as the S&P 500 in order to diversify overall portfolio risk as risk is spread across currencies and countries. According to Manungo (2017), to achieve optimal portfolio risk management an investor should seek to invest in a basket of assets that do not move together, and thus by investing in international/foreign markets portfolios can achieve diversification as international markets have a small correlation to a single domestic market.

The foundational work by Ross (1976) on the International Asset Pricing Theory posits that portfolio risk can be effectively mitigated and optimized through the strategy of international portfolio diversification. This theoretical proposition underscores the potential for risk reduction when investors diversify their investment portfolios across international borders, tapping into the unique risk-return profiles of assets from different countries. Subsequent research conducted by Driessen & Laeven (2007) further explores the nuances of international portfolio diversification, providing empirical evidence to support the notion that the benefits of such diversification are palpable across both developed and developing markets. Notably, their findings indicate that the advantages of diversifying internationally are especially pronounced in developing markets. This suggests that investors in these markets can achieve a greater enhancement in their risk-return trade-off by incorporating assets from a broad array of international sources into their portfolios.

Therefore, given the widespread adoption of portfolio theory and international diversification by investors, it is crucial to investigate whether an association exists between the JSE All Share Index and international equity markets such as the popular S&P 500. Understanding the existence and nature of any potential association will provide valuable insights for investors and help them make more educated choices regarding portfolio construction and the choice of risk management strategies implemented.

1.2 Stock market interdependence

Interdependence of stock markets, in the context of this research paper, simply refers to the mutual influence between different stock exchanges (Thangamuthu and Parthasarathy, 2015). A measure of interdependence in the context of stock markets describes the extent to which stock return movements in a particular stock market can impact or propagate another stock market return movement, this ultimately results in the two markets having a higher degree of comovements or even correlation of stock returns. The intensification of globalization has led to a rise in financial market integration. This has been identified as a significant factor in the stronger interdependence observed among different stock markets, as examined by Thangamuthu and Parthasarathy (2015). Pretorius (2002) also noted that the rise in globalization leads to an increase in bilateral trade and overall economic integration. These factors contribute to the growing interdependence among stock markets. Mensah and Premaratne (2018) have suggested that the growing integration of financial markets in the last forty years can be attributed to the relaxation of restrictions on the movement of capital, the decrease in banking regulations, the easing of central bank controls on foreign exchange, and advancements in information technology.

The interdependence of stock markets, as discussed in section 1.1, is crucial for comprehending the efficacy of diversification in line with the International Asset Pricing Theory and Modern Portfolio Theory. This understanding is central to optimizing portfolio risk and implementing risk reduction strategies, which can be explored by investors, policymakers, and financial institutions. The higher the interdependence and/or correlation of stock markets, the lower the benefits of diversification of stock market returns will exist. The presence of high interdependence among invested stock markets for an investor can lead to non-optimal portfolio risk-adjusted returns leading to investors considering a higher allocation to alternative assets or non-traditional assets such as cryptocurrencies to enhance the risk-adjusted returns of a portfolio through these alternative asset classes which have proven to have a low degree of integration with stock markets (Kumah and Odei-Mensah, 2021).

1.3 Problem Statement

Considering the information that has been presented in sections 1.1 and 1.2 of this report, the research problem addressed in this study is the interdependence between the JSE All Share Index and the S&P 500. Specifically, the study seeks to answer the following primary research question:

> ***"Is there an interdependence between the JSE All Share Index and the S&P 500, and if there is to what extent does this association exist?"***

Given the principles of portfolio theory and diversification, many South African investors look to foreign markets like the S&P 500 to diversify their portfolios for a better risk-return trade-off.

Investment fund managers and overseas investors must ascertain whether participating in both the JSE All Share and the S&P 500 yields the risk management advantages of international diversification.

Furthermore, this study is timely because as of 1 July 2022, the South African pension fund industry; which according to the Financial Services Conduct Authority has 5000 retirement funds that have a combined value of assets of more than R4 trillion (FSCA,2021); can now invest up 45% of their pension assets (previously 30%) in international markets through the Regulation 28 amendment. Therefore, many South African investment consultants and pension funds need to understand the benefits of augmenting their asset allocation to include international asset classes in line with the new limits that have been set in Regulation 28. Therefore, the need to understand the international diversification impact that certain global markets such as the S&P 500 have on local South African pension plans is imperative for risk management and portfolio management purposes.

In addition to managing systemic risk, understanding the interdependence amongst stock markets has implications on hedging, pricing, determining optimal asset allocations and capital adequacy calculations for banking and insurance sectors (Mensah and Premaratne, 2017 & Kim and Sun, 2017). As market dynamics and relationships evolve over time due to various factors such as contagion, economic integration, bilateral trade, and the cash flow model; however, as these statistical relationships amongst markets evolve over time the extent to which these relationships remain significant needs to be constantly reassessed (Pretorius, 2002).

1.3.1 Research Questions

The primary research questions posed of this study is:

"How is the JSE All Share Index and S&P 500 Index associated?"

To support the primary research problem, the following secondary research problem is posed:

> **“Has the association between the JSE All Share Index and the S&P 500 remained consistent over the sample period (January 2011 to December 2022)?”**

1.4 Delimitations, limitations of the research study

As all research studies are subject to certain limitations and delimitations, it is important to highlight the key limitations and delimitations of this research paper.

Firstly, limitations as defined by Creswell and Creswell (2018), refers to certain constraints that may negatively impact the reliability and/or the validity of a research study. On the other hand, Creswell and Creswell (2018) define delimitations as the deliberate choices made by researchers to narrow down the scope of their research to specific contexts, variables and methods.

To assess the limitations of this research paper, an assessment of the limitations of studies related to stock market comovements and interdependence shall be conducted; followed by an assessment of the methodological limitations and delimitations of this research paper.

A key limitation with any study of stock market return behaviour is the time dependency which is limited to the period during which data is available. Time series stock market data is utilized as an input in any study of stock market interdependence; thus, the data itself may suffer from time-dependent statistical difficulties such as serial correlation, autocorrelation, and heteroscedasticity. These variables are all examples of time-dependent statistical problems. Additionally, in the event that it is discovered that the estimated model has serial correlation, it is possible to integrate lagged values of the augmented function in order to correct for such serial correlation. This will allow the DCC to produce estimates that are reliable.

Additionally, financial data in general often exhibits non-stationarity as historical data often displays time-varying volatility and asymmetries in stock market returns which violates a common assumption of stationarity which is a key assumption of GARCH models typically used in a study of interdependence (Bollerslev, 2023). Stationarity of data assumes that in a time series analysis the statistical properties of the data being assessed remains constant over the period being assessed. This assumption of stationarity implies that the in a study of stock market interdependence the mean and volatility of returns (measured through standard deviation) remains constant over the sample period, which is not the case with stock market return data. This assumption implies that the interdependence between stock market securities influences the flow of financial and investment resources across boundaries of different countries.

As a key delimitation, this research focuses primarily at the impact of the JSE All Share Index to a single foreign market index being the S&P 500 Index. Therefore, the study does not investigate the interdependence to other large stock market indices in the USA such as the NASDAQ or Dow Jones Indices nor does it assess the interdependence to other European and Asian markets. The research also broadly assumes investors and financial institutions apply the various concepts of modern portfolio theory to diversify their portfolios with an aim of achieving higher risk to return ratios.

2. LITERATURE REVIEW

This portion of the research paper will comprehensively analyse both theoretical literature and empirical results on the concept of stock market interdependence to offer a distinct viewpoint on the topic.

The first part of this section of the paper shall review theoretical underpinnings of interdependence and integration in the context of stock markets. The objective of this research paper is to provide a comprehensive knowledge of the notions of stock market interdependence by conducting a comprehensive assessment of academic research articles. These papers include foundational theories on the concepts of interdependence, such as those developed by Grubel (1968), as well as research hypotheses on the subject. Additionally, the broad definitions of stock market interdependence will be investigated in this portion of the literature study. used by the authors as well as the general underlying drivers of stock market interdependence including the impact thereof on investors and policymakers.

The second part of this section shall be reviewing empirical evidence that has been presented in contemporary research, therefore providing real context to the theoretical framework established in the first section of the literature review. This section will review research papers that have demonstrated the existence of stock market interdependence and the degree to which this interdependence exists. The empirical evidence review section will also look at how stock market interdependence has evolved over time including any specific identified linkages between African or other developing countries' stock markets and those of developed countries such as the USA.

2.1 Theoretical Review - Interdependence

In general, the interdependence of stock markets has been characterized in the same manner by a number of writers. For example, Masih and Masih (1999) have a definition that is comparable to that of Thangamuthu and Parthasarathy (2015). They define it as the degree to which stock markets from various nations move in tandem with one another.

A significant amount of research has been carried out to investigate the degree of correlation between stock markets. This research dates back to as early as 1968 when Grubel conducted a study, which was later followed by Masih and Masih in 1999. However, the majority of the research conducted so far has not specifically examined the connections between African stock markets and developed markets. Instead, most recent studies have primarily focused on stock markets in the USA, Europe, ASEAN, and Asia, as highlighted by Rafiq and Hassan in 2019. This is a significant gap in the knowledge of scholars as we examine the increasing importance of African economic marketplaces in the global financial sector.

According to Graham et al. (2012), international co-movements of stock markets has been increasing with evidence suggesting that countries with smaller cultural distance between them having a higher stock market co-movement. This further shows the importance of international diversification with stock markets in Africa, which may have differing cultures to developed country markets.

It is important to note that previous studies on stock market interdependence have found that the relationship between stock markets can change over time. Rua and Nunes (2009) and Candelon et al. (2008) have identified that the co-movement of stock markets is not constant, and correlations can vary depending on the time period observed. Specifically, developed stock markets tend to have higher interdependence in the short-term and lower interdependence in the long-term, as observed by Graham et al. (2012). This brings attention to the fact that investors in developed markets may profit more from diversification internationally in the near run as opposed to the long-term owing to the fluctuating degrees of dependence between developed markets and developing economies over the course of time (Chen et al., 2014).

Early studies have suggested that emerging economies have distinctive characteristics when compared to the developed markets due the differences in political structure, economic conditions, higher volatility, and a low correlation to developed markets (Rafiq and Hassan, 2019). However, studies have been inconclusive on whether the differing macroeconomic factors can be strongly linked to differing stock market returns and thus the level of interdependence (Rafiq and Hassan, 2019).

In the quest to understand why stock market interdependence exists, limited research has been conducted to explain the key drivers to stock market interdependence, with key research being conducted by Pretorius (2002). In the research conducted by Pretorius (2002) the author investigated the trend of increased stock market interdependence with a view of understanding why stock markets are increasingly becoming interdependent, the research concluded that economic integration and bilateral trade driven by globalisation has played a significant role with this increasing interdependence of stock markets. Other contemporary research on the reasons for the stock market interdependence phenomenon include research conducted by Bartram et al. (2007), which investigated the increasing interdependence and co-movements of European stock markets, found that general economic market integration increased stock market integration; therefore, the harmonization of regulations and reductions in transaction costs has increased interdependence.

Understanding stock market interdependence and its implications is significant importance to investors and policy makers alike. As expounded in research conducted by Mensah and Alagidede (2017) the understanding of stock market interdependence is pivotal to investors as they strategize on their portfolio allocation, asset pricing, portfolio allocation and diversification objectives. Investors thus need to understand the existence of interdependence to allow for more effective risk management and to potentially earn superior risk-adjusted returns.

Furthermore, the research by Mensah and Alagidede (2017) also underscores the importance of stock market interdependence to policy makers as strong market linkages influence the propagation of market shocks which has significant implications on systemic risk management across the financial system. Therefore, policy makers need to understand the extent to which certain markets are interdependent to inform policy responses, regulations and prudential measures that may need to be implemented to ensure the overall resilience of the financial sector.

In addition, several research investigating stock market connections have particularly concentrated on analysing the interdependence of stock markets at times of notable financial shocks or crises (Bekaert and Harvey, 2003; Tam, 2014). The research conducted by Liao et al. (2021) highlights the substantial influence of increased international financial integration on global financial markets, specifically demonstrating how this intensified integration has facilitated tighter connections across different markets. This development, while facilitating greater interconnectedness and potential efficiencies in global financial dynamics, concurrently elevates the susceptibility to systemic risks. The research illuminates the dual-edged nature of financial globalization, where on one hand, it promotes the seamless flow of capital across borders, enhancing market efficiency and providing investors with a broader array of investment opportunities. On the other hand, however, this interconnectedness means that shocks in one market can rapidly propagate through the network of global financial markets, potentially triggering widespread systemic crises.

2.2 Empirical Review - Evidence of stock market interdependence

Research conducted by Aityan et al., (2010) has shown that there has been a trend over the last three decades of international financial markets becoming more interdependent with each other.

One of the initial studies into the concept of international stock market interdependence was conducted by (Eun & Shim, 1989). Their study aimed to comprehend the transmission of stock market movements between international markets, specifically examining the influence of United States stock markets on other international stock markets and the speed at which price movements in one market affect others (Eun & Shim, 1989).Their study discovered a significant level of interconnectedness among the stock markets of the USA, Europe, and the Asia-Pacific region using vector autoregressive analysis (VAR). This research paper is quite relevant as it is one of the pioneering investigations into stock market co-movements and thus has laid the foundation for the many studies in trying to understand the interdependence of global financial markets.

In order to assess the impact of the United States stock markets on the markets of other countries, Balclir, Gupta, Nguyen, and Wohar (2018) undertook research with the objective of quantifying stock market interconnections. They accomplished this by analysing the causal relationship between the USA and Japan stock markets and fifteen other stock markets in the Pacific-Rim area, using Granger causality tests. The study's results indicated a substantial impact of the United States markets on the stock markets of the fifteen Pacific-Rim countries. Hence, it may be inferred that the potential for diversification between the United States and these nations is restricted.

Samouilhab (2006) empirically tested the widely held view that the JSE's behaviour is associated with international market behaviour. Using the LSE as a proxy for the international market, the study found that there is a positive relationship between domestic market returns and international market returns. Additionally, a positive relationship was found between domestic and international volatility. The study also highlighted that these associations were primarily observed during the same concurrent trading period, implying that foreign markets cannot be used as a signal of future JSE behaviour. However, it was noted that using finer-grained data might reveal that international market movements can anticipate local market movements. The study also found significant heterogeneity across different years and sectors regarding the existence, magnitude, and importance of global factors.

Samarakoon (2010) examined the transmission of shocks between the U.S. and foreign stock markets to differentiate interdependence from contagion during the U.S. financial crisis. The study found bi-directional, yet asymmetric, interdependence and contagion between the U.S. and emerging markets, with significant regional variations. The findings suggest that U.S. shocks drive interdependence, while emerging market shocks drive contagion. The study also found that during crises, Asian emerging markets have a strong contagious effect on the U.S., while U.S. crises do not significantly impact emerging markets in other regions except Latin America. The study further noted that frontier markets exhibit interdependence and contagion with U.S. shocks more influential during crises.

Although evidence of stock market interdependence has been demonstrated in research conducted for the developed markets, limited research has been conducted investigating interdependence of emerging markets (Rafiq and Hassan, 2019). In particular, very limited research is available that investigates the linkages of the JSE All Share Index to foreign stock markets (Thangamuthu and Parthasarathy, 2015; Mvita et al., 2021;, Mensah and Algidede, 2017).

Agyei-Ampomah (2011) examined whether major stock markets in Africa, including the JSE, have become more integrated into the global capital market. The study found that low levels of correlation among African markets and with global markets persist, with South Africa being an exception. The JSE shows significant linkages with global stock markets, unlike other African markets. The study also found that the total volatility of domestic indices in African markets is largely country-specific, with minimal influence from regional and global indices. Despite sub-regional blocs' development, African markets remain segmented, offering substantial diversification benefits for fund managers. The study highlights the need for significant reforms to enhance market transparency and liquidity, encouraging investors to diversify beyond their domestic markets.

3. METHODOLOGY

This study employed a quantitative methodology to investigate and address the research inquiries. In order to examine the presence of a mutual reliance connection between the JSE and S&P stock markets, a revised edition of the conventional conditional correlation method created by Bollerslev (1990) was employed. This adaptation utilizes a bivariate GARCH model that includes time-varying conditional variance and covariance. Specifically, it employs the dynamic conditional correlation ("DCC") model described by Engle (2002).

This DCC model is ideal for analysing financial time series data because it accounts for time-varying conditional variance and covariance, which are common in stock returns due to volatility clustering. The DCC model allows for capturing the dynamic co-movements between the two indices over time, making it particularly suitable for assessing the evolving relationship between the JSE All Share Index and the S&P 500 Index.

The data for this study utilizes secondary data obtained from Bloomberg ®, a worldwide market data supplier. The dataset primarily comprises the closing market index values recorded from January 2011 to December 2022. This extended period ensures a comprehensive analysis of the relationship between the two indices under various market conditions.

Following sourcing of the data, descriptive statistical tests were conducted to better understand the market data for the JSE All Share and the S&P 500 indices. The DCC is part of the GARCH framework of models, as heteroskedasticity is a common issue in analysing stock returns due to volatility clustering the GARCH based model was ideal for use to assess time varying co-movement of financial indices (Engle, 2001).

3.1 Sample

To assess the association of the JSE All Share Index to the S&P 500 we shall use data from January 2011 to December 2022. This period provided for 623 weekly observations and incorporated the 2020 Covid-19 market shock period. The chosen data period, spanning from January 2011 to December 2022, offers several advantages in this regard.

Firstly, the selected data period covers a length of over ten years, allowing for a substantial number of data points for analysis. This extended timeframe enables a comprehensive evaluation of market behaviour, encompassing multiple economic conditions, market cycles, and events of significance. Moreover, financial markets exhibit cyclical patterns characterized by phases of expansion, contraction, and volatility. By utilizing a longer data period, this research was able to capture various market cycles, facilitating a more robust analysis of the interdependence between stock markets across different market conditions.

Additionally, the chosen data period facilitates a thorough assessment of stability in the relationship between the two stock markets. Analyzing interdependence over a shorter period might fail to capture instances of market stress or significant events that could influence correlation dynamics. The longer period provides a more comprehensive perspective, enabling the identification and evaluation of stability or changes in the relationship over time.

Furthermore, a longer data period enhances the statistical significance of the analysis. With an increased number of observations, the estimation of dynamic conditional correlation becomes more reliable, reducing the risk of spurious or coincidental results that may arise when analysing shorter periods.

The stock market index weekly returns were calculated as the logarithm of $(\frac{R_t}{R_{t-1}})$. In general, weekly data is less prone to statistical problems due to non-synchronous trade and short-term correlations resulting from noise (Graham et al., 2012).

3.2 Estimation procedure and techniques

Prior to applying the DCC approach to estimate the connection between the variables, we performed descriptive statistics, pairwise correlation, and unit root tests on the series of JSE and S&P weekly log returns. The attributes were calculated to evaluate the appropriateness of the DCC approach. In order to delve deeper into the connections between the stock markets, we ran cointegration tests to examine the conditional correlations.

3.2.1 Descriptive Statistics

The descriptive statistical analysis for JSE and S&P weekly log returns encompasses a broad spectrum of measures: minimum and maximum values delineate the data range, while the arithmetic mean provides a central tendency insight. The standard error reflects the mean's precision, and the standard deviation reveals absolute dispersion, indicating volatility. The coefficient of variation, comparing standard deviation to the mean, assesses relative volatility. Additionally, kurtosis and skewness are calculated to evaluate the distribution's tails and asymmetry, respectively.

3.2.2 Pairwise Correlation

The Pearson correlation coefficient was calculated to evaluate the level of correlation between the weekly logarithmic returns of JSE and S&P. The coefficient, ranging from

±1 in extreme circumstances, was utilized to evaluate the extent of linear correlation between the aforementioned pair of variables in order to prevent multicollinearity arising from strong linear associations. The measure used to evaluate the level of correlation adheres to the categorization defined by Schober, Boer, and Schwarte (2018), which is as follows: 0.00-0.10 (insignificant), 0.11-0.39 (low), 0.40-0.69 (moderate), 0.70-0.89 (high), and 0.90-1.00 (very high). Prior to estimating the DCC-GARCH model, the correlation coefficient was calculated.

3.2.3 Unit Root Test

The examination of unit roots plays a role in establishing the necessity for differencing within a time series, or in identifying whether a time series variable exhibits non-stationarity — a state where its statistical properties are not constant over time. A process that is covariance stationary, or second-order weakly stationary, is characterized by three principal attributes: a constant mean, constant variance, and a covariance function that is solely dependent on the temporal interval between observations. It is a well-acknowledged fact in time series analysis that most series are integrated, attaining stationarity only after being differenced a specific number of times. An integrated series, which achieves stationarity upon being differenced d times, is classified as being of order d. However, it is critical to note that not all integrated series attain stationarity post-differencing.

In this study, the Augmented Dickey-Fuller (ADF) test is used as the main statistical tool to assess the stationarity of a certain time series. EViews is used for finding the appropriate lag durations for ADF unit root tests due to its adept utilization of the Akaike Information Criterion (AIC) for optimal assessment of test statistics. The Augmented Dickey-Fuller technique is founded on the generic autoregressive process of order AR (p) process, as defined by the function proposed by Akaike in 1973:

$$X_t = \pi + \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + ... + \gamma_p X_{t-p} + \varepsilon_t \quad (3.1)$$

If we assume that the process of data generation is governed by an AR (1), then the equation shown above may be simplified to:

$$X_t = \pi + \gamma_1 X_{t-1} + \nu_t \tag{3.2}$$

The autocorrelations of υ_t and υ_{t-i} $(\text{for } i > 1) = 0$ owing to the lagged X terms and if there order = 2; then the AR (2) process works out to:

$$X_t = \pi + \gamma_1 X_{t-1} + \gamma_2 X_{t-2} + \varepsilon_t \\ \equiv \\ X_t = \pi + (\gamma_1 + \gamma_2) X_{t-1} - \gamma_2 (X_{t-1} - X_{t-2}) + \varepsilon_t \tag{3.3}$$

Which can be reduced by eliminating X_{t-1} from both sides to

$$\Delta X_{t-1} = \pi + \beta X_{t-1} - \alpha_1 \Delta X_{t-1} + \varepsilon_t \tag{3.4}$$

and solving for β and α_1 one derives:

$$\beta = \gamma_1 + \gamma_2 - 1 \text{ and } \alpha_1 = -\gamma_2 \tag{3.5}$$

The analytical exploration of unit root tests, through the scrutiny of equations (3.4) and (3.5), provides critical insights into the stationarity transformation of non-stationary series. This transformation is pivotal when the variables under consideration exhibit concurrent movements over future periods. The following is a model and regression of the unit root test performed on an AR(p) series, as described in (3.6):

$$\Delta X_t = \pi + \beta X_{t-1} - \sum_{i=1}^{p-1} \alpha_i \Delta X_{t-i} + \varepsilon_t \tag{3.6}$$

such that ε_t represents the error term, $\Delta X_{t-i} = X_{i-1} - X_{i-2}$ and p denotes the level of autoregression; assuming that the null hypothesis being β = 0 (Akaike, 1973). This is the manner in which the ADF tests (Dickey & Fuller, 1979) were adopted to assess stationarity properties of the JSE and S&P weekly returns series modelled at level with a constant term at 99%, 95% and 90% confidence levels based on the general auto-regressive (AR (p)) shown below in (3.7).

$$\Delta X_t = \pi + \beta X_{t-1} - \sum_{i=1}^{p-1} \alpha_i \, \Delta X_{t-i} + \varepsilon_t \qquad (3.7)$$

such that ε_t represents a pure white noise error term, $\Delta X_{t-i} = X_{i-1} - X_{i-2}$ and p is the class of autoregression. The Akaike Information Criterion (AIC) was used to ascertain the most suitable lag lengths for the series. The AIC serves as the foundation for picking the model that optimally identifies the connections between the variables that are provided, as well as the model that is the best.

3.3 Dynamic Conditional Correlation

There was a modification to the standard conditional correlation model that was developed by Bollerslev (1990) that utilized a bivariate GARCH model with time-varying conditional variance and covariance. This model was called the DCC model (Engle, 2002). The objective of this update was to examine the potential correlation between the weekly returns of the JSE and the weekly returns of the S&P. Despite the fact that markets and the relationships between them change over time, Bollerslev's conventional conditional correlation model makes the assumption that correlations move in a monotonic fashion (Zainudin and M'ng, 2014). Therefore, Engel (2002) developed a time-varying conditional correlation GARCH model named DCC that was uses to assess the time varying interdependence between the JSE returns and S&P returns.

From a methodological perspective, given the dynamic nature of financial markets especially in periods of market shocks, a key limitation is that even a conditional correlation from a DCC model assumes that the conditional correlations remain constant over each assessed period. The DCC-GARCH model is an important computational approach that is used for the purpose of measuring the changes brought about by volatility correlations between two or more variables. This model illustrates the integration of markets through the lens of conditional correlations in movements, which are inherently time-varying. Engle (2002) introduced this framework with the intention of capturing the dynamic correlations of returns, thereby providing a nuanced understanding of how correlations between market returns evolve over time.

3.4 Cointegration Tests

The Johansen cointegration method has been applied to empirically ascertain the existence of long-term equilibrium relationships, specifically testing for a cointegrating relationship between the JSE and S&P weekly log returns. This approach is predicated on the theoretical premise that variables, once integrated of order 0 or 1, are capable of exhibiting a cointegrating relationship, thereby implying the potential for a long-term equilibrium wherein the JSE and S&P weekly log returns may oscillate.

The implementation of the ADF test to challenge the null hypothesis of the absence of cointegration plays a pivotal role in this analysis. A rejection of this null hypothesis provides substantial evidence in favor of cointegration. Such a scenario suggests that any disturbances to the equilibrium state are likely temporary, with stationarity facilitating mean reversion that inherently reinstates the long-run equilibrium.

3.4.1 Maximum Eigenvalue Test

The Maximum Eigenvalue statistical test is used to examine the null hypothesis (H0) that the quantity of cointegrating vectors is equivalent to r0, in comparison to the alternative hypothesis (H1) that it is equal to r0 + 1. In this case, rejecting the null hypothesis means that there is at least one group of variables that are initially not stable, but when integrated in a linear manner, they create a stable process. This result indicates the presence of a cointegrating link between the variables, emphasizing their long-term equilibrium connection despite possible short-term variations.

3.4.2 Trace Test

The trace statistic is used to assess the null hypothesis that the quantity of cointegrating vectors is equivalent to a specified value, r*, rather than the alternative hypothesis that the quantity of cointegrating vectors exceeds r*. This strategy may be referred to as checking for the presence of cointegration vectors, by comparing the number of vectors to a certain threshold, k. The alternate scenario involves comparing the number of vectors to k as well. The testing procedure is conducted in a sequential manner, first with r* being set to 1, followed by progression to 2, and so on. The technique is repeated until the null hypothesis is first accepted, at which point the particular r* value is regarded as the estimated number of cointegrating vectors.

In summary, the study employed Johansen's procedure (Johansen, 1988) to rigorously test for the presence of cointegration among the variables under investigation. Utilizing the max eigenvalue as well as the trace likelihood ratio (LR) statistics allowed for the successful completion of this task. These statistical tools are instrumental in identifying the number of cointegrating vectors within a dataset, thereby providing a robust framework for assessing the long-term equilibrium relationships between financial time series, such as those between the JSE and S&P weekly log returns.

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The descriptive statistics for both the JSE and S&P weekly log returns are shown below. These include the minimum and maximum values, which delineate the range of the dataset; the arithmetic mean, providing a central tendency measure; the standard error, indicating the precision of the mean estimate; and the standard deviation, which quantifies the absolute dispersion within the dataset. Furthermore, the coefficient of variation is reported to assess the relative dispersion, offering insights into the variability of returns in relation to the mean.

Additionally, the analysis extends to the calculation of kurtosis and skewness statistics, essential for evaluating the distribution characteristics of the variables under scrutiny. The kurtosis statistic is pivotal for understanding the sharpness or flatness of the distribution, whereas the skewness statistic helps ascertain the degree of asymmetry around the mean.

Table 1: Descriptive statistics of the JSE and S&P weekly log returns

Statistic	JSE weekly log returns	S&P weekly log returns
Mean	0.0020	0.0022
Maximum	0.0871	0.1146
Minimum	-0.1617	-0.1620
Std. Dev.	0.0224	0.0232
Coefficient of variation	11.3778	10.5176
Skewness	-0.7965	-0.8193
Kurtosis	9.2002	9.8412
Observations	623	623

Source: EViews 13

Table 1 statistics provide key insights into the comparative performance of the two stock markets. On average, both markets exhibited positive returns, with the JSE averaging a weekly log return of approximately 0.0020 and the S&P slightly outperforming it with an average of about 0.0022. However, both markets displayed notable volatility over the sample period, as evidenced by their standard deviations of 0.0224 for the JSE and 0.0232 for the S&P. This suggests that the S&P market experienced slightly greater return variability. Furthermore, skewness values for both markets were negative, indicating a leftward skew in return distributions, signifying a higher frequency of negative returns. Both markets also exhibited positive kurtosis, indicating fatter-tailed return distributions, suggesting a propensity for extreme market movements.

4.2 Pairwise Correlations

Table 2: Pairwise correlations between JSE and S&P weekly log returns

	JSE weekly log returns	S&P weekly log returns
JSE weekly log returns	1	0.654
S&P weekly log returns	0.654	1
Sig (2-tailed)	0.000	0.000

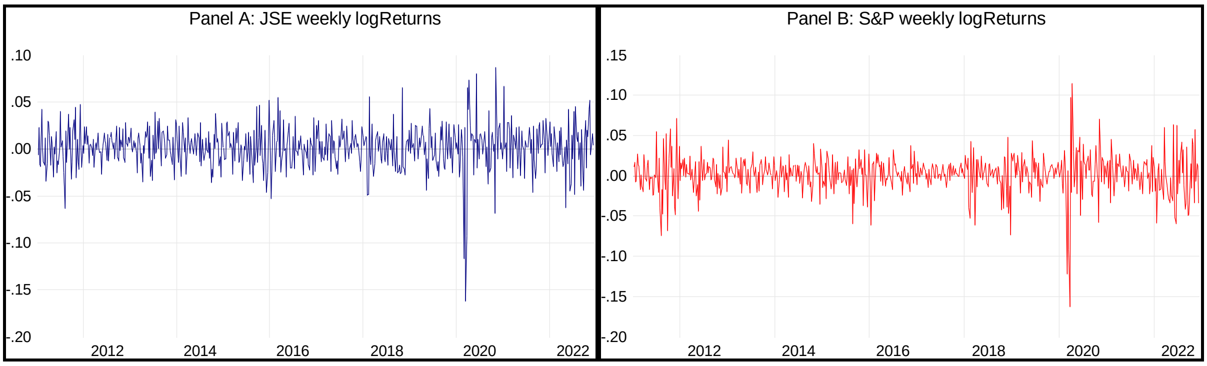
Source: EViews 13

The Pearson's correlation coefficient (r = 0.654) between JSE weekly Returns and S&P weekly log returns was computed prior to estimating the DCC-GARCH model. A Pearson's correlation coefficient of 0.654 indicates a moderate positive linear relationship exists between the two stock markets if we apply the criterion established by Schober, Boer and Schwarte (2018). However, although correlation does not mean nor imply causation; this statistical measure is important to justify the use of a DCC-GARCH model as there appears to be a relationship with the moderate correlation coefficient.

4.3 Volatility Clustering

The clustering of volatility was assessed to determine the appropriateness of GARCH-type models; precisely the DCC-GARCH model in respect of this research study. The graphical depiction approach was used in this study to identify clustering volatility.

Figure 1: Test for presence of clustering volatility in JSE and S&P weekly log returns graphs



Source: EViews 13

Figure 1 shows that the graphical representations of both JSE and S&P weekly log returns demonstrate a distinct pattern: periods characterized by low volatility are successively followed by similarly low-volatility intervals, and intervals of elevated volatility tend to precede subsequent periods of high volatility. This observation underscores the presence of volatility clustering within the behavior of JSE and S&P weekly returns throughout the sample period spanning from 7 January 2011 to 9 December 2022. The manifestation of such patterns signals the heteroscedastic nature of these series, affirming their amenability to modeling via GARCH models.

4.4 Unit Root Tests

The results of the unit root test, executed at various significance levels utilizing the Augmented Dickey-Fuller (ADF) technique, are detailed below. For these tests, a singular model was employed to conduct and calculate the estimates for stationarity tests: the constant model. The outcomes derived from the unit root test estimations are systematically presented in Table 3 below:

Table 3: Variables' ADF stationarity tests statistics in levels

Null Hypothesis: JSE weekly log returns has a unit root			
		t-stat	Probability
ADF test statistic		-25.626	0.000
Test critical values:	1% level	-3.440	
	5% level	-2.865	
	10% level	-2.569	
Null Hypothesis: S&P weekly log returns has a unit root			
		t-stat	Probability
ADF test statistic		-27.158	0.000
Test critical values:	1% level	-3.440	
	5% level	-2.865	
	10% level	-2.569	

Source: EViews 13

The stationarity test results, done with a constant term, unequivocally rejected the null hypothesis that there are unit roots in both the JSE Weekly log returns and S&P Weekly log returns series at the 1% significance level. This rejection signifies that both series exhibit stationary characteristics, implying that their statistical properties such as mean and variance do not change over time. The selection of the optimal lag order, set at zero (0), for the models concerning both JSE and S&P Weekly log returns was determined based on the Akaike Information Criterion (AIC).

4.5 Dynamic Conditional Correlation (DCC) Estimates

Table 4: JSE Weekly log returns, DCC-GARCH model estimates

Dependent Variable: JSE Weekly log returns
GARCH = 4.120 + 0.112*RESID(-1)^2 + 0.803*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.120	1.980	2.080	0.037
RESID(-1)^2	0.112	0.039	2.835	0.004
GARCH(-1)	0.803	0.058	13.730	0.000

R-squared	-0.000	Mean dependent var	0.001
Adjusted R-squared	-0.000	S.D. dependent var	0.022
S.E. of regression	0.022	Akaike info criterion	-4.874
Sum squared resid	0.313	Schwarz criterion	-4.846
Log likelihood	1522.409	Hannan-Quinn criter.	-4.863
Durbin-Watson stat	2.056		

Source: EViews 13

The variance equation one period lagged squared residual term of the JSE Weekly log returns DCC-GARCH model regression estimates (Table 4) are statistically significant at 5% level. The calculated regression estimates show that JSE Weekly log returns improved by about 0.1 of a percentage point in response to the previous week residual position. This result indicates strong evidence that the previous week's JSE returns information significantly influenced the current period volatility of JSE returns. Concurrently, the GARCH term regression estimates are statistically significant at 1% level, indicating that previous week's volatility of JSE returns significantly influenced the current period (week's) volatility of JSE returns during the study sample January 2011 to December 2022.

Coupled with evidence of the absence of autocorrelation (Durbin-Watson statistic = 2.056), results confirm that the JSE returns previous week's returns information significantly influences the current period's volatility of JSE returns, and previous week's volatility of JSE returns also significantly influences current period volatility of the JSE returns. The mean equation regression estimate show that the JSE returns intercept equal to 0.803 is also statistically significant at 1% level over the sample period under review.

Table 5: S&P Weekly log returns, DCC-GARCH model estimates

Dependent Variable: S&P Weekly log returns GARCH = 3.380 + 0.309*RESID(-1)^2 + 0.66*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	3.380	1.015	3.332	0.001
RESID(-1)^2	0.309	0.066	4.622	0.000
GARCH(-1)	0.660	0.042	15.606	0.000
R-squared	-0.002	Mean dependent var		0.002
Adjusted R-squared	-0.002	S.D. dependent var		0.023
S.E. of regression	0.023	Akaike info criterion		-5.020
Sum squared resid	0.336	Schwarz criterion		-4.991
Log likelihood	1567.869	Hannan-Quinn criterion.		-5.009
Durbin-Watson stat	2.166			

Source: EViews 13

The variance equation one period lagged squared residual term of the S&P Weekly log returns DCC-GARCH model regression estimates (Table 5) are statistically significant at 5% level. The computed regression estimates show that S&P Weekly log returns improved by about 0.3 of a percentage point in response to the previous week residual position. This finding indicates compelling evidence that the information on S&P returns from the previous week had a considerable impact on the volatility of S&P returns in the current week. The GARCH term regression estimates show statistical significance at a 1% level. This indicates that the volatility of S&P returns in the previous week had a substantial impact on the volatility of S&P returns in the present week over the study's sample period from January 2011 to December 2022.

Together with evidence of the absence of autocorrelation (Durbin-Watson statistic = 2.166), results strongly confirm that the S&P returns prior week’s returns information significantly influences the current period’s volatility of S&P returns, and previous week’s volatility of S&P returns similarly significantly influences current period volatility of the JSE returns. The mean equation regression estimate show that the S&P returns intercept equal to 0.660 is also statistically significant at 1% level over the sample period under review.

Table 6: DCC-GARCH model estimates

	Coefficient	Std. Error	z-Statistic	Prob.
theta(1)	0.011	0.007	1.459	0.144
theta(2)	0.957	0.028	33.64398	0.000
Log likelihood	2.592913	Schwarz criterion	-10.30591	
Avg. log likelihood	-10.33634	Hannan-Quinn criter.	-10.32441	
Akaike info criterion	-10.34930			
*** Stability condition: theta(1) + theta(2) < 1 is met.**				

Source: EViews 13

The estimates indicating that the stability condition was met (Table 6) confirm that the dataset consisting of the JSE weekly log returns and S&P weekly log returns series was suitable for applying the DCC-GARCH model in estimating the relationship and interdependence between the respective variables. The DCC model, therefore, strongly fits the dataset quite well; hence the estimates calculated are reliable. The findings of this study provide evidence that the weekly log returns of the JSE and the S&P are interdependent and that there is a statistically significant link between them.

4.5.1 Cointegration Test

Cointegration tests are essential for identifying whether the JSE and S&P Weekly log returns exhibit stable and meaningful connections over extended periods. The significance of cointegration lies in its ability to distinguish between mere short-term correlations and genuine, enduring relationships between these variables.

The evaluation of cointegrating relationships between the JSE weekly log returns and S&P weekly log returns was meticulously carried out utilizing the Johansen Trace statistic as well as the Max-Eigen statistic methods. Results for this respective test are reported in Table 7.

Table 7: Cointegration test between JSE weekly log returns and S&P weekly log returns

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.3897	**564.5550**	**15.4947**	0.0000
At most 1 *	0.3399	**257.8926**	**3.8415**	0.0000
The asterisk (*) indicates that the hypothesis has been rejected at the 0.05 significance level. The p-values from MacKinnon-Haug-Michelis (1999) are shown by double asterisks (**).				
Unrestricted Cointegration Rank Test (Max-eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.** Critical Value
None *	0.3897	**306.6624**	**14.2646**	0.0000
At most 1 *	0.3399	**257.8926**	**3.84147**	0.0000
The asterisk (*) indicates that the hypothesis has been rejected at the 0.05 significance level. The p-values from MacKinnon-Haug-Michelis (1999) are shown by double asterisks (**).				

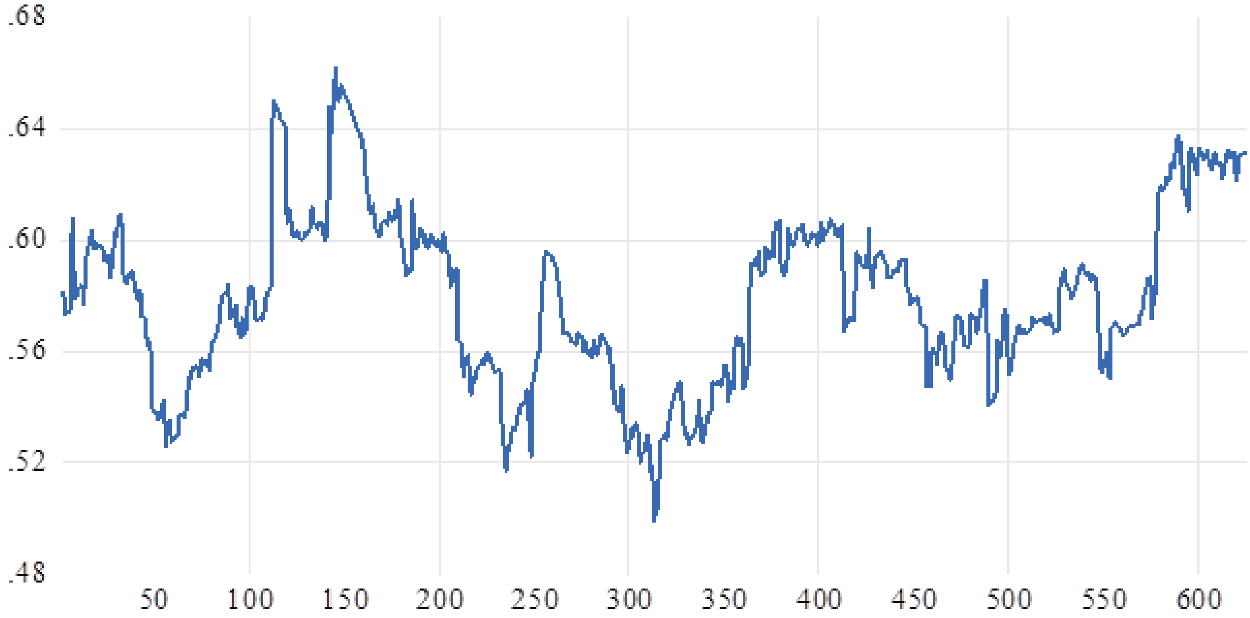
Source: EViews 13

The results that were acquired from the examination of the Johansen Trace and Maximum Eigen test statistics strongly confirm the presence of one cointegrating equation at a significance level of 5%. This conclusion is drawn from the computed Trace statistic, which amounts to 564.555, surpassing the critical threshold of 15.495 ($p < 0.05$), and the Max-Eigen statistic, which registers at 306.662, exceeding its corresponding critical value of 14.265 ($p < 0.05$). Such findings unequivocally affirm the presence of a long-run equilibrium relationship between JSE weekly log returns and S&P weekly log returns. Moreover, these results lend empirical support to the applicability of the DCC-GARCH model for capturing the nuanced interdependence between these financial series, thereby highlighting their interconnected dynamics within the global financial landscape.

4.5.2 Dynamic Conditional Correlation Plot

The Dynamic Conditional Correlations that have been obtained from the DCC-GARCH model are plotted in figure 2 below. The plot of the conditional correlations shows that the dynamic nature of the correlation between the JSE Weekly log returns and the S&P weekly log returns over the 653 weekly periods investigated, which again justifies the use of a DCC-GARCH model.

Figure 2: Conditional correlation among the JSE All Share Index and the S&P 500 Index



Source: Author’s calculation using EViews 13

Table 7 below presents the descriptive statistics of the conditional correlations shown in the graph above. These statistics will provide an overview of the dynamic interdependence of the JSE weekly returns to that of the S&P weekly returns:

Table 8: Descriptive statistics of the DCC between the JSE and S&P weekly log returns

	Conditional Correlation
Mean	0.5788
Median	0.5779
Maximum	0.6622
Minimum	0.4985
Std. Dev.	0.0308
Skewness	0.1961
Kurtosis	2.6675
Jarque-Bera	6.8639
Probability	0.0323

Source: Author's computations using EViews 13

Using the DCC-GARCH model to explore the dynamic relationship between the JSE and S&P indices, the descriptive statistics of the conditional correlations show that the mean conditional correlation coefficient is 0.5788; indicating moderately strong positive correlation if we apply the criterion established by Schober, Boer and Schwarte (2018).

To further support this mean correlation coefficient, the median value is 0.5779, which also suggests that the central tendency of the correlation distribution is strong. The range of correlations observed over the sample period ranged between 0.4985 and 0.6622 which indicates that there is a variation amongst the correlations over time but not to the extreme, further supported by the standard deviation being 0.0308 which shows a moderate level of volatility in the conditional correlation values.

The skewness of the conditional correlations is 0.1961, thus showing a slightly positive asymmetry in the distribution of correlations and with a kurtosis value of 2.6675 which is close to the value of 3 for a normal distribution. However, the Jarque-Bera statistic of 6.8639 concludes that the distribution of conditional correlations deviates from normality at a 5% significance level as the probability is 0.0323; thus concluding that the presence of non-standard dynamics in the conditional correlation structure between the JSE and S&P indices.

5. CONCLUDING REMARKS

The main research problem addressed in this study was the interdependence between the JSE All Share Index and the S&P 500 Index. The purpose of this study was to examine this relationship using a quantitative research methodology, specifically the DCC-GARCH model, analysing weekly log returns from January 2011 to December 2022.

This section is structured as follows: 5.1 Summary of the findings, 5.2 Policy implications and recommendations, 5.3 Limitation of the study, and 5.4 Areas for further research.

5.1 Summary of the Finding

The results obtained from the estimated DCC-GARCH model confirm that JSE returns, and S&P returns have a strong relationship and interdependence. This discovery echoes the familiar adage that "When the U.S.A sneezes, the other side of the world gets the flu."[1] What sets our research apart is our unique dive into this interdependence, focusing keenly on the JSE as a significant player in the global financial arena.

Furthermore, the estimates from individual regression equations confirm quite strong evidence through variance equation one period lagged squared residual terms that the previous period residual positions and returns information significantly influenced the current period volatility of each of the series returns. Contemporaneously, the GARCH term regression estimates that were all significant at 1% level reveal that the previous period’s volatility significantly influenced the current period (week’s) volatility of each of the series (JSE and S&P) returns.

5.2 Policy Implications and Recommendations

This research suggests that this interdependence has an impact on portfolio diversification. Specifically, it diminishes the diversification benefits of adding the S&P stock market to a South African JSE equity portfolio. Considering this, South African investors aiming to optimize their portfolio diversification may need to explore alternative international markets or asset classes to effectively achieve their diversification goals.

Beyond the numbers and statistics, the study brings to the forefront the growing significance of African stock markets, such as the JSE, on the global financial stage. As we navigate an ever-evolving financial landscape, this research provides a unique perspective on how African markets are intricately connected with global financial developments. This perspective is not just informative but also actionable, offering guidance to investors, policymakers, and financial institutions seeking to navigate the complexities of a global financial landscape where African markets continue to rise in prominence.

5.3 Limitations of the Study

While this research provides valuable insights, it is important to acknowledge its limitations. The study is based on historical data from January 2011 to December 2022, and the findings may not fully capture future market dynamics. Additionally, the focus on the JSE and S&P 500 may limit the generalizability of the results to other stock markets or asset classes.

5.4 Areas for Further Research

Future research could expand the scope by exploring other international markets and their interdependence with the JSE. Investigating different asset classes beyond equities, such as bonds or commodities, could provide a more comprehensive understanding of diversification strategies for South African investors. Additionally, examining the impact of specific economic events or policy changes on the interdependence between these markets would be valuable.

In summary, this research reinforces the enduring and unwavering nature of the JSE-S&P interdependence and its implications for South African investors. It not only echoes the well-known adage but also underscores the enduring dominance of the S&P/United States of America in shaping this relationship. As African markets gain prominence, our study serves as a beacon of understanding, encouraging investors to explore diverse strategies beyond the S&P stock market when optimizing their portfolios for risk diversification.

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