AFRICAN FINANCIAL MARKETS AND GLOBAL UNCERTAINTIES: NONLINEARITIES, ASYMMETRIES, AND INFORMATION FLOW

BY

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A DOCTORAL THESIS SUBMITTED TO THE WITS BUSINESS SCHOOL, UNIVERSITY OF THE WITWATERSRAND, IN FULFILMENT OF THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE

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ABSTRACT

The global economy has witnessed rapid integration of financial markets, resulting in increased interdependence. This thesis investigates how global uncertainties or shocks impact African financial markets, focusing on both stock markets and currencies. The study examines how African markets have become more exposed to shocks, uncertainties, and spillover effects originating from other regions, particularly during crises and pandemics. Given the increasing significance of global policy shocks in investment decisions, portfolio design, and risk management, this research seeks to fill the gap in understanding the robustness of African markets in the face of such challenges. It employs advanced econometric models to capture nonlinearities, asymmetries, and information content flow within a time-frequency domain, addressing the underexplored areas of the literature.

The thesis covers African stocks or equities markets and currencies. The selection of markets reflects the diverse economic landscapes and conditions across the continent. Prominent stock exchanges such as the Nigerian Stock Exchange, Botswana Stock Exchange, Egyptian Exchange, Tunis Stock Exchange, Namibian Stock Exchange, Moroccan All Shares Index, Ghana Stock Exchange, Lusaka Stock Exchange, and the Johannesburg Stock Exchange Africa All Share Index in South Africa have been captured. In addition to the stocks or equities markets, the choice of currencies also reflects the economic diversity and regional dynamics across the continent. These include the Egyptian Pound, the South African Rand, the Nigerian Naira, the Tunisian Dinar, the Ghanaian Cedi, the Moroccan Dirham, the Botswana Pula, the Mauritian Rupee, the

Kenyan Shilling, the Namibian Dollar, and the West African CFA Franc. The global uncertainties or global shocks used in this thesis are the US Economic Policy Uncertainty Index, Oil Volatility Index, and Volatility Index. These indices are crucial indicators of economic instability and market sentiment and provide insights into the level of uncertainty surrounding economic policies, oil prices, and overall market volatility. The analysis covers 1 January 2010 to 31 December 2022 giving 3,379 daily observations for each variable.

The thesis is organized into six chapters, with three self-contained empirical chapters. Each empirical chapter focuses on one specific objective or research question. The first empirical chapter examined the information flow between African stocks and global uncertainties using advanced analytical techniques. Employing the Complete Ensemble Empirical Mode Decomposition with Adaptive Noise method for data decomposition and the Rényi effective transfer entropy technique for information exchange estimation, the relationships between economic policy uncertainty, oil volatility index, CBOE volatility index, and African stock markets are investigated. The findings reveal both significant and insignificant positive information flows between US Economic Policy Uncertainty and African stocks across different investment horizons. Similar trends were observed with the oil volatility index and the CBOE volatility index, indicating a consistent pattern of information exchange. Importantly, no significant negative transfers were observed, suggesting a limited risk of contagion and high market resilience. Moreover, all three global uncertainty indices were identified as net positive information senders to African stocks across various investment horizons.

The second objective investigates the effect of global uncertainties on the currencies of both oil-exporting and oil-importing African currencies. The Chapter reveals asymmetrical relationships with generally positive associations, suggesting currency depreciation during changes in global shocks. Employing the Variational Mode Decomposition technique, the time series data is decomposed to reveal underlying patterns and dynamics. The results of the quantile regression model reveal asymmetries in the effects of these shocks on currency rates, with generally positive associations suggesting currency depreciation amidst fluctuations in global uncertainties. The study highlights mixed effects across different quantiles and market conditions. Short-term, medium-term, and long-term analyses reveal the varying effects of global uncertainties on African currency rates, which provides revelations into the dynamics shaping currency movements in Africa.

The third objective also applies the Variational Mode Decomposition technique and the nonlinear causal technique by Diks and Panchenko (2006) to investigate the effects of global uncertainties on the currencies of oil-exporting and oil-importing African countries, across various time frames. The findings of the robust nonparametric causal tests reveal interesting patterns in the relationships between global shocks and African currencies. Notably, the US Economic Policy Uncertainty demonstrates a significant causal impact on the Ghanaian Cedi, while other oil-exporting and oil-importing currencies exhibit varied responses to global economic shocks. The Oil Volatility Index exerts short to medium-term influences on specific currency rates, with differential effects observed between

exporting and importing countries. Similarly, the Volatility Index affects the returns of certain currencies, highlighting the connectedness between global uncertainties and African currency markets.

The evidence of asymmetric effects of global uncertainties on African financial markets and the diverse exposure of oil-exporting and oil-importing economies underscore the importance of considering country-specific contexts and economic structures in analyzing the impact of global shocks on the dynamics of African markets. Efforts by monetary and fiscal policymaking fronts to enhance market integration and improve information dissemination mechanisms are crucial to help African financial markets better respond to global uncertainties while minimizing adverse effects. The thesis offers valuable insights for policymakers, investors, and corporate bodies navigating African markets.

Keywords

Africa

Financial Markets

Global Uncertainties

Nonlinear Causality

Quantile Regression

Time Series Decomposition

Transfer Entropy

JEL Classifications

C1- Econometric and Statistical Methods: General

C22 - Time-Series Models; Dynamic Quantile Regressions; Dynamic Treatment

F21 - International Investment; Long-Term Capital Movements

G1 - General Financial Markets

G11 - Portfolio Choice; Investment Decisions

G14 - Information and Market Efficiency

G15 - International Financial Markets

DECLARATION

I, **Emmanuel Dadzie**, declare that this research report is my work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Management at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: **Emmanuel Dadzie** Signature: 

Signed at …**Johannesburg** …….

On the ……**10**…….. day of …**October…… 2024**……...

DEDICATION

To my wife and children

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LIST OF ACRONYMS & ABBREVIATIONS

Acronym	Meaning
ADF	Augmented Dickey Fuller
AMH	Adaptive Market Hypothesis
ARDL	Autoregressive Distributed Lag Model
ASI	All Share Index
BSE	Botswana Stock Exchange
BWP	Botswana Pula
CBOE	Chicago Board Options Exchange
CCC	Constant Conditional Correlation
CEE	Central and Eastern European
CEEMDAN	Complete Ensemble Empirical Mode Decomposition with Adaptive Noise
COVID-19	Coronavirus Disease
DCC	Dynamic Conditional Correlation
EEMD	Ensemble Empirical Mode Decomposition
EGP	Egyptian Pound
EGX	Egyptian Exchange
EMD	Empirical Mode Decomposition
EME	Emerging Market Economy
EMH	Efficient Market Hypothesis
EPU	Elevated Policy Uncertainty
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GARCH-M	Generalized Autoregressive Conditional Heteroscedasticity in Mean

GDP	Gross Domestic Product
GEPU	Global Economic Policy Uncertainty
GHC	Ghana Cedis
GVOL	Global Volatility Index
HMH	Heterogeneous Market Hypothesis
ICEEMDAN	Improved Complete Ensemble Empirical Mode Decomposition with Adaptive Noise
IMFs	Intrinsic Mode Functions
JSE	Johannesburg Stock Exchange
KES	Kenyan Shilling
LSE	Lusaka Stock Exchange
MAD	Moroccan Dirham
MHS	Moroccan All Shares Index
MODWT	Maximal Overlap Discrete Wavelet Transform
MS VAR	Markov Switching Vector Autoregression
NAD	Namibian Dollar
NAS	Namibian Stock Exchange
NASDAQ	National Association of Securities Dealers Automated Quotations
NGN	Nigerian Naira
NSE	Nigerian Stock Exchange
OLS	Ordinary Least Squares
OPEC	Organization of the Petroleum Exporting Countries
OVX	Crude Oil Volatility Index

PP	Phillips and Peron
QR	Quantile Regression
RTE	*Renyi* Transfer Entropy
SADC	Southern African Development Community
SARS	Severe Acute Respiratory Syndrome
TGARCH	Threshold Generalized Autoregressive Conditional Heteroscedasticity
THD	Tunis Stock Exchange
TND	Tunisian Dinar
UNCTAD	United Nations Conference on Trade and Development
VAR	Vector Autoregression
VARMA-	Vector Autoregressive Moving-Average with Asymmetric Multivariate
AGARCH	Generalized Autoregressive Conditional Heteroscedasticity
VIX	CBOE Volatility Index
VMD	Variational Mode Decomposition
XOF	West African CFA Franc
ZAR	South African Rand

CHAPTER ONE

GENERAL INTRODUCTION

1.0 BACKGROUND AND CONTEXT OF THE STUDY

The global economic/finance space has experienced uncertainties of a diverse nature in the past, which have occasioned various challenges or consequences for economies. This has been revealed by the recent economic/financial crisis and pandemics. Some of the global financial crunches in recent times are the debt crisis in Mexico (1982), black Monday stock market crash (1987), asset price bubble crash in Japan (1990,) economic crisis in Argentina (1999–2002), *peso* crisis in Mexico (1994), financial crisis in Asia (1997), financial crisis in Russia (1998), financial crisis in Brazil (1999), NASDAQ crash (2000), global financial crisis (2008–2011), sovereign debt crisis in Europe (2010), stock market crash in China (2015–2016), and stock market downturn in US (2018). Some recent pandemics are the severe acute respiratory syndrome (SARS) which occurred between 2002–2004 and the coronavirus (COVID-19) which also occurred between 2019–2022. The coronavirus pandemic had a lot of effect on all economies in the world. The pandemic caused shock, panic, and fear among domestic and international investors (He & Harris., 2020). This was occasioned by the various methods adopted by countries to curb the spread of the virus, which included lockdowns, cancellation of international travel, closure of schools, hotels, and restaurants, as well as suspension of trade.

The rising intensity of uncertainties in recent years has intensified the concerns among investors, financial analysts, and regulators across the world. It is becoming apparent that shocks in one market could be transmitted very rapidly to the rest of the world. This was

the case of the Mexican crisis of 1984/85 that affected its stock market but rapidly spread and affected many Latin American stock markets. Similarly, the Asian financial crisis that started in Thailand also quickly spread and affected many Asian economies. The global financial crisis of 2007/08 manifested in the US subprime markets and quickly affected all developed markets. These uncertainties have further deepened the debate on the implications or consequences of these uncertainties for emerging and developing markets, especially fragile African markets. The risks associated with these shocks on countries and regions depend on their exposure to foreign markets (Park & Shin, 2020). African markets have reacted negatively towards these uncertainties since research has shown that the spillover effect of these uncertainties on the African stock market is an adversary. Bakas and Triantafyllon (2020) among others have confirmed, in separate studies, that economic uncertainties inform commodity price volatilities and returns in the region.

The global economy has witnessed rapid/heightened integration and interdependence of financial markets, and this has exposed African markets to shocks/uncertainties and spillover effects originating from other markets. The connectedness between African economies and global uncertainties remains a critical factor for policy in the continent. The relaxation of the various restrictions to the flow of funds across borders has contributed to the rapid integration of financial markets in the world for some decades. The call to build up capital flows in all economies, including Africa, has encouraged fund managers to consider the African market as a means of investigation. The role played by integrated stock markets in economies cannot be overstated.

It has been observed that the share of African markets in the global equity market has been insignificant. Despite the importance of integration of the individual markets, African markets still operate in isolated markets, though efforts are being made for regional integration. Several studies have confirmed the fact that African equity markets are not integrated. Emenike (2021) studied interdependence among the West African stock markets and revealed that there is a weak relationship among equity markets in the sub-region. Also, Gil-Alana et al. (2018) investigated the linkages between African stock markets and the global market and found that there is low cointegration between the markets.

Global shocks or uncertainties have significant effects in the global economy and has become gradually noticeable in recent years (Zhou et al., 2022). This is because international trade and financial markets established relationships between nations and as such any economic policy uncertainty has the tendency to have a spillover effect on other economic variables in other nations and regions (Marfatia, et al., 2020). Recent studies have stressed the essence of incorporating global policy shocks and uncertainties in portfolio design, diversification, risk management, and investment decisions. This has occasioned the imperative to advance research in this direction. The study of uncertainty is of major importance to EMEs because of the following characteristics. Firstly, studies have shown that the Great Recession that occurred during 2007-2009 led to a significant rise and higher levels of volatilities of uncertainty in most EMEs because of the transmission of US shocks (Fernandez-Villaverde, Guerrón-Quintana, Rubio-Ramírez, &

Uribe, 2011; Bloom, 2014; Bloom, 2009). Secondly, EMEs suffer much more severe falls in investment and private consumption because of exogenous uncertainty shock (Carrière-Swallow & Céspedes, 2013). Thirdly, it has also been proven that monetary and fiscal policy actions (as compared to general uncertainty) have a greater significant impact in increasing and decreasing uncertainty shocks in EMEs (Krol, 2014). Fourthly, in recent time, EMEs have influenced the rise in EPU by transmitting these negative shocks to other countries (Dizioli, Guajardo, Klyuev, Mano, & Raissi, 2016). Lastly, studies on the effect of EPU in EMEs are inadequate since most studies on EPU have focused on developed countries (Redl, 2018). These implications of uncertainty on EMEs have made it very relevant to focus on the role uncertainty plays in EMEs. However, little research has been advanced to explore the linkages between these global policy shocks or uncertainties and African financial markets. The few studies done so far have yielded inconclusive findings.

Takyi and Bentum-Ennin (2021) investigated the impact of COVID-19 and revealed that the pandemic affected stock markets in the continent between -2.7% to -21%. The Nigerian stock market for instance, was badly hit by the outbreak of the pandemic as revealed by Oyelami et al. (2022) who presented that the pandemic harmed the Nigerian stock market as a unit increase in the COVID-19 cases led to a decline in All Share Index (ASI) by 0.07%. Zoungrana et al (2020) reveal through a study of how the pandemic affected stock markets in the West African Economic and Monetary Union, that the stock market was negatively affected by the pandemic by over 34%. Asafo-Adjei et al. (2022) demonstrated that the pandemic had a short-term fluctuation in the market concerning

economic growth. The study also shows a multi-frequency entropy which means that there is a negative bi-directional causality of information flow in the long term between global commodities and uncertainty.

This thesis deepens our knowledge base and understanding of the behaviour of African markets relative to shocks or uncertainties emanating from global stocks, currencies, and commodities markets in this highly integrated global financial system. It models the dynamic interconnectedness between African markets and global uncertainties by employing econometric tools suited to capture nonlinearities, asymmetries, and information content flow or exchange within a time-frequency domain. The thesis focuses on three main aspects of the relationship after employing the Improved Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (ICEEMDAN) technique to decompose the time series data. First, the research will apply the Rényi effective transfer entropy technique to estimate the exchange/flow of information between global uncertainties and African stock markets. The study will distinguish between oil exporting countries and non-oil exporting countries, as well as account for the impact of the COVID-19 pandemic. Second, the thesis examines the asymmetric relationship between African currencies and global uncertainties. The quantile regression technique would be employed to model the degree of asymmetry and nonlinear directional causal relationships between African currencies and global uncertainties in the frequency domain. Third, the study would model the quantile connectedness and directional predictability between African financial markets and commodities (global asset classes). Unlike the previous studies that claim that gold and crude oil are the essential

commodities in the commodity market and could proxy for the broader commodity market, this study will make use of several global commodities, as well as distinguish between the various categories of commodities – precious metals, industrial metals, agriculture, and energy.

1.1 PROBLEM STATEMENT

Some interesting aspects that have been completely ignored/untouched or underexplored in the extant literature are nonlinearities, asymmetries, and information content flow or exchange. This research seeks to model these concepts within the dynamic interconnectedness between African stocks and global shocks and uncertainties to deepen our knowledge base and understanding of the behaviour of African stocks relative to shocks or uncertainties emanating from global stocks, currencies, and commodities markets in this highly integrated global financial system. The thesis aims to model the effects of global uncertainties or shocks on African financial markets. The study makes use of econometric models suited to capture nonlinearities, asymmetries, and information content flow or exchange within a time-frequency domain. Although studies have been conducted to examine the degree of connectedness among African markets and global stock markets, exchange rates, as well as commodities markets, these studies have failed to focus on uncertainty indexes such as global economic policy uncertainty (GEPU), global volatility Index (GVOL), US volatility index (VIX) or fear index, crude oil volatility index (OVX), cryptocurrency volatility index (VCRIX), and COVID-19 pandemic. It must be indicated that some studies (including Adam 2020) have used economic policy uncertainty.

One interesting perspective that has been ignored or least explored is the decomposition of time series data to ensure robustness in analysis and interpretation. The incumbent literature has not captured some recent advances in research and has failed to explore some of the necessary ingredients required for policy and practice. Studies that focus on Africa fail to decompose data and have not focused on nonlinearities and asymmetries. Some studies such as Owusu Junior and Tweneboah (2020), Tweneboah et al (2020), Bossman and Agyei (2022), and Adam et al (2021) have employed decomposition techniques in African markets. Apart from Bossman and Agyei (2022) that employ the ICEEMDAN, these studies have relied on the maximal overlap discrete wavelet transform (MODWT), the empirical mode decomposition (EMD), the Ensemble Empirical Mode Decomposition (EEMD), and the Variational Mode Decomposition (VMD).

Another weakness associated with the existing literature borders on the lack of distinction or failure to distinguish between African countries in terms of oil exporting potentials. African countries are usually classified based on their resources. The behaviour of these economies is fundamentally affected by their ability to weather shocks associated with crude oil uncertainties. These are based on the essence of crude oil in the activities of the countries, such as how crude oil features in the revenue structure of the economy or the manufacturing or production processes. Failure to categorise African economies on this basis would hamper the benefits of hedging and diversification potentials.

I. Information Content Exchange Between Global Uncertainties and African Stocks

The flow of information and interactions within a particular market are so crucial since the financial market is made up of several subsystems and as such need to be coordinated as often as possible. Several extant studies used parametric methods of investigating interactions between financial markets but failed to show the direction of the flow and those that showed the direction indicated there is a linear relationship between variables in the market but did not show the dynamic nature of the information flow. Some of the methods used included multi-fractal (Kim & Yoon, 2004) Granger causality with vector autoregression (Granger, 1969), and probability distribution (Yang et al., 2008; Kaizoji, 2006). Haken (2006) indicates that interdependence between financial markets, as a measure of information flow is nonlinear, and information theory provides the means for measuring these nonlinear dependencies within financial markets. The stock market does not operate in a vacuum; it interacts with the real sector of the economy which depends largely on the information on the stock.

Several methods have been used to estimate information flow in the financial market. One method that has been identified to be robust is the transfer entropy introduced by Schreiber in 2000, which measures time dependence between variables. To quantify information flow between stock market variables will help to ascertain stocks that has the tendency to withstand changes in the markets and its agents (Behrendt, et al., 2019). The transfer entropy method also estimates flow of information among stock marks and its allies and to determine the route of information transfer in a bid to identify the overriding

variable (Kwon & Oh, 2012), which has been used to estimate time series data of the financial sector. Baek et al. (2005) estimated the linkages among stock markets and individual stocks to identify internal stock market structures. Marschinski and Kantz (2002) investigated the flow of information between Dow Jones and DAX stock markets in a bit to ascertain interactions between the two big stock exchanges and established the nonlinearity of information flow between the markets. Dimpfl and Peter (2013) used transfer entropy to estimate the flow of information among financial markets and found that information flow between CDS markets and the market for credit risk shows a nonlinear movement, but the former dominates the latter. Yao and Li (2020) also used the transfer entropy approach to estimate the flow of information among EPU, investor sentiment, and the stock market. They found that the sentiments of investors change more with changes in stock prices.

The strength of the transfer entropy model is that it is a non-parametric model that deals with both linear and non-linear dynamics of financial time series models. This is an improvement of the Granger causality which only shows the flow of information in stock markets but fails to quantify the magnitude of the transfer. The extent of information flow is also helpful in revealing the dominant market in terms of the flow of information.

II. Asymmetric Interconnectedness Between African Currencies and Global Uncertainties

The currency market is critical in stimulating economic activities in an economy. It is established in the extant literature that uncertainties in the economy cause the contraction

of economic activities since it distorts the free flow of money within the economy (Basu & Bundick, 2017; Baker et al., 2016). It has been established that the US Dollar for instance, appreciates whilst the Euro and the British pound depreciate as well as the Japanese yen and the Swiss franc serves as a safe haven when there are global shocks (Georgiadis et al., 2021). In Africa, due to overreliance on imports, its already fragile currencies are affected negatively when there is any global uncertainty. This is because important sectors such as food, tourism, energy, and transportation, among others, are adversely affected during global shocks (Wu et al., 2021; Narayen et al., 2021).

African countries in the last four decades have been hit by several shocks, ranging from the global financial crises, the COVID-19 pandemic as well as the Russian-Ukraine war. This is due to the loss in income because of losses from exports, tourism, foreign direct investments, and remittances (Kamau & Lewis, 2011) which led to an increase in poverty due to job losses. As a result of these shocks, it impacts the financial markets of the continent leading to the depreciation of African currencies and a rise in inflation. Domestic factors such as political unrest, drought, and speculators also contribute sometimes to the volatility in the currencies of the continent. Agyei et al. (2021) indicated that the socioeconomic effects of the COVID-19 pandemic, for instance, are severe on African economies to the extent that its effect could extend to the long term.

According to Kamau and Lewis (2011), the vulnerability associated with African currencies is worsened through the persistent rise in inflation and weak Central Bank instruments because of the increase in foreign-denominated debts and a widened trade imbalance.

This negatively impacts investor confidence in these economies and as such discourages them from participating in the financial market by affecting inflows that stimulate economic growth. Foreign direct investment, which helps to strengthen the local currency is heavily affected when there are global uncertainties (Ogbonna et al., 2021). Bloom (2009) indicates that investors or companies make decisions to invest based on the level of uncertainty. Investor decisions during uncertainties are therefore delayed which affects the local currency of the recipient country. For instance, UNCTAD indicated that the COVID-19 pandemic led to a decline of 10% ($45.3 billion) in FDI in 2019, and further predicted a decline of between 25% to 40% inflows of FDI in Africa in 2020 (UNCTAD, 2020).

Africa as a net importer is always hit by spillover effects from European, Asian, and the US markets. Sugimoto (2014) hinted those African markets, both commodity and currency, are severely affected by spillover emanating from any global uncertainty. Gurara and Ncube (2013) examined the effect of global economic spillover on Africa and established that there is a significant level of effect on Africa because of the spillover from developed economies, which confirms the linkage between Africa's growth pattern and global economic growth. This is evident in the fact that a percentage point decline in GDP of the World is found to lead to a contraction of 0.5 percentage point in the GDP of sub-Saharan Africa (Gurara & Ncube, 2013). Dabla-Norris et al. (2012) posits that external shocks have debilitating effects on low-income countries due to the linkages between developed and developing markets. This spillover effect is harmful to both fragile and oil exporting countries more than the remaining African countries (Gurara & Ncube, 2013).

Despite evidence of global uncertainties, in terms of its spillover effects on performance of African currencies as well as economies, there is scarcity of studies about the real impacts of global shocks on currency performance in African markets and the few studies are not able to predict the true behaviour of African currencies during global uncertainties. This study therefore proposes to fill this knowledge gap by estimating the connection between African currencies and global uncertainties.

III. Directional Dependency of African Markets and Commodities Markets

The financial and commodity markets have over the last two decades witnessed a significant level of volatility with its attendant economic, social, and political consequences on African countries (United Nations Conference on Trade and Development, 2012). Adebusuyi (2004) buttressed this by indicating that instability in the commodity market, for instance results in government deficits and national debts, appetite for short-term investments, capital flight and fall in export earnings.

Despite integration of the financial markets of the world with its relevance in risk sharing and maximum yield, African markets are less interconnected with the global or regional financial markets. With the help of Information Communication Technologies coupled with market reforms, this trend is improving due to its empirical financial innovation benefits (Atenga & Mougoue, 2021). The increased integration of stock and commodity markets globally, with its attendant effect on prices, returns on stocks and volatilities have attracted attention in recent years (Pinho & Maldonado, 2022).

There is therefore the need to explore the connectedness and interdependence between financial markets of African countries and global/regional commodity markets for both oil and non-oil countries with emphases on COVID-19 period due to the emerging surge in trading on the commodity and financial markets (Urom et al., 2020; Tand & Xiong, 2012). This is eminent because according to Adekoya and Oliyide (2021) and Shaikh (2021), investors now show more interest in investing in commodities especially during crises period in the bid to diversify their investments. The commodities markets therefore serve as an alternative investment vehicle since the financial market is vulnerable to global shocks that result in losses, which has improved the connectedness between the commodity and financial markets (Urom, 2021). Studies have therefore shown that there is a weak association between commodities, equities, and the oil markets, which has been criticized by some scholars. It has also been empirically shown that shocks in other markets have consequences for others. Shocks in the oil market for instance have been identified to transmit to other markets because of the rebalancing trading in the paper commodity markets (Chang & Su, 2010; Alom et al., 2011). It is therefore imperative to investigate whether there is a strong or weak connection between the commodity and equity markets relative to volatilities in African markets since connectedness is a function of volatility.

Several global markets are connected through economic variables. Albulescu et al. (2019) studied the connectedness between oil and currency markets which is mostly driven by policy-influenced uncertainties. There is limited empirical studies that have estimated the

impact of global uncertainties on the connectedness across commodity and financial markets, especially linking such spillovers to a health-related uncertainty like the corona virus pandemic that hit the world in 2019. This paper will therefore investigate the contribution of the pandemic to the volatility connectedness among precious metals, industrial metals, agriculture, and financial markets. The outbreak of the COVID-19 pandemic has had a significant negative effect on economic activities globally, including Africa, with the commodities market been the most affected.

The uncertainty during the pandemic reduced investments on the financial market resulting in a reduction in demand which led to destruction in the supply chain. Zhang et al. (2020) confirms this effect by indicating that the pandemic has increased volatility in stock markets and as such makes it difficult to predict. Mhalla (2020) has further revealed that the pandemic has significantly affected the global oil market and increased the level of fears and uncertainties in the market. According to Sheth et al. (2022), agricultural commodities, natural gas and energy markets were adversely affected by the pandemic. Benlagha and Omari (2021) also established a strong connectedness between stock markets and, gold and oil markets at the period of the pandemic. They further indicated that gold served as a receiver of shocks from the stock markets whilst oil served as a net transmitter of these shocks. This became eminent when investors began selling their stocks during the pandemic due to the fear of short-run losses in the stock market in favour of other assets, resulting in the spillover during the period (Salisu & Vo, 2020). The pandemic notwithstanding, benefited commodities like oil and gold leading to an all-time high price of oil during the period (Sheth et al., 2022).

1.2 OBJECTIVES OF THE THESIS

The specific objectives of the study have been captured in the objectives of the three interrelated but self-contained papers below. The research is focused on exploring how African stocks (or equities) and currencies respond to global uncertainties, with a specific emphasis on information flow, nonlinear patterns, and asymmetric responses.

I. To investigate the information flow between African stocks and global uncertainties.

This objective seeks to investigate and quantify the extent to which information flows between African stock markets and global uncertainties. In other words, it aims to assess how much influence or impact global uncertainties have on African stock markets and vice versa. The research will examine how African currency markets respond to events or uncertainties in the global financial landscape, such as economic crises, geopolitical developments, or changes in global market sentiment. This objective may involve measuring the strength of this information flow, determining the direction of influence (from global uncertainties to African stocks or the other way around), and identifying any patterns in this flow of information.

II. To study the asymmetric connection between African currencies and global uncertainties.

This objective focuses on exploring the relationships between African currencies (foreign exchange rates) and global uncertainties, with a specific emphasis on whether these relationships exhibit asymmetry. Asymmetry in relationships implies that the responses or

reactions of African currencies to global uncertainties are not uniform. In other words, the impact of positive and negative global events on African currencies may differ. Researchers will likely examine how African currencies are influenced by global uncertainties and whether certain types of uncertainties have a more pronounced effect in one direction (e.g., positive global events impact African currencies differently from negative global events).

III. To model the nonlinear causal effects of global uncertainties on African financial markets.

It seeks to determine the degree of interconnectedness or dependence between African financial markets (e.g., stock markets or currency markets) and commodities markets. Specifically, researchers will assess whether changes in one market (for example, a commodity market) have varying degrees of impact on different segments or quantiles of African financial markets. This can reveal how the interconnectedness between markets varies across different levels of market conditions. This aspect examines whether it is possible to predict the direction of movements between African financial markets and commodities markets. In other words, researchers will explore whether changes in one market can provide information or signals about the likely direction of changes in the other market. This directional predictability can be valuable for investors and policymakers to make informed decisions.

1.3 CONTRIBUTIONS OF THE STUDY

The thesis makes significant contributions to research, policy, and practice. Contemporary arguments in finance and economics require evidence based on the application of quantitative and econometric tools/techniques to time series data. This has advanced empirical and theoretical contributions from different trajectories or perspectives. The first contribution aims at addressing the dearth of knowledge on the behaviour or strength of African markets when confronted with shocks or uncertainties emanating from the global financial architecture or ecosystem. Investors naturally shift from risky assets into safe haven assets during periods of economic recession and financial market crises. Thus, an analysis of the lead-lag interconnectedness, information content flow, quantile dependence, as well as directional predictability between African stocks and global uncertainties is expected to advance our understanding of the behaviour of African markets and advance our ability to provide prescriptions for investors on the hedging strategies to employ against global or equity market uncertainties or crises. Furthermore, this would serve as a guide for regulators and policymakers on how to shield domestic financial markets from uncertainties attributed to global market dynamics.

A plethora of literature on Africa examines the co-movement and interdependence of African stocks and advanced financial markets. However, there is less attentiveness to the time-frequency dimension, nonlinearities, and asymmetric implications of uncertainties emanating from global financial markets and other external shocks. The emerging research has evolved due to the intrinsic intricacies associated with time series

and the need for advancement to high-level analysis that incorporates or captures these aspects of markets. The quantile regression, partial wavelets techniques, quantilogram, and transfer entropy are therefore emerging as relevant tools for examination of complex time series analysis. These tools possess the ability to explore the variations within a time series to define both prevailing modes of variability and how the modes change in time through decomposition. This is pertinent to attempts by researchers targeted at establishing the appropriateness of African stock markets for diversification and risk management purposes. Also, the study contributes to the heterogeneous nature of market participants and the adaptiveness of markets across time. In addition to the contribution to the body of knowledge on African financial markets and uncertainties, the novelty in this research is also propagated through the data and econometric techniques employed in this thesis, which are very limited or scanty in the African narrative. Thus, there is much potential in this thesis to rejuvenate further research into unexplored or undiscovered domains in the financial market ecosystem.

Another key contribution of this thesis hinges on its departure from the existing trend in the literature by applying decomposition and innovative statistical tools for the analysis. Existing studies have ignored the imperative to decompose time series data to investigate heterogeneity and adaptiveness of market participants across time. The evolution of markets and players due to their responses to shocks and uncertainties impose asymmetries, nonlinearities, and transmission effects that are difficult to model by relying on certain techniques. Our attempt to model a mixture of asymmetric and non-linear causal effects of global uncertainties presents the opportunity to ascertain the degree of

information content flow at different frequencies (low, medium, and high domains) and determine the susceptibility or immunity of African markets to uncertainties in times of economic shocks. Decomposing time series into intrinsic mode functions (IMFs) give the long-, short-, and medium-term patterns and minimise the noise in the data. Aside the usual advantages derived from decomposition, the CEEMDAN approach employed for this study has additional benefits (see Torres et al., 2011).

This study also provides further insight into the influence of three uncertainty indicators. The findings offer an intriguing opportunity for investors and policymakers, by suggesting partial hedging benefits toward risk exposures concerning both currency and stock fluctuations. These results are useful for investors and portfolio managers aiming for specific time horizons for their investments, preferences, and risk assessment. The findings will also help policymakers focus on building optimal measures to promote stock-market stability, especially during crises, as well as designing an appropriate framework for foreign exchange management to stabilize the currency.

This research contributes to the empirical literature in the context of the African stock market by adding new evidence and literature regarding EPU, OVX, and VIX effects on the relationship between stock returns and exchange rates. This study looks at the dynamic relationship between stock markets and exchange rates and the period studied includes the pandemic period. Thus, this study also contributes to the developing body of knowledge about how COVID-19 affects financial markets.

1.4 SCOPE AND LIMITATIONS

The scope of this research includes modelling the nonlinear and asymmetrical effects of global uncertainties on African stock, currency, and commodity markets, with a focus on selected African economies. The study will distinguish between oil-exporting and non-oil-exporting African countries to better understand how oil-related shocks impact these economies differently. The study will employ advanced econometric techniques, such as ICEEMDAN and transfer entropy, to capture the dynamic and nonlinear interactions between these markets.

However, the study has several limitations. First, the availability of high-frequency and long-term data for some African countries may be limited, which could affect the accuracy of the models used. Second, the unpredictability of global shocks and uncertainties, particularly in the wake of unprecedented events such as the COVID-19 pandemic, may introduce a level of uncertainty into the forecast models. Additionally, the study focuses primarily on financial markets, and while it touches on broader economic variables, the full macroeconomic implications of these shocks are beyond the scope of this research.

1.5 STRUCTURE OF THE THESIS

The thesis will follow a structured organization in alignment with the defined objectives. Chapter One serves as the General Introduction, providing an overview of the research context, problem statement, and its significance. Chapter Two delves into a review of related studies, offering a comprehensive examination of existing research and theories in the field. The next three chapters address the specific research objectives. Chapter Three examines the information content flow between African stocks and global

uncertainties, while Chapter Four investigates the asymmetric interconnectedness between African currencies and global uncertainties. Chapter Five is dedicated to analyzing the directional predictability between African markets and global commodities. Chapter Six presents the conclusions, recommendations, and potential directions for further research, based on the key findings and their implications for the field.

1.6 CHAPTER SUMMARY

This introductory chapter of the thesis has provided an overview of the research context, problem statement, purpose, contributions, and structure of the study. It begins by delineating the background and context within which the research is situated, highlighting the growing interconnectedness of African financial markets amidst global uncertainties. The problem statement underscores the existing gap in the literature regarding the nature of the exposure of African equities and currencies to global shocks or uncertainties, warranting a thesis aimed at addressing the limitations and weaknesses in the existing body of knowledge.

Following the background and problem statement, the purpose of the thesis is then articulated. The contributions of the study are delineated, emphasizing its relevance in advancing scholarly understanding, informing policymaking, and guiding practical decision-making in financial markets. Finally, the structure of the thesis is outlined, providing readers with a roadmap for the subsequent chapters.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.0 INTRODUCTION

This Chapter presents a review of the concepts, theories, and empirical evidence. It begins with a review of concepts related to the study. It then continues with a review of the theoretical underpinnings of the study. Finally, the empirical review is presented and the gaps and limitations in the existing literature are identified. The Chapter synthesizes existing knowledge, identifies research gaps, and establishes a robust foundation for the empirical analysis.

2.1 CONCEPTUAL REVIEW

This section serves as a foundational grounding and provides explanations for key concepts relevant to the thesis. The section lays the basis for the empirical analysis by synthesizing definitional insights and meanings, which contribute to the advancement of knowledge.

2.1.1 Time Series Decomposition

Time series decomposition is a useful analytic technique for economics and finance. Time series decomposition separates a time series into different components, allowing each to be examined in isolation (McCleary et al., 1980). One decomposition technique that has seen growing usage as a time series analysis tool in economics and finance research is Empirical Mode Decomposition (EMD). Specifically, Nava et al. (2018) utilised EMD to reveal the multifractal structure and long memory of commodity price volatility across

timescales. Additionally, Liu et al. (2019) showed EMD's efficacy in modeling conditional heteroscedasticity in crude oil prices. EMD was then enhanced by Yu et al. (2005) with an adaptive approach to improve foreign exchange rate prediction accuracy. Crucial EMD applications highlight financial data decomposition for simulation modeling, prediction systems, adaptive filters, operating decisions, and market analysis. The adaptive, multi-resolution capabilities uncover hidden data structures missed by other techniques. As an emerging method, EMD promises further valuable insights into economics and finance.

Furthermore, the Ensemble Empirical Mode Decomposition (EEMD) is another type of time series decomposition that has been applied in finance and economics. As an enhancement of basic EMD, EEMD addresses mode mixing issues through noise-assisted analysis (Wu & Huang, 2009). In finance contexts, EEMD has effectively captured multifractal attributes and long-range correlations in stock markets. For instance, Li et al. (2019) used EEMD to uncover hidden periodicities predictive of price fluctuations. Relatedly, Wang et al. (2016) showed EEMD can improve financial time series forecasting by extracting useful modes. Also, for exchange rates, Yu et al. (2005) devised an adaptive EEMD method that outperformed benchmarks in nonlinear prediction. Additionally, Li & Yu (2019) used an EEMD ensemble neural network that captured underlying data-generating processes for superior economic forecasting. It has therefore been noted that key EEMD applications cover financial market analysis, trading signals, macroeconomic modelling, forecast combinations, and econometric frameworks leveraging the decomposed mode strengths. The method shows promise for nonlinear and nonstationary economics and finance data.

According to Owusu Junior and Tweneboah (2020), EEMD is an improvement on basic EMD by adding white noise across ensemble trials, providing more robust intrinsic mode function (IMF) components. Key applications of EEMD include extracting cyclical components from economic data. Additionally, Owusu Junior et al. (2020) isolated growth, business cycle, and irregular IMFs underlying Ghanaian GDP using EEMD. Similarly, Ijasan et al. (2021) decomposed Nigerian public debt into trend, cycle, seasonal, and residual IMFs via EEMD to assess fiscal sustainability. In the field of finance, Agyei et al. (2022) modelled volatility persistence in gold returns through high- and low-frequency IMFs from EEMD signaling long memory. Recent studies demonstrate EEMD effectively filters complex time series across disciplines into interpretable oscillations for analysis - structural breaks, cycles, persistence patterns - better than Fourier or wavelet techniques. The data-driven adaptivity provides an alternative nonparametric method for dimensionality reduction and feature extraction (Armah et al., 2023).

Additionally, there is the Variational Mode Decomposition (VMD), another variant applied in finance and economics. Yu et al. (2005) developed a VMD ensemble framework that modelled high-fluctuation nonlinear patterns in stock markets for accurate forecasting. As a non-recursive signal decomposer, VMD extracts discrete modes concurrently through an alternating direction multiplier algorithm (Dragomiretskiy & Zosso, 2014). Additionally, in the context of finance, Sezer et al. (2020) combined VMD and statistical filtering to construct a decision support system with promising returns in algorithmic trading. The

technique revealed a wider potential for financial signal decomposition and econometric frameworks.

Furthermore, the Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) is an enhancement of Ensemble Empirical Mode Decomposition (EEMD) designed to overcome residual noise problems (Torres et al., 2011). In EEMD, added white noise residuals can remain in the decomposed intrinsic mode functions (IMFs) and negatively impact signal reconstruction (Torres et al., 2011). The technique CEEMDAN introduces an adaptive selection of optimal noise levels at each decomposition stage such that added noise is completely nullified across all IMFs (Torres et al., 2011). In recent financial applications, CEEMDAN demonstrated advantages over EEMD for stock price forecasting using machine learning models (Zhang et al., 2022). Using CEEMDAN-decomposed IMFs as model inputs then improved multi-step ahead forecast accuracy for Support Vector Regression and Long Short-Term Memory networks compared to benchmarks (Zhang et al., 2022). Overall, CEEMDAN is a promising refinement technique in financial forecasting which enables complete noise-filtered decomposition of complex price dynamics across different frequency scales (Zhang et al., 2022). It has the potential to pre-process financial and economic time series before predictive modeling.

The Improved Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (ICEEMDAN) is another emerging variant. The technique is an enhancement over basic EEMD. Bossman et al. (2022) used ICEEMDAN to decompose real estate price and

policy uncertainty time series into intrinsic mode functions capturing fluctuations on different timescales, enabling study of information transmission between indicators related to the frequency bands. As discussed by Colominas et al. (2014), ICEEMDAN overcomes issues like mode mixing that distort transfer entropy estimation. It iteratively calculates true intrinsic mode functions (IMFs) based on complete sifting using an adaptive white noise standard deviation across ensemble trials (Hua et al., 2018). Key applications showed extracting more accurate IMF components from complex data than EEMD or CEEMDAN. Additionally, Ali & Prasad (2019) employed ICEEMDAN to decompose nonlinear and nonstationary wind speed time series into trend, cycle, and residual IMFs for better forecasting. Apaydin & Sibtain (2021) modeled time-varying stock volatility dynamics via ICEEMDAN, finding improved risk metrics over other modes. The complete iteration with adaptive noise limits signal distortion and IMF mixing for more robust decomposition of datasets (Chen et al., 2021). Overall, ICEEMDAN research demonstrates superior performance separating complex time series into interpretable latent components for prediction tasks by overcoming weaknesses of basic EMD extensions. It provides an effective nonparametric analysis framework for nonlinear systems.

Additionally, wavelets are an effective time-frequency localisation technique for transient spikes, abrupt changes, and multi-horizon cycles (Ramsey 2002). Ramsey & Lampart (1998) demonstrated wavelets' superiority over Fourier methods for decomposing macroeconomic indicators into business cycle components. Aguiar-Conraria & Soares (2011) extended usage for separating US cyclical linkages dynamics. Furthermore,

applications like Gencay et al. (2001) for asset pricing and Kim and In (2005) for volatility forecasting demonstrate the advantages of using wavelets in economics and finance. In addition, recent studies by Percival and Walden (2000) used wavelets for analysing the effects of policy intervention and Masaki (2018) applied wavelets for nowcasting economic time series during turning points and abrupt shifts. Gansoul et al. (2020) proposed a wavelet neural network ensemble model for stock price prediction. The technique can isolate short-run shocks while preserving long-run relationships in economic variables (Ramsey & Lampart, 1998). Louhichi et al. (2021) provided a contemporary literature review on wavelet applications in financial econometrics. The research discussed various studies that utilised wavelets for modeling volatility clustering, market risk analysis, financial asset pricing, and high-frequency data modeling. Additionally, Louhichi et al., (2021) also combined wavelets with machine learning techniques, such as fuzzy logic systems and neural networks, for financial forecasting and trading models. Recent work applies complex wavelets to capture higher-order correlations and reveal market shocks or anomalies for trading signals (Polydoros et al., 2021). According to Louhichi et al. (2021), wavelets remain an active area of research in finance with growing emphasis on machine learning integration and high-frequency data applications. The multi-resolution analysis of wavelets provides economic insights across different time horizons and frequencies. As new types of financial data emerge, wavelets will continue enabling effective modeling, forecasting, and decision making.

The various time series decomposition techniques reviewed offer several key advantages for economics and finance analysis. As McCleary et al. (1980) discussed, separating out

the components allows examination of the distinct drivers of trends, cycles, seasonality, and noise. Further, decomposition also enables the identification of turning points in economic expansions and recessions (Canova, 1998). Furthermore, extracting the noise component can highlight unexplained volatility not captured in other elements (Baxter & King, 1999). Additionally, comparing decomposed components across series uncovers business cycle relationships between economic indicators (Denis et al., 2006). Huang et al. (2003) showed that techniques like EMD and its variants adaptively model the data without imposing any functional forms.

In conclusion, time series decomposition facilitates the isolation and investigation of different features in economic and financial data. Key benefits highlighted by the reviewed methods include univariate and multivariate analysis of components, turning point detection, analyzing unpredictability, discovering interrelationships across indicators, and flexibly modeling complex dynamics. These lend substantial utility to decomposition techniques for inquiring about time-dependent economic and financial phenomena.

2.1.2 Information Flow/Exchange and Signal Transmission

Information flow or information exchange is a key concept in financial markets research. This refers to how new information gets incorporated into asset prices (Hou & Moskowitz, 2005). Efficient information flow and processing ensures financial markets rapidly reflect new developments, enabling accurate discovery and pricing of risk and returns (Grossman & Stiglitz, 1980). However, frictions can impede smooth information flow,

including opaque trading practices, complex securities, irrational behaviors, and regulatory issues (Akerlof, 1970; Baker & Wurgler, 2007).

Additionally, Peng and Xiong (2006) investigating information transmission through markets reveals how investors interpret and react to fundamental signals, guidance, environmental developments, and others. This offers insights into market efficiency, overreaction tendencies, concentration of influence, and other behavioral phenomena (Daniel et al., 1998). Information flow analytics leverage approaches from machine learning and signal processing to track evolving interconnections between market segments (Dimpfl & Jank, 2015).

Understanding how African markets absorb and distribute information - including nonlinearities, asymmetries, and information flow dynamics - has important implications for risk modeling, volatility forecasting, and policy reform during global uncertainties. These highlight how inefficiencies are illuminated as well as how opportunities are exploited while explaining market contagions in times of crisis. Therefore, enhancing information flow transparency and efficiency constitutes an ongoing priority for African financial progress and stability.

Signal transmission refers to how new information gets disseminated through and incorporated into financial markets (Peng & Xiong, 2006). This constitutes a key mechanism enabling market efficiency, as prices rapidly reflect relevant signals about asset fundamentals, cash flows, economic policies, investor behaviors and more (Hou &

Moskowitz, 2005). However, frictions can impede smooth signal transmission, causing price delays, over-/underreactions, volatility clustering, and contagion effects during crises (Baker & Wurgler, 2007; Daniel et al., 1998).

Examining signal transmission mechanics in African markets is crucial for understanding market linkages with global centers, risk pricing behaviors, and systemic stability across periods of expansion and uncertainty. Additionally, nonprofit reforms have targeted enhancing transparency and velocities of locally integrating signals. However, key challenges remain, with many African exchanges exhibiting delays translating international cues during events like commodity price spikes. Often assets react only segmentally, with asynchronous updating creating short-term distortions and arbitrage prospects (Dimpfl & Jank, 2015). Developing transmission capacities constitutes an ongoing priority. Advances in machine learning and alternative datasets are supporting more granular tracking of signaling pathways influencing African finance. Ultimately smooth, rapid flows allow healthy price discovery and efficient risk transfers supporting local growth.

2.1.3 Causality, Asymmetric Relationships, and Directional Dependency

Causality refers to the causal relationship between a cause and its effect, where the cause precedes and influences the effect (Granger, 1969). Determining accurate causality has major implications in finance for elucidating mechanisms behind market behaviors, risk factors, policy impacts, and others. However, establishing genuine causation versus spurious correlation poses challenges, as relationships can be bidirectional or dependent

on hidden variables (Verma & Pearl, 2022). Complex systems like markets often entail feedback loops and emergent properties from lower-level interactions.

In addition, economic events and statistical tests offer some insight into the direction and magnitude of causal forces. However, they require complementing with experimental and natural evidence to make robust causal inferences (Imbens & Lemieux, 2008). Africa's structural differentiation and unique shock exposures facilitate the quasi-experimental isolation of causal pathways concerning regional integration, commodity reliance, climate impacts, etc. These can strengthen theory and planning. It behooves analysts to remain cognizant of limitations involving exterior validity and the challenges in the ecosystems.

Causality analytics are crucial for highlighting market behaviors and directing functional policy. However, accurately untangling multivariate relationships hinges on applying diverse methodological approaches while considering contextual insights from Africa's distinct structure. Analytical techniques require continual reevaluation for biases that lead to spurious interpretations.

Asymmetric relationships refer to unequal interdependencies between variables in a system (Akerlof, 1970). This concept has growing relevance in analyzing modern African financial markets amid global uncertainty. Assets like currencies and commodities often exhibit asymmetric correlations, where they respond differently to positive versus negative shocks in the world economy. Additionally, relationships frequently demonstrate

asymmetry over time, like fluctuating correlation between developed and emerging market returns during risk-on versus risk-off phases (Rey, 2015).

Furthermore, sources of asymmetry stem from heterogeneous information sets, institutional frictions like capital controls, behavioral factors like loss aversion, and structural imbalances in market power or leverage distribution (Rey, 2015). Properly modeling asymmetric dynamics can enhance risk forecasting, portfolio optimization, and market stability policy across African economies. Techniques like regime switching models and asymmetric volatility estimators help better capture asymmetric dependencies underpinning asset performance. Further reforms seek to mitigate asymmetry drivers through increased regional coordination and global financial integration. However, success assumes improving synchronization with worldwide business and liquidity cycles (Rey, 2015).

Directional dependency refers to when the relationship between variables changes fundamentally based on the direction of market moves or shocks (Stock & Watson, 2006). For example, African currencies may respond differently to positive commodity price rises than to equivalent price declines. This arises from behavioral and institutional frictions causing asymmetric reactions to nominally similar inputs. Sources include loss aversion, incomplete information, policy interventions that ratchet in one direction like capital control easing, and trader herding behaviors that concentrate momentum trades (Kyle & Xiong, 2001).

Detecting directional dependency supports building models robust across varying regimes in an environment with nonlinear feedback. Techniques like Wiener's nonlinear generalization of Granger causality and state-dependent sensitivity analysis help uncover masked dependencies conditional on the market phase (Baek & Brock, 1992; Wiener, 1956).

For African markets, partitioning analyses by directionality improves global transmission comprehension, currency pricing, and systemic risk modeling amid periods of growth uncertainty or commodity gyrations. However, analysts must also test detected dependencies for spurious false positives before inferring generalizable mechanisms (Paluš, 2007).

2.1.4 Adaptive and Heterogeneous Market Dynamics

Heterogeneous markets refer to markets comprised of diverse participants exhibiting variant behaviors, preferences, constraints, and information sets (Akerlof, 1970). This contrasts the assumption of representative homogenous agents underpinning classical financial paradigms. African markets frequently demonstrate acute heterogeneity across dimensions including investment horizons, risk appetites and product preferences between domestic retail, institutional investors, and foreign traders. Furthermore, heterogeneity often clusters distinctively during phases of market exuberance or anxiety (Kumar & Persaud, 2002).

Sources of heterogeneity cover structural demographics, cultural attitudes, uneven information access, heterogeneous agent models with recursive interactions, and segmented reactions to centralized policy reforms or global uncertainties. Heterogeneity contributes to inefficiencies, liquidity mismatches and instability through asynchronous trading, excess volatility, and concentrated liquidations during crises relative to homogeneous markets (Brunnermeier & Pedersen, 2005). Analyzing African market heterogeneity offers insights into systemic risks, behavioral microstructures, and structural headwinds to efficiency. While clustering behaviors facilitate herding, a diversity of preferences raises coordination challenges. Understanding distinct strategies and drivers can guide regulatory improvements beyond one-size-fits-all assumptions.

Adaptive markets refer to financial systems that evolve dynamically as participants learn and adapt to changing environments and new information (Lo, 2004). This contrasts strict efficient market assumptions where prices instantly reflect all available information. African markets demonstrate adaptive features as investors calibrate to structural shifts, policy reforms, global cycles, and technological innovations over time. However, adaptations may overshoot rational equilibrium or exhibit bias given cognitive and institutional frictions (Lo, 2004).

Key drivers of adaptive behaviors include sentiment herding, risk premium fluctuations during uncertainty, heterogeneous agent interactions enabling positive feedback, and regulatory phases allowing strategic evolution like financial innovation waves (Kumar & Persaud, 2002; Simon, 1955). Analyzing adaptive dynamics improves explanations for

temporal market inefficiencies, boom-bust patterns across frontier economies, and lagged responses to global interconnectivity.

Crucially, adaptive frameworks remain grounded in neoclassical constructs about rational utility maximization. But accommodating behavioral inputs and evolutionary perspectives allows models better aligned with real-world emergent complexity. Understanding African market adaptations is essential for supporting sustainable growth.

2.1.5 Global Uncertainties and Spillover Effects

Global shocks or uncertainties refer to unpredictable external events that rapidly propagate across world markets (Rey, 2015). African markets remain prone to global cascades despite decoupling progress, due to trade linkages and investor herd behaviors. Recent examples include commodity price fluctuations, climate events, global pandemics, and international policy shifts around stimuli withdrawal. These non-diversifiable risks pressure African currencies and raise external financing costs amid capital outflows (Manama, 2016). Regional contagion also arises from financial centers through information transmission and risk rebalancing channels with mixed evidence on whether markets overreact relative to global signals (Kyle & Xiong, 2001; Morse & Shive, 2011).

Mitigating global shock impacts remains challenging despite expanded forex reserves and macro prudential policies. Attempts at shielding can ironically increase systemic fragility via information distortion and moral hazard (Rey, 2015). Ultimately smooth

absorption relies on advances in domestic risk sharing channels and transparency to avoid asymmetric reactions. Sustained progress lowering external debts and improving current account balances should organically temper transmission. But in the interim, African policymakers face balancing stabilization efforts against market flexibility to global cycles outside their control.

Recently, studies have further examined global shock impacts and transmission mechanisms in African economies. Mat Armenia et al. (2022) utilised financial network models to uncover the amplification effects of global uncertainty shocks on African sovereign credit default swap spreads. Their connectedness measures highlight vulnerabilities to investor risk perception spirals during times of market turmoil. Similarly, Di Muzio & Dow (2022) estimated that global public health emergencies like pandemics can depress African GDP by over 5% through trade and tourism linkage disruptions.

These analyses reinforce that African economies remain prone to real and financial sector spillovers from global crises despite policy buffers. As Mat Armenia et al. (2022) discussed, “risk-on” periods see some decoupling progress partly reversed during “risk-off” phases of global tightening. Estimates continue to show African markets exhibit excess comovement with world shocks beyond economic fundamentals, therefore suggesting investor behavioural biases remain an issue (Berger et al., 2011). Thus, even as African countries make domestic structural improvements, coordinating global safety nets and countercyclical facilities to mitigate contagion threats retains importance in an ever more connected world (Di Muzio & Dow, 2022).

Additionally, the COVID-19 pandemic and associated economic crisis have led to heightened global uncertainty and spillovers across multiple systems. Studies find daily volatility spillovers from the US stock market to other major markets increased during pandemic uncertainty (Narayan, 2020). The financial markets saw rising volatility connectivity amid unpredictable pandemic developments and policy responses (Shahzad et al., 2021). Further analyses also trace spillovers through trade networks. A study by Yousef (2020) revealed that countries deeply integrated in global value chains faced production disruptions and economic shocks from overseas disruptions. At the firm level, multivariate quantile analyses showed spillovers from pandemic uncertainty led to shifting correlations between stock returns, volatility, liquidity, and investor attention (Bouri et al., 2018). Downside risk transmission increased. News sentiment proxies capturing global uncertainty now better predict return spillovers (Abuzayed et al., 2021).

Furthermore, the EPU indices can spill over across borders and asset classes leading to heightened volatility and interconnected risks (Chen, 2022). For instance, rising US economic ambiguity transmits to international stock and commodity markets via financial and trade channels, evidenced by the 2007-09 global financial crisis (Nkrumah-Boadu, 2021). Similarly, jumps in Crude Oil Volatility (OVX) index inject significant volatility spillovers into equity markets based on cross-quantilogram tests, increasing during large systemic shocks like COVID-19 (Dutta et al., 2021). Overall volatility indices also capture global uncertainties. Also, VIX spikes have amplified spillovers to gold and oil futures returns and volatility in recent times (Prasad et al., 2022). Across frameworks, EPU, OVX

and VIX proxies significantly transmit uncertainties across assets and borders, unearthing greater interdependencies during periods of market turmoil (Mensi et al., 2023; Shaikh, 2019; Al-Yahyaee et al., 2018; Pham & Nguyen, 2021).

Similarly, the Elevated economic policy uncertainty and geopolitical risks transmit internationally through real and financial channels, evidenced by the global reach of recent systemic shocks (Foglia, Palomba, & Tedeschi, 2023). Also, trade linkages propagate supply chain turmoil across borders, visualised through rising connections in country production network models since 2020 (Ohikhuare, 2023). Relatedly, US stock market uncertainty and volatility spillovers strengthened to other major markets over the last decade per correlation-network analyses (Shen & Hong, 2023). Spikes in global volatility indices like VIX now explain over 20% of commodity price fluctuations through futures markets integration (Zhang, Yang, Hu, Jiao, & Wang, 2023). In addition, cryptocurrencies also faced heightened return and volatility spillovers from equities amid recent pandemic-induced uncertainty (Shaik, Jamil, & Hawaldar, 2023). In summary, complex interconnections between policy ambiguities, real uncertainties and financial risks continue to grow worldwide, increasing systemic fragility during crises (Ettayib & Soufyane, 2023; Khurshid, Khan, Rauf, & Cifuentes-Faura, 2024).

2.2. THEORETICAL UNDERPINNINGS

This section covers the theories covering the concepts in the thesis. It provides an understanding of the theoretical underpinnings informing the approaches and methodology employed in the thesis. By examining the key theories, models, and

paradigms, the section contextualizes the research within existing scholarly debates and conceptual frameworks, particularly focusing on the vulnerability of African financial markets to global shocks or uncertainties. The theories discussed are the situated information flow theory, adaptive market hypothesis, and heterogeneous market hypothesis.

2.2.1 Theory of Situated Information Content Flow

According to Benthall (2019), information flows are causal flows that are situated among other causal linkages. To explain information semantics, Benthall (2019) employed the theory of causation by Pearl (2009) and drew on the concept of information flow by Dretske (1981). The situated information flow theory looks at information flow from a scientific, and statistical perspective and handles the practical issues of unintended data meaning. In defining information flows as causal flows with nomic associations because of a larger framework of causal links, the theory likewise relied on works by Nissenbaum (2004) and Nissenbaum (2009).

According to the theory, information flows differently than water or electricity. Instead, it suggests that information flow refers to two different phenomena: a flow of causality, in which one event affects the result of another, and regular linkages between occurrences. An observed event has meaning because of the associations, but those associations are dependent on a broader background of causal relations. The situated information flow theory based on Dretske (1981) definition of information flow further argues that a

message contains information about a phenomenon if an observer with the right tools can learn about the phenomenon from the message.

The situated information flow theory argues that the understanding of the theory has three policy implications. Firstly, privacy policies should focus on data transfers because they are more accurate and easier to enforce than regulations on information flows. The second requirement is that information meaning be defined in terms of a certain class of observers and consider their acceptable background knowledge. Thirdly, the information asymmetry between data aggregators and individual data subjects is one reason why data processors are difficult to regulate. This is due to the ambiguity in data semantics that results from the unknown causal structure.

2.2.2 Adaptive Market Hypothesis

Financial market swings have captivated a variety of market participants over time, including academic researchers, speculative traders, and policymakers. The Efficient Market Hypothesis (EMH) has been a cornerstone idea and a source of heated controversy in the field of asset price modeling (Khuntia & Pattanayak, 2020). The main argument of the EMH is that asset value changes represent all information available, and therefore no economically exploitable mispriced assets exist (Fama, 1970). Lo (2004; 2005) proposed the Adaptive Market Hypothesis (AMH) as an alternative paradigm to bridge the tense relationship between proponents of the EMH and behavioural economists who criticise it. Lo (2004) examined how efficiency varies over time and concluded that AMH is a more reliable approach than EMH since it states that human

errors can cause arbitrage opportunities to surface at specific times and then vanish once they are utilised. The AMH uses a logical coherent approach to determine the existence of market efficiencies and inefficiencies. In contrast to EMH, market efficiency evolves in AMH.

However, due to its abstract and qualitative nature, previous works have not explicitly explained the AMH, but its practical implications have been extensively investigated to illustrate how adaptive a market is. The first implication is that the relationship between risk and reward is extremely volatile. Second, investment opportunities change with time. Thirdly, different business environments have an impact on investing methods. The fourth consequence is that the key to market survival is the ability to adapt to changing market conditions (Lo, 2004). As indicated by Lo (2004), survival is the sole goal that matters for every financial market player, and fear and greed are tied to evolutionary factors, which are linked to the likelihood of survival.

Furthermore, the literature suggests that AMH cannot be used in place of EMH. The AMH, on the other hand, backs up the empirical variations of the EMH. Time-varying efficiency of stock or exchange rate markets, for example, could be better examined considering AMH implications (Khursheed et al., 2020). For currency markets, a plethora of research have identified changing market conditions, caused by the events such as central bank intervention (LeBaron, 1999; Jeon & Lee, 2002; Yilmaz, 2003), the global financial crisis (Ali et al., 2011), and financial crisis in Asia (Jeon & Seo, 2003; Ali et al., 2011; Al-Khazali et al., 2012), not forgetting the recent COVID-19 pandemic can affect other features and

efficiency of the market. These occurrences have significant ramifications for market players' psychology and how they assimilate new information into prices, which could result in time fluctuation in a serial correlation of returns. Given the AMH, such dynamic market conditions are most likely to determine the degree of return predictability.

2.2.3 Heterogeneous Market Hypothesis

Researchers and investors have investigated fresh data over the years to improve the existent EMH and better comprehend the actual information flow that underpins financial markets. One of the innovative hypotheses that proposed non-homogeneous market players is the heterogeneous market hypothesis (Cheong, 2013; Cheong et al., 2016; among others). Müller et al. (1993), Dacorogna et al. (1997), Peters (1994), and Dacorogna et al. (2001) pioneered this notion in the foreign currency and stock markets.

The Heterogeneous Market Hypothesis (HMH) views market participants as heterogeneous, with a wide range of endowments, investment horizons, information, geographical locations, information processing ability, institutional restrictions, trading horizons, and so on (Müller et al., 1993; Corsi, 2009; Chen et al., 2017; Owusu Junior et al., 2020; Patil & Rastogi, 2019; Hwang & Yu, 2021; Owusu Junior et al., 2021; Adam et al., 2021). Participants in the market react to information at different times and with diverse interests and strategies, resulting in market data being noisy (Asafo-Adjei et al., 2022). Financial time series, including stock and exchange rate markets, are surrounded by noise and endure quick changes due to the ubiquitous behaviour of unstable signals (Asafo-Adjei et al., 2021).

The HMH theorises the existence of short-term (market makers/speculators), long-, and medium-term investors (central banks/institutional investors) (Mensi et al., 2016). Thus, according to HMH, various market players' reaction times vary greatly when given the same information set. Hence, testing the current phenomenon over several periods is unavoidable. Thus, motivated by HMH, this study uses the wavelet decomposition framework to elucidate newer insights into the conventional relationship between stock returns and exchange rates, as well as the impact of uncertainty indices in West Africa.

Consequently, the appearance of the coronavirus necessitates a more thorough examination of the stock market-exchange rate relationship in Africa. Given the inherent heterogeneity in stock markets, which is prevalent during times of crisis and continues during times of high market volatility (Badshah et al., 2018), like pandemic conditions, a heterogeneous investigation is timely (Boateng et al., 2021).

2.3. REVIEW OF EMPIRICAL STUDIES

This section focuses on a review of empirical evidence. The review scrutinizes methodological approaches and analytical techniques used in previous studies to investigate the dynamics of African equities and currencies markets, to identify gaps and opportunities to warrant further research. This is meant to set the stage for the empirical analysis that follows.

2.3.1 Global Uncertainties and Financial Markets

Several studies in the literature relate currency, uncertainty, and stock markets in discrete contexts, but little is known about how uncertainty indicators such as EPU, OVX, and VIX affect the link between currency rate and different classes of assets, in this case, stock. Other empirical works have also looked at different connections between stock market, exchange rates, EPU, OVX, and VIX (Jayashankar & Rath, 2017; Juhro & Phan, 2018; Hoque & Zaidi, 2019; Bartsch, 2019; Abid, 2020).

Christou et al. (2017) investigated the impact of EPU on stock market returns for six nations, based on a PVAR model estimates. The impact of the own country's EPU shocks and the US EPU shocks were assessed across the timeframe to account for international uncertainty spillovers. The major findings suggested that rising policy uncertainty has had a detrimental impact on stock market performance over the last decade. Furthermore, when uncertainty spillovers are considered, all countries except Australia show a significant negative relationship between stock market returns and US EPU shocks, which could be explained by opportunities that are favourable that investors could gain by investing in the country following a rise in policy uncertainty in the economy.

Similarly, Roubaud and Arouri (2018) add to the existing literature on the consequences of economic policy uncertainty on the interconnections between exchange rates, oil prices, and stock markets. They show that there are strong interrelations between stock markets, oil, and currency by implementing a VAR and a multivariate Markov switching vector autoregressive (MS-VAR) model. Their research found that the associations

between the variables are non-linear, and that the links between them shift from one regime to the next, but that they are stronger during volatile periods. Finally, they claimed that oil plays a significant role in the transmission of price shocks to the exchange rate and stock markets. Only EPU was included in this investigation. Other indices of uncertainty include the OVX, VIX, news-based uncertainty, and so on. This research might also be expanded to include other developed and developing countries to see how their stock markets and currency rates react to oil prices, policy shocks, and uncertainties.

By examining how GEPU affects Malaysian sectoral stock performance, Hoque and Zaidi (2019) contribute to the growing literature. The empirical findings showed that the linear framework fails to detect the effects of GEPU, whereas the Markov switching model showed that GEPU had a significant impact on all sectoral stock returns, except for the technology sector. The data also portrayed that the effects of GEPU differ according to sectors and regime states with adverse consequences outweighing positive outcomes. GEPU has a significant impact on stock returns in an environment that is highly volatile. As a result, the study suggested that GEPU has an asymmetric, non-monotonic, nonlinear, and state-dependent relationship with sectoral stocks in Malaysia. The results also implied that uncertainty about global economic policy might be a systemic risk factor and a predictor of stock market performance.

Albulescu et al. (2019) contributed to the growing literature on the monetary policy of US as a global financial cycle driver by looking at the possible causal effect of US EPU on the comovement between markets for currency and crude oil, using commodity

currencies from emerging and advanced economies. A series of nonlinear and linear Granger-based causality tests showed that there is a causal link between policy uncertainty and the connection between oil and currency rate, especially at low frequencies and more so since the global financial crisis erupted. While crude oil was a net transmitter of currency shocks across all frequency bands, the spillover effects from oil primarily focused on the Australian and New Zealand dollars, which are frequently employed as investment currencies in global trade schemes. An interesting application for future research would be to see whether domestic uncertainty, as compared to global uncertainty, provides an indirect route via which uncertainty can influence oil-currency market interactions. Another area of investigation will be the financial markets together with other indicators of instability.

Conversely, Wen et al. (2019) investigated the correlation of VIX, OVX and EPU with some macroeconomic variables in a nonlinear cointegrating ARDL model in China. Their empirical findings indicated that, except for OVX, there is evidence of a link between the variables. In the long run, the most important in fuelling uncertainty in China's macroeconomy seemed to be the VIX. However, EPU and OVX also triggered reactions in the inflation rate, outputs, and supply of cash and influenced uncertainty in the economy. Although investors policy makers would benefit from this study, it is limited to China and the use of US-based EPU.

Chen et al. (2020) employed quantile regression to examine the link between the EPU of various markets and exchange rate volatility in China. The following are the findings:

The influence of the EPU on exchange rate volatility was asymmetric. At all quantiles, EPU had a favourable and significant impact, with an inverted-U relationship. There were also heterogeneous effects of EPU from different markets on exchange rate volatility across quantiles. This study used EPU of specific nations rather than global EPU and is limited to China. The economic orientation of this country is different from that of the African countries.

By applying the wavelet analysis technique, Das (2021) addressed frequency and time connections between stock, crude oil, and exchange rates. In India, there was evidence of multiple substantial comovements between the price of oil and the stock, as well as between the foreign exchange rate and the price of oil. This means that economic shocks in developed markets have an impact on the Indian market. Das (2021) also discovered a short-term effect of lower-scale volatility. Furthermore, wavelet coherency at a large scale had a slower influence on the relationships over time. This study did not consider other factors such as EPU, OVX, or VIX that can influence how these markets operate.

In the same vein, Shaikh (2020) looked at the commodity, interest rate, equity, and currency markets while taking the US economic policy uncertainty index into account. The empirical findings demonstrated that during times of economic uncertainty, market volatility remains high and favourable. Economic uncertainty is increased by the lack of future economic and political movements, and this uncertainty impacts many market specifics. The research revealed that the unpredictability of future occurrences is reflected in VIX-based volatility metrics in several markets. Asafo-Adjei et al. (2020) explored how

global EPU shocks interact with stock returns of eight countries in Africa via wavelet technique. The results revealed that global EPU correlates with most of the stock returns and were concentrated over a longer period. This indicated that investments in African stocks, in the short-term, are less susceptible to GEPU.

Specifically, the impact of the VIX shock was greater than the EPU shock. Kang et al. (2021) employed time and frequency analysis to study the association among US sector equity ETFs, oil, gold, stocks, and uncertainty indicators. According to the paper, VIX has the most effect on ETFs in the periods studied and OVX comes next. The US EPU had the lowest influence on ETFs, but ETFs showed a stronger association with oil than gold. The co-movement among gold, oil, ETFs, and uncertainty factors exhibited temporal asymmetry and were more pronounced in the short run.

2.3.2 Equities, Commodities, and Global Shocks

Evidence on African Equities and Global Shocks

An investigation was conducted by Agyei-Ampomah (2011) on the existence and degree of connection between the African stock market and the relationships among the markets. The monthly returns of the S&P/IFC return indices for ten African nations from 1998 to 2007 were examined. According to Barari (2004), the index return volatility is split into three components to quantify the impact of regional and worldwide market movements to local index volatility. Despite recent structural modifications, African stock markets remain separated from global markets, and local index volatility is generally country-specific, which can be spread away by cross-country diversification.

Coffie and Chukwulobelu (2014) compared evidence from selected emerging African (Morocco, Egypt, and Nigeria) and Western established markets (France, UK, USA, Japan, and Germany) stock return volatility persistence, considering the rate of volatility decay. The volatility persistence and risk premium for these markets are estimated using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) and GARCH-in Mean (GARCH-M) models. The findings indicate that the various markets' volatility persists. The study indicates that these markets have volatility risk, and that investors should be compensated for taking such a risk.

Using the daily all-share index of Nigeria, Kenya, the United States, Germany, South Africa, and China from 14 February 2000 to 14 February 2013, Uyaebo, Atoi, and Usman (2015) estimated asymmetric generalized autoregressive conditional heteroscadasticity models with endogenous break dummy on two innovation assumptions. In addition to the asymmetric features, the best fitted models are examined in terms of conditional volatility sensitivity to market shocks and volatility persistence. The findings show that the volatility of Nigerian and Kenyan stock returns reacts to market shocks more quickly than other countries. The findings also imply that the leverage effect is absent in Nigerian and Kenyan stock returns, while it is present in others.

With information from five African nations, Aderajo and Olaniran (2021) analyzed the dynamic correlation of financial contagion (South African, Nigeria, Egypt, Kenya, and Tunisia). The dynamic conditional correlation multivariate GARCH model was used to

evaluate monthly stock price indices from 2004 to 2018 to determine the infectious effect of US market on selected African exchanges. Three phases of crisis eras were discovered by studying the correlation coefficient series: pre-crisis (2004–2007), crisis (2007–2009), and post-crisis (2009–2018). According to the findings, there is a considerable association between the returns of the US market and the returns of African markets. The analysis of the pre-crisis, crisis, and post-crisis mean, and variance estimations reveals that the crisis period is marked by significant increases in volatility, indicating that the US shock constituted a threat to the African markets under consideration. Furthermore, evidence revealed that during the crisis period, there was an increase in correlation (contagion), while in the post-crisis period, there was a continuation of correlation (herding).

Evidence from Other Markets

Bekaert, Ehrmann, Fratzscher, and Mehl (2011) examined the transmission of crises to country-industry equity portfolios in 55 nations. The researchers used an asset pricing framework with global and local factors to forecast crisis returns, defining unexplained increases in factor loadings as indicators of contagion. They discovered evidence of systematic contagion from US markets and the global financial sector, but the effects are minor. On the other hand, there has been systematic and significant contagion from domestic equity markets to individual domestic equity portfolios, with the severity of the contagion being inversely related to the quality of a country's economic fundamentals and policies. As a result, the study rejects the globalization hypothesis, which claims that the severity of the crisis is proportional to the level of global exposure. Instead, the study

confirms the old “wake-up call” hypothesis, with markets and investors focusing substantially more on idiosyncratic, country-specific characteristics during the crisis.

Waleed and Khalil (2015) examine volatility spillover from the stock markets of the G5 countries to the Karachi Stock Exchange (KSE), using weekly data from 5 January 2004 to 30 December 2013. France, Germany, Japan, the United Kingdom, and the United States are among the G5 countries studied in this study. The long-run link between the KSE and the G5 equity markets was investigated using the Johansen cointegration test. The GARCH (generalized autoregressive conditional heteroskedasticity) model was used to examine the volatility spillover. We discovered a long-term link between the KSE and equities markets in Germany and the United Kingdom. The GARCH (1, 1) model shows that all G5 equity markets have a considerable volatility spillover effect on the KSE.

In the post-2007 financial crisis period, Hung (2019) investigates the conditional correlations and spillovers of volatilities across CEE markets, particularly Hungary, Poland, the Czech Republic, Romania, and Croatia. The estimation technique employed was the five-dimensional GARCH-BEKK model, as well as the CCC and DCC models. Three models showed that the correlations between these markets are very substantial, according to the findings. In addition, for all markets, own-volatility spillovers are often lower than cross-volatility spillovers.

Hussin, Muhammad, Razak, Tha and Marwan (2013) used the vector autoregression (VAR) method to determine how strategic commodities (crude oil and gold prices) affected

the Islamic stock market in Malaysia from January 2007 to December 2011. The findings reveal that in the long run, Islamic stock returns are not co-integrated with critical commodities. There was a bi-directional causality relationship between Islamic stock returns and oil prices, according to the Granger causality model. The FBMES, on the other hand, was unaffected by gold prices or vice versa. As a result, it can be stated that, among strategic commodities, only the price of oil will affect the Islamic stock return in Malaysia in the short term.

Macroeconomic Factors and African Markets

The effects of commodities prices and selected macroeconomic variables on stock market performance are investigated by Mongale and Eita (2014). The estimation encompassed the years 1994 to 2013 and was based on quarterly time series data. The underlying series are evaluated for univariate characteristics of the unit root of the variables using the Augmented Dickey-Fuller, Phillips-Perron, and Kwiatkowski-Phillips Schmidt-Shin test statistics using the Engle-Granger two-step econometric technique. The findings revealed that rising commodity prices are linked to rising stock market performance and that there is a positive relationship between stock market performance and macroeconomic variables such as money supply and exchange rate in South Africa.

For the instance of the South African Rand, Ndlovu and Schaling (2015) examined the exchange rate fundamentals argument, emphasizing the impact of commodities prices. The exchange rate determination question has been at the centre of exchange rate studies. The authors used floating nominal exchange rate data for South Africa and found

evidence in the commodity-price augmented PPP and monetary models for South Africa that supported a long-run link. The findings show that including commodity prices in canonical exchange rate model formulations enhances in-sample fit. The inclusion of commodity prices improves the accuracy of out-of-sample short-horizon forecasts, albeit this result is not resilient to model and horizon specification.

Salisu and Oloko (2015) examined modelling spillovers between the Nigerian stock market and the foreign exchange market. The study demonstrated that volatility persistence in the stock market is exacerbated by bad news in the market and mitigated by good news in the FX market, using variations of the VARMA-AMGARCH model. Finally, the study found that disregarding asymmetric effects can lead to exaggerated spillover effects.

Boako and Alagidede (2016) argue that both local and international investors with long-term investment views may be able to take advantage of arbitrage and diversification opportunities. The data also show that some African equities markets are separated from dollar and euro exchange rate volatility to some extent. As a result, foreign investors can diversify their portfolio investments across various economies, ceteris paribus, without having to worry about the effects of currency price volatility.

Matadeen (2017) used a dynamic panel vector error correction model to identify the key macroeconomic factors of stock market performance in a sample of Sub-Saharan African nations. Economic growth, banking development, stock market liquidity, investment, and

macroeconomic stability appear to be major predictors of stock market development in the region, according to the findings. Surprisingly, the study discovers that savings have a large and negative impact on the region's equities market growth. Furthermore, the findings suggest that, in the short run, economic growth indirectly boosts stock market development.

Morema and Lumengo (2018) investigated the impact of gold and oil price fluctuations on the volatility of the South African stock market and its component indices or sectors, namely the financial, industrial, and resource sectors. The study also looked at the size of the optimal portfolio weight, hedge ratio, and hedge efficacy for portfolios made up of two assets, such as oil-stock and gold-stock pairs. According to the findings of the study, there is significant volatility spillover between gold and stock markets, as well as between oil and stock markets.

The impact of oil prices on African stock markets was studied by Kelikume and Muritala (2019). The study used a dynamic panel analysis technique to create a model that included stock returns, real gross domestic product growth rate, exchange rate, and OPEC basket price, using quarterly data from five oil-producing countries with stock markets from 2010 to 2018. According to the findings, oil prices had a negative impact on African stock markets, which could be attributed to the continent's fragmented and underdeveloped financial markets. Furthermore, the real GDP growth rate had a favourable impact on African stock markets, showing that economic growth has a beneficial impact on stock returns in African stock markets. The relationship between

stock markets and oil prices has an immediate impact on foreign direct investment in and away from stock markets in African oil-dependent economies.

With wavelet-based coherency, wavelet multiple cross-correlation analysis, and wavelet-based Sharpe ratio, and generalized Sharpe ratio diversification analysis, Boako and Alagidede (2020) explored the connectedness of returns on African equity markets. They reported that combining commodities and equities in a portfolio boosts performance over a range of investment horizons.

Jones, Kyiu, and Li (2020) investigated the relevance of earnings announcements in African stock markets, examining whether market reactions are influenced by earnings characteristics, conditional on the level of synchronicity and liquidity of stocks. Earnings releases are informative throughout the sample, according to normalized volatility. Less frequently traded equities drive the results, and informativeness is more visible at the announcement and in the post-announcement timeframe. There is not a lot of proof that there's been any leaking. The quality of being informative is also present for highly present stocks, especially after the announcement. Cross-sectional tests provide evidence of an effect of both earnings fundamentals and investor behaviour on stock returns around earnings announcements.

The influence of the results announcement on the market price of manufacturing firms on the Ghana Stock Exchange was researched by Owusu, Gyau, and Amaning (2016). Because it investigates the impact of information on stocks, the event research

methodology was chosen. The study used the Standardized Excess Return technique, which compensated for most of the issues involved with intercompany stock aggregation, with a 21-day window and a 60-day estimating period. The study indicated that earnings announcements had little effect on stock price using the Single Index and Risk Adjusted Returns Model, indicating that the Ghana Stock Exchange is inefficient in its semi-strong form.

2.3.3 Review of Empirical Literature on African Stocks and Commodities

The relationship between global commodity prices and movement in stock prices has gained prominence in the literature due to its stimulating effect on any economy, especially Africa. Notwithstanding there is still an inconclusive debate on the relationship between the variables, especially during considering several commodities, that has occasioned the need for this study.

Pinho and Maldonado (2022) empirically explored the relationship between shocks in the commodity and stock markets. Employing a total volatility connectedness measure the result shows that there is 35% of the total variation in both volatility and returns of forecast errors is because of shocks to the market. The result also revealed that equity market shocks play a role in terms of spillover on other markets than the commodity market, but the markets returns is more in the short- run than long-run. The result also shows that both volatility and result connectivity change significantly over a period, which means that series of events has substantial impact on them.

Johnson and Soenen (2009) explored how commodity and stock markets behave in South American countries in the short term with the use of the Geweke feedback measures, it was revealed that stock markets in South American countries are mostly affected when there is any change in the commodity market. Specifically, the study concludes that Argentina, Brazil, and Peru stock markets and highly affected by daily commodity price charges.

Adekoya and Oliyide (2021), in using the TVP-VAR and causality-in-quantities techniques found that there is a strong volatility across the commodity and equity markets having the gold as the net receiver of shocks. The study also reveals that the COVID-19 pandemic has largely affected the risks of transmission among commodity and equity markets.

Using the DCC-GARCH model, Benlagha and Omari (2022) investigated the connectedness of stock markets and the commodity market (gold and oil) during the COVID-19 pandemic. The study found a stronger interrelationship between stock markets and the gold and oil markets during the period of the pandemic and the pre-COVID-19 period. Gold was found to be the receiver of shocks emanating from the five stock markets and oil served as the net transmitter of these shocks.

Aziz et al. (2020) investigated volatility spillover among equity and commodity markets (crude oil, rice, and gasoline) of the United States. Using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model on monthly data for the period of February 2005 to December 2016, the study established that there is no volatility spillover.

It was also found that there is neither mean spillover nor volatility spill over among gold and equity market in the United States.

Urom et al. (2022) investigated the interconnectedness between equity markets and the global market, especially the evolution at the time of the COVID-19 pandemic. The study revealed that developed countries have their equity markets integrated more than African markets. This means that there is evidence of a weak integration among African commodity and equity markets as well as weak integration among African commodity and equity markets and that of the global commodity and equity markets. The COVID-19 pandemic has notwithstanding, increased the degree of connectedness among these markets, which sterns from the fact that there were uncertainties in the investment climate and as such increase movement of founds across markets in different assets.

Omane-Adjepong and Dramani (2017) reported that the volatility between global commodities and the African equity markets are not specific to a certain time horizon, but it rather portrays a time varying relationship. The results also show a significant co-movement between the two markets in the short-to-medium term frequencies, where these changes in the horizons are partly influenced by crises seasons.

To investigate the relationship between global commodity prices and stock markets, Oyelami and Yinusa (2019) examined prices in the global and stock market returns in sub-Saharan African countries, using the Johannesburg Stock Exchange (JSE) and the Nigerian Stock Exchange (NSE) due to its market capitalization. With the use of the ARDL

estimation method, the study revealed that there is a significant long-run global commodity prices and stock market return nexus. Furthermore, the study shows a bi-directional causal relationship between global commodity prices and stock market returns in the two selected exchanges. The results further indicate that there is both a short-run as well as a long-run relationship between global community prices and stock market returns in the two markets.

Boako and Alagidede (2016) examined the relative potential of African shock markets in providing a means for diversification by way of hedging for international investors. The study shows a non-linear relationship between the stock markets in Africa and the returns on global commodity prices. This indicates that global investors behave irrationally towards investing in African stocks, especially during global uncertainties.

Ofori-Boateng et al. (2022) also examined volatilities in commodity prices and stock returns in emerging economies, particularly the Ghana Stock Exchange (GSE), using the Threshold Generalized Autoregressive Conditional Heteroskedasticity (TGARCH) estimation method, the results indicate that when commodity prices change because of volatilities on the global front, it has a significant effect on daily stock returns on the GSE. Similarly, Gyasi (2016) explored the connectedness between the Ghana stock market and commodity (cocoa, crude oil, and gold) prices, which are the main export commodities in Ghana using the bi-variate GARCH-BEKK model. It was established that there is a strong bi-directional linkage between the equity and, gold and crude oil prices in Ghana.

2.4 CHAPTER SUMMARY

The literature review chapter has synthesized existing knowledge about concepts, theories, and empirical evidence. This exercise is useful in critically identifying gaps and contributing to the advancement of scholarly understanding. By doing this, a robust foundation is laid for the empirical analysis that follows and highlights areas for future inquiry, thereby enriching scholarly discourse in the field.

CHAPTER THREE

INFORMATION CONTENT FLOW BETWEEN GLOBAL UNCERTAINTIES AND AFRICAN STOCKS

3.0 INTRODUCTION

The intrinsic information shared by financial assets provides a means of assessing their mutual linkages. In times of crisis, spillovers and information flow between markets increase, and this drives empirical investigations into the degree of connectedness between financial assets. Global uncertainties, whether economic, health or environmental, have had a debilitating impact on economic activities. This is mostly profound in Africa due to the susceptibility of the economies to vulnerabilities owing to the fragile nature of these economies. The global financial crises of the U.S. in 2008 and the COVID-19 that recently hit the world are examples of such uncertainties that have influenced the attention of policyholders on putting down measures to curtail the impact of such occurrences. Seck (2017) avers that the financial crises affected the world to the extent that most economies, especially emerging markets, like the African stock market, have not fully recovered from the uncertainties. These uncertainties have undoubtedly posed a weightier effect on the African stock market since most African countries witnessed a decline in their domestic investments, resulting in some turbulence in the financial sector (Bossman, 2021).

Davig and Hakkio (2010) assert that when there is stress in the financial sector, resulting from these uncertainties, it influences investors' mindset to avoid the risk associated with the financial sector, leading to a reduction in investments in financial assets. In a similar

vein, COVID-19 has increased anxiety in the financial market due to its effect on aggregate demand in the world since the world production index fell by 4.5 percent during the pandemic, specifically in the first quarter of the year 2020 (Baumeister & Hamilton, 2019).

It is estimated that about 27 million people, mostly Africans, will be pushed into extreme poverty because of a slow growth rate of 1.8% owing to the COVID-19 pandemic (UNCA, 2020). This indicates the level of vulnerability of African markets to global uncertainties. It has also been presented in the literature that the pandemic negatively impacted the real GDP of the USA. and many other nations, as such affected the stock market growth in these countries (Baker et al., 2020a; Ma et al., 2020). Uncertainties hurt an economy through their effects on the financial market (Gilchrist et al., 2014) as well as affect consumption expenditure of households and government expenditure, leading to a decline in economic activities (Baker et al., 2020). Global uncertainties affect African stock markets due to the integration of the stock markets in the continent into that of the world (Asafo-Adjei et al., 2021; Owusu et al., 2021), increasing the susceptibility of the market to global shocks (Bodomo & Che, 2020; Seck, 2017).

In this study, we investigate the information flow between African stocks and global uncertainties by employing the CEEMDAN to decompose the data and apply the Rényi effective transfer entropy technique to estimate the exchange of [frequency-domain] information between global uncertainties and African stock markets. Our approach is unique as we seek to distinguish between oil-exporting countries and non-oil-exporting

countries, as well as account for the impact of the COVID-19 pandemic. Due to the volatile nature of global oil prices in response to geopolitical tensions and other major global uncertainties, it is imperative to ascertain how these developments influence the information exchanges with oil-importing African countries on one side and oil-exporting countries on the other side. This has become imperative because investors have developed a growing interest in African stocks and other emerging markets, leading to a shift of investment interests in these economies. Therefore, analysing these markets from the segmented angle of oil-importing and oil-exporting countries introduces an additional layer of risk management strategies for efficient portfolio allocations. This provides a basis for researchers to adopt the necessary methodologies to assess how information exchanges can affect investors' choices.

Additionally, the recent COVID-19 pandemic, the Russia-Ukraine war, and numerous geopolitical tensions have heightened global uncertainties. Amid that, research has shown the rising integration of African stocks to global markets. This provides a basis for ascertaining the information content between uncertainties and African stocks with recent data for new insights. This is crucial for investors who desire African stocks as a means of diversification and hedging for optimal portfolio allocation.

The global financial landscape is characterized by interconnectedness and interdependencies among various economies, making it crucial to understand the flow of information between stock markets and global uncertainties. In the context of African stock markets, investigating the information exchange between these markets and global

uncertainties such as the EPU, OVX, and VIX is of paramount importance. In essence, the study looks at the information flows between each of the indexes for global uncertainties and the stock indexes of the respective nine African economies - Nigeria, Botswana, Egypt, Tunisia, Namibia, Morocco, Ghana, Zambia, and South Africa.

This study adopts a three-pronged approach by employing three key indices to represent global uncertainties and interrogate how they have shared information content with African stocks. This approach has hardly been employed in the observed literature, making the results of this study a reference point to enrich the extant literature. This will be achieved with a robust method noted for eliciting the strength of information exchanges between variables.

Several methods have been used to estimate information flow in the financial markets. One of the methods identified to be robust is transfer entropy introduced by Schreiber (2000). This method can measure the time dependence between variables and the direction of information flow in the financial market. The transfer entropy method also estimates the flow of information among stock markets and their allies and determines the direction of the flow in a bid to identify the dominant variable (Kwon & Oh, 2012).

The strength of the transfer entropy model is that it is a non-parametric model that deals with both linear and non-linear dynamics of financial time series models. This is an improvement of the Granger causality which only shows the flow of information in stock markets but fails to quantify the magnitude of the information flow. The transfer entropy is

also helpful in revealing the dominant market in terms of the flow of information. Understanding the flow of information within financial markets is crucial for identifying resilient stocks and comprehending market dynamics. The transfer entropy method offers a robust approach to quantifying information flow, capturing both linear and nonlinear dependencies and providing valuable insights into the direction and intensity of information transmission.

The rest of this paper is segmented as follows: Section 2 covers a review of related empirical studies to appreciate the trend of the empirical literature. In Section 3, we present the techniques being employed by the study. Results and analysis are discussed in Section 4. We conclude and proffer recommendations in Section 5.

3.1 REVIEW OF EMPIRICAL LITERATURE

Theoretically, this study draws inspiration from the adaptive and heterogeneous market hypothesis. The adaptive market hypothesis (AMH), introduced by Lo (2004), combines the efficient market hypothesis and behavioural finance. The theory indicates that economic agents are ordinarily rational but may overact during periods of excessive market volatility. In summary, the AMH adopts both the principles of rationality and irrationality. Meanwhile, the heterogeneous market hypothesis (Muller et al. 1993; Dacorogna et al. 2001) posits that market players are non-homogenous and react differently towards the same available information. The crux of this theory is that people vary depending on their risk appetite and other characteristics and will end up interpreting information differently.

Empirically, according to Korsah and Mensah (2023), the increased capital flow coupled with declining information asymmetry in Africa has deepened integration, increasing African stocks' susceptibility to spillovers. That notwithstanding, research has shown that African stocks provide avenues for diversification amid global uncertainties. For example, Adam (2023), opined that African stocks are alternatives for international portfolio diversification when economic uncertainties are rising. This corroborates the findings of Asafo-Adjei et al. (2020), who earlier indicated that African stocks could hedge against policy uncertainties.

Africa harbours small markets with many inefficiencies, which makes them risky for prospective investors due to their extreme illiquidity, coupled with weak institutional framework. There have however been some improvements in the stock markets of the region in terms of the establishment of stock exchanges by member countries (Allen et al., 2011). The expansion of the markets has however suffered some challenges, especially during global uncertainties, partly due to the level of vulnerabilities of these markets.

This makes it important to explore the exchanges between global uncertainties and African stocks from the angle of information transmissions as information remains an important asset in financial markets. The effect of global uncertainties on the financial sector is due to the contagious nature of financial variables. Bello et al. (2022) explored the contagion effects of the major crises that have hit the world over the period on African

markets. The study specifically investigated the contagion effects of member countries and the perspective of regional blocks with the use of the Dynamic Conditional Corrections Model during the global financial crises, COVID-19, European debt crises and Brexit. The study found that there is significant evidence of the existence of contagion effects during financial crises from the regional and global market perspective. It further found that there is an increase in the risk of contagion effects at the country level, as well as market capitalization. The contagion effects of each of the crises however vary due to the nature and origin of the crises, suggesting that foreign investors can benefit from the diversification from some of the African stock markets.

On the devastating shock to the African stock market in the recent war involving Russia and Ukraine, which has been found to increase disaster risk and decline in stock markets, Muller and Sehn (2022) explored the stock market response to the war between Russia and Ukraine. Using the OLS method, the study found that stock prices are affected greatly and negatively in countries with high proximity to the crisis zone. Tetteh et al. (2022) examined the performance of the Ghana and Botswana markets during the COVID-19 pandemic using the period of March 2020 to September 2021. Using the ARDL cointegration technique, the study established that the COVID-19 outbreak is negatively related to stock market performance in Ghana and Botswana, with Ghana's market being greatly affected.

In a related study, Ashraf (2020) examined how the stock market responded to the COVID-19 pandemic, using the daily confirmed cases and deaths from January 2020 to

April 2020. With the use of the OLS method, the study established that stock markets responded inversely to the surge in the case counts during the period, indicating that the increase in the number of COVID-19 cases, the more stock market returns declined, especially during the early days of the pandemic.

Similarly, Boako and Alagidede (2018) examined how African markets decoupled or recoupled because of the 2008-2009 global financial crises, as well as ascertaining the possible spillovers arising from the crisis. Using the asset pricing model, the study found an increased correlation between African stock markets and that of global stock markets during the crisis period. The spillover was however profound in North Africa, South Africa, and West Africa as well as emerging markets. The study further found that shocks in the market do not only affect stocks within the region but also global markets.

To be able to increase liquidity, improve access, and reduce the cost of capital, integration of the African stock markets into the global market is essential. Anyikwa and Le Roux (2020) analysed the co-movements, volatility, and contagion effect of integrating the African stock markets into the stock markets of developed economies during global uncertainties. That is, to examine how African stock markets co-move with the markets of the developed world during crisis moments regarding how integrated they are. Using the ARDL method, the study found weak integration between the African stock market and the stock markets of developed economies, with a positive dynamic correlation being higher during crises, confirming the contagion effect of the African and global stock

markets. The co-movements, as revealed in the study, confirm the contagion effect of the markets during crisis periods.

To add to the importance of integrating the African stock market for its intended benefits, Bundoo (2019) assessed the extent to which the stock market in the Southern African Development Community (SADC) is integrated, by analysing the level of convergence of the markets, with the usage of sample market index data from January 1999 to December 2011. The study used the US and SSA markets indexes as a benchmark, and the deployment of the price-based approach in measuring stock market integration, with the beta and sigma convergence, and cointegration analysis methods. They found that there is no cointegration between the US market and the SADC market with beta convergence observed.

Ncube and Mingiri (2015) explored the integration of stock markets in Africa, using the Johannesburg stock exchange and some selected African stock markets using monthly data from 2000-2008. The study used the Johansen and Julius cointegration method and found that despite the observed growth in the stock markets of the selected countries, they are still fragmented. The results further reiterated the fact that African stock markets are affected by global uncertainties.

Agyapong (2014) investigated how stock markets in the West African monetary zone are integrated, which has advocated to use of one common currency. Using three cointegration methods, Johansen, ARDL, and Bruitung cointegration methods were

employed and found that Ghana and Nigerian stock markets, which are the only active markets in the monetary zone are not integrated.

Kapingura et al. (2014) empirically examined the level of integration of the South African stock market into well-developed markets of the US, Japan, and Germany as well as its integration with other African stock markets. Employing the ARDL technique of cointegration reveals that the South African stock market is well integrated with the developed markets investigated but not well integrated with other African stock markets. Ntim (2012) further confirmed the small nature of the African stock markets, and how fragmented, illiquid, and technologically weak effects in information flow, as such affecting profitability and integration of the African stock markets. In a study into the need for a harmonized and integrated African stock market, using parametric and non-parametric variance-ratios tests involving 8 each of regional and individual stock prices from 1995 to 2011, it was found that all the 8 African regional stock markets appear to perform better as compared to the individual indices. The study further revealed that there is weak informational efficiency in the African stock market, signalling that to ensure information flow among stock markets to ensure the efficiency of the market, integration, and harmonization of the African stock markets is key.

Agyei-Ampomah (2011) avers how stock markets in Africa are integrated from a period of 1998-2007. That is, to assess how the African stock markets link with other regional and global markets. The study established a low level of correlation among individual African stock markets, the regional market as well as global markets. The study confirms the fact

that African stock markets are not integrated with the global stock market, with evidence of a long-time span of integration of the stock market on a regional basis. With the use of a two-index return generating function, the study further revealed a country-specific level of volatility of the domestic index in the market of these countries.

Alagidede (2008) explored how African stock markets are integrated into the global financial markets as well as the risks associated with investment in these markets. Employing the Johansen cointegration method, the study established that African stock markets are segmented, indicating the need for an integrated exchange for the region. The study further revealed a weak stochastic movement between stock markets in Africa and the global stock markets, signalling that African stock markets respond more to fluctuations in the local markets than the global markets.

3.2 DATA AND METHODOLOGY

The section provides insights into the data and their sources, the methodological approaches, as well as the analytical techniques employed to investigate the information content flow between global uncertainties and African stocks.

3.2.1 Data Description

The research covers African stocks or equities markets, reflecting diverse economic landscapes and market conditions across the continent. It includes prominent stock exchanges such as the Nigerian Stock Exchange (NSE), Botswana Stock Exchange (BSE), Egyptian Exchange (EGX), Tunis Stock Exchange (THD), Namibian Stock

Exchange (NAS), Moroccan All Shares Index (MAS), Ghana Stock Exchange (GSE), Lusaka Stock Exchange (LSE), and the FTSE/JSE Africa All Share Index in South Africa. Therefore, in line with Fameliti and Skintzi (2023), we adopt the respective composite indices of the various markets for this study.

These exchanges represent key economies and regions within Africa, offering insights into the performance and dynamics of various sectors and industries across the continent's equity markets. The inclusion of such stock exchanges provides a robust foundation for analyzing the effect of global uncertainties on African stocks. This is backed by Bonga et al. (2022), who revealed that these stock exchanges rank among the top in Africa by way of market capitalisation. Our selection of EPU, OVX, and VIX as metrics for global uncertainties is influenced by the fact that they are the most referenced in the literature. We also took inspiration from Li et al. (2023) who adopted these indices in forecasting global stock market volatilities in an uncertain world.

These stock exchanges were selected to ensure the representation of diverse African economies with varying levels of development, economic structures, and market maturity. Also, the inclusion of stock exchanges from different regions of Africa—West, North, Southern, and East Africa—ensures that the study captures the regional heterogeneity in market responses to global shocks. This is crucial given that different regions face distinct economic, political, and financial challenges.

The selected stock exchanges include some of the most liquid and integrated markets in Africa, which are important for ensuring reliable and robust empirical analysis. The selected stock exchanges represent key markets that are more likely to exhibit significant responses to these global shocks, owing to their levels of exposure to international trade, capital flows, and oil price volatility. The selected stock exchanges provide consistent and reliable historical data on stock returns, which is crucial for the application of advanced econometric techniques. Stock exchanges like JSE, NSE, and EGX have well-documented financial data, making them ideal for empirical studies that require long-term datasets.

The selection of these stock exchanges is driven by the need to provide a representative analysis of how different African financial markets respond to global economic uncertainties, considering the diversity in their economic structures, market maturity, oil dependency, and regional contexts. This approach ensures that the study captures the heterogeneous impacts of global shocks on both oil-exporting and oil-importing African economies, contributing to more actionable insights for policymakers and investors.

The selection is based on their economic diversity, market integration with global financial systems, empirical support from literature, heterogeneous market structures, and the availability of reliable data for long-term analysis. These factors collectively ensure that the selected stock exchanges are well-positioned to capture the varied impacts of global uncertainties on African stock markets.

3.2.2 The CEEMDAN Technique

The Improved Complete Ensemble Empirical Mode Decomposition with Adaptive Noise (CEEMDAN) is a method developed by Huang (1998), which is part of the Empirical Mode Decomposition (EMD) techniques, has been identified recently by economists to be robust in terms of the connectedness of variables concerning direction, degree, and shape as unique across time scales (Ramsey & Lampart, 1998). There were no methods in the past to be useful in separating economic data series into all orthogonal time scale components.

Yang and Worry (2020) indicate that instruments to withstand short-time noise from the financial asset series have been recently introduced. The transfer entropy method which is rooted in the CCEMDAN is used to estimate information flow between global uncertainties and the African stock market.

The CEEMDAN method is also important in the signal-to-noise (SNR) minimization of mode decomposition in unsteady-state signals, efficiency, and reconstruction (Luukko et al., 2016). The complete Ensemble Empirical Decomposition with Adaptive Noise (CEEMDAN) which was one of the methods used for decomposition was bedevilled with a provision of spurious nodes, and the presence of residual noise in the modes, coupled with the availability of a substantial amount of noise and comparable signal scales, which the ICEEMDAN has the property to correct (Colominas et al, 2014).

The CEEMDAN framework is stated following Li et al., (2020) as contained in Colominas et al. (2014) as presented below:

1. Step 1

A white noise $\tau_1[\omega^{(i)}]$ is appended to a signal x to produce a new series

$$x^{(i)} = x + P_0\,[\omega^{(i)}],\ i = 1, 2, 3, \ldots N \quad (1)$$

where $\omega^{(i)}$, P_0 and N represent the $i-th$ white noise added, SNR and the amount of white noise, respectively.

2. Step 2

Estimate the local mean of $x^{(i)}$ using EMD to retrieve the first residual

$$r_1 = \frac{1}{N}\sum_{i=1}^{N} M(x^{(i)}) \quad (2)$$

Where IMF $c_1 = x - r_1$ can be obtained

3. Step 3

Obtain $k-th$ IMF $c_k = r_{k-1} - r_k$ recursively for $k \geq 2$, where (3)

$$r_k = \left(\frac{1}{N}\right)\sum_{i=1}^{N} M\left(r_{k-1} + \rho_{k-1}\tau_k(\omega^{(i)})\right)$$

This will produce decomposed series from ICEEMDAN such that the problem of residual noise and the problem of the mean value emanating from the varied numbers of intrinsic mode functions (IMFs) created by the ensemble empirical mode decomposition (EEMD) is reduced substantially (Yang et al., 2020; Colominas et al., 2014).

Throughout the decomposition, it is imperative to note that the default experimental parameters to among others produce maximum iterations and a maximum number of modes, are used. The decomposition is simulated using MATLAB as specified by Colominas et al. (2014). As prescribed by the literature the flow chart of the CEEMDAN decomposition process is reported.

3.2.3 The Transfer Entropy Method

Shannon entropy is a measure of uncertainty upon which transfer entropy is embedded in information theory (Boateng et al., 2022). In line with Hartley (1928), each symbol's average can be expressed as:

$$H = \sum_{j=1}^{n} P_j \ log_2 \left(\frac{1}{P_j}\right) \ bits \tag{4}$$

Where n stands for the number of distinct symbols concerning the probabilities $P_{j..}$ Assuming that log represents the logarithm of a number to base 2, Shannon (1948) states that for a discrete random variable *J* with a probability distribution *p(j),* where j is assumed to represent all outcomes, *j* can take the average number of bits needed to encode the independent draws from the distribution of j can be calculated as follows:

$$H_J = -\sum_{j=1}^{n} P(j) \ log_2 P(j) \tag{5}$$

To measure the information flow between two-time series, we combine the concepts of Shannon entropy and Kullback-Liebler distance (Kullback & Leibler, 1951), in addition to an assumption that the underlying process evolves through a Markov process (Schreiber, 2000). If we allow *I* and *J* to denote two discrete random variables with a marginal

probability distribution *p (i)* and *p (j)* respectively, as well as a joint distribution *p (i, j),* whose dynamical structure corresponds to stationarity Markov process of order *k* and *j.,* then the Markov property implies that the probability to observe *I* and *t+1* in state *i* conditional on the k previous observation is: $p\left(i_{t+1} \left| i_{t,\ldots\ldots,i_{t-k+1}}\right.\right) = p\left(i_{t+1} \left| i_{t,\ldots\ldots,i_{t-k}}\right.\right)$. The average number of bits required to encode the observation in *t+1* if the previous K values are known are stated as:

$$h_j\,(k) = -\sum_{I} P\left(i_{t+1,i_t^{(k)}}\right)\, logP\left(i_{t+1} \left| i_t^{(k)}\right.\right) \tag{6}$$

Where $i_t^{(k)} = \left(i_{t,\ldots\ldots,i_{t-k+1}}\right)$ is subject to an analogous direction for process *J.*

In a bi-variate perspective, and in accordance with Kullback-Leibler distance, information flow from process *(J)* to process *(I),* is calculated by finding the departure from the generalized Markov property $P\left(i_{t+1} \left| i_t^{(k)}\right.\right) = \left(i_{t+1} \left| i_t^{(k)}, j_t^{(i)}\right.\right)$. The Shannon transfer entropy can therefore be expressed as:

$$T_{J\to I}\,(K,l) = \sum_{i,j} P\left(i_{t+1,} i_t^{(k)}, j_t^{(l)}\right).\ log\left(\frac{P\left(i_{t+1} \left| i_t^{(k)}, j_t^{(i)}\right.\right)}{P\left(i_{t+1} \left| i_t^{(k)}\right.\right)}\right), \tag{7}$$

Where $T_{J\to I}$ measures the flow of information from *J* to *I*. Likewise, $T_{I\to j}$ which measures information flow from *I* to *J* can also be attained. The net information flow from *I* to *J* can be obtained by differencing (taking the difference between $T_{J\to I}$ and $T_{I\to j}$.

The STE approach is appropriate for a portfolio of techniques and tools that are vital in addressing causality issues in complex dynamical systems; Shannon's information theory is, however, limited in its scope and represents idealized information appearing only in situations when the buffer memory or a transmitting channel is infinite (Jizba et al., 2022).

On the back of that, information theorists have developed remedies including the Rényi transfer entropy.

According to Nyakurukwa (2021), relevant information, empirically, is related to tail events which are relatively large positive and negative returns. Transfer entropy based on the Rényi entropy is capable of extending more weights to tail events in terms of its contribution to the entire information flow system. RTE introduces a weighting parameter p > 0, which is introduced by the Rényi-based entropy for the individual probabilities p (j) and is calculated as:

$$H_J^q = \frac{1}{1-q}\log\left(\sum_j p^q\ (j)\right) \tag{8}$$

With q > 0. For q → 1, RTE and STE converge. For 0 < q < 1, events that stand low profitability of occurrence are given more weights, while for q > 1, the weights tilt towards outcomes j with a probability of occurrence. RTE presents a dynamic mechanism for measuring uncertainties which are activated by observing different areas of the distribution depending on parameter q . Using the escort distribution $\emptyset_q(j) = \frac{p^n\,(j)}{\sum_j p^q\,(j)}$ with a normalization of the distribution with q > 0. Jizba et al. (2012) proceed to derive RTE as:

$$RT_{J\to I}(k,l) = \frac{1}{1-q}\ log\left(\frac{\sum_{i\phi_q}\left(i_t^{(k)}\right)p^q\left(i_{t+1}\,|i_t^{(k)}\right)}{\sum_{i,j}\,\phi_q\left(i_t^k,\ j_t^l\right)p^q\left(i_{t+1}|i_t^{(k)},j_t^{(l)}\right)}\right) \tag{9}$$

where $RT_{J\to I}$ estimates the information flow from process J to process I.

It will suffice to note that the calculation of RTE can yield negative values. In such a case, the history of *J*, if known, depicts a greater level of uncertainty than knowing just the history of *I*. According to Marschiniski and Kantz (2002), estimates from TE are efficient

when dealing with large samples, but are susceptible to biased results in small data samples. This bias, can, however, be corrected with a shuffled version as described below:

$$ETE_{J\to I}(k,l) = T_{J\to I}(k,l) - T_{J\ shuffled\to I}(k,l) \quad (10)$$

$T_{J\ shuffled\to I}(k,l)\ is\ TE\ using\ shuffled\ version\ of\ the\ time\ series\ J.$

The shuffling process is achieved by realigning the values to generate a new series after randomly drawing values from time series *J*. This process snuffs the time series dependencies of *J* and factors in the statistical dependencies between *I* and *J.* An increasing sample size causes $T_{J\ shuffled\to I}(k,l)$ to consequently converge to zero. However, in any case of $T_{J\ shuffled\to I}(k,l)$ posting non-zero values, then that can be attributed to small sample size. We can achieve a consistent estimator can be achieved by repeating the shuffling process multiple times and averaging the TE estimates across all replications. To get the bias-corrected TE estimates, the average is subtracted from the RTE and STE. Relying on a Markov block bootstrap proposed by Dimpfl & Peter (2013), the statistical significance of the TE estimates, as expressed in equation 4.6 can be examined. The bootstrap process generates TE estimates under the null hypothesis of no information. Both RTE and STE are then estimated using the simulated time series. The p-value associated with the null hypothesis of no information transfer is given by $1 - \hat{q}_{TE}$, where $\hat{q}_{TE}$ represents the quantile of the simulated distribution that relates to the original TE estimate.

Algorithms of the TE are based on discrete data This is done by the discretization of the continuous data. A symbolic encoding that partitions the data into a finite set of bins is

performed. For a given number of bins *n*, with bounds q_1, q_2, q_3, q_4, ….., q_{n-1} ($q_1 < q_2 < q_3 < q_4$ …..q_{n-1}), its partitioning is given by:

$$\begin{cases} 1, & y_t \leq q_{1,} \\ 2, & q_1 < y_t < q_2 \\ \vdots & \\ n-1, & q_{n-2} < y_t < q_{n-1} \\ n, & y_t \geq q_{n-1.} \end{cases}$$

The number of bins is selected based on the size and distribution of the observed time series. Each value in the time series y_t is replaced with an integer 1, 2,…n. This is done by how s_t relates to the interval specified by the lower and upper bounds $q_1 q_n$.

3.3 RESULTS AND ANALYSIS

This Chapter is on the information flow between African stocks and global uncertainties for the period January 2010 to June 2022. The chapter employs the CEEMDAN technique to decompose the data and apply the Rényi effective transfer entropy to estimate the exchange of [frequency-domain] information between global uncertainties and African stock markets. We focused our discussions on the flow from global uncertainties to African stocks/equities. The RTE technique produces ETEs that are both negative (high risk) and positive (low risk). The results are analysed from a portfolio hedging perspective. A parameter weight of 0.30 is adopted to account for fat tails in the return series, which corresponds to the stylised fact about financial time series (Behrendt et al., 2019). The ETEs are shown by black points within blue bars. The 95% confidence bounds are indicated at the ends of the blue bars. This will help in determining whether there is a statistically significant information flow between global uncertainties and African stock markets. As a result, a rejection of the null hypothesis of “no information flow” holds if

these confidence boundaries are in either the positive or negative sections. Information flow is insignificant if there is any overlap at the origin.

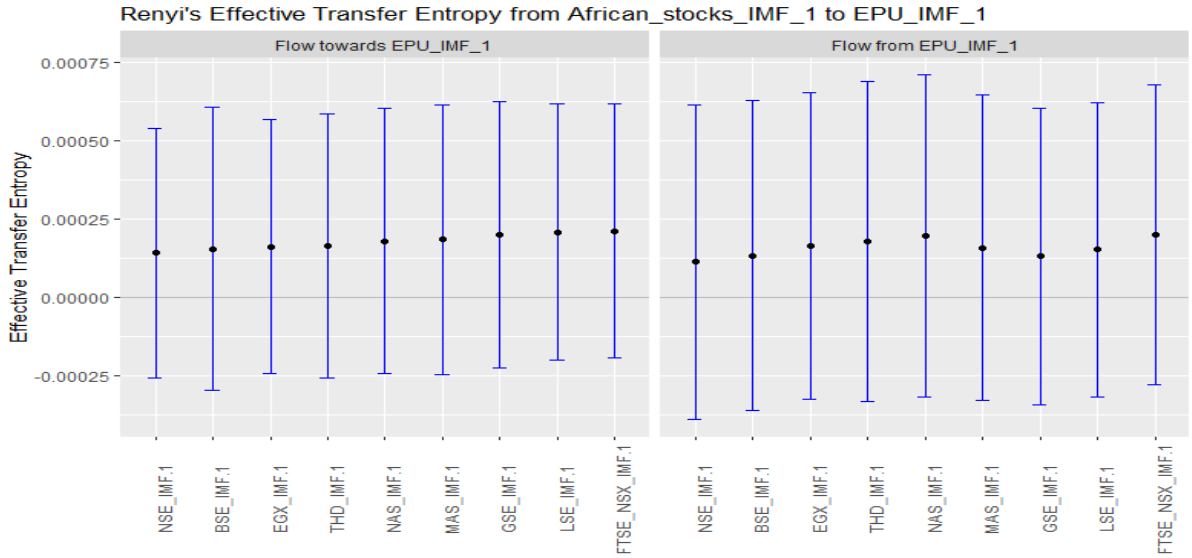
3.3.1 Information Transfer between African Stocks and EPU

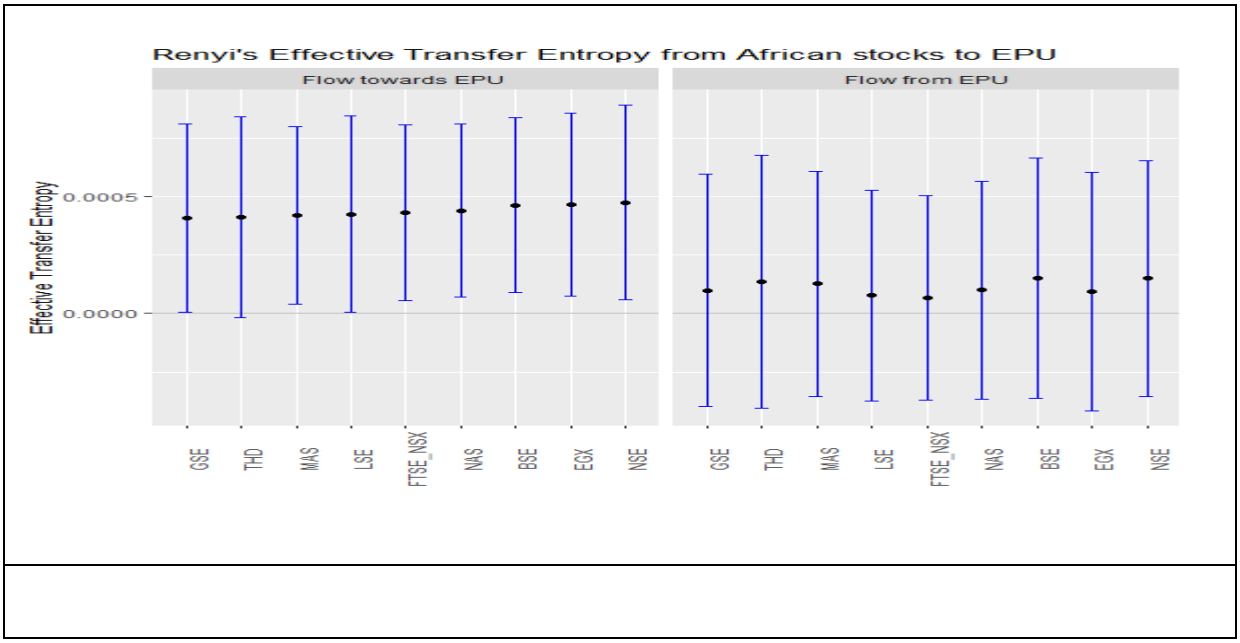
In this section, we present the results of the RTE to assess the bi-directional information flow between the economic policy uncertainty index (EPU) and African stocks as depicted in Figure 3.1. From the composite level, we observed a positive transfer of information from all the African stocks (except THD) to EPU. The flow to THD was positive but insignificant. However, EPU transmitted insignificant information flows to African stocks. The results are indicative of low-risk transfers from African stocks to EPU. This means African stocks dominated EPU by being a net transmitter of information.

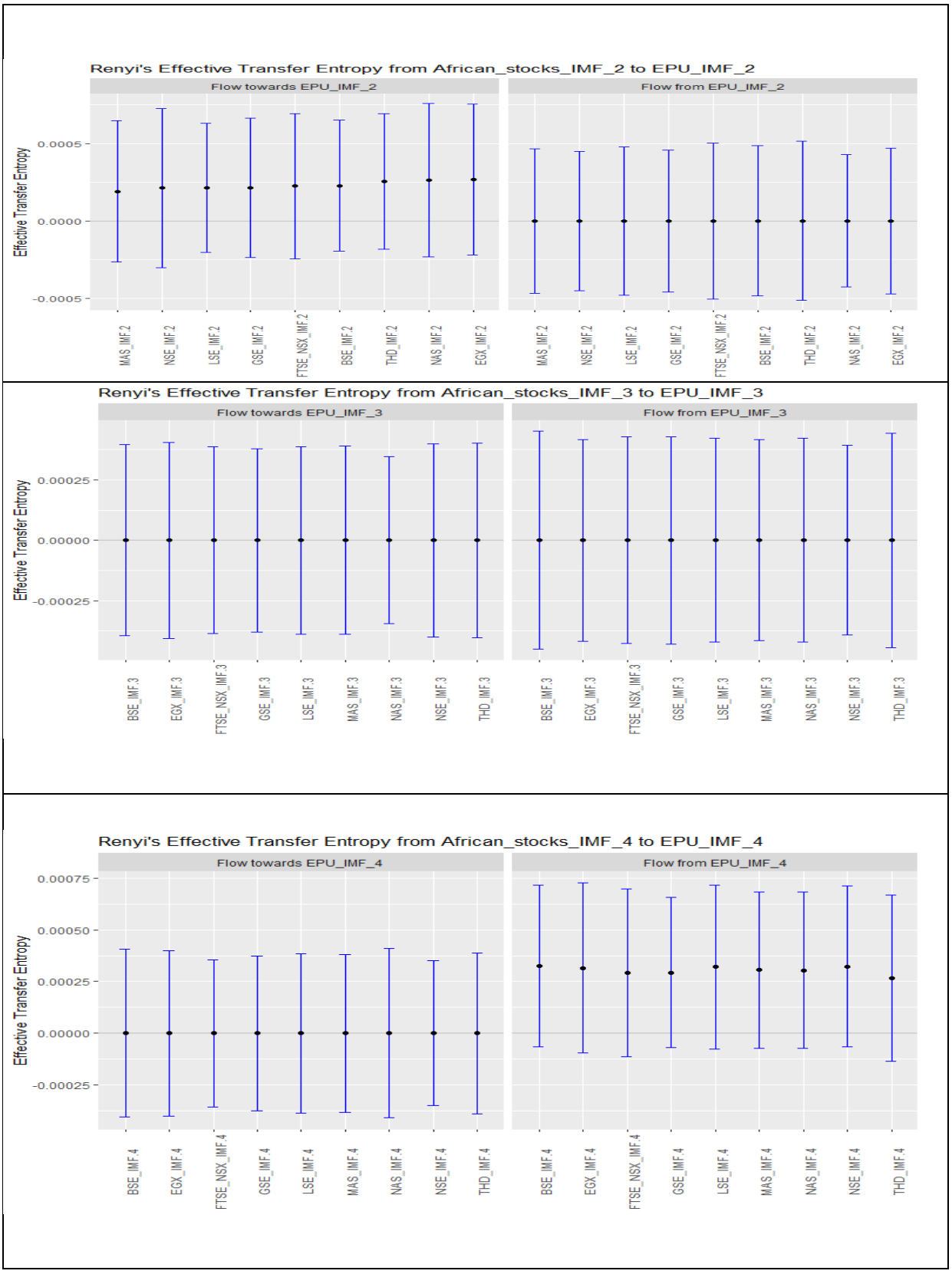
The plots from IMF1 to IMF5 showed no significant transfer of information from both sets of markets, implying that from the short term to a chunk of the medium term, there was no influence from either side. However, when the horizon is extended to the IMF6 plot, we observed a transfer of positive information from EPU to all the African stocks under consideration, whereas no significant transfers were observed from the opposite direction. This means there was a transfer of low risks from EPU to African stocks. The IMF7 plot produced the same trend as the IMF6. At the long end of the investment horizon, the remaining plots (IMF8, IMF9 and the residuals plot) produced insignificant information exchanges from both markets. This means the two markets did not influence each other, either positively or negatively.

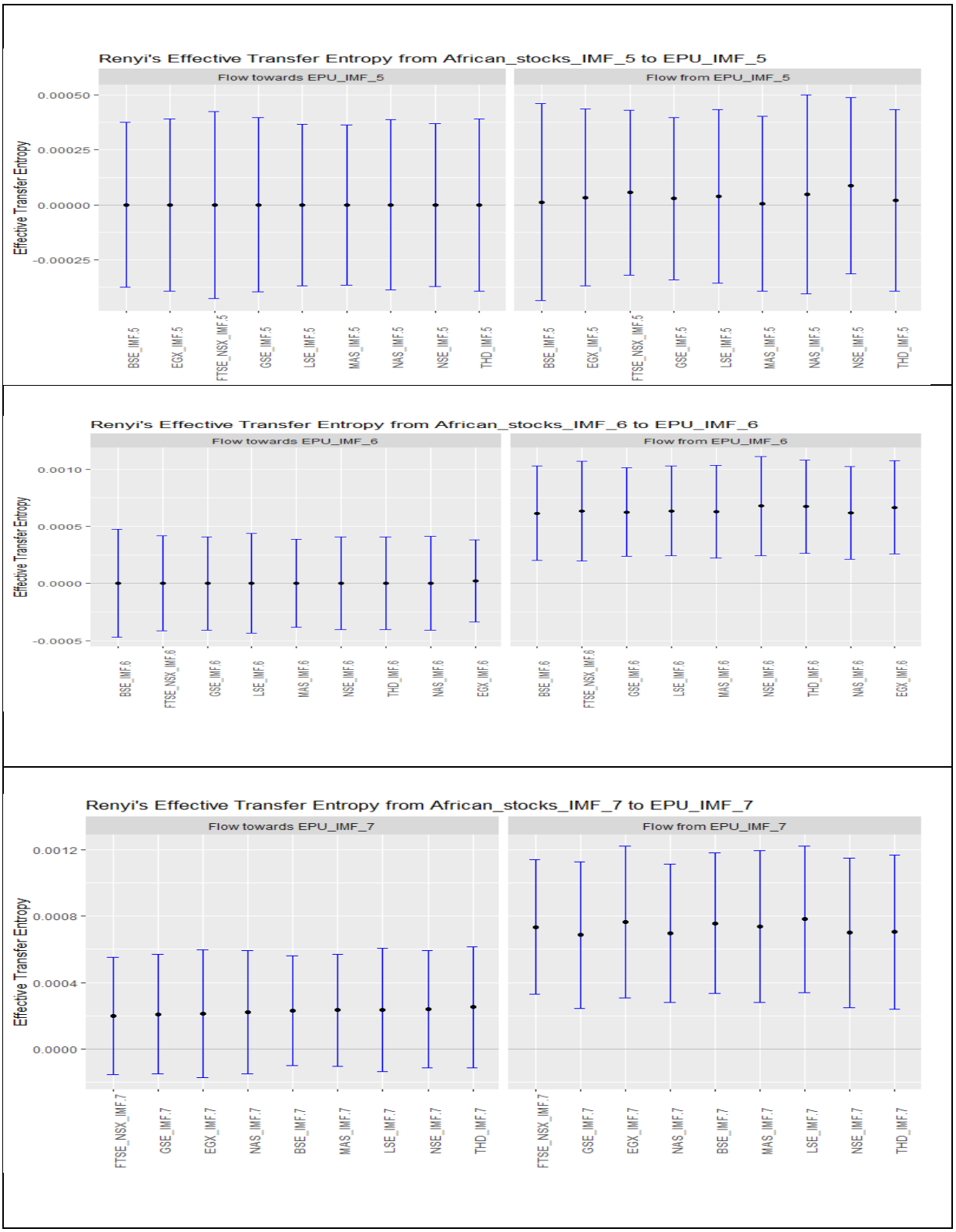
From the above plots, there were just a few information transfers (positive) with no established bilateral information exchanges between the two markets. Additionally, there was no negative information transfer from either side of the market signalling the absence of contagion or risk spillovers from each market. This is contrary to the findings of Armah et al. (2023), who recorded that African equity markets are highly risky for information flow from global financial market stress. The absence of both positive and negative information transfers reduces the potential for diversification. Armah et al. (2013) had portions of their findings pointing to potential diversification prospects for some African equities based on market conditions.

The short to medium ends produced noticeable moments of low-risk transfers, while the EPU dominated as a net transmitter of information across the entire investment horizon, although the dominance was less frequent. The findings with low-risk transfers between economic uncertainty and African stocks are backed by Asafo-Adjei et al. (2020). The profound cases of insignificant transfers portend investment opportunities for portfolio managers since it could be inferred that the two markets are not integrated. More specifically, economic policy uncertainty transmitted positive or insignificant information flows to African stocks. This is like the findings of Adam (2020) who indicated that African markets serve as an alternative for the diversification of international portfolios when the uncertainty of the global economic policy is on the rise. Asafo-Adjei et al. (2020) also indicated that term investments in African stocks are less susceptible to economic policy uncertainty in the short term, making it possible to hedge against policy uncertainty.


Renyi's Effective Transfer Entropy from African_stocks_IMF_1 to EPU_IMF_1
Flow towards EPU_IMF_1
Flow from EPU_IMF_1
Effective Transfer Entropy
0.00075
0.00050
0.00025
0.00000
-0.00025
NSE_IMF.1
BSE_IMF.1
EGX_IMF.1
THD_IMF.1
NAS_IMF.1
MAS_IMF.1
GSE_IMF.1
LSE_IMF.1
FTSE_NSX_IMF.1


Renyi's Effective Transfer Entropy from African stocks to EPU
Flow towards EPU
Flow from EPU
Effective Transfer Entropy
0.0005
0.0000
GSE
THD
MAS
LSE
FTSE_NSX
NAS
BSE
EGX
NSE


Renyi's Effective Transfer Entropy from African_stocks_IMF_2 to EPU_IMF_2
Flow towards EPU_IMF_2
Flow from EPU_IMF_2
Effective Transfer Entropy
0.0005
0.0000
-0.0005
MAS_IMF.2
NSE_IMF.2
LSE_IMF.2
GSE_IMF.2
FTSE_NSX_IMF.2
BSE_IMF.2
THD_IMF.2
NAS_IMF.2
EGX_IMF.2
Renyi's Effective Transfer Entropy from African_stocks_IMF_3 to EPU_IMF_3
Flow towards EPU_IMF_3
Flow from EPU_IMF_3
Effective Transfer Entropy
0.00025
0.00000
-0.00025
BSE_IMF.3
EGX_IMF.3
FTSE_NSX_IMF.3
GSE_IMF.3
LSE_IMF.3
MAS_IMF.3
NAS_IMF.3
NSE_IMF.3
THD_IMF.3
Renyi's Effective Transfer Entropy from African_stocks_IMF_4 to EPU_IMF_4
Flow towards EPU_IMF_4
Flow from EPU_IMF_4
Effective Transfer Entropy
0.00075
0.00050
0.00025
0.00000
-0.00025
BSE_IMF.4
EGX_IMF.4
FTSE_NSX_IMF.4
GSE_IMF.4
LSE_IMF.4
MAS_IMF.4
NAS_IMF.4
NSE_IMF.4
THD_IMF.4


Renyi's Effective Transfer Entropy from African_stocks_IMF_5 to EPU_IMF_5
Flow towards EPU_IMF_5
Flow from EPU_IMF_5
Effective Transfer Entropy
0.00050
0.00025
0.00000
-0.00025
BSE_IMF:5
EGX_IMF:5
FTSE_NSX_IMF:5
GSE_IMF:5
LSE_IMF:5
MAS_IMF:5
NAS_IMF:5
NSE_IMF:5
THD_IMF:5
Renyi's Effective Transfer Entropy from African_stocks_IMF_6 to EPU_IMF_6
Flow towards EPU_IMF_6
Flow from EPU_IMF_6
Effective Transfer Entropy
0.0010
0.0005
0.0000
-0.0005
BSE_IMF:6
FTSE_NSX_IMF:6
GSE_IMF:6
LSE_IMF:6
MAS_IMF:6
NSE_IMF:6
THD_IMF:6
NAS_IMF:6
EGX_IMF:6
Renyi's Effective Transfer Entropy from African_stocks_IMF_7 to EPU_IMF_7
Flow towards EPU_IMF_7
Flow from EPU_IMF_7
Effective Transfer Entropy
0.0012
0.0008
0.0004
0.0000
FTSE_NSX_IMF:7
GSE_IMF:7
EGX_IMF:7
NAS_IMF:7
BSE_IMF:7
MAS_IMF:7
LSE_IMF:7
NSE_IMF:7
THD_IMF:7

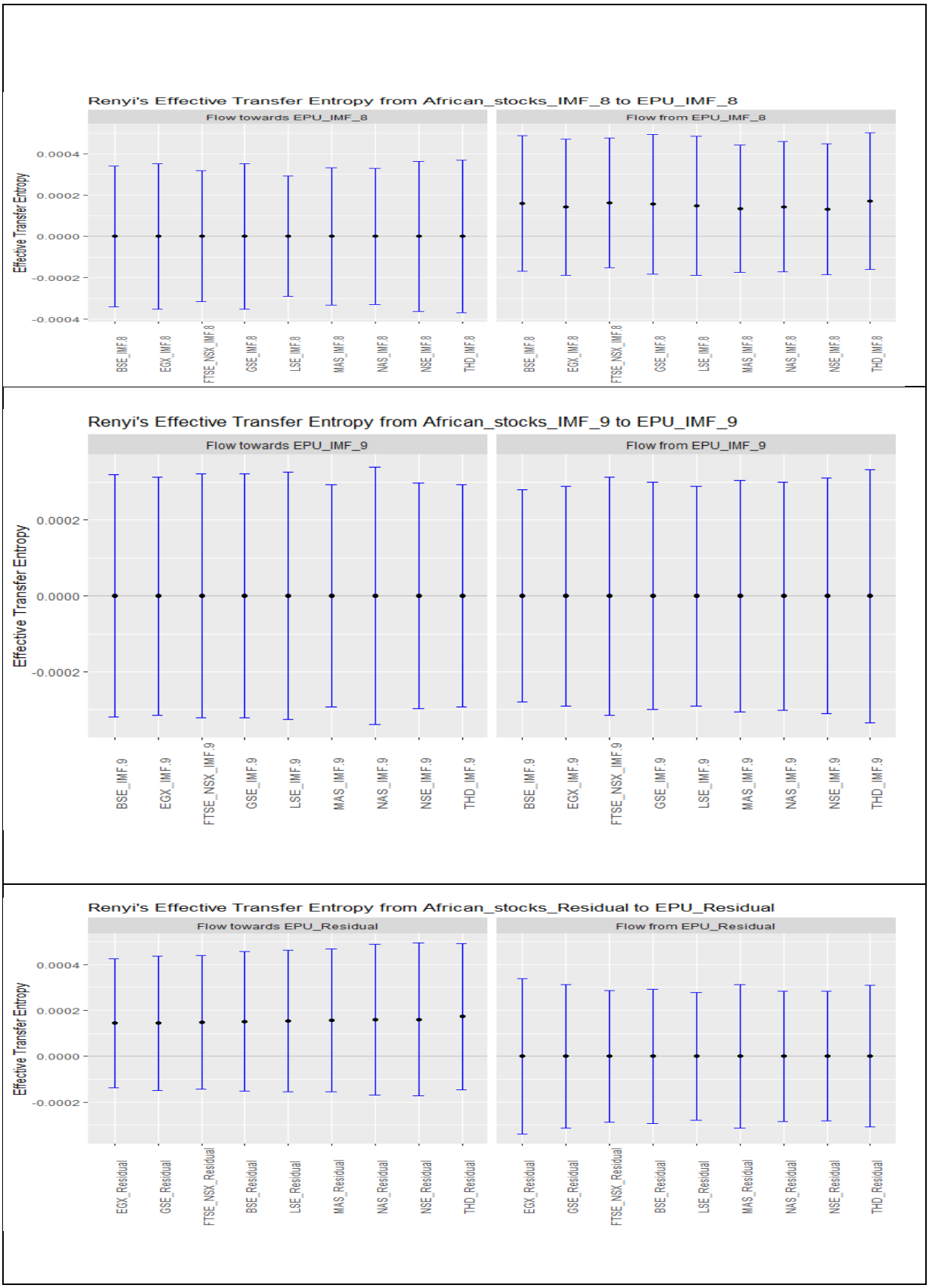

Renyi's Effective Transfer Entropy from African_stocks_IMF_8 to EPU_IMF_8
Flow towards EPU_IMF_8
Flow from EPU_IMF_8
Effective Transfer Entropy
0.0004
0.0002
0.0000
-0.0002
-0.0004
BSE_IMF.8
EGX_IMF.8
FTSE_NSX_IMF.8
GSE_IMF.8
LSE_IMF.8
MAS_IMF.8
NAS_IMF.8
NSE_IMF.8
THD_IMF.8
Renyi's Effective Transfer Entropy from African_stocks_IMF_9 to EPU_IMF_9
Flow towards EPU_IMF_9
Flow from EPU_IMF_9
Effective Transfer Entropy
0.0002
0.0000
-0.0002
BSE_IMF.9
EGX_IMF.9
FTSE_NSX_IMF.9
GSE_IMF.9
LSE_IMF.9
MAS_IMF.9
NAS_IMF.9
NSE_IMF.9
THD_IMF.9
Renyi's Effective Transfer Entropy from African_stocks_Residual to EPU_Residual
Flow towards EPU_Residual
Flow from EPU_Residual
Effective Transfer Entropy
0.0004
0.0002
0.0000
-0.0002
EGX_Residual
GSE_Residual
FTSE_NSX_Residual
BSE_Residual
LSE_Residual
MAS_Residual
NAS_Residual
NSE_Residual
THD_Residual

Figure 3.1: Information transfer between African Stocks and EPU

3.3.2 Information Transfer between African Stocks and the OVX

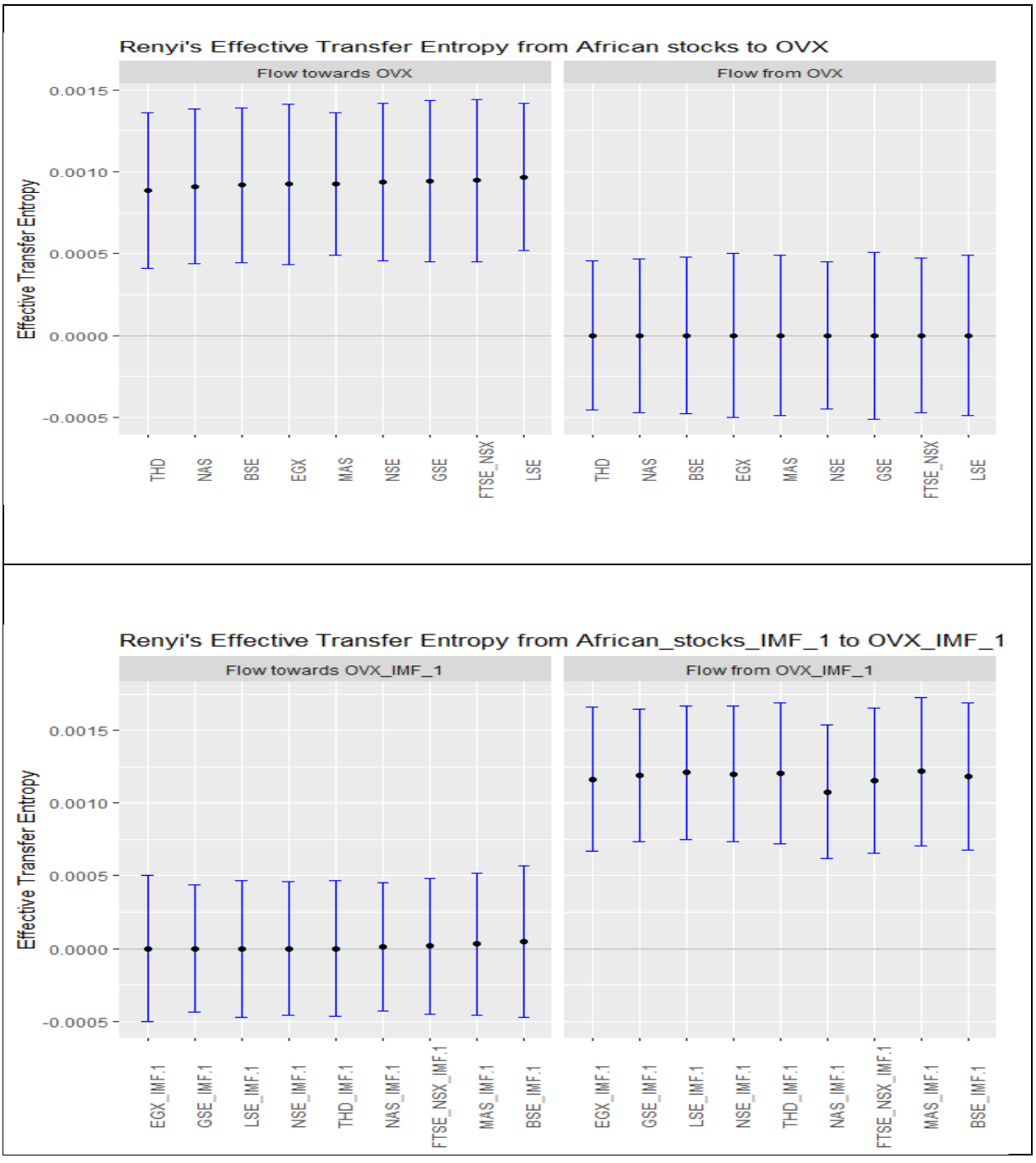
We discuss the results of the RTE concerning the information flow between the CBOE crude oil volatility index (OVX) and African stocks as shown in Figure 3.2. From the composite level, information flow from African stocks to OVX were all significantly positive highlighting the emission of low risks. The opposite end recorded no significant transfers. Meanwhile, the IMF1 plot produced significant positive information from OVX towards African stocks. At IMF2, we observed insignificant information transfers from both ends of the market. However, with the IMF3 plot, there was a perfect positive bi-directional information transfer between the two markets. Although the exchanges were bi-directional, the transfers from OVX towards African stocks were more significant. This means that the two markets influence each other by creating low risks. We can also infer that the bi-directional exchanges signal some level of market integration. In the short term, the OVX transmitted positive information to African stocks. This is contrary to an earlier finding by Aye (2015) who recorded a negative but marginally significant effect on stock returns.

Moving to the IMF4 plot, we noticed that the risks emanating from African stocks to OVX were low through positive information transfers, while the IMF5 plot produced no significant information transfers from both markets. For IMF6, information transfers towards OVX from African stocks were all significantly positive, while the opposite direction produced no significant relationship.

There was a perfect positive bi-directional informational transfer – this means both African stocks and OVX simultaneously transmitted and received information indicating the exchanges of low risks on IMF7. The flows from OVX to African stocks were more significant. IMF8 and IMF9 plots produced no significant information exchanges between the two markets, the same as the relationship between African stocks residuals and OVX residuals as the investment horizon is prolonged.

The results show that from the short, medium to long-term investment horizons, there were generally positive and insignificant transfers. The transmission of positive transfers is an indication of no contagion or risk spillovers from either African stocks or OVX. The presence of positive transfers, especially the bidirectional exchanges indicate some level of integration. Market integration bodes well for a globalised economy and the standardisation of prices and risks.

Another observation was the absence of negative transfers across the entire investment horizon highlighting the non-existence of contagion from either side of the market. This is supported by the findings of Boateng et al. (2021). The absence of both positive and negative transfers, however, reduces the potential for diversification. We observed that in the short term, OVX dominated African stocks in the exchanges, while the order was reversed in the medium term. This observation can be linked to the findings of Hung and Vo (2023).


Renyi's Effective Transfer Entropy from African stocks to OVX
Flow towards OVX
Flow from OVX
Effective Transfer Entropy
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BSE
EGX
MAS
NSE
GSE
FTSE_NSX
LSE
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Flow towards OVX_IMF_1
Flow from OVX_IMF_1
Effective Transfer Entropy
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GSE_IMF.1
LSE_IMF.1
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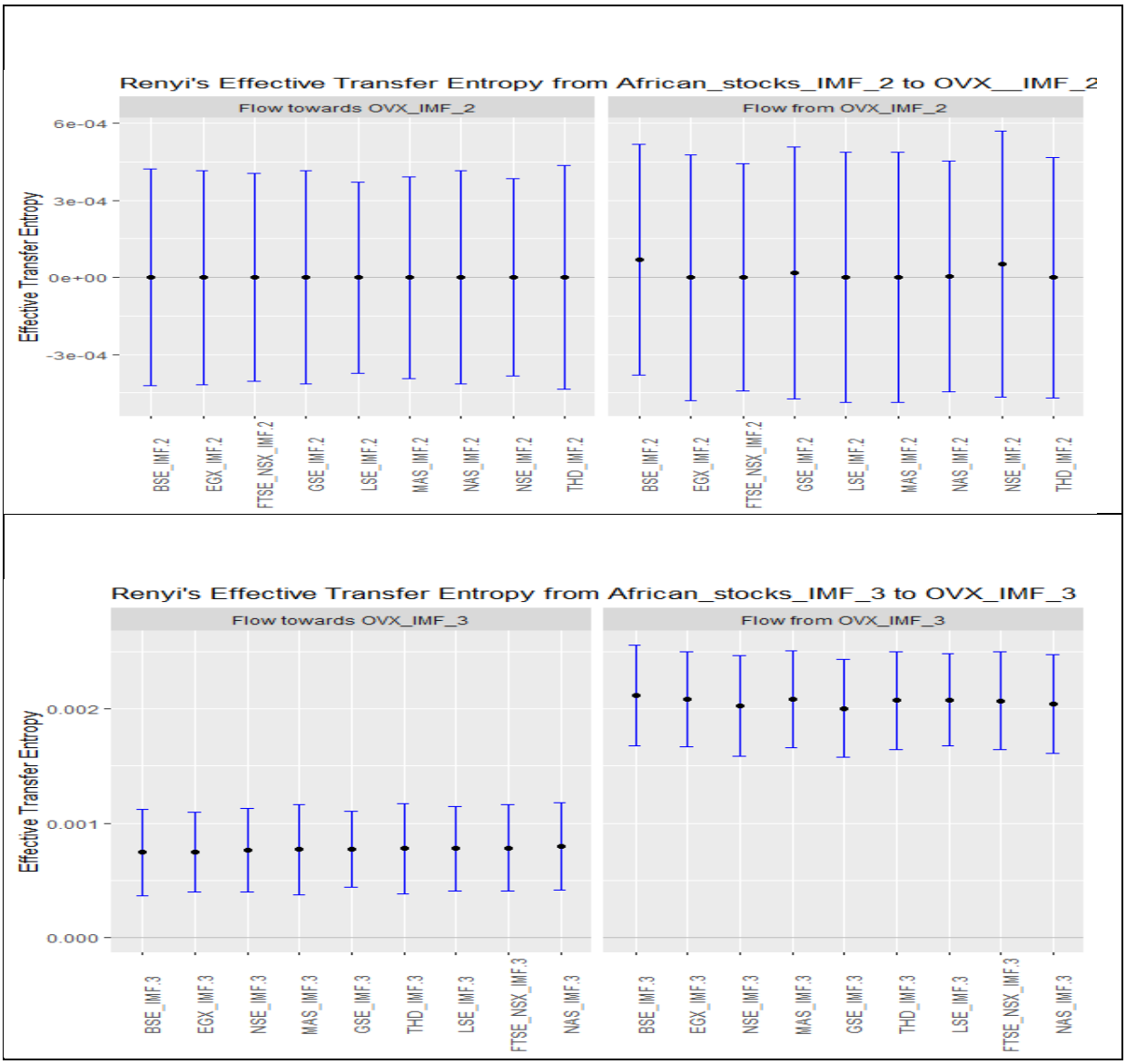
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Flow from OVX_IMF_2
Effective Transfer Entropy
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0e+00
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FTSE_NSX_IMF.2
GSE_IMF.2
LSE_IMF.2
MAS_IMF.2
NAS_IMF.2
NSE_IMF.2
THD_IMF.2
Renyi's Effective Transfer Entropy from African_stocks_IMF_3 to OVX_IMF_3
Flow towards OVX_IMF_3
Flow from OVX_IMF_3
Effective Transfer Entropy
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0.000
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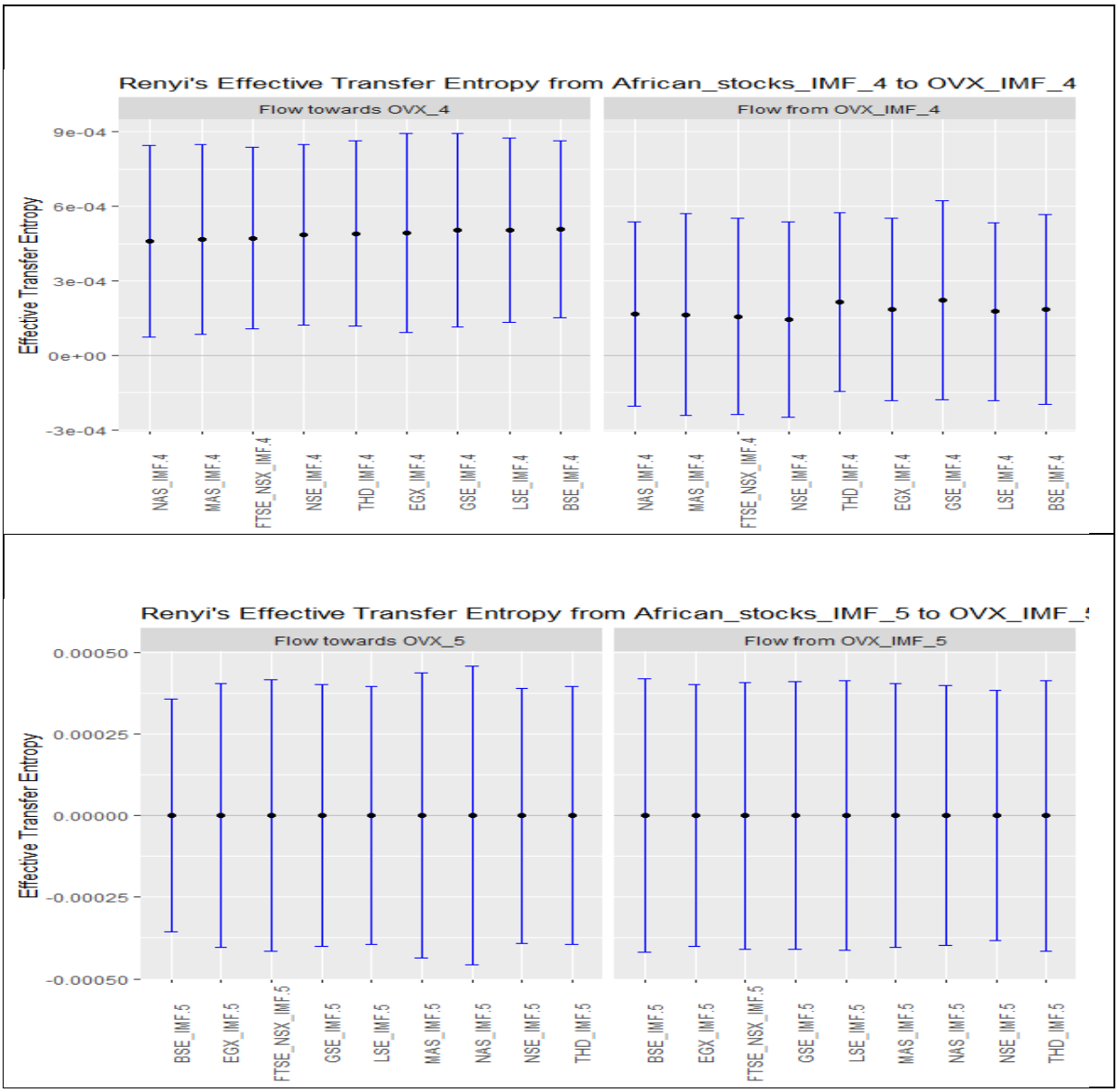
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Flow from OVX_IMF_4
Effective Transfer Entropy
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-3e-04
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MAS_IMF.4
FTSE_NSX_IMF.4
NSE_IMF.4
THD_IMF.4
EGX_IMF.4
GSE_IMF.4
LSE_IMF.4
BSE_IMF.4
Renyi's Effective Transfer Entropy from African_stocks_IMF_5 to OVX_IMF_5
Flow towards OVX_5
Flow from OVX_IMF_5
Effective Transfer Entropy
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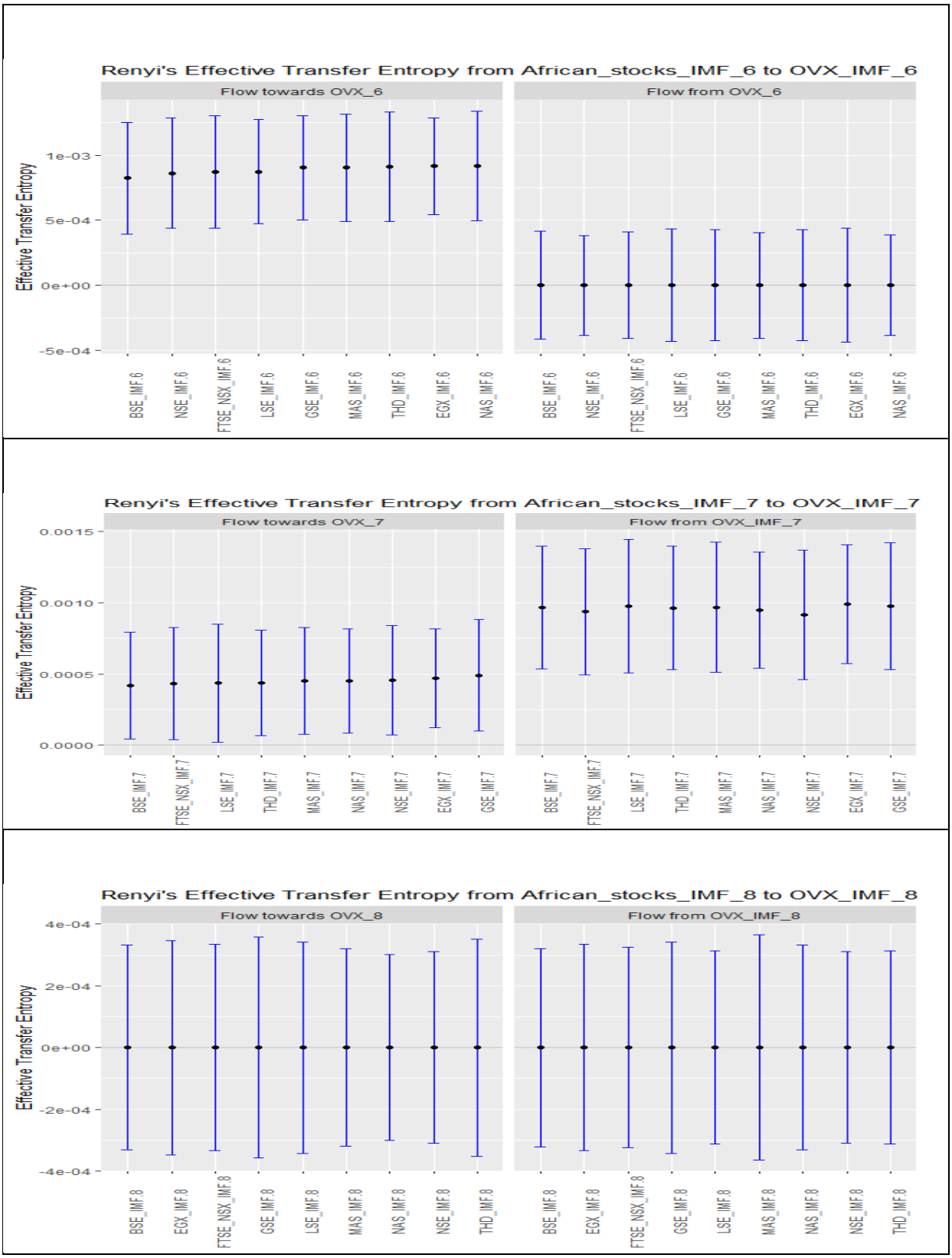
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Flow from OVX_6
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FTSE_NSX_IMF.6
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MAS_IMF.6
THD_IMF.6
EGX_IMF.6
NAS_IMF.6
Renyi's Effective Transfer Entropy from African_stocks_IMF_7 to OVX_IMF_7
Flow towards OVX_7
Flow from OVX_IMF_7
Effective Transfer Entropy
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0.0000
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FTSE_NSX_IMF.7
LSE_IMF.7
THD_IMF.7
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EGX_IMF.7
GSE_IMF.7
Renyi's Effective Transfer Entropy from African_stocks_IMF_8 to OVX_IMF_8
Flow towards OVX_8
Flow from OVX_IMF_8
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-4e-04
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EGX_IMF.8
FTSE_NSX_IMF.8
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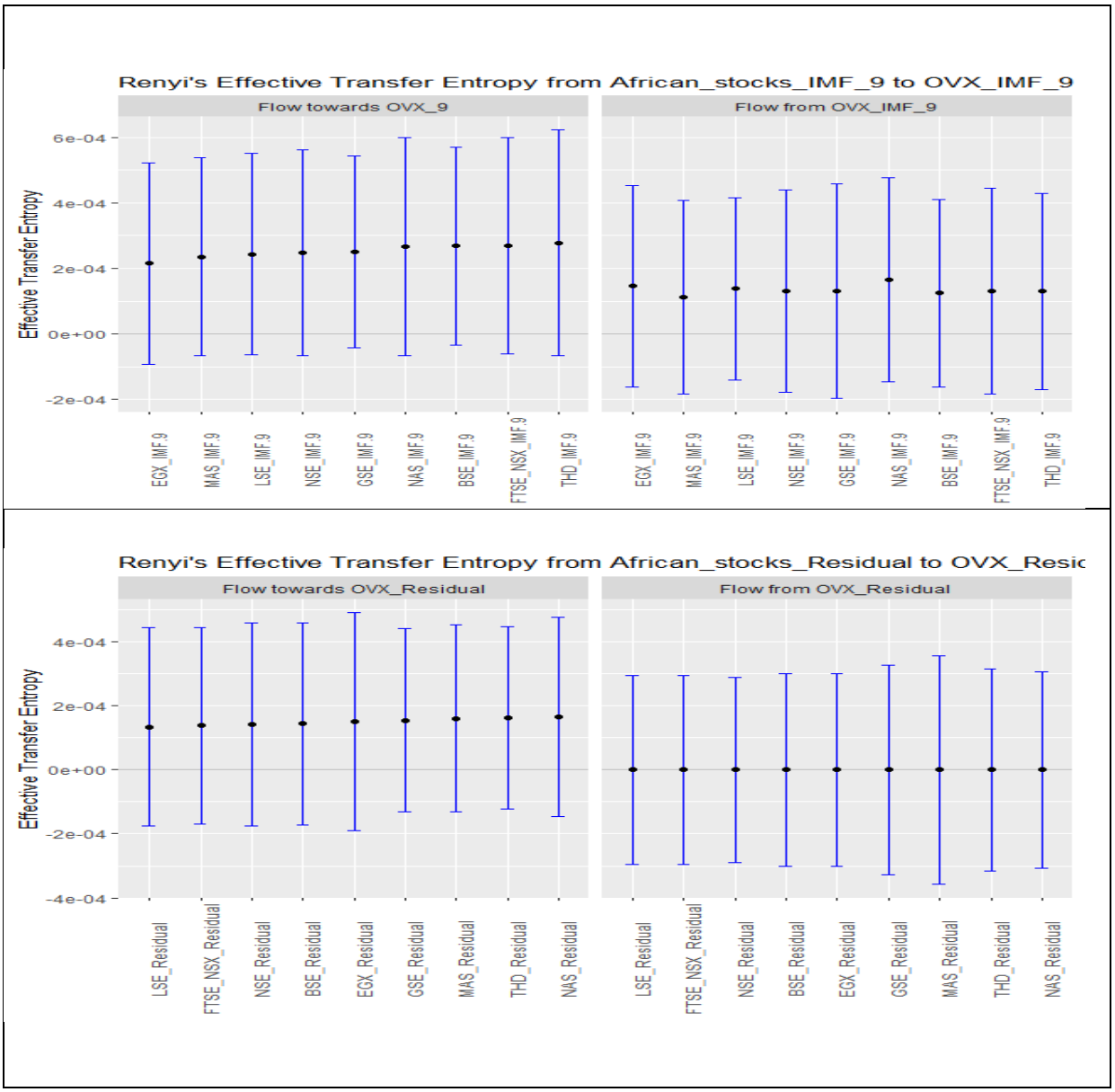


Figure 3.2: Information flow between African Stocks and OVX

3.3.3 Information Transfer between African Stocks and the VIX

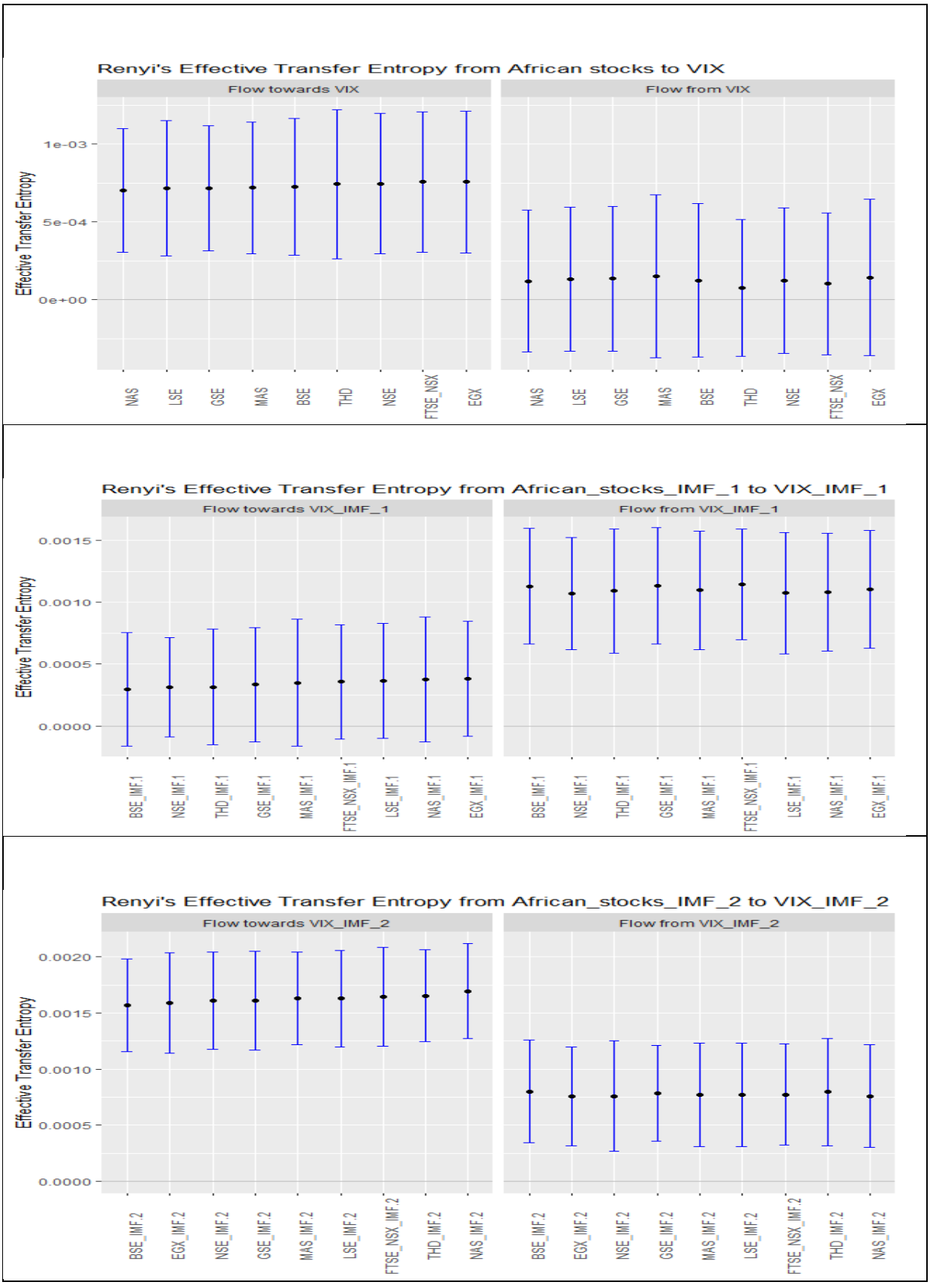
On the relationship between African stocks and the volatility index (VIX), flows towards VIX from African stocks on the composite output were significantly positive. The reverse produced no significant relationship. At IMF1, we noticed significant positive information flows from VIX to African stocks. There was a perfect bilateral information exchange

between the two markets at IMF2 but the flows from African stocks to VIX were more profound. At IMF3, there were bilateral positive information transfers between NAS, EGX, THD, GSE, MAS, FTSE_NSX, LSE, and NSE. However, there was a noticeable unilateral transfer as the VIX only sent positive information to the BSE. The reverse order was insignificant for all the variables.

Stretching the analysis to the medium investment horizon, there were positive information flows from the VIX to African stocks, while the opposite end produced insignificant transfers at IMF4. At IMF5, there were bilateral positive information exchanges across all the variables from the two markets. At IMF6, flows from VIX to African stocks were all positive while insignificant transfers were recorded in the reverse direction.

In the long-term investment horizon, starting with IMF 7, there was a perfect bilateral positive information transfer even though the flows from VIX were stronger. IMF8 produced positive transfers from VIX to African stocks, while no significant information transfers were established at IMF9. For the residuals, African stocks transmitted positive flows to VIX.

Generally, there were profound positive information transfers across the entire investment horizon. It is important to note that VIX was broadly a dominant information transmitter than African stocks. We can, therefore, infer that the VIX index creates the transfer of low risks to African stocks. This is like the results of Huong et al. (2022). The absence of negative transfers means the non-existence of the spread of contagion or high risks.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Flow towards VIX
Flow from VIX
Effective Transfer Entropy
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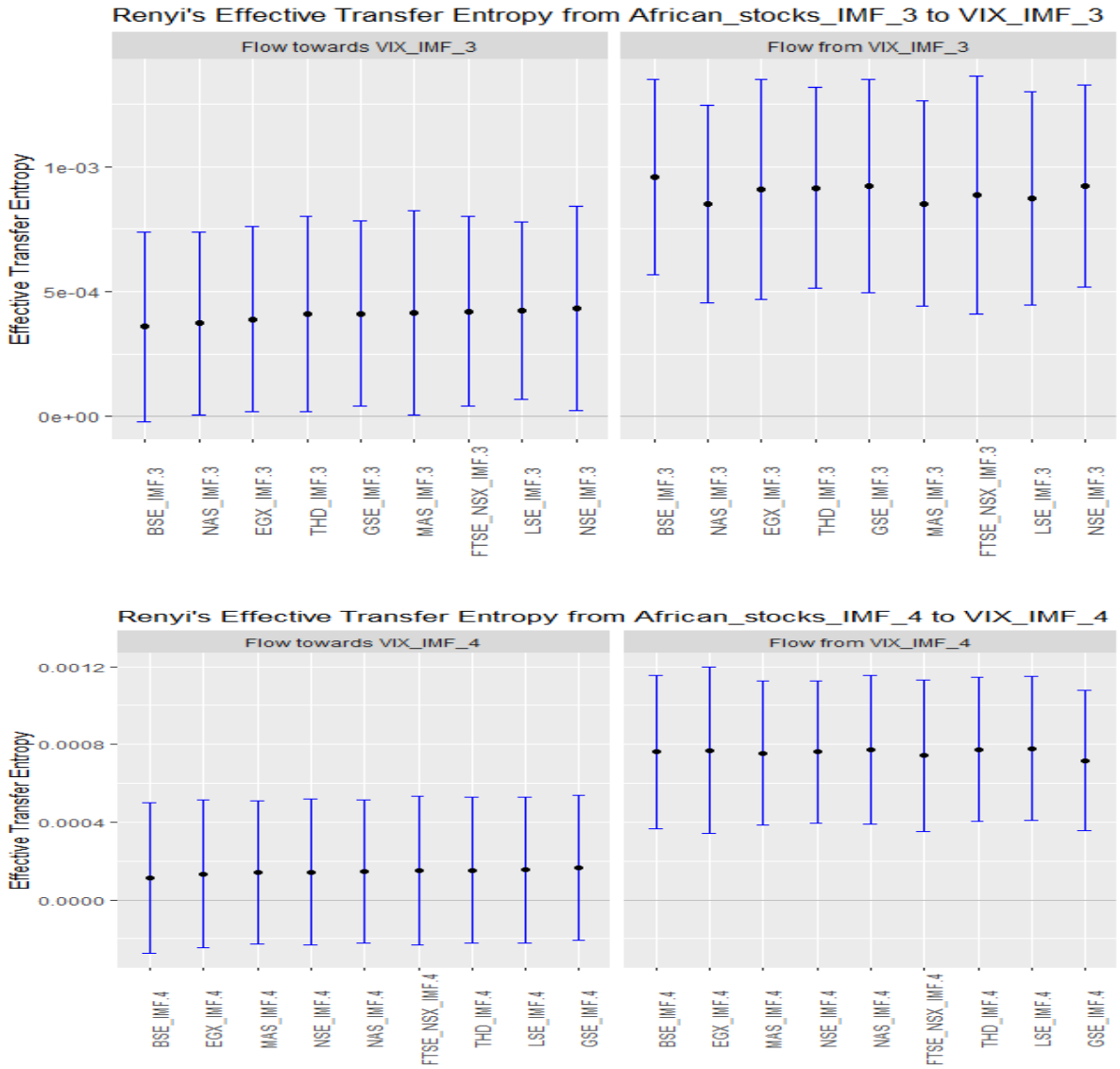
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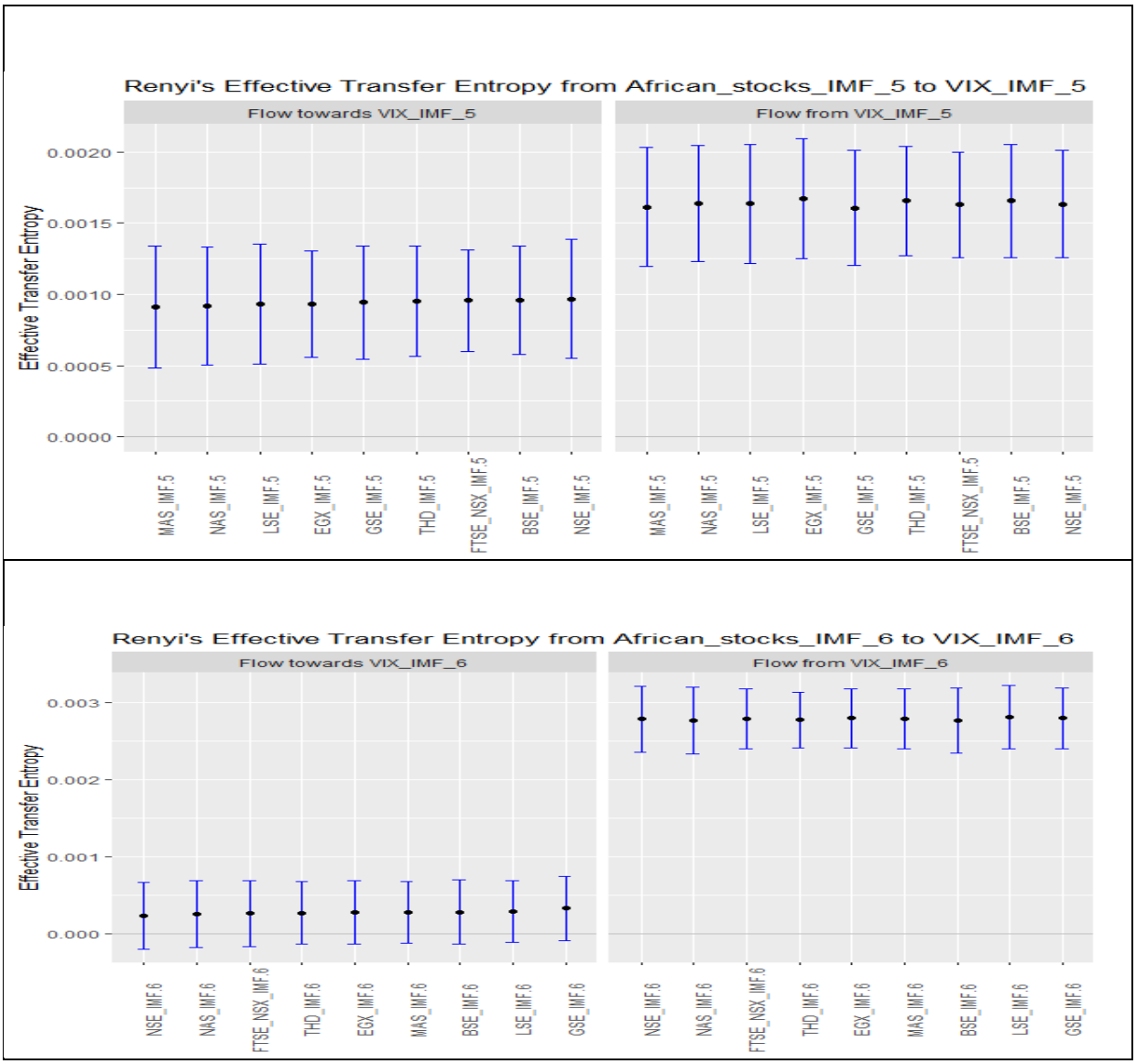
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Flow from VIX_IMF_6
Effective Transfer Entropy
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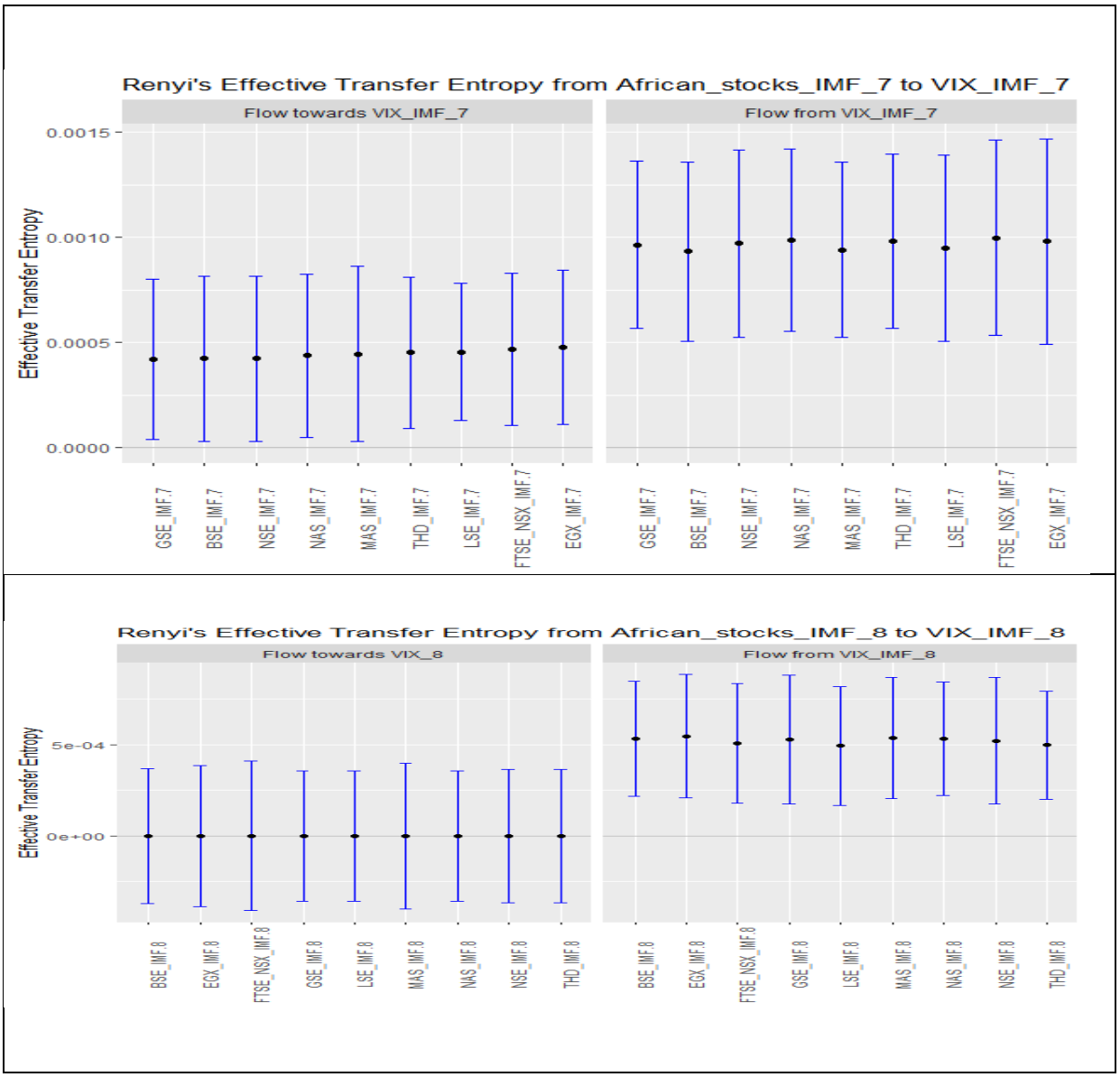
Renyi's Effective Transfer Entropy from African_stocks_IMF_7 to VIX_IMF_7
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Flow from VIX_IMF_7
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MAS_IMF.7
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FTSE_NSX_IMF.7
EGX_IMF.7
Renyi's Effective Transfer Entropy from African_stocks_IMF_8 to VIX_IMF_8
Flow towards VIX_8
Flow from VIX_IMF_8
Effective Transfer Entropy
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BSE_IMF.8
EGX_IMF.8
FTSE_NSX_IMF.8
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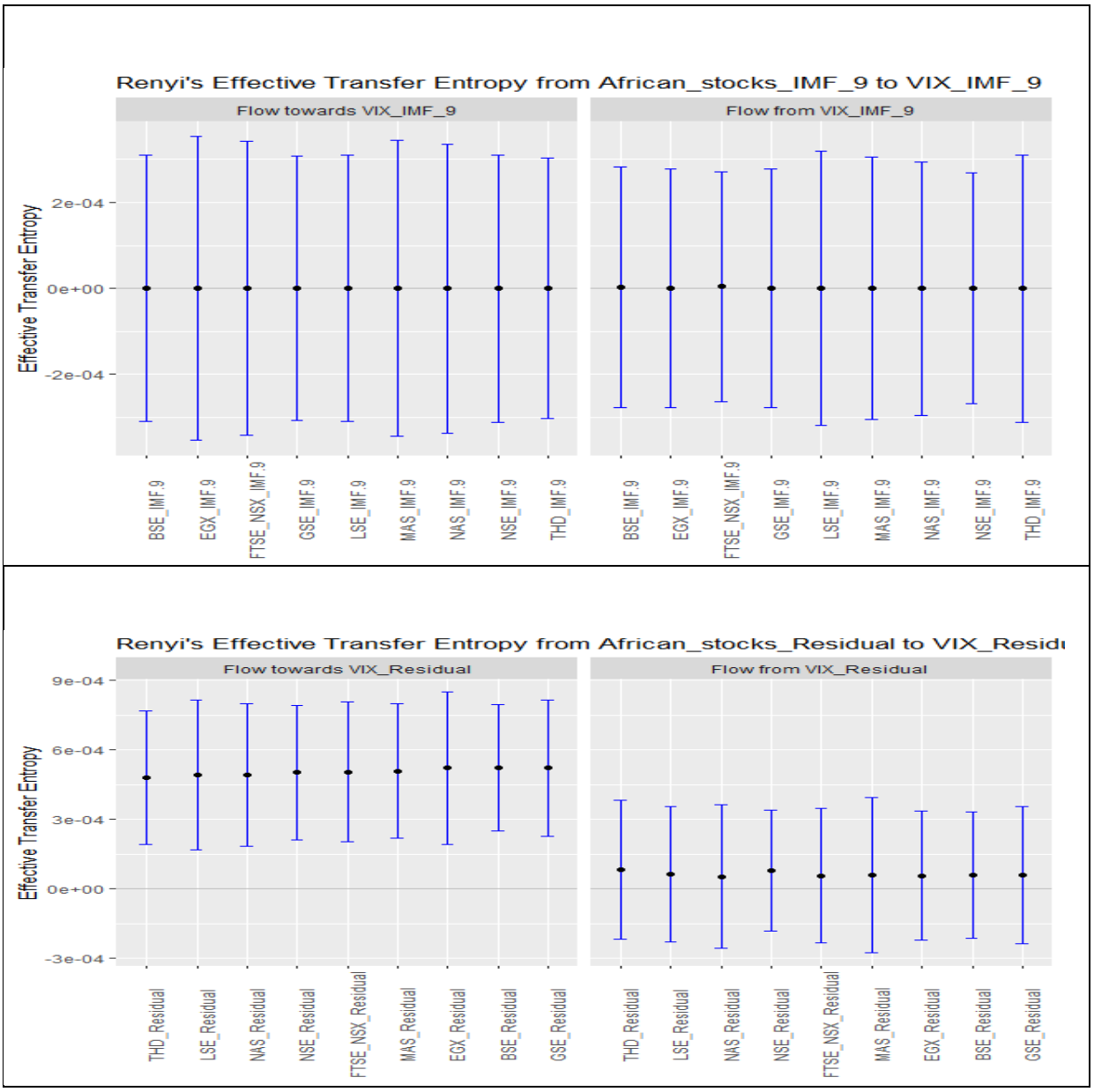


Figure 3.3: Information flow between African stocks and VIX

3.4 DISCUSSIONS AND POLICY IMPLICATIONS

The study investigates the information flow between African stocks and global uncertainties over the period January 2010 to June 2022, employing the CEEMDAN technique to decompose the data and the Rényi Effective Transfer Entropy (RTE) method

to assess the exchange of information between African stocks and three global uncertainty indices: the Economic Policy Uncertainty (EPU) index, the Oil Volatility Index (OVX), and the CBOE Volatility Index (VIX).

Our findings demonstrate that African stocks exchanged both significant and insignificant positive information flows with the three global uncertainty indices at various stages of the investment horizon. No significant negative information transfers were recorded, indicating low levels of risk spillover or contagion. Furthermore, across different investment horizons, the three indices acted as net transmitters of positive information to African stocks. This finding aligns with theoretical foundations such as the adaptive and heterogeneous market hypotheses, which suggest that market participants respond differently to information depending on their risk preferences and investment horizons.

The results highlight important policy and investment implications. First, the absence of significant negative transfers suggests that African stock markets are relatively resilient to global uncertainties, including policy, oil, and market volatility. This finding is particularly relevant for investors seeking diversification opportunities. For example, Qabhobho et al. (2022) suggested that the presence of insignificant information flows across multiple investment horizons points to the potential for portfolio diversification. Policymakers and market regulators should promote this advantage by further developing financial markets to attract international investors who seek to hedge against global risks.

Additionally, the positive information exchanges observed over the long-term investment horizon between African stocks and the EPU, OVX, and VIX indices suggest marginal market integration. As noted by Adam (2020), African markets can serve as an alternative for international portfolio diversification during times of rising global economic uncertainty. This also points to the potential for African stocks to provide a hedge against global risks in the short term, as indicated by Asafo-Adjei et al. (2020), which reinforces the need for strategic reforms to further integrate African markets into the global financial system.

From a policy perspective, the findings indicate a need for African countries to strengthen their financial markets to better absorb global shocks. Policymakers should focus on regulatory improvements that enhance transparency, investor confidence, and liquidity, which are critical for market stability during periods of heightened global volatility. Moreover, building resilient stock markets and economies should be a priority to minimize the impact of global shocks, such as those related to oil price volatility and economic policy changes. Measures like circuit breakers, better risk management tools, and cross-border market integration can bolster resilience.

For investors, the observed insignificant transfers across short-, medium-, and long-term scales represent a strong signal for portfolio diversification opportunities. African stocks can provide returns that are less affected by global uncertainty, especially in the short to medium term. This suggests that African equities can act as a buffer for investors during periods of global economic turmoil, further emphasizing their role in diversified investment strategies.

In conclusion, the findings of this study provide valuable insights into the dynamics of African stock markets about global uncertainties. By understanding the patterns of information flow between these markets and global indices, policymakers and investors can adopt adaptive strategies that promote resilience, stability, and sustainable growth in African financial markets. The adaptive and heterogeneous market hypotheses offer a theoretical framework for interpreting these findings, showing that investors react differently to global uncertainties based on their specific risk appetites and investment strategies, further affirming the potential of African markets as a diversification tool in a globalized economy.

3.5 CHAPTER SUMMARY

This Chapter explored the information flow between African stock markets and global uncertainties over the period from January 2010 to June 2022. The analysis utilized the CEEMDAN technique to decompose the data and the Rényi Effective Transfer Entropy (RTE) method to examine the bi-directional exchange of information between African stocks and three global uncertainty indices: the Economic Policy Uncertainty (EPU) index, the Oil Volatility Index (OVX), and the CBOE Volatility Index (VIX). The study aimed to assess how these global uncertainties influence African stock markets across various investment horizons.

The results revealed that African stocks consistently exhibited significant positive information flows with the EPU, OVX, and VIX indices, particularly at long-term horizons,

while no significant negative transfers were observed. This indicates the absence of contagion or high-risk spillovers from global uncertainties to African stocks, highlighting the resilience of African markets. African stocks, in fact, emerged as net transmitters of positive information across most horizons, reinforcing their potential role in international investment strategies.

CHAPTER FOUR

ASYMMETRIC INTERCONNECTEDNESS OF AFRICAN CURRENCIES AND GLOBAL UNCERTAINTIES

4.0 INTRODUCTION

The contemporary financial landscape is marked by various challenges, including heightened global uncertainties and the emergence of tail risk exposures inherent in currency market dynamics. It is well-established that fluctuations in exchange rates are influenced by global uncertainties such as financial crises, political instability (e.g., Brexit), and health emergencies like the COVID-19 pandemic. Some studies suggest that economic uncertainty has minimal impact on currency rates. For instance, Békesová and Bohdalová (2022) found that while the influence of the VIX was consistently weak, it was statistically significant for USD/HUF and USD/PLN exchange rates. However, the study indicated that the EMV and EPU indices did not significantly affect the exchange rate returns under analysis.

In contrast, in emerging regions such as Africa, global uncertainty—stemming from economic shocks, geopolitical tensions, financial market volatility, or pandemics—significantly affects currencies, particularly in oil-exporting and oil-importing countries. The impact varies depending on a country's reliance on oil trade, economic resilience, and currency regime. For example, the exchange rates of major oil-exporting countries generally appreciate when oil prices rise and depreciate when prices fall (Amano & Van

Norden, 1995). However, this correlation can fluctuate over time and even reverse, as high oil prices sometimes coincide with weak exchange rates (Akram & Mumtaz, 2019). Oil price changes are crucial for predicting future shifts in exchange rates (Brahmasrene et al., 2014), and both oil prices and exchange rates are key factors that significantly affect the overall economy (Evgenidis, 2018). These variables are essential for forecasting future macroeconomic activity (Raymond & Rich, 1997; Evgenidis, 2018). During periods of global uncertainty, such as financial crises or pandemics, global oil demand often falls as economic activity slows, leading to lower oil prices. For oil-exporting countries, this translates into reduced export revenues and currency depreciation due to lower foreign exchange earnings. Akram (2020) empirically demonstrated that shifts in the main factors influencing oil prices could result in fluctuating relationships between oil prices and the currencies of oil-exporting countries. Oil price volatility also increases exchange rate volatility, especially in oil-exporting nations, where currencies become highly correlated with oil price movements. These fluctuations affect both oil-exporting and importing economies simultaneously, but oil-exporting countries face additional structural challenges due to their reliance on oil (Eagle, 2017).

Economic policy uncertainty (EPU) also plays a critical role in exchange rate volatility. Chen et al. (2020) found that as a country's EPU increases, exchange rates tend to fluctuate more, particularly in a flexible exchange rate regime. EPU not only affects the overall economy but also amplifies exchange rate volatility. Dai, Zhang, Yu, and Li (2017) showed that EPU significantly contributes to asymmetric exchange rate volatility. Brogaard and Detzel (2015) suggested that this relationship is largely influenced by

government regulations. Central bank policies in response to fluctuating exchange rates can further alter the impact of EPU on currency volatility. The effects of EPU shocks on correlations diminish during periods of extreme exchange rate volatility, as high volatility reshapes economic conditions and major events. Therefore, EPU may trigger different and asymmetric shocks across various levels of exchange rate volatility, as indicated by Dai et al. (2017), potentially influencing investor confidence. Balcilar, Gupta, and Segnon (2016) argued that as the largest and most liquid financial market globally, the foreign exchange market is particularly vulnerable to uncertainty. Exchange rate fluctuations can negatively impact the economy, complicating the formulation of economic policies and exacerbating economic policy uncertainty.

Globally integrated economies expose emerging markets to short-term external financial shocks, leading to excessive fluctuations in key economic indicators like exchange rates. Financial integration amplifies vulnerability to global uncertainty, often reflected in elevated VIX levels, which can disrupt capital inflows, increase funding costs, and drive significant exchange rate movements (Magud et al., 2023). Magud et al. (2023) empirically evidenced that VIX amplifies currency depreciation in such scenarios.

From a theoretical standpoint, Forbes and Rigobon (2002) define contagion as the predominant rise in cross-market linkages after a country experiences a shock. Sun and He (2012) similarly observed a notable increase in the transmission of shocks across countries. Tiwari, Mutascu, and Albulescu (2016) further argue that contagion occurs when a financial crisis in one country spreads to other financial systems. Aderajo and

Olaniran (2021) found that the U.S. financial shocks posed a threat to African markets, with correlations rising during crisis periods. Anyikwa and Le Roux (2020) also discovered that co-movements between African and developed markets were primarily driven by contagion during crises. As a result, increased global uncertainties predominantly affect African currencies, particularly in oil-importing countries.

Market players' anticipation of heightened interconnectedness in financial markets can shape investment behaviour. Békesová and Bohdalová (2022) argue that uncertainty often leads companies to hold off on new investments, complicating decisions about resource allocation. In the financial sector, heightened uncertainty results in lower financial asset prices and tighter lending practices by banks, with broader negative consequences for the economy.

The portfolio balance theory supports this notion, suggesting that investors adjust their portfolios based on risk and return considerations, and global uncertainties can lead to shifts in international capital flows, affecting demand for and value of African currencies (Branson & Henderson, 1985). This theory posits that as exchange rates vary, investors rebalance portfolios to capitalize on changes while striving for diversification (Branson, Halttunen, & Masson, 1977; Efuntade & Efuntade, 2023). Diversification, which is an anchor for risk minimization, requires a deep understanding of global uncertainty indices such as EPU, VOX, and VIX for investment decisions and policy-making. According to the heterogeneous market hypothesis, investors construct their portfolios based on

varying time horizons and market conditions, so changes in policy uncertainties can trigger reactions in African currency markets.

Empirical research has extensively examined factors influencing exchange rate returns, with emphasis on financial variables (Korley & Giouvris, 2021), macroeconomic factors (Chang & Su, 2014), and governance (Fraj et al., 2018). However, studies on oil shocks in Sub-Saharan Africa remain limited (Nusair & Olson, 2019). Changes in OVX, VIX, and EPU are also critical for predicting shifts in exchange rates.

Africa plays a crucial role in the global oil market, contributing 9.6% of the world's total oil production in 2019, with Nigeria as a leading producer (EIA, 2020). Emerging oil-producing nations like Ghana, Mauritania, Senegal, and Kenya are also reshaping the continent's oil landscape. Eagle (2017) notes that the oil sector has a significant impact on these countries' trade balances, making their economies highly vulnerable to fluctuations in oil prices. Despite the region's growing importance, research on the economic effects of oil shocks remains scarce, particularly regarding policy implications and resilience-building measures (You et al., 2017).

Despite increasing attention to the interconnectedness of African currencies with global uncertainties, notable gaps remain in the literature, especially regarding the asymmetric nature of currency movements in response to global uncertainty. Korley and Giouvris (2022) addressed part of this gap by investigating the joint effect of OVX and oil price fluctuations on the currencies of five Sub-Saharan African countries. However, their study

is limited in scope due to the small number of countries analyzed and reliance on one EPU index.

To bridge this gap, this study examines the asymmetric interconnectedness of three global uncertainty indices—the Economic Policy Uncertainty Index (EPU), Oil Volatility Index (OVX), and Volatility Index (VIX)—on 11 African countries, including six oil-exporting and five oil-importing nations. To the authors' knowledge, this is a novel approach, combining key global uncertainty indices to explore their effects on African currencies.

Moreover, existing studies often overlook the heterogeneous responses of currencies across different quantiles of the conditional distribution, failing to capture the full spectrum of interconnectedness and risk exposures (Akram, 2020; Brogaard & Detzel, 2015; Korley & Giouvris, 2022). Against this backdrop, this study employs an empirical framework combining Variational Mode Decomposition (VMD) and quantile regression techniques to analyze currency market dynamics, capturing both deterministic trends and stochastic fluctuations.

VMD-based quantile regression offers several advantages over Markov switching models (MSMs) for analyzing financial data. VMD decomposes signals into different modes, each capturing specific frequencies or trends, effectively isolating short-term variations and long-term trends in financial data. This flexibility is crucial for analyzing non-stationary and volatile financial markets, where trends and patterns shift rapidly. Unlike MSMs, which

rely on predefined states (e.g., bull or bear markets), VMD captures continuous variability without assuming distinct regimes, allowing models to adapt to unpredictable shifts in the financial environment and providing more nuanced insights into financial returns (Foroni, Merlo & Petrella, 2023; Gu et al., 2021; Ye, Zhu, Wu & Miao, 2016).

This study makes significant contributions to research, policy, and practice in currency market dynamics and global uncertainties. From a research perspective, the combination of VMD and quantile regression techniques represents a methodological advancement that enriches the literature on financial market analysis. It provides a deeper understanding of the asymmetric nature of currency movements amidst global uncertainties, offering guidelines for future research on financial market interconnectedness.

From a policy standpoint, the findings hold implications for policymakers and central banks tasked with maintaining financial stability in African economies. By revealing the asymmetric nature of currency interconnectedness with global uncertainty indices, this study provides valuable insights into the vulnerabilities and resilience of African economies, helping policymakers craft targeted interventions to mitigate the adverse effects of global uncertainties. Furthermore, the study offers practical insights for international investors and financial market participants seeking to manage risk exposure in African markets, particularly in the face of global uncertainties.

In conclusion, this study deepens understanding of how African currencies are connected to global uncertainties. It provides a fresh perspective by exploring the asymmetric nature of these connections through the use of innovative quantitative methods. The findings will help guide research, policy, and practical applications, contributing to the long-term stability and growth of African economies amidst an increasingly interconnected and uncertain global environment.

4.1 LITERATURE REVIEW

This section encompasses the review of prior studies relating to this current study. Kido (2016) used the dynamic conditional correlation GARCH (DCC-GARCH) model to examine the spillover effects of shocks from US economic policy uncertainty on real effective exchange rates. The analysis revealed that the correlations between US economic policy uncertainty (EPU) and the returns of high-yielding currencies are consistently negative over the entire sample period, whereas the correlation between US EPU and the returns of the Japanese yen remains consistently positive. Shaikh (2020) analyzed the equity, commodity, interest rate, and currency markets, considering the U.S. Economic Policy Uncertainty (EPU) index. The findings indicate that equity market volatility is significantly elevated during periods of high policy uncertainty. The results also show that the implied volatility index serves as a forward-looking indicator of future stock market volatility and reveals that policy uncertainty impacts investor sentiment.

Aimer (2021) investigated the impact of economic policy uncertainty (EPU) and the VIX index on exchange rates in four countries that experienced the highest number of COVID-

19-related deaths. The study employed the bounds-testing approach to cointegration and the error correction model within an ARDL framework. The results indicated that, in the pre-pandemic period, the VIX index had a long-term positive effect on the Brazilian real. During the pandemic, the volatility index positively influenced the exchange rates of both the Indian rupee and the Swedish krona. Additionally, a positive relationship was found between EPU and the Brazilian real during the pandemic.

Akram (2020) discovered that rising geopolitical uncertainty, along with the associated increase in oil prices, tends to weaken the currencies of oil-exporting countries. Chen, Du and Hu (2020) examined the influence of economic policy uncertainty (EPU) on the volatility of China's exchange rates and found that China's EPU has a positive and significant effect on the volatility across all quantiles of exchange rates. The EPU from the US, Europe, and Japan also has significant effects, whereas the EPU from Hong Kong shows no significant correlation with exchange rate volatility. You et al. (2017) examined how crude oil shocks and uncertainties in China's economic policy affect stock returns across various points in the return distributions through quantile regression analysis. Their findings shown that the influences of oil price fluctuations and economic policy uncertainty are asymmetric and closely tied to the prevailing conditions in the stock market.

Magud, Magud, and Pienknagura (2023) employed panel quantile regressions to examine extreme fluctuations in the real effective exchange rate (REER) of small open economies. They found that global uncertainty (VIX) and shocks to global financial conditions (U.S. monetary policy) significantly influence the distribution of REER changes, with more

pronounced effects at the extremes of the distribution. These impacts are particularly strong in economies with less developed foreign exchange markets, lower central bank credibility, and higher credit risk (i.e., weaker macroeconomic fundamentals).

Korley and Giouvris (2022) analyzed the impact of oil shocks on exchange rates in Africa by exploring the relationship between oil prices and exchange rates in both oil-exporting countries (such as Angola and Nigeria) and oil-importing nations (including Côte d'Ivoire, Ghana, and Mauritania). Their findings showed that volatility in the Oil Volatility Index (OVX) had a significant effect on the exchange rates of all countries in the study. However, oil price fluctuations mainly influenced the exchange rates of oil-importing countries. They also noted that an increase in OVX typically led to a depreciation of local currencies, while a decrease resulted in currency appreciation. Eagle (2017) explored the connection between oil price volatility and macroeconomic performance in Angola and Nigeria. Utilizing a Structural Vector Autoregressive Model (SVAR), E(GARCH), and Granger Causality tests, the results indicate that oil price volatility has a minimal effect on the GDP growth rate in both countries.

Kocaarslan and Soytas (2024) investigated both the long-term and short-term connections between the exchange rates of three oil-exporting and two oil-importing countries and COVID-19-related factors, as well as crude oil prices. The ARDL estimation results revealed a strong relationship between the exchange rates and COVID-19 variables for two of the countries studied. Agyei, Bossman, Asiamah, and Adela (2022) opined that while COVID-19 does not amplify the strength of the relationship between EXR and STK returns in Africa, it does lead to a notable shift in the lead-lag dynamics

between the two assets. Yunusa (2020) analyzed the impact of exchange rate volatility on Nigeria's crude oil exports to its trading partners (UK, USA, Italy, France, Spain, Canada, and Brazil). The ARDL results indicate that the exchange rate volatility of Nigeria's trading partners is statistically significant for all of them.

4.2 QUANTILE REGRESSION

To examine the asymmetric relationship between African currencies and global uncertainties, the quantile regression (QR) method is used. The QR method was introduced by Koenker and Bassett (1978), which is an improvement of the Ordinary Least Square (OLS) regression. The traditional OLS approach only presents a summary of the mean relationship between the dependent and independent variables, which is generated through the contingent average of the regressand. According to Mosteller and Tukey (1977), the standard OLS results only show a fractional view of the relationship between the dependent variable and independent variables. Furthermore, the OLS shows results on the contingent mean of the variables explained, which leads to coefficients that are either overestimated or underestimated or unable to reveal the exact relationship between the dependent and independent variables (Binder & Coad, 2011).

To overcome the weakness of the traditional OLS, the QR method provides a holistic relationship between the dependent and explanatory variables, which is done by modelling the relationship between the explanatory variables and a set of distinct quantiles of the dependent variable (Nusair & Al-Khasawneh, 2018). Also, the QR method describes the whole contingent distribution as far as the dependent variable is concerned.

To generate a comprehensive interrelationship between the dependent variable and the independent variables, the QR technique is generally robust in handling outliers in the data set as well as heterogeneity and skewness within the regressand. From the traditional OLS regression, the QR method is specified. From the OLS model.

Let y be a dependent variable, which is dependent on x linearly. The τ^{th} conditional quantile function of y is then specified below:

$$Q_y(\tau/x) = inf\{b\backslash F_y(b\backslash x) \geq \tau\} = \sum_k \beta_k(\tau)\, x_k = x\beta(\tau) \quad (11)$$

where $F_y(b\backslash x)$ represents the conditional distribution function y given x and the QR coefficients $\beta(\tau)$ shows the dependence relationship between vector x and the τ^{th} conditional quantile of y. Dependence is unconditional as there are no exogenous variables included in x but it is conditional if exogeneous variables are added to x. The values of $\beta(\tau)$ for $\tau \in [0,1]$ shows the complete dependence on y.

The dependence of the dependent variable y which is based on some specific explanatory variables in the vector x could be represented as constant where the values of $\beta(\tau)$ remain the same for different values of τ, monotonically decreasing or increasing where $\beta(\tau)$ decrease or increases with the value of τ asymmetric or symmetric where the value of $\beta(\tau)$ is similar or dissimilar for low and high quantiles. The coefficients $\beta(\tau)$ for a given τ are estimated by minimizing the weighted absolute changes between y and x:

$\hat{\beta}(\tau)$ =argmin $\sum_{t=1}^{T}\left(\tau - 1_{\{y_t<x_t^1\beta(\tau)\}}\right)|y_t - x_t^1\beta(\tau)|$, where $1_{\{y_t<x_t^1\beta(\tau)\}}$ is the usual indicator function. To investigate the different effects of the conditional variables on the quantile

function, we specify the QR model with regards to the effect of global uncertainties on African currencies below:

$$Q_y(\tau/\chi) = \beta(\tau) + \sum \alpha_k(\tau) x_k + D[\gamma(\tau) + \sum_k \theta_k(\tau)\, x_k] \quad (12)$$

where D is the dummy variable of the global uncertainty that assumes the value of 1 if the dependent variable is in the global uncertain sub-period and zero otherwise. The parameters $\gamma(\tau)$ and $\theta_k(\tau)$ represent the additional marginal effects of the various conditional variables in the uncertain subperiod for each quantile τ in comparison with the effects determined by parameters $\beta(\tau)$ and $\alpha_k(\tau)$ in the stable sub-period.

4.3 DATA AND DESCRIPTIVE STATISTICS

4.3.1 DATA

The analysis draws upon a rich dataset comprising daily observations of key African currencies including the Egyptian Pound (EGP), South African Rand (ZAR), Nigerian Naira (NGN), Tunisian Dinar (TND), Ghanaian Cedi (GHS), Moroccan Dirham (MAD), Botswana Pula (BWP), Mauritian Rupee (MUR), Kenyan Shilling (KES), Namibian Dollar (NAD), and West African CFA Franc (XOF), alongside three global uncertainty indices – the Economic Policy Uncertainty Index (EPU), Oil Volatility Index (OVX), and Volatility Index (VIX).

The dataset spans from 1 January 2010 to 31 December 2022, encompassing 3,379 daily observations for each variable, a timeframe that includes the announcement and implementation of Brexit (see Békesová & Bohdalová, 2022). The time also captures major health challenges (COVID-19) and geopolitical tension (Russian-Ukraine war).

Again, the choice of data from 2010 was to capture major global uncertainties (Eurozone debt crisis, quantitative easing [QE2] in the U.S, and emerging market pressures) that impacted the global financial markets (International Monetary Fund [IMF], 2010; Aaron et al., 2010). For instance, it was noted that sovereign risks in certain parts of the eurozone had emerged and extended into the financial sector, creating the potential for spillovers into other regions and risking a negative feedback loop with the broader economy (IMF, 2010).

Data for the study was contained from EquityRT.com. The results reveal asymmetries in the effects of these shocks on currency rates, with generally positive associations suggesting currency depreciation amidst fluctuations in global uncertainties. The study highlights mixed effects across different quantiles and market conditions. Short-term, medium-term, and long-term analyses reveal the varying effects of global uncertainties on African currency rates, which provides revelations into the dynamics shaping currency movements in Africa.

4.3.2 DESCRIPTIVE STATISTICS

Graphical representations of the original and return series of variables were presented in Figures 4.1 to 4.6. Figures 4.1 and 4.2 provide the price trends for major oil-exporting and oil-importing countries respectively. Figures 4.3 and 4.4 depicted returns of major oil-exporting currencies and returns of major oil-importing currencies, respectively. Figure 4.5 illustrates the trend of uncertainty indices while Figure 4.6 portrays returns of

uncertainty indices. Tables 4.1 and 4.2 continued with preliminary analysis. The dataset covers daily observations from 01/01/2010 to 31/12/2022.

The original series as depicted in Figure 1 shows a steady currency rate fluctuation, with some spikes in currency rate depreciation across 2015 (MAD), 2016 (NGN, ZAR), 2017 (EGP), and 2020-2022 (all oil-exporting countries). A notable depreciation as observed across all currency rates was observed during 2020–2022. Although the study observes somewhat of an appreciation of currency rates during those years, the general observation is that the study notices an upward trend which signifies currency depreciation for all oil-exporting countries. The absurd currency depreciation across all oil-exporting countries during the years 2020-2022 could be related to the effect of the COVID-19 pandemic which has a devastating impact on the economies around the world. However, the individual country-specific currency depreciation could be associated with country-specific problems.

Moreover, the study notices an improvement in currency rates getting to the end of 2022 (except for EGP). Regarding the price trends of the major oil-importing countries, the study observes similar patterns with the major oil-exporting countries. Noticeably, the study observed a depreciation in the currencies of major oil-importing countries from 2020 onwards signifying the devasting effect of the COVID-19 pandemic and to some extent, the effect of Russia's conflict with Ukraine, which affected supply of oil to oil-importing countries and hence putting stress on the currencies of oil-importing countries, thereby causing currency depreciation. The results of descriptive analysis affirm Kocaarslan and

Soytas (2024) who discovered that during a crisis like the COVID-19 pandemic, the currencies of both oil-exporting and oil-importing countries tend to depreciate, while oil prices simultaneously decline. They, however, disagree with Agyei et al. (2022) who found no impact of COVID-19 on the relationship between African currencies and stock returns in Africa.

About the returns (see Figures 4.3 and 4.4) of major oil-exporting and importing currencies, the study observes high fluctuations in currency rates for most currencies (ZAR, TND, MAD, BWP, MUR, KES, NAD, and XOF) that is, exhibiting volatility clustering. Again, the study observes that many of the oil-importing countries exhibit high levels of volatility clustering as compared to the oil-exporting countries. These results support the ARDL results of Yunusa (2020) who found that the exchange rate volatility of Nigeria's trading partners is statistically significant for all of them.

This section examines the fundamental attributes of the variables employed in the study. Consequently, the mean serves as a representation of the arithmetic average of each of the variables, the median corresponds the middle observation within the variables. The standard deviation provides insight into the temporal fluctuations within the time series, offering a measure that can elucidate the volatility present among the returns within the variables. The skewness and kurtosis encapsulate the distribution characteristics of the returns in the time series. The Jaque-Bera test examines the returns of the series for normality. The test criteria are that if the test statistics are further away from zero, then it implies that the data is not normally distributed. The Augmented Dickey-Fuller (ADF) and

Phillips and Perron Test (PP) unit root test determines whether the return series is stationary.

Table 4.1: Descriptive Statistics of Currencies

Statistics	EGP	ZAR	NGN	TND	GHS	MAD	BWP	MUR	KES	NAD	XOF
						Signal					
Mean	0.0004	0.0003	0.0003	0.0003	0.0006	0.0001	0.0002	0.0001	0.0001	0.0003	0.0001
Std. dev.	0.0111	0.0097	0.0109	0.0062	0.0102	0.0041	0.0064	0.0060	0.0030	0.0095	0.0069
Skewness	36.5558	0.3304	11.5359	-0.8298	-1.2965	0.1114	0.4504	-0.2498	-0.1329	0.2821	0.1102
Kurtosis	1698.0127	1.6692	352.4087	21.0918	38.4655	2.3036	4.0151	6.7130	22.8699	1.1208	0.1102
Jarque Bera	407172***	455.12***	175810***	63106***	209529***	756.14***	2388.7***	6390.8***	73747***	222.48***	3120.4***
ADF	-13.473***	-16.129***	-14.97***	-13.31***	-13.403***	-14.182***	-15.748***	-14.143***	-13.616***	-16.039***	-15.052***
PP	-3291***	-3311.9***	-3930***	-3931.8***	-4521***	-3428***	-3552***	-14.143***	-3226.8***	-3226.8***	-3699.5***
						M1					
Mean	0.0003	0.0001	0.0002	0.0002	0.0004	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Std. dev	0.0030	0.0024	0.0019	0.0009	0.0028	0.0009	0.0013	0.0009	0.0008	0.0024	0.0013
Skewness	9.3783	0.4459	9.5105	0.0431	-1.8062	0.3769	0.4139	1.0680	-0.9457	0.4226	-0.0892
Kurtosis	123.1865	0.2528	129.2166	0.8714	26.3959	1.4463	0.3582	6.8245	12.1389	0.1482	0.5640
Jarque Bera	21886***	121.19***	24041***	108.52***	10004***	375.64***	114.83***	7211.3***	7211.3***	103.84***	49.613***
ADF	-12.4***	-13.378***	-11.4***	-10.457***	-8.1006***	-10.811***	-15.763***	-10.231***	-10.231***	-13.341***	-14.768***
PP	-228.16***	-368.15***	-340.72***	-229.61***	-149.72***	-238.68***	-358.53***	-248.38***	-248.38***	-363.69***	-327.55***

Table 4.1 Continued

					M2						
Mean	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Std. dev	0.0028	0.0021	0.0020	0.0009	0.0027	0.0007	0.0011	0.0008	0.0002	0.0021	0.0012
Skewness	3.2357	0.0517	2.3342	0.0734	0.6291	0.1721	0.0749	0.0821	-0.2453	0.0404	-0.0447
Kurtosis	160.8396	0.7868	76.9721	1.4221	118.2738	1.1617	0.9421	4.8434	17.5958	0.6695	1.0124
Jarque Bera	36528***	89.163***	83827***	288.8***	19726***	207.49***	128.75***	3312.8***	43685***	64.433***	146.12***
ADF	-28.693***	-24.812***	-26.506***	-29.174***	-22.336***	-23.297***	-28.412***	-25.337***	-17.378***	-25.033***	-28.687***
PP	-454.86***	-339.94***	-279.93***	-369.89***	-551.13***	-451.46***	-363.72***	-490.28***	-458.39***	-343.8***	-366.34***
					M3						
Mean	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Std. dev	0.0026	0.0027	0.0024	0.0010	0.0023	0.0005	0.0015	0.0006	0.0002	0.0027	0.0016
Skewness	2.8219	-0.0024	1.4857	-0.0299	-0.5055	0.0803	0.0144	-0.0942	-1.0389	-0.0053	-0.0891
Kurtosis	166.8889	1.6206	88.0467	2.9186	59.2539	1.5412	4.1838	6.2843	19.1605	1.5461	4.6678
Jarque Bera	39305***	371.02***	109402***	1202.7***	49508***	339.23***	2469.6***	5574.9***	52367***	337.74***	3078.1***
ADF	-25.051***	-22.15***	-23.501***	-24.901***	-25.216***	-21.135***	-23.925***	-21.191***	-22.902***	-22.271***	-24.002***
PP	-217.11***	-517.8***	-562.05***	-472.53***	-456.29***	-268.39***	-447.7***	-367.66***	-499.18***	-509.71***	-446.02***

Table 4.1 Continued

	MRes										
Mean	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	0.0000	-0.0001	0.0000	0.0000	-0.0001	0.0000
Std. dev	0.0084	0.0073	0.0091	0.0053	0.0081	0.0034	0.0051	0.0053	0.0026	0.0071	0.0056
Skewness	-23.9139	-0.1007	-5.1522	1.0113	-0.3501	-0.0451	-0.2502	0.1646	0.0095	-0.0941	-0.1250
Kurtosis	1116.7493	0.9724	149.5142	26.2007	20.9960	2.1896	4.0918	5.5807	21.9165	0.7863	3.8552
Jarque Bera	176116***	139.49***	31660***	97354***	6222***	678.03***	2397.3***	4408***	67718***	92.541***	2105.7***
ADF	-18.046***	-13.215***	-15.687***	-18.928***	-14.462***	-11.986***	-14.959***	-14.328***	-27.183***	-13.334***	-14.652***
PP	-3568.3***	-3932.5***	-4349.9***	-4147.2***	-4227.9***	-3438.2***	-4017.1***	-4050***	-2671.3***	-3877.3***	-4115.6***

Note: ***, **, and * indicate significance levels of 1%, 5%, and 10% respectively. The dataset covers daily observations from 01/01/2010 to 31/12/2022. Descriptive statistics have been computed across seven distinct assessments for currency rates, spanning various frequencies including short-term, medium-term, and long-term, alongside the original series. The null hypothesis for the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests presumes the existence of unit roots. It is pertinent to note that the return series associated with the currency rates demonstrate a departure from normal distribution across all frequencies, whereas the majority of return series exhibit stationary behaviour.

Table 4.1 presents the descriptive statistics on currency rate returns across the original (signal) as well as the decomposed data at M1 (short-term), M2 and M3 (medium-term), and the M Residual (long-term) frequency levels. It can be observed that the original and the short-term series exhibit positive mean values suggesting an increased market performance. However, in the medium and long terms, the study observes zero and negative mean values respectively. From the signal, it is evident that the GHS rate has the highest mean in comparison to other currency rates. It is however not surprising that the GHS rate has the highest standard deviation indicating fluctuations in returns and higher risk. The positive skewness for many currency rates suggests a heavier right tail of the distribution indicating that there may be instances where the currency rates experienced significant appreciation in value. On the other hand, the negative skewness as shown in Table 1 might suggest that there are periods when the currency rates sharply depreciated. The kurtosis statistics largely depict leptokurtic behaviour across the original and decomposed series.

The null hypothesis of the normality for the original series as measured by the Jarque-Bera statistics is rejected at the 1% significance level, indicating that the returns are not normally distributed. Additionally, the study compares the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) test for the robustness of stationarity. It can be observed from the ADF and PP test that all the return series are stationary.

Table 4.2: Summary statistics of uncertainty indices

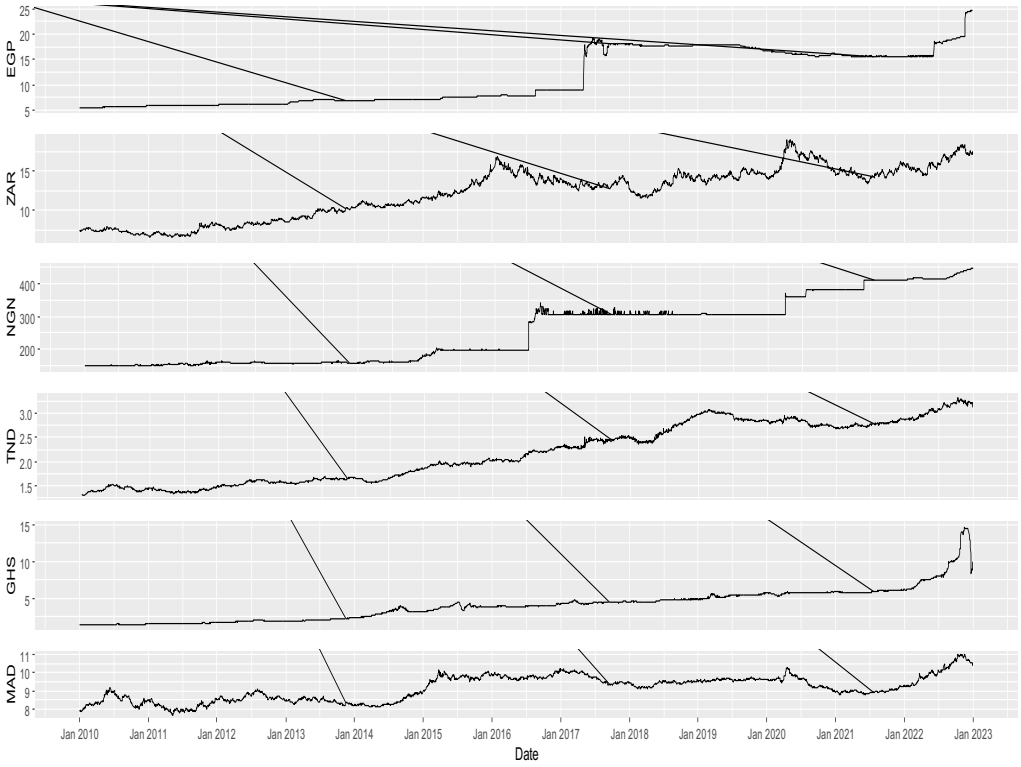
Statistics	EPU	OVX	VIX
	Signal		
Mean	-0.0001	0.0001	0.0000
Std. dev.	0.5269	0.0578	0.0752
Skewness	-0.0469	1.8036	0.7800
Kurtosis	3.8756	30.2665	4.8688
Jarque Bera	2120.4***	130976***	3686.8***
ADF	-21.768***	-14.596***	-16.441***
PP	-3591.9***	-14.596***	-3247.9***
	M1		
Mean	-0.0001	0.0000	0.0000
Std. dev.	0.1843	0.0181	0.0240
Skewness	-0.0035	0.4144	0.1396
Kurtosis	0.1087	6.4879	1.3478
Jarque Bera	1.727	6033.4***	267.73***
ADF	-23.672***	-20.454***	-20.483***
PP	-895.56***	-255.28***	-271.56***
	M2		
Mean	-0.0001	0.0000	0.0000
Std. dev.	0.1733	0.0188	0.0228
Skewness	-0.0833	0.0734	0.0332
Kurtosis	0.5885	19.3022	1.7784
Jarque Bera	53.028***	52530***	447.3***
ADF	-24.974***	-17.323***	-23.587***
PP	-3229.6***	-1001***	-1664.6***
	M3		
Mean	0.0000	0.0000	0.0000
Std. dev.	0.2301	0.0185	0.0251
Skewness	-0.0001	-0.1778	0.0139
Kurtosis	1.4667	11.8711	1.7300
Jarque Bera	303.96***	19888***	422.87***
ADF	-24.021***	-17.38***	-20.408***

Table 4.2 Continued

PP	-5605.6***	-3772.3***	-5718.7***
	Magg		
Mean	0.0000	0.0000	0.0000
Std. dev.	0.2520	0.0339	0.0425
Skewness	0.0914	-1.2175	-0.5310
Kurtosis	1.7414	14.3931	2.9221
Jarque Bera	433.04***	30044***	1364***
ADF	-23.501***	-15.775***	-11.569***
PP	-4001.5***	-6051.7***	-4850.4***

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively. The daily data observed are 3,379 for each variable sampled from 01/01/2010 to 31/12/ 2022. Descriptive statistics are presented for 7 tests for uncertainty indices at various frequencies (short-, medium-, and long-term) in addition to the original series. The null hypothesis for ADF and PP tests is the presence of unit roots. The return series for the uncertainty indices depict nonnormal distribution at all frequencies, whereas most return series are stationary.

The descriptive statistics for the uncertainty indices are depicted in Table 4.2. The observation from Table 4.2 indicates that US EPU largely has a negative mean across the original and decomposed series while OVX and VIX have positive mean values. It can also be observed that US EPU has the highest standard deviation across the original decomposed series, indicating that it transmits the most risk. Furthermore the, the JB statistics of the signal indicate that none of the series is normally distributed, except for the short-term of the US EPU. The ADF and PP statistics indicate that all return series are stationary. The associated non-normality of the data coupled with heavy tails justifies the relevance of employing an asymmetric statistical technique capable of exposing relationships across market conditions. This provides a good motivation for relying primarily on a VMD-based quantile regression approach to accommodate for the heavy tails of the data.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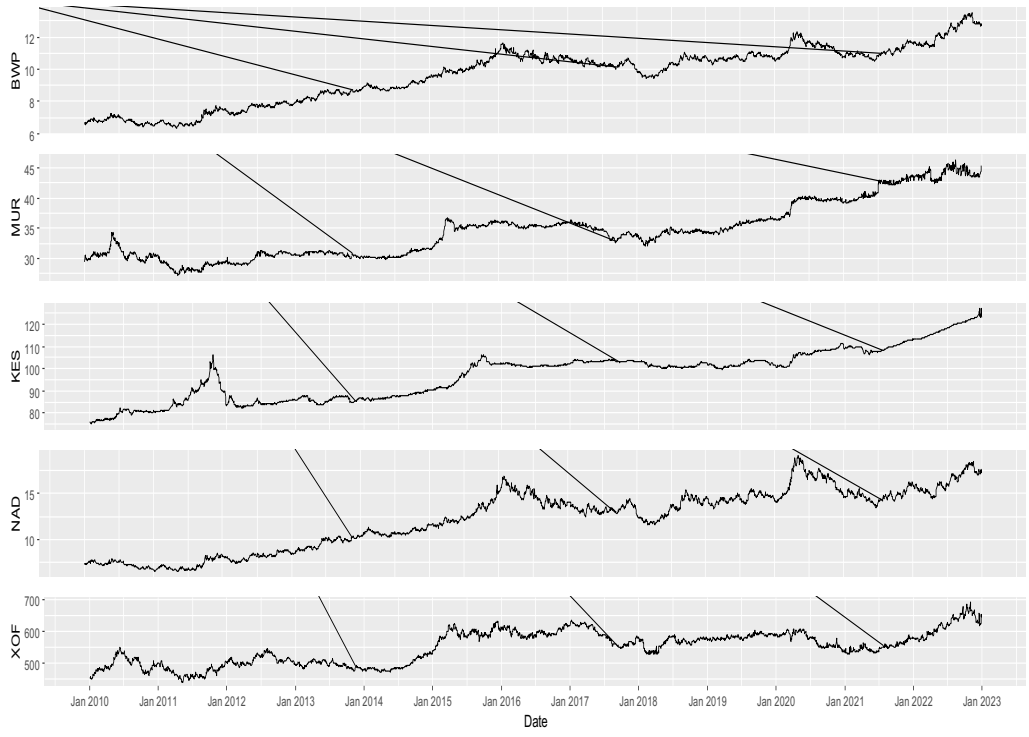
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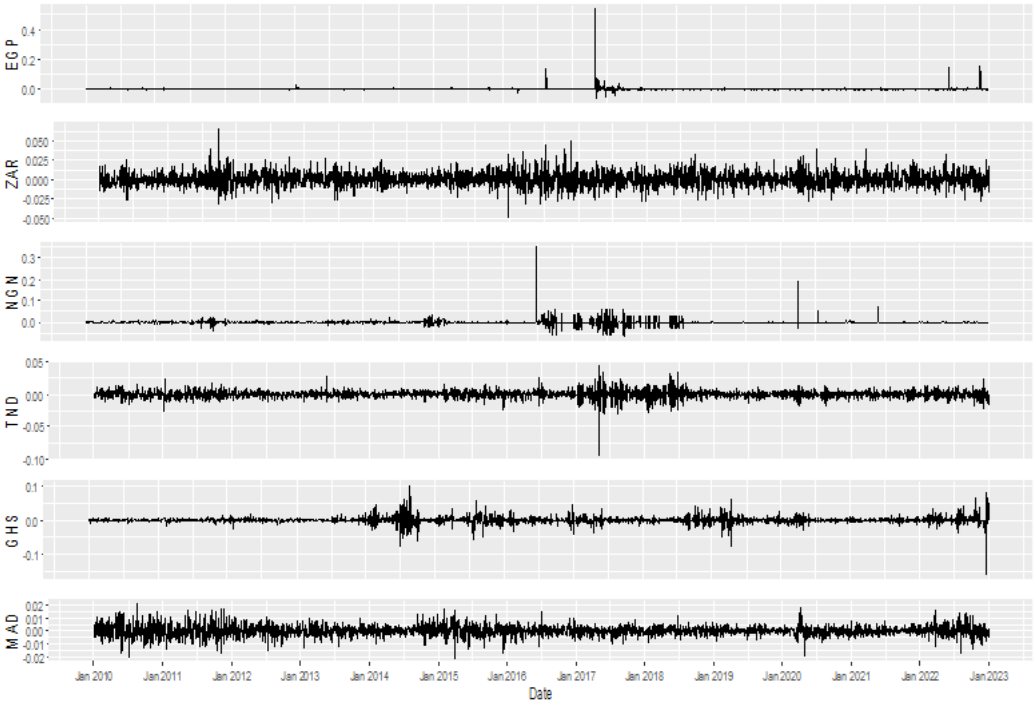
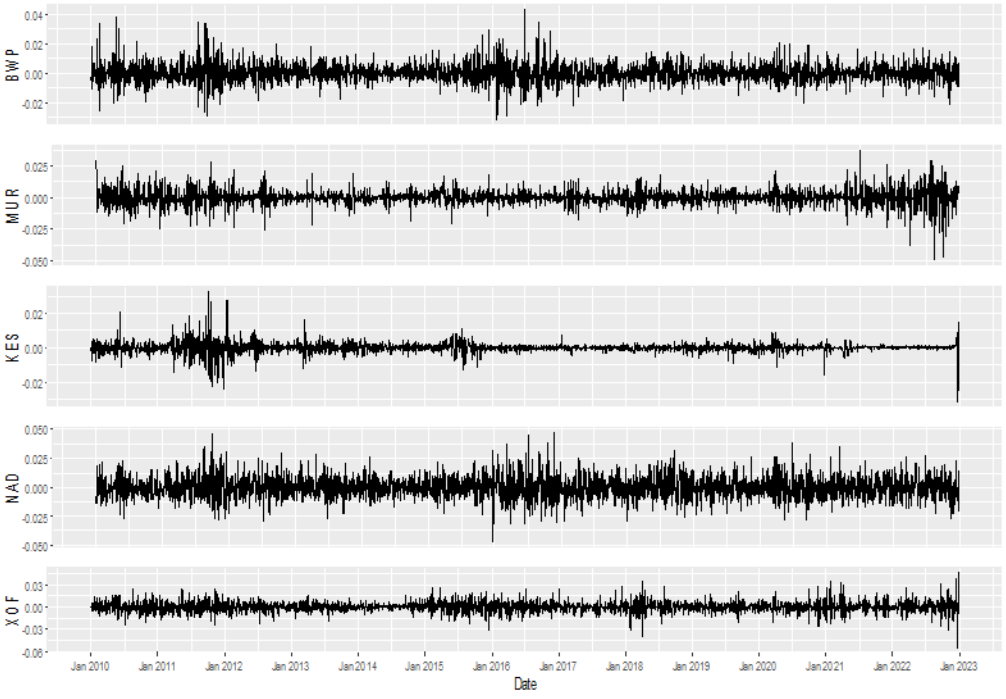


Figure 4.3: Returns of major oil-exporting currencies.



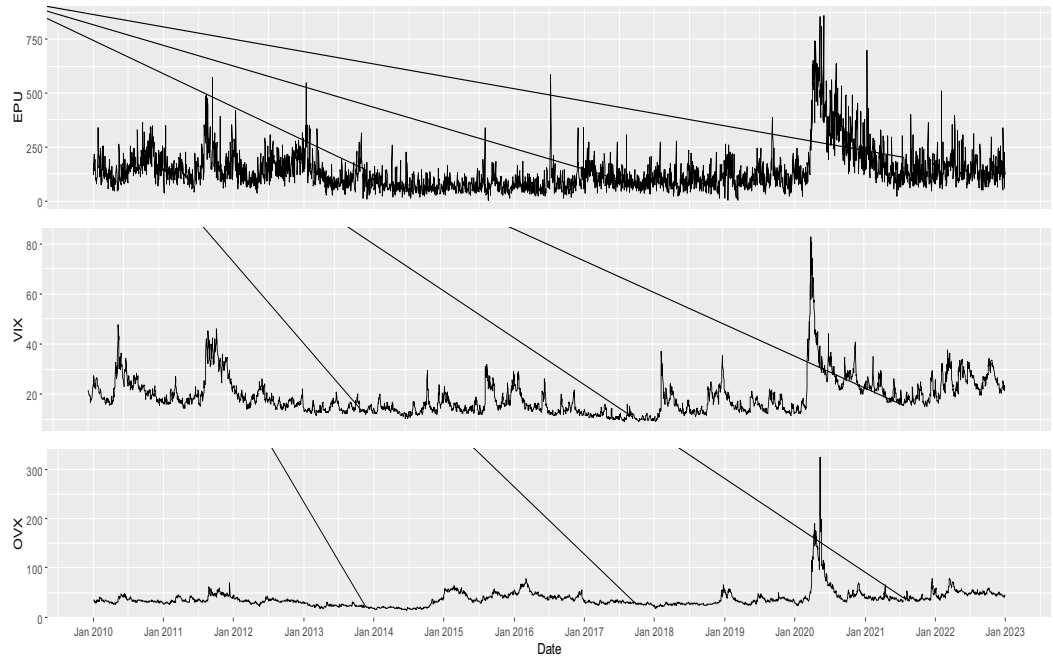
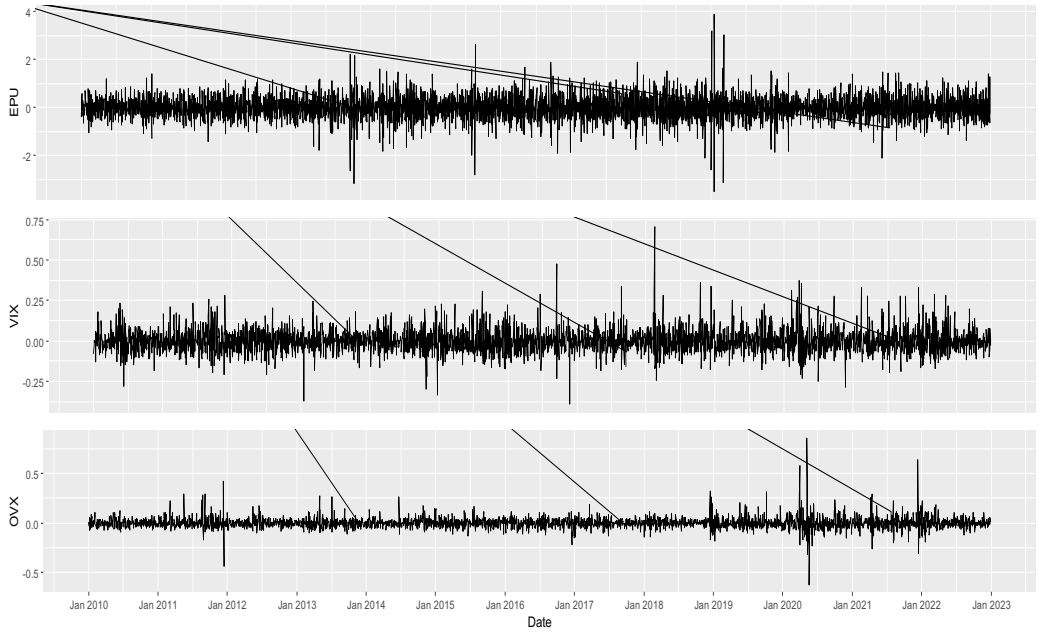


Figure 4.5: Trend of uncertainty indices



Conversely, in the case of risk and uncertainty indices (US EPU, OVX and VIX) which is depicted in Figures 4.5 and 4.6, the study observes that returns of the indices were highly volatile during the years 2020 and 2022 which reflect the spikes in the uncertainty indices during such global mishaps (COVID-19 pandemic and Russia's Invasion of Ukraine). In a general sense, it is apparent that the return series for the analysed currencies display the phenomenon of volatility clustering, aligning with the commonly observed patterns found in the dynamics of various financial assets (Adam & Owusu Junior, 2017).

4.4 MAIN RESULTS

The study presents the results of the frequency-dependent quantile regression for the original and decomposed series. This study utilizes 19 quantiles to reveal the asymmetric relationship between economic uncertainties and the African currency rates. The study defines three market conditions as (τ = 0.05, 0.10, 0.15, ... 0.95). For lower quantiles (bearish market), (τ = 0.05, 0.1, 0.15, 0.20, 0.25, 0.30) for intermediate quantiles (normal market), (τ = 0.35, 0.40, 0.45, 0.50, 0.55, 0.60) and (τ = 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95) for upper quantiles (bullish market). It is important to note that the study uses direct quotations of exchange rates in this study. In that regard, the study follows the work by Ijasan, Owusu Junior, Tweneboah, Oyedokun, and Adam (2021) examined the relationship between global REITS and exchange rates to establish that rising (bear market) values indicate depreciation of the local or domestic currency while falling (bull market) rates signify the appreciation of the local currency.

The study begins by analysing the time-varying asymmetric relation between the US EPU and the African currency rates, followed by the oil volatility index and the African currency rates lastly, the study examines the relationship between US investor fear (VIX) and the African currency rates. A summary of the discussion is provided after every section.

4.4.1 Relationship Between US EPU and African Currencies

This section of the study examines the asymmetry in the nexus between US EPU and the currency rates of major oil-exporting and importing countries across the signal and decomposed series. The study first discusses the nexus between US EPU and the currencies of major oil-exporting countries followed by the currencies of major oil-importing countries. The summary of the discussion is provided in the last paragraph.

Table 4.3: US EPU and African Currencies (Signal)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	GHS	MAD	BWP	MUR	KES	NAD	XOF
0.05	-1.74E-05	-0.0004	0.0012	0.0003	-0.0015	1.56E-05	4.96E-05	0.0009	-0.0002	-0.0003	-0.0013*
0.10	-1.06E-06	0.0003	0.0004*	-0.0004	0.0000	-7.53E-05	-0.00046	0.0009***	0.0002	0.0005	-0.0009*
0.15	-8.20E-05	0.0005	0.0002	-0.0003	0.0000	-0.00014	-0.00019	0.0007**	0.0000	0.0004	-0.0004
0.20	-9.54E-05*	0.0004	0.0000	0.0000	0.0000	-0.00019	-0.0002	0.0004*	0.0000	0.0004	-0.0004
0.25	0.000	0.0005*	0.0000	0.0000	0.0000	-0.00017	-0.00028	0.0002	0.0000	0.0005	-0.0004*
0.30	0.000	0.0003	0.0000	0.0000	0.0000	-4.01E-05	-0.00023	0.0001	0.0000	0.0003	-0.0004
0.35	0.000	0.0001	0.0000	0.0001	-0.0001	2.08E-05	-0.00028	0.0002	0.0000	0.0003	-0.0003*
0.40	0.000	0.0003	0.0000	0.0001	0.0000	4.43E-05	-1.29E-05	0.0001	0.0000	0.0004	-0.0001
0.45	0.000	0.0006*	0.0000	0.0000	0.0000	4.34E-05	2.15E-05	0.0000	0.0000	0.0008***	-0.0002
0.50	0.000	0.0007	0.0000	0.0001	0.0000	5.11E-05	0.000	0.0000	0.0000	0.0007*	0.0000
0.55	0.000	0.0007**	0.0000	0.0001	0.0000	-1.09E-05	-0.00016	0.0000	0.0001	0.0006**	-0.0001
0.60	0.000	0.0005	0.0000	0.0000	0.0001	0.000133	-6.53E-06	0.0001	0.0000	0.0005	-0.0002
0.65	0.000	0.0006	0.0000	0.0000	0.0001	0.000155	-0.00012	0.0000	0.0000	0.0007**	-0.0004
0.70	0.000	0.0003	0.0000	0.0000	0.0001	2.32E-05	-6.12E-05	0.0000	0.0000	0.0004	-0.0004
0.75	-7.60E-05	0.0001	0.0000	-0.0001	0.0003	-4.17E-05	-0.00019	0.0000	0.0001	0.0004	-0.0003
0.80	-0.00017*	-0.0002	0.0001	0.0000	0.0003	9.14E-05	-0.00018	-0.0002	0.0000	-0.0001	-0.0003
0.85	-0.00021	-0.0003	0.0002	-0.0001	0.0002	-0.00022	-0.00012	0.0001	0.0001	0.0001	-0.0004
0.90	-0.0003	-0.0004	0.0002	0.0001	-0.0002	-0.00019	5.45E-06	0.0004	0.0000	-0.0006	0.0001
0.95	-0.00022	0.0002	-0.0005	0.0010*	-0.0003	-0.0001	0.000251	0.0004	0.0001	0.0010	0.0008

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.3 presents the quantile regression coefficient estimates of the original return series. The nexus between the US EPU and the currency rates of major oil-exporting countries, the study observes that generally, the US EPU has varying effects on the currency rates of the oil-exporting countries. The study observes that US EPU has a negative impact on the lower and upper quantiles of EGP currency rates. However, the majority of the effect is deemed to be largely insignificant (with the exception of 0.20 and 0.80 quantiles). With regard to the ZAR rate, it is evident from Table 4.3 that the US EPU largely has a positive relationship with it. Specifically, US EPU has a positive significant effect on some selected quantiles in the bearish (0.25 quantile) and normal market (0.45 and 0.55 quantiles) conditions. A similar trend observed in the US EPU-ZAR rates nexus is seen in the relationship between US EPU and the currency rates of NGN, TND, GHS, and MAD. The study observes that US EPU has a positive and significant effect on NGN currency rates in the 0.10 quantile and a positive and significant effect on the 0.95 quantile of TND rate. Regarding the relationship between the US EPU and GHS rate, it is seen that the US EPU has varying but insignificant effects across the quantiles of the study. The study observes a similar trend of insignificant effect on the quantiles of the MAD rate. The findings partly support the results of Kido (2016), who found negative co-movements between higher performing currencies and US EPU, but partly contradict Krol (2014) who found that domestic and U.S. economic policy uncertainty contribute to an increase in exchange rate volatility for certain currencies analysed.

Regarding the asymmetry in the relationship between US EPU and the major oil-importing countries, the study observes that the MUR rates is mostly affected positively and significantly during bearish market conditions while NAD experiences a positive and significant effect of US EPU in some selected quantiles during normal (0.45-0.55 quantiles) and bullish market conditions (0.65 quantiles). Unlike the trend observed about the association between US EPU and the currencies of oil-importing countries, it is seen that changes in US EPU generally have an adverse effect on rates of XOF and BWP, representing an appreciation of currencies rates in light EPU changes. Again, it is worth noting that US EPU has a significant adverse effect on rates of XOF during some selected quantiles in the bearish market (0.05, 0.10, 0.25, and 0.35 quantiles). The findings resonate with the findings of Chen et al. (2020), who noted that China's Economic Policy Uncertainty (EPU) has a consistently positive and significant influence on exchange rate volatility across all quantiles. The current findings also affirm the effect of EPU on exchange rate as seen in Aimer (2021).

Table 4.4: Results of US EPU and African Currencies (M1)

	Major oil-exporting countries						Major oil-importing countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	-8.45E-05	-0.0001	0.0001	0.0002	0.0002	0.0003	1.3E-05	-0.0003	4.9E-05	-0.0002	0.0005
0.10	2.05E-05	0.0000	0.0000	0.0001	0.0000	0.0000	-5.8E-05	0.0000	5.3E-05	0.0000	0.0001
0.15	9.71E-06	0.0001	0.0001	0.0000	-0.0001	0.0001	5.7E-05	0.0000	5.3E-05	0.0002	0.0000
0.20	1.24E-05	0.0002	0.0001	0.0000	0.0000	0.0000	-1.7E-05	0.0000	-1.5E-05	0.0001	-0.0001
0.25	-1.79E-05	0.0001	0.0001	0.0000	0.0000	0.0001*	7.6E-05	0.0000	-4.3E-05	0.0000	0.0000
0.30	-2.32E-06	0.0001	0.0000	0.0000	0.0000	0.0000*	1.6E-04	0.0000	-4.0E-06	0.0000	-0.0001
0.35	-1.13E-05	0.0001	0.0000	0.0001	0.0000	0.0000*	5.8E-05	0.0000	-8.4E-06	0.0001	-0.0001
0.40	-6.31E-06	-0.0001	0.0000	0.0000	0.0000	0.0000**	-3.1E-05	0.0000	-1.0E-05	-0.0001	0.0000
0.45	3.95E-08	-0.0001	0.0000	0.0000	0.0000	0.0001*	-9.4E-05	0.0000	1.1E-05	-0.0001	0.0000
0.50	7.66E-06	-0.0002	0.0000	0.0000	0.0000	0.0000	7.0E-07	0.0000	-1.5E-06	0.0000	0.0001
0.55	2.65E-06	0.0001	0.0000	0.0000	-0.0001	0.0000	8.6E-05	0.0000	2.4E-05	0.0001	0.0000
0.60	9.52E-07	0.0002	0.0000	0.0000	0.0000	0.0000	5.3E-05	0.0000	4.2E-05	0.0000	-0.0001
0.65	-1.22E-05	0.0000	0.0000	0.0000	0.0000	0.0000	-7.0E-05	0.0000	1.8E-05	0.0000	0.0000
0.70	3.97E-06	0.0001	0.0000	0.0000	0.0000	0.0000	-1.8E-04	0.0000	2.5E-05	0.0001	0.0000
0.75	9.67E-06	0.0001	0.0000	0.0000	0.0001	-0.0001	-1.7E-04	0.0000	3.3E-05	-0.0001	0.0000
0.80	-7.29E-06	-0.0001	0.0000	0.0000	-0.0001	-0.0001	4.7E-05	0.0000	5.0E-05	0.0001	0.0000
0.85	1.41E-05	-0.0001	0.0001	0.0001	-0.0002	0.0000	-1.6E-04	0.0000	5.5E-05	-0.0001	-0.0001
0.90	-1.58E-04	-0.0002	0.0001	-0.0002	-0.0001	-0.0001	-5.8E-05	0.0000	1.0E-04	-0.0005	-0.0001
0.95	-1.40E-04	0.0002	-0.0002	-0.0002	0.0012	0.0001	1.4E-04	0.0001	5.7E-05	0.0002	-0.0002

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

The short-term relationship between US EPU and African currency rates is depicted in Table 4.4. In the short term, the study observes that the US EPU largely has a positive effect on the currencies of major oil-exporting countries. The exception is the MAD rates where the study observes a positive and significant effect of US EPU in some selected quantiles (0.25 – 0.45 quantiles) in the bearish market. About the major oil-importing countries, although the study observes varying relationships across the quantiles, these relationships are not statistically significant. This result agrees with Bartsch (2019), who ascertained that change in EPU have an immediate or rapid impact on dollar-pound exchange rate volatility.

Table 4.5: Results of US EPU and African Currencies (M2)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	1.5E-05	-0.0001	-0.0001	-0.0001	-0.0005	1.91E-05	1.0E-05	-4.70E-05	-3.0E-05	-0.0003	3.27E-05
0.10	-7.2E-05	0.0004	0.0000	-0.0002	-0.0001	2.04E-05	-1.4E-04*	6.71E-05	-8.3E-06	0.0003	-1.58E-04
0.15	-2.8E-05	0.0002	0.0002	-0.0002	0.0000	1.71E-05	-1.1E-04	-2.58E-05	1.4E-05	0.0003	-3.27E-05
0.20	-2.5E-05	0.0001	0.0000	0.0000	0.0000	-2.64E-07	-2.1E-04	4.58E-05	-6.1E-06	0.0001	-4.33E-06
0.25	-8.7E-06	0.0000	0.0000	0.0000	0.0000	1.70E-05	-8.3E-05	2.85E-05	-2.3E-05	-0.0001	-2.91E-05
0.30	2.3E-06	-0.0001	0.0000	0.0000	0.0000	1.32E-05	7.4E-06	-7.10E-06	-9.2E-06	0.0000	8.62E-06
0.35	5.8E-07	-0.0001	0.0000	0.0000	0.0000	-1.24E-05	2.5E-05	-1.82E-05	-6.8E-06	-0.0001	6.27E-06
0.40	-3.5E-06	0.0000	0.0000	0.0000	0.0000	4.11E-05	-1.3E-05	-2.49E-05	-8.8E-06	0.0000	8.57E-05
0.45	5.2E-07	0.0000	0.0000	0.0001	0.0000	4.21E-06	-2.1E-05	-6.03E-05	-1.0E-05	-0.0001	-1.22E-06
0.50	5.1E-06	0.0000	0.0000	0.0001	0.0000	-1.01E-06	9.9E-06	-6.57E-05	-5.2E-06	0.0001	-2.95E-06
0.55	2.7E-06	0.0000	0.0000	0.0001	0.0000	-2.76E-05	9.1E-05	1.29E-05	-4.1E-06	0.0000	8.96E-06
0.60	1.7E-06	0.0001	0.0000	0.0001	-0.0001	-2.19E-05	7.6E-05	-7.85E-06	-1.4E-06	0.0000	-7.54E-06
0.65	6.5E-06	0.0001	0.0000	0.0000	-0.0001	-1.25E-05	8.5E-05	7.91E-06	-3.2E-06	0.0001	3.12E-05
0.70	1.8E-06	0.0002	0.0000	0.0000	0.0000	-1.11E-05	7.0E-05	3.13E-05	2.9E-06	0.0001	-7.23E-05
0.75	-5.4E-06	0.0000	0.0000	0.0000	0.0000	-5.13E-05	8.2E-05	6.64E-05	-2.7E-06	0.0000	-2.82E-05
0.80	-8.3E-06	-0.0001	0.0000	0.0000	0.0000	-2.97E-05	1.4E-04	1.02E-04	5.7E-06	-0.0002	-1.01E-04
0.85	-3.3E-05	-0.0001	0.0001	0.0001	0.0000	-7.86E-05	1.5E-04	1.34E-05	-2.1E-06	0.0000	1.39E-05
0.90	-1.4E-05	-0.0004	0.0003	0.0002	0.0001	5.46E-05	-2.8E-05	7.91E-05	-1.1E-05	-0.0002	1.44E-04
0.95	-2.7E-04	-0.0001	0.0004	-0.0002	-0.0004	7.13E-05	-7.8E-05	8.20E-05	7.0E-05	-0.0001	1.67E-04

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.6: Results of US EPU and African Currencies (M3)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0001	-0.0001	-0.0007	0.0002	0.0002	-3.9E-05	-7.2E-05	-9.93E-05	1.7E-06	-7.13E-06	-0.0003
0.10	0.0001	0.0000	0.0000	0.0000	-0.0003	-6.5E-05	-3.4E-05	-8.60E-05	-2.0E-06	-2.17E-04	0.0000
0.15	0.0000	-0.0001	-0.0001	0.0000	-0.0002	-3.8E-05	-3.6E-06	-1.06E-05	3.6E-06	-2.34E-04	-0.0001
0.20	0.0000	0.0002	0.0000	0.0000	-0.0001	-4.3E-06	-6.5E-05	3.72E-05	-2.6E-06	-3.22E-05	-0.0001
0.25	0.0000	0.0001	0.0000	0.0000	-0.0001	3.5E-05	-3.6E-05	-9.12E-06	2.8E-07	3.98E-05	-0.0001
0.30	0.0000	0.0001	0.0000	0.0000	0.0000	-1.7E-05	2.6E-05	-3.72E-06	1.1E-06	-4.83E-05	0.0000
0.35	0.0000	0.0000	0.0000	0.0001	0.0000	-4.1E-05	-5.0E-06	3.83E-05	7.8E-07	7.50E-05	-0.0001
0.40	0.0000	0.0000	0.0000	0.0000	0.0000	-5.2E-05	3.3E-05	1.47E-05	-2.7E-06	7.25E-05	0.0000
0.45	0.0000	0.0001	0.0000	0.0001	0.0000	6.2E-06	5.7E-05	2.00E-05	-1.0E-06	-5.76E-05	-0.0001
0.50	0.0000	0.0000	0.0000	0.0001	-0.0001	1.0E-05	1.0E-04	-9.94E-07	-1.5E-07	1.01E-05	0.0000
0.55	0.0000	0.0000	0.0000	0.0000	-0.0001	-1.9E-06	1.0E-04	-9.48E-06	-1.8E-06	-3.31E-05	0.0001
0.60	0.0000	0.0001	0.0000	0.0000	0.0000	1.4E-05	8.5E-05	-8.84E-06	-6.4E-07	-1.50E-05	0.0002*
0.65	0.0000	0.0000	0.0000	-0.0001	0.0000	-2.1E-05	4.7E-05	-1.38E-05	-8.8E-07	1.24E-04	0.0001
0.70	0.0000	0.0000	0.0000	-0.0001	-0.0002	8.4E-06	-5.0E-07	2.89E-05	2.2E-07	5.12E-05	0.0000
0.75	0.0000	0.0001	0.0000	0.0000	-0.0001	-4.0E-06	-1.2E-05	-5.53E-06	5.3E-06	7.53E-05	0.0001
0.80	0.0000	0.0001	0.0001	0.0001	-0.0001	-2.0E-05	-6.3E-05	4.08E-05	3.7E-06	8.97E-05	0.0000
0.85	0.0001	0.0001	0.0000	0.0001	0.0000	-3.5E-05	-4.3E-05	4.74E-05	-4.2E-06	1.27E-04	-0.0001
0.90	0.0000	0.0002	-0.0003	0.0001	0.0003	5.1E-05	2.3E-05	1.99E-05	-1.7E-06	2.74E-04	-0.0001
0.95	-0.0001	0.0001	-0.0001	-0.0002	0.0003	7.0E-06	-2.1E-04	-6.39E-05	2.9E-05	2.99E-04	-0.0003

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Like what is observed in the short-term, Tables 5 and 6 which establish the medium-term relationship between US EPU and African currency rates also show both positive and negative associations in the nexus under study. However, these relationships are statistically insignificant. The only exception is the rates of XOF where the study observes a positive and statistically significant effect at the 0.6 quantile. The positive association between the variables is indicative of currency depreciation amidst EPU changes. The findings partly support Kido (2016) who found that the correlations between U.S. Economic Policy Uncertainty (EPU) and the returns on high-yielding currencies were consistently negative throughout the study period, whereas the correlation between U.S. EPU and the returns on the Japanese yen was consistently positive.

Table 4.7: Results of US EPU and African Currencies (M Residual)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0006	0.0015	0.0006	0.0001	-0.0006	0.0005	0.0010	-0.0002	0.000	0.0026*	0.0006
0.10	0.0001	0.0024**	-0.0006	-0.0003	-0.0001	0.0001	-0.0001	-0.0003	0.000	0.0019**	0.0006
0.15	0.0000	0.0017**	0.0002	-0.0003	0.0006	0.0001	-0.0004	-0.0002	0.000	0.0017**	0.0006
0.20	0.0000	0.0019**	0.0004*	-0.0003	0.0005	0.0005*	-0.0003	-0.0005	0.000	0.0016**	0.0003
0.25	-0.0001	0.0016**	0.0004	-0.0001	0.0001	0.0000	-0.0002	-0.0002	0.000	0.0010	-0.0001
0.30	-0.0001	0.0013**	0.0002	-0.0002	0.0002	0.0002	0.0003	-0.0002	0.000	0.0015***	-0.0003
0.35	-0.0001	0.0014***	0.0001	-0.0003	0.0004	0.0001	0.0004	0.0001	0.000	0.0016***	-0.0001
0.40	0.0000	0.0014***	0.0000	-0.0002	0.0004	0.0001	0.0002	0.0000	0.000	0.0015***	0.0000
0.45	0.0000	0.0011*	0.0000	-0.0002	0.0002	0.0002	0.0001	-0.0001	0.000	0.0013***	0.0000
0.50	0.0000	0.0011*	0.0000	-0.0003	0.0003	0.0002	-0.0001	0.0000	0.000	0.0009*	-0.0002
0.55	0.0000	0.0010*	0.0000	-0.0003	0.0003	0.0001	-0.0002	-0.0001	0.000	0.0011***	-0.0004
0.60	0.0000	0.0011*	0.0000	-0.0002	0.0003	-0.0001	-0.0002	-0.0001	0.000	0.0012**	0.0001
0.65	0.0000	0.0007	0.0000	-0.0003	0.0002	-0.0003	-0.0001	-0.0001	0.000	0.0012	-0.0003
0.70	0.0000	0.0005	0.0001	-0.0004	0.0003	-0.0003	0.0002	0.0000	0.000	0.0011*	-0.0004
0.75	0.0000	0.0006	0.0002	-0.0003	0.0003	-0.0003	-0.0001	0.0001	0.000	0.0005	-0.0006
0.80	-0.0001	0.0003	0.0002	-0.0005	0.0001	-0.0004	-0.0001	0.0007	0.000	0.0001	-0.0006
0.85	-0.0001	-0.0001	-0.0001	-0.0004	-0.0002	-0.0003	0.0004	0.0009	0.000	0.0004	-0.0012*
0.90	0.0002	0.0000	-0.0003	-0.0009*	-0.0004	0.0000	0.0006	0.0018	0.000	0.0001	-0.0015*
0.95	-0.0001	-0.0010	0.0023	-0.0018	-0.0025	-0.0003	0.0012	0.0017	0.000	-0.0006	-0.0028*

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Unlike the medium-term relationship discussed above, the long-term relationship as depicted in Table 4.7 reveals a more statistically significant relationship. The study observes that in the long term, US EPU has a positive and significant relationship with ZAR rates during bearish and normal market conditions. On the Nigerian naira, the study observes that generally, it has a positive relationship with US EPU with a 10% significant level in 0.20 quantile. A similar observation is realized in MAD rates where the study observes a positive and significant positive effect with US EPU in the bearish market (0.20 quantile). This result is consonant with Akram (2020) who found that rising geopolitical uncertainty, combined with increases in oil prices, is linked to the depreciation of currencies in oil-exporting nations.

Regarding the relationship between US EPU and oil-importing currency rates, the study observes that notably, US EPU has a positive and significant effect on most quantiles of the NAD rates. The study observes a negative and statistical relationship between US EPU and XOF in some selected quantiles in the bullish market (0.85 – 0.95 quantiles).

In summary, the study observes that there exists asymmetry in the relationship between US EPU and the returns of African currency rates. Generally, it can be observed that US EPU has a positive association with the returns of African currency rates, thereby depicting the depreciation of the respective local currencies. It is also imperative to note that the effect of US EPU on the relationship between returns of African currency rates extends into the long term, reiterating the significant role of EPU on currency rates in

Africa. The findings support the outcomes of a plethora of literature (Akram, 2020; Chen et al., 2020; Kwon & Oh, 2012; Maydybura et al., 2023).

4.4.2 Effect of Oil Volatility Index on African Currencies

This section of the study discusses the asymmetric frequency-dependent association between oil volatility uncertainty and the returns of African currencies. This section first addresses the association between OVX and the major oil-exporting countries, followed by the analysis regarding oil-importing currency rates. A summary of the findings is provided at the of the study.

Table 4.8 presents the quantile regression results (signal) of OVX and the returns of African currency rates. Regarding the relationship between OVX and the currency rates of major oil exporting currencies, the study observes that generally, OVX harms the returns of their currencies. Specifically, the study observes that during bearish market conditions, OVX has a significant adverse effect on the rates of TND and GHS. This represents an appreciation of the currency rates considering changes in OVX. This finding agrees with Korley and Giouvris (2022) who found that OVX shocks have a significant effect on exchange rates across all countries in Sub-Saharan African countries. Authors posited that the impact of OVX on exchange rates is more pronounced during bearish market conditions.

Table 4.8: Results of OVX and African currencies (Signal)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0014	-0.0014	-0.0093	-0.0122***	-0.0182*	-0.0014	0.0055	-0.0063	-0.0019	-0.0011	-0.0013
0.10	0.0008	0.0006	-0.0003	-0.0052	-0.0104***	0.0001	0.0057**	-0.0001	-0.0036	-0.0002	-0.0093*
0.15	0.0000	0.0009	0.0007	-0.0041	-0.0087***	-0.0007	0.0039	0.0013	-0.0008	-0.0008	-0.0025
0.20	0.0005	-0.0032	0.0009	-0.0017	-0.0058***	-0.0011	0.0023	0.0015	0.0001	-0.0018	-0.0016
0.25	0.0000	-0.0012	0.0003	-0.0027**	-0.0033	-0.0012	0.0016	-0.0013	-0.0003	-0.0022	-0.0008
0.30	0.0000	-0.0017	0.0002	-0.0031**	-0.0014	-0.0006	0.0036*	-0.0006	0.0000	-0.0009	0.0013
0.35	0.0000	-0.0003	0.0000	-0.0021	-0.0014	-0.0008	0.0028*	0.0003	0.0000	-0.0020	-0.0001
0.40	0.0000	-0.0003	0.0000	-0.0025	0.0000	-0.0005	0.0003	0.0004	0.0000	-0.0008	0.0009
0.45	0.0000	0.0010	0.0000	-0.0014	0.0000	-0.0003	0.0014	0.0000	0.0000	-0.0025	0.0006
0.50	0.0000	0.0027	0.0000	-0.0014	0.0000	-0.0002	0.0000	0.0000	0.0000	0.0012	0.0000
0.55	0.0000	0.0028	0.0000	-0.0016	0.0000	0.0003	-0.0014	0.0000	0.0002	0.0003	0.0002
0.60	0.0000	0.0042	0.0000	-0.0007	0.0014	-0.0008	-0.0009	0.0015	0.0000	0.0006	0.0007
0.65	0.0000	0.0000	0.0000	-0.0012	0.0020	0.0000	-0.0033*	0.0010	-0.0002	0.0007	0.0007
0.70	0.0000	-0.0011	0.0005	-0.0011	0.0006	-0.0001	-0.0020	0.0010	-0.0001	0.0001	0.0026
0.75	0.0004	0.0021	0.0004	-0.0017	0.0006	0.0005	-0.0028	0.0019	0.0000	0.0002	0.0030
0.80	-0.0001	0.0052	-0.0006	-0.0016	0.0017	0.0019	-0.0015	0.0010	0.0004	0.0018	0.0039
0.85	-0.0003	0.0068	-0.0008	0.0000	-0.0001	0.0000	-0.0031	0.0025	0.0011	0.0060	0.0062**
0.90	-0.0003	0.0086	-0.0010	0.0005	-0.0023	-0.0016	0.0000	0.0063	0.0011	0.0058	0.0100***
0.95	-0.0020	0.0077	0.0006	0.0028	0.0012	-0.0004	0.0012	0.0091	0.0021	0.0098	0.0130**

NB: $***$, $**$, and $*$ denote significance at 1%, 5%, and 10%, respectively.

The association observed between OVX, and the currencies of oil-exporting countries differs significantly from that with the currencies of oil-importing countries. Concerning the OVX-oil-importing currency nexus, the study finds that OVX generally exhibits a positive and statistically significant relationship with these currencies. Specifically, during bearish market conditions, the BWP rates are positively and statistically associated with OVX shocks. These findings support Tian, Li, and Wen (2021), who discovered that fluctuations in the OVX are the primary driver, exerting a positive influence on changes in USDCNYV1M and VXFXI during significant political and economic events.

However, the study also identifies a negative association between OVX and the BWP rates in bullish market conditions, indicating asymmetry in their relationship. A similar asymmetrical association is observed in the XOF-OVX nexus, where the study notes that during bearish market conditions, OVX negatively affects the lower quantiles of XOF rates, while a positive and significant effect of OVX is recorded on the higher quantiles of XOF. These findings align with Joo and Park (2021), who suggest that oil price uncertainty has uneven effects on stock returns, with these effects varying based on both the level of stock returns and the state of the oil market. Their research reveals that rising oil price volatility negatively impacts stock returns when both oil price volatility and stock returns are low.

It is noteworthy that the negative association between OVX and the currency returns of oil-exporting countries in Africa can be attributed to several factors, including oil price dependency, investor sentiment, monetary policy response, declines in export revenues,

and budget deficits coupled with government debt (Korley & Giouvris, 2022; Tian et al., 2021). When oil prices become volatile (as indicated by the OVX), uncertainty is introduced into the revenue streams of oil-exporting countries. This uncertainty affects their national budgets, trade balances, and ability to service debts, placing downward pressure on their currencies due to oil price dependency.

According to the adaptive market hypothesis and the heterogeneous market hypothesis, during periods of high oil price volatility, investors typically perceive oil-dependent economies as risky, leading to capital outflows. As investors divest from assets denominated in local currencies and shift their investments to safer currencies (such as the U.S. dollar or Euro), demand for the local currency decreases, resulting in depreciation (investor sentiment). To counteract capital outflows or inflationary pressures arising from oil price volatility, central banks in these oil-exporting countries may be compelled to raise interest rates or intervene in the foreign exchange market. However, if they do not act aggressively enough or their reserves are depleted, it can exacerbate currency depreciation (monetary policy response).

Additionally, volatile oil prices lead to unpredictable export earnings. For example, when oil prices drop or fluctuate dramatically, the inflow of foreign currency from oil sales diminishes, reducing the supply of foreign exchange in these economies. This deterioration in trade balances can accelerate the depreciation of the local currency. As oil prices become more volatile, governments of oil-exporting countries may face budget deficits due to reduced revenues. To cover these deficits, they may resort to borrowing or

printing money, which further weakens their currencies. The relationship between governmental fiscal stress and oil price volatility can result in a negative correlation with the currency's value.

Table 4.9: Results of OVX and African Currencies (M1)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0010	-0.0010	0.0014	0.0030	0.0054	-0.0015	-0.0039	0.0008	-0.0014	0.0000	0.0005
0.10	-0.0009	0.0005	0.0018	0.0009	0.0011	-0.0012	0.0000	-0.0007	0.0005	0.000585	0.0001
0.15	-0.0005	0.0008	0.0003	0.0002	0.0005	-0.0002	-0.0001	-0.0012	-0.0004	-0.00015	0.0000
0.20	-0.0001	0.0011	-0.0003	0.0004	0.0001	0.0005	0.0008	-0.0008	0.0009	0.001537	-0.0001
0.25	0.0004	0.0021	-0.0003	0.0010	0.0003	0.0015	0.0017	-0.0002	0.0010	0.00317	0.0000
0.30	0.0001	0.0023	0.0000	0.0009	0.0007	0.0018	0.0001	0.0003	0.0004	0.002032	-0.0001**
0.35	0.0000	0.0030*	0.0001	0.0010	0.0000	0.0019	0.0013	0.0003	0.0001	0.002126	-0.0001*
0.40	-0.0001	0.0041	0.0001	0.0008	0.0002	0.0021	0.0011	0.0003	-0.0004	0.002542	0.0000**
0.45	-0.0001	0.0039	0.0001	0.0004	0.0006	0.0019	0.0002	0.0000	-0.0005	0.003812	0.0000
0.50	-0.0001	0.0074**	0.0001	0.0001	0.0014**	0.0015	-0.0008	0.0001	-0.0004	0.0084**	0.0001
0.55	-0.0002	0.0112***	0.0001	0.0003	0.0016	0.0013	-0.0014	0.0002	-0.0001**	0.0117***	0.0000
0.60	-0.0001	0.0119***	0.0003	0.0004	0.0005	0.0012	-0.0008	0.0003	-0.0003*	0.0113***	-0.0001
0.65	0.0000	0.0100***	0.0003	0.0013	-0.0007	0.0011	0.0002	0.0000	-0.0004	0.0102***	0.0000
0.70	-0.0001	0.0080***	-0.0001	0.0008	0.0012	0.0008	-0.0011	-0.0005	0.0001	0.009***	0.0000
0.75	0.0004	0.0065**	-0.0004	0.0008	0.0022	0.0005	0.0007	-0.0005	0.0002	0.0069***	0.0000
0.80	0.0005	0.0067**	0.0002	0.0019	0.0051	-0.0006	0.0031	-0.0003	0.0000	0.0065**	0.0000
0.85	-0.0002	0.0036	0.0008	0.0019	0.0039	-0.0012	0.0051	0.0003	0.0009	0.0028	-0.0001
0.90	0.0010	0.0082	0.0028	0.0028**	0.0088	0.0037	0.0031	0.0036	0.0035**	0.0072	-0.0001**
0.95	-0.0062	0.0099	0.0066	0.0035	-0.0030	0.0041	0.0078	0.0072	0.0099***	0.0108	-0.0002***

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.9 depicts the short-term relationship between OVX and African currency rates. In the short term, the study observes that major oil-exporting currencies generally have a positive and significant effect on most oil-exporting currencies. Specifically, the study identifies a positive and significant effect of OVX on the rates of ZAR (0.35, 0.50–0.80 quantiles), TND (0.90 quantile), and GHS (0.50 quantile).

Regarding oil-importing countries, the study notes that OVX shocks have varying effects on the currency rates of these nations. For the OVX-KES nexus, the study finds a statistically significant adverse effect at certain quantiles during normal market conditions (0.55 and 0.60 quantiles) and a positive effect during bullish market conditions (0.90–0.95 quantiles). The OVX-NAD nexus, as depicted in Table 4.9, reflects a significant and positive relationship at selected quantiles during normal market conditions (0.50 and 0.60 quantiles) and bullish market conditions (0.65–0.80 quantiles). Conversely, the OVX-XOF nexus reveals a significant adverse relationship at certain quantiles during bearish (0.30 and 0.35 quantiles) and bullish market conditions (0.90 and 0.95 quantiles). These current results are consistent with previous studies, such as Nusair and Al-Khasawneh (2018) and He et al. (2022), which uncovered that oil price shocks have asymmetric impacts on stock returns, with the influence of these shocks on stock market performance varying depending on prevailing market conditions.

Table 4.10: Results of OVX and African currencies (M2)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	-0.0024	-0.0008	-0.0016	0.0007	0.0075	0.0002	-0.0023	-0.0016	0.0002	-0.0009	3.3E-05
0.10	-0.0003	-0.0044	0.0002	0.0002*	0.0028	-0.0016	-0.0030	-0.0014	0.0006	-0.0051	-1.6E-04
0.15	0.0002	-0.0005	-0.0007	-0.0016**	0.0013	-0.0013	-0.0015	-0.0011	0.0002	0.0006	-3.3E-05
0.20	0.0002	0.0000	-0.0007	-0.0015**	-0.0003	-0.0010	-0.0013	0.0000	0.0002	0.0017	-4.3E-06
0.25	0.0001	-0.0013	-0.0001	-0.0022**	-0.0002	-0.0002	0.0001	0.0000	0.0001	0.0018	-2.9E-05
0.30	0.0000	-0.0003	0.0001	-0.0011	-0.0010	0.0004	0.0002	0.0000	0.0001	0.0006	8.6E-06
0.35	0.0002	-0.0018	0.0004	-0.0007	-0.0009	0.0002	0.0007	0.0000	0.0000	-0.0022	6.3E-06
0.40	0.0000	0.0006	0.0001	0.0001	-0.0010	0.0004	0.0006	-0.0004	0.0000	0.0006	8.6E-05
0.45	0.0000	0.0019	0.0001	0.0006	-0.0008	0.0003	0.0002	-0.0003	0.0001	0.0008	-1.2E-06
0.50	-0.0001	0.0034	0.0001	0.0005	-0.0006	0.0004	0.0003	-0.0006	0.0000	0.0015	-2.9E-06
0.55	0.0000	0.0002	0.0002	0.0004	-0.0003	-0.0001	0.0003	-0.0001	0.0000	0.0008	9.0E-06
0.60	0.0001	0.0011	0.0003	-0.0004	-0.0005	0.0000	0.0005	0.0000	0.0000	0.0009	-7.5E-06
0.65	0.0000	-0.0006	0.0002	-0.0004	-0.0006	0.0001	0.0003	0.0002	0.0000	-0.0010	3.1E-05
0.70	0.0000	-0.0005	-0.0001	-0.0002	0.0001	0.0005	0.0005	0.0006	0.0000	0.0010	-7.2E-05
0.75	0.0003	0.0000	-0.0004	-0.0002	-0.0006	0.0004	0.0013	0.0011	-0.0001	0.0007	-2.8E-05
0.80	0.0000	0.0020	-0.0003	-0.0002	-0.0008	-0.0002	0.0016	0.0003	-0.0003	0.0015	-1.0E-04
0.85	0.0002	0.0025	-0.0001	-0.0007	-0.0017	-0.0005	0.0014	0.0005	-0.0004	0.0023	1.4E-05
0.90	0.0001	-0.0014	-0.0008	-0.0005	-0.0022	0.0001	0.0010	0.0006*	-0.0001	0.0003	1.4E-04
0.95	0.0007	-0.0087	-0.0038	-0.0030*	-0.0031	0.0020	0.0009	0.0003	-0.0001*	-0.0057	1.7E-04

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively

NB: ∗∗∗, ∗∗, and ∗ denote significance at 1%, 5%, and 10%, respectively

Table 4.11: Results of OVX and African Currencies (M3)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0021	-0.0008	0.0001	-0.0016	0.0013	-0.0024**	-0.0017	-0.0001	-1.55E-05	-0.0012	-0.0003
0.10	-0.0007	0.0012	0.0020	-0.0008	-0.0022	-0.0010	-0.0001	-0.0005	0.00015	-0.0004	0.0000
0.15	-0.0003	0.0019	0.0032	-0.0018	-0.0012	0.0001	-0.0001	0.0000	0.000155	0.0016	-0.0001
0.20	0.0000	-0.0001	0.0014	0.0005	-0.0008	0.0002	-0.0008	0.0003	0.000133	0.0027	-0.0001
0.25	0.0002	0.0024	0.0002	0.0000	0.0000	0.0004	0.0000	-0.0004	0.00021	0.0028	-0.0001
0.30	0.0004	0.0032	0.0003	-0.0005	-0.0007	0.0003	0.0005	-0.0002	8.49E-05	0.0010	0.0000
0.35	0.0004	0.0000	0.0005	0.0000	-0.0009	0.0004	0.0004	-0.0003	1.40E-05	0.0014	-0.0001
0.40	0.0003	0.0001	0.0001	0.0003	-0.0003	0.0003	0.0003	0.0003	9.81E-06	0.0023	0.0000
0.45	0.0001	-0.0004	0.0000	0.0005	0.0006	0.0002	0.0004	0.0007	-1.72E-05	-0.0002	-0.0001
0.50	0.0001	-0.0003	0.0000	0.0006	0.0015	-0.0001	0.0010	0.0003	-3.53E-05	-0.0007	0.0000
0.55	0.0001	-0.0001	-0.0001	0.0008	0.0007	-0.0004	-0.0004	0.0001	-2.01E-05	-0.0004	0.0001
0.60	0.0001	-0.0003	0.0000	0.0004	0.0007	-0.0002	0.0001	-0.0001	2.24E-05	-0.0007	0.0002
0.65	0.0000	-0.0032	0.0003	0.0003	0.0009	-0.0002	-0.0003	-0.0001	1.75E-05	-0.0034	0.0001
0.70	0.0000	-0.0034	-0.0001	-0.0001	0.0017	-0.0003	-0.0009	-0.0006	4.02E-05	-0.0031	0.0000
0.75	0.0003	-0.0035	-0.0005	-0.0010	0.0017	-0.0005	0.0000	-0.0006	7.32E-05	-0.0043	0.0001
0.80	0.0001	-0.0031	0.0001	0.0006	0.0020	-0.0005	-0.0015	-0.0005	0.000144	-0.0027	0.0000
0.85	-0.0008	0.0019	0.0014	0.0002	0.0003	0.0000	-0.0011	-0.0015	-2.59E-05	-0.0035	-0.0001
0.90	0.0003	0.0037	0.0028	-0.0015	-0.0009	0.0002	-0.0018	-0.0010*	2.74E-05	0.0022	-0.0001
0.95	-0.0007	0.0040	0.0038	-0.0001	-0.0019	0.0000	0.0014	-0.0001	-0.00047	0.0014	-0.0003

The medium-term relationship between OVX and African currencies is illustrated in Tables 4.10 and 4.11. In the medium term, the study reveals an asymmetry in the relationship between OVX and the returns of African currencies. Concerning the relationship between OVX and major oil-exporting currencies, the study finds that OVX has a statistically significant positive effect (0.10 quantile) and a negative effect (0.15-0.25 quantile) on the TND rate during bearish market conditions. Additionally, during bullish market conditions, a significant adverse effect is observed at the 0.95 quantile. In Table 4.11, we again note an adverse and statistically significant effect on the lower quantile of the MAD rates. It is important to emphasize that while there exists asymmetry in the relationship between OVX and the currencies of other major oil-exporting countries (EGP, ZAR, NGN, GHS), these relationships do not show statistical significance.

Regarding the relationship between OVX and the returns of currencies in oil-importing countries, Tables 4.10 and 4.11 demonstrate that asymmetry persists in the relationship between OVX and most oil-importing currencies. Specifically, the study identifies a positive and significant relationship between OVX and MUR rates at the 0.90 quantile during bullish market conditions. Furthermore, the study documents that OVX has a statistically significant adverse effect on KES rates in the bullish market.

The practical implications of the insignificant relationship between OVX and oil-exporting countries' currency returns suggest that these countries may have mechanisms in place to buffer their economies against oil price volatility. Such mechanisms could include

diversified economies, sovereign wealth funds, or effective fiscal policies (see Korley & Giouvris, 2022). The positive but insignificant relationship may indicate that market sentiment towards oil-exporting countries is not significantly influenced by short-term oil price volatility (Choi & Hong, 2020; Qin & Bai, 2022). Additionally, the asymmetry in the relationship between OVX and the currencies of oil-importing African countries implies that when OVX increases, signaling greater oil price volatility, the currencies of oil-importing countries typically depreciate. This occurs because heightened volatility generates uncertainty and risk, causing investors to retreat from these currencies. Increased oil price volatility can lead to economic instability in oil-importing nations by raising import costs, which may trigger inflation and slow economic growth. Moreover, higher oil price volatility can adversely affect foreign direct investment (FDI) and portfolio investments, as investors tend to become more cautious, leading to reduced inflows and further impacting economic growth.

Table 4.12. Results of OVX and African currencies (M Residual)

	Major Oil-Exporting Countries						Major Oil-Importing Contries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	-0.0039	0.0168***	0.0096	0.0114	0.0095	-0.0064	-0.0006**	0.0074	-0.0041	0.0169*	0.0006*
0.10	-0.0002	0.0132**	0.0016	0.0023	0.0037	-0.0022	0.0007	0.0136***	-0.0005	0.0104*	0.0006
0.15	0.0004	0.0136**	-0.0006	-0.0006	-0.0017	-0.0036*	-0.0021	0.0072	-0.0002	0.0093**	0.0006
0.20	0.0006	0.0120*	-0.0010	-0.0013	-0.0002	-0.0040**	-0.0048	0.0053	-0.0006	0.0070	0.0003
0.25	0.0004	0.0106	-0.0011	-0.0021	-0.0003	-0.0030*	-0.0019	0.0032	-0.0011	0.0074	-0.0001
0.30	0.0001	0.0097*	-0.0005	-0.0028	-0.0018	-0.0011	-0.0024	0.0027	-0.0005	0.0058	-0.0003**
0.35	0.0000	0.0119***	-0.0007	-0.0034*	-0.0010	0.0007	-0.0009	0.0031	-0.0004	0.0069	-0.0001
0.40	-0.0001	0.0093**	-0.0003	-0.0024	0.0001	-0.0006	-0.0031	0.0012	-0.0001	0.0102**	0.0000
0.45	-0.0001	0.0093*	-0.0001	-0.0013	-0.0001	-0.0008	-0.0050	0.0012	-0.0003	0.0063	0.0000
0.50	-0.0001	0.0055	-0.0001	-0.0023	0.0004	-0.0012	-0.0055*	0.0021	-0.0001	0.0071	-0.0002
0.55	0.0000	0.0074	-0.0001	-0.0012	0.0001	-0.0012	-0.0045*	0.0024	0.0002	0.0065	-0.0004
0.60	-0.0002	0.0043	-0.0001	-0.0010	-0.0012	-0.0009	-0.0052**	0.0014	0.0002	0.0061	0.0001
0.65	-0.0004	0.0067	-0.0006	-0.0026	-0.0009	-0.0006	-0.0046	0.0011	0.0000	0.0091*	-0.0003
0.70	-0.0002	0.0036	-0.0013	-0.0027	-0.0037	0.0005	-0.0046**	0.0011	-0.0005	0.0061	-0.0004
0.75	-0.0003	0.0053	-0.0019	-0.0024	-0.0029	0.0009	-0.0040	0.0006	-0.0004	0.0053	-0.0006
0.80	0.0000	0.0088*	-0.0008	-0.0036	-0.0007	0.0005	-0.0018	0.0033	-0.0006	0.0081	-0.0006
0.85	0.0012	0.0076	-0.0036	-0.0039	-0.0085	0.0012	0.0005***	0.0014	-0.0014	0.0060	-0.0012
0.90	0.0017	0.0062	-0.0094**	-0.0060	-0.0084	-0.0001	0.0037	0.0027	-0.0018	0.0073	-0.0015
0.95	0.0035	0.0078	-0.0225*	-0.0051	-0.033***	-0.0071**	0.0079	-0.0026	-0.0042	0.0085	-0.0028

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.12 presents the long-term relationship between OVX and the returns of African currencies. The study documents that the OVX has a significant and positive effect on selected quantiles of ZAR rates during bearish (0.05 – 0.35 quantiles), normal (0.40 – 0.45 quantiles), and bullish market conditions (0.80 quantile). This positive relationship observed between the OVX and ZAR rates indicates currency depreciation in response to OVX shocks. This result resonates with the findings of Tian et al. (2021).

In contrast, the study finds that other major oil-exporting currencies exhibit a significant adverse effect in response to OVX shocks. Specifically, the study reveals that NGN rates are negatively and statistically related to OVX in certain quantiles during bullish market conditions (0.90 and 0.95 quantiles). Regarding the OVX-TND nexus, a significant adverse effect is documented in a selected quantile during bearish market conditions (0.35 quantile). Additionally, GHS rates are adversely related to OVX shocks in the upper quantile, and a similar trend is observed in the MAD-OVX nexus. These findings regarding the long-term relationship between OVX and the currencies of major oil-exporting countries depict an overall adverse relationship, signifying currency appreciation in response to OVX shocks. The only exception is the ZAR rates, where a significant positive relationship is documented. These findings contradict those of Korley and Giouvris (2022), who indicated that an increase (decrease) in the OVX leads to a depreciation (appreciation) of the local currency. Their effects were consistent for both oil-importing and oil-exporting countries, although the influence of rising and falling oil prices differs between them. This partially disagrees with Akram (2020), whose findings suggest that

rising geopolitical uncertainty, coupled with an increase in oil prices, tends to weaken the currencies of oil-exporting countries.

The dynamics of OVX shocks in relation to the rates of major oil-importing countries are also depicted in Table 4.12. The general observation from the study is that there exists asymmetry in the relationship between OVX and the currency rates of major oil-exporting currencies. For instance, BWP rates are adversely related to OVX shocks in selected quantiles during bearish and normal market conditions, while a significant positive relationship is observed in the 0.85 quantile. In contrast, MUR rates exhibit a positive correlation with OVX shocks, with a similar trend observed in the OVX-NAD rates. Like the OVX-BWP relationship, the study documents that XOF responds both positively and negatively to OVX, signifying asymmetry in the relationship. In summary, the study finds that in the long term, the relationship between OVX and the rates of major oil-importing currencies is unstable, as some rates react positively (MUR, NAD) while others react negatively (BWP, XOF). Furthermore, the study documents asymmetry in the analyzed nexus, with results similar to those observed for oil-importing currencies.

From the perspective of portfolio balance theory, the negative response of the BWP to OVX shocks during bearish and normal market conditions indicates that investors may sell off the currency as oil prices become volatile. This behaviours reflects an attempt by investors to minimize risk by reallocating their portfolios away from currencies perceived as unstable due to fluctuating oil prices. The significant positive relationship between the BWP and OVX at the 0.85 quantiles suggests that in more stable conditions, investors

might view the BWP as a haven or favourable investment, leading to increased demand for the currency. This reflects how investor sentiment can shift based on market conditions, thereby affecting currency valuation (Branson et al., 1977; Efuntade & Efuntade, 2023). The positive correlation of MUR with OVX shocks indicates that some investors perceive opportunities in Mauritian assets amid oil volatility. This variation among currencies demonstrates the portfolio rebalancing behavior of investors based on their perceptions of risk and return, contributing to the asymmetric relationships observed (You et al., 2017).

In the context of heterogeneous market hypothesis (HMH), the observed asymmetry in the OVX-BWP and OVX-MUR relationships can be attributed to the differing strategies employed by investors. For instance, short-term investors may react quickly to OVX shocks by selling the BWP, resulting in negative correlations during uncertain periods. In contrast, long-term investors may hold onto the currency, expecting recovery once volatility subsides, which leads to the positive correlation observed in more stable conditions (Bekaert & Harvey, 2003). The instability of the relationship between OVX and the exchange rates of major oil-importing currencies, such as the BWP and XOF, suggests that investor sentiment and market conditions can shift significantly over time. Different investor horizons contribute to this instability, as some currencies react positively (like the MUR and NAD) while others react negatively (like the BWP and XOF) to OVX shocks, reflecting the heterogeneous nature of market participants (Dornbusch, 1976). The finding that XOF relates both positively and negatively to OVX illustrates how different investor groups interpret oil price movements differently, leading to asymmetric responses

based on their individual strategies and market outlooks. This variation underscores the influence of the heterogeneous market hypothesis on currency valuation dynamics.

Conversely, for oil-exporting countries, when the OVX rises, these countries may experience currency appreciation in the short term. This phenomenon occurs because higher volatility can sometimes signal potential increases in oil prices, benefiting oil exporters with increased revenues, at least in the short term. The SICFT explains that information regarding rising oil price volatility creates an expectation of higher revenues from oil exports. This positive market sentiment may lead to increased demand for the local currency, as international buyers need it to purchase oil exports, ultimately resulting in currency appreciation (Kilian, 2009; Zhang & Wei, 2010).

In summary, the relationship between OVX and the rates of African currencies is observed to be asymmetric and varies over time. Specifically, the study documents that in the short term, the OVX is positively and significantly associated with the currencies of most oil-exporting countries, while the relationship with oil-importing countries fluctuates between positive and negative. In the medium term, the OVX is found to negatively relate to most oil-exporting countries, while a mixed effect is observed for the currency rates of importing countries. In the long term, the OVX largely adversely affects major oil-exporting countries, signifying currency appreciation in response to OVX shocks. Conversely, the study documents that the relationship between OVX and the currencies of oil-importing countries is not constant; it varies across different countries.

4.4.3 Market Sentiment and the Currencies of African Countries

This section of the study discusses the asymmetric frequency-dependent association between market sentiments and the returns of African currency rates. This section first addresses the association between VIX and the currencies of major oil-exporting countries, followed by the analysis regarding oil-importing currency rates.

Table 4.13: Results of VIX and African currencies (Signal)

	Major Oil-Exporting Countries						Major Oil-importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	4.47E-05	0.0011	-0.0035	-0.0003	0.0059	0.0012	0.0053**	-0.0006	0.0019	0.0045	0.0020
0.10	0.0004	0.0000	-0.0015	-0.0023	0.0016	0.0006	0.0053	-0.0028	-0.0002	0.0016	0.0032
0.15	0.0002	0.0006	-0.0008	0.0001	0.0002	0.0002	0.0053	0.0003	-0.0014	0.0010	0.0035**
0.20	0.0006	0.0007	-0.0001	0.0005	0.0011	0.0003	0.0053	0.0007	-0.0007	0.0015	0.0027
0.25	0.000	-0.0010	0.0000	0.0005	0.0006	-0.0001	0.0053	0.0020	-0.0012*	0.0000	0.0020
0.30	0.000	0.0000	-0.0001	-0.0001	0.0004	0.0007	0.0053	0.0006	-0.0006	0.0002	0.0032
0.35	0.000	-0.0001	0.0000	-0.0004	0.0007	0.0008	0.0053**	0.0002	-0.0014*	0.0002	0.0033***
0.40	0.000	-0.0016	0.0000	-0.0002	0.0000	0.0005	0.0053	0.0006	0.0000	-0.0012	0.0028***
0.45	0.000	-0.0003	0.0000	0.0004	0.0000	0.0004	0.0053*	0.0000	0.0000	-0.0003	0.0016
0.50	0.000	-0.0009	0.0000	-0.0004	0.0000	0.0005	0.0053	0.0000	0.0000	0.0000	0.0002
0.55	0.000	0.0001	0.0000	-0.0002	0.0000	0.0007	0.0053	0.0000	-0.0009	0.0013	0.0017
0.60	0.000	-0.0014	0.0002*	-0.0008	0.0016	0.0010	0.0053	0.0024**	-0.0001	0.0015	0.0012
0.65	0.000	-0.0007	0.0000	-0.0006	0.0021	0.0013	0.0053***	0.0011	-0.0004	0.0007	0.0015
0.70	0.000	0.0028	0.0000	0.0012	0.0021	0.0011	0.0053**	0.0001	-0.0005	0.0028	0.0016
0.75	0.001	0.0019	0.0003	0.0009	0.0035**	0.0020*	0.0053**	0.0003	-0.0007	0.0042	0.0016
0.80	0.002*	0.0014	0.0005	0.0007	0.0051***	0.0018	0.0053	0.0003	-0.0008	0.0027	0.0013
0.85	0.001	0.0002	0.0005	0.0008	0.0047	0.0019	0.0053	-0.0002	-0.0009	0.0010	0.0019
0.90	-1.38E-05	-0.0002	0.0018	-0.0008	0.0050	0.0006	0.0053	-0.0017	-0.0011	0.0012	-0.0004
0.95	0.001	0.0010	0.0054	0.0009	0.0089	-0.0002	0.0053	-0.0012	-0.0014	0.0087	-0.0009

Note: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.13 depicts the original series on the relationship between market sentiment (VIX) and the currencies of African countries. Regarding the relationship between the VIX and the currencies of major oil-exporting countries, the study generally finds that the VIX has a positive and significant relationship with these currencies. This indicates currency depreciation in response to an upsurge in the VIX. Specifically, the study observes that the VIX positively and significantly affects the 0.80 quantiles of EGP rates, the 0.60 quantiles of EGP rates, the 0.75 and 0.80 quantiles of GHS rates, and the 0.75 quantiles of MAD rates. Significant associations were evident between normal and booming market conditions for oil-exporting countries in Africa, suggesting that the currencies of these nations depreciate when market sentiment rises in stable and improving markets. This result aligns with Vuong et al. (2022), who found that an increase in the VIX index positively influences corporate market leverage. However, this finding contradicts Shang and Hamori (2021), whose results demonstrated that the sentiment index acts as a receiver of directional spillovers in its relationship with both oil-exporting and oil-importing countries.

Concerning the relationship between the VIX and the currencies of major oil-importing countries, the study documents that the VIX has a positive and statistically significant relationship with selected quantiles of the BWP rates during bearish market conditions (0.05 quantile), normal market conditions (0.35 and 0.40 quantiles), and bullish market conditions (0.65 – 0.75 quantiles). A similar observation is noted in the VIX-MUR and VIX-XOF relationships. However, the dynamics between the VIX and KES rates depict a

negative and significant relationship, indicating currency appreciation in response to changes in the VIX. The findings demonstrate that the short-run behaviour of market participants translates into long-run effects. This aligns with the work of Filippou, Taylor, and Wang (2024), who, after analyzing 48 foreign exchange (FX) rates and 1.2 million FX-related news articles over 35 years using digital text analysis, discovered that a currency reversal investment strategy—buying currencies with low media sentiment and selling those with high sentiment—yields substantial positive and statistically significant returns.

As established by the situated information content flow, adaptive market hypothesis, and heterogeneous market hypothesis, market participants are sensitive to information flow; thus, rising volatility often leads to increased risk aversion among investors. This may result in capital outflows from African oil-importing countries as investors seek safer assets, ultimately leading to currency depreciation. The real economic consequence of this devaluation may be increased import prices, driving inflation, which can reduce purchasing power. Such developments could prompt stricter monetary policies, potentially slowing down economic growth (Akinlo, 2024).

Table 4.14. Results of VIX and African currencies (M1)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	-0.0030	0.0030	0.0014	-5.97E-05	0.0006	-0.0018	7.19E-05	-0.0020	-0.0008	0.0030	0.0028
0.10	0.0000	0.0000	0.0018	-4.69E-05	-0.0015	-0.0008	-0.00026	-0.0003	0.0000	0.0000	0.0015
0.15	-0.0005	0.0024	0.0003	-0.00046	-0.0005	-0.0003	-0.00081	-0.0006	0.0001	0.0024	0.0017
0.20	-0.0003	0.0015	-0.0003	-0.00116	0.0000	0.0005	-0.00093	-0.0004	-0.0002	0.0015	0.0014
0.25	-0.0004	0.0013	-0.0003	-0.00089	-0.0006	0.0009	-0.00012	-0.0003	0.0002	0.0013	-0.0001
0.30	-0.0002	0.0013	0.0000	-0.00081	-0.0009	0.0007	0.000295	-0.0001	-0.0001	0.0013	0.0000
0.35	-0.0002	0.0012	0.0001	-0.00072	-0.0008	0.0001	0.000846	0.0000	-0.0001	0.0012	0.0007
0.40	-0.0002	0.0019	0.0001	-0.00046	-0.0002	0.0000	0.000745	-0.0001	-0.0002	0.0019	0.0009
0.45	-0.0001	0.0005	0.0001	7.45E-05	-0.0001	0.0001	0.000628	-0.0001	-0.0003	0.0005	0.0004
0.50	-0.0001	0.0003	0.0001	0.000248	0.0001	-0.0003	0.00141	-0.0001	-0.0004	0.0003	0.0000
0.55	-0.0002	0.0012	0.0001	0.000698	-0.0001	-0.0001	0.001832**	-0.0002	-0.0006	0.0012	-0.0007
0.60	-0.0002	0.0010	0.0003	0.001505**	-0.0003	-0.0004	0.001893	-0.0005	-0.0006	0.0010	-0.0006
0.65	-0.0003	0.0011	0.0003	0.001009	0.0005	-0.0005	0.001124	-0.0001	-0.0005	0.0011	-0.0006
0.70	-0.0002	0.0020	-0.0001	0.000544	0.0008	-0.0013*	-8.40E-05	-0.0002	-0.0003	0.0020	-0.0004
0.75	-0.0003	0.0027	-0.0004	4.15E-05	0.0013	-0.0014*	-0.00077	-0.0002	-0.0003	0.0027	0.0002
0.80	-0.0001	0.0047*	0.0002	0.000479	0.0022	-0.0009	-0.00092	0.0001	-0.0001	0.0047	0.0007
0.85	-0.0001	0.0019	0.0008	0.000901	0.0022	0.0000	-0.00055	0.0003	0.0002	0.0019	0.0009
0.90	0.0000	0.0041	0.0028	-0.00045	0.0023	-0.0004	-0.00058	0.0009	-0.0017	0.0041	-0.0001
0.95	-0.0052	0.0015	0.0066	0.000455	-0.0017	-0.0007	0.003864	0.0002	-0.0001	0.0015	0.0034

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.14 demonstrates that the VIX exhibits a positive and significant relationship with several oil-exporting currencies, except the VIX-MAD rates, which show a negative significant effect. Specifically, the VIX negatively impacts the ZAR rates at the 0.80 quantiles, and the TND rates at the 0.60 quantiles, and shows a significant adverse relationship with the MAD rates at the 0.70 and 0.75 quantiles. In contrast, the analysis indicates a positive and significant relationship between the VIX and BWP rates at the 0.55 quantile. However, the study finds that the relationship between the VIX and the currencies of other oil-importing nations is not statistically significant.

These findings suggest an asymmetric outcome in the short run. The adverse effects align with Hwang and Lee's (2022) findings, which indicated that currency values tend to increase based on market sentiment, with appreciation occurring rapidly within a short timeframe. Conversely, the short-run positive associations noted differ from Hwang and Lee's conclusions. Given the positive influence of the US Economic Policy Uncertainty (EPU) on the currencies of major oil-exporting countries, investors should consider increasing their investments in these nations, particularly in sectors directly related to oil exports, such as energy, logistics, and infrastructure development.

Table 4.15: Results of VIX and African currencies (M2)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0001	0.0007	-1.77E-05	-0.0017	0.0046	0.0008	0.0009	0.0015	3.84E-05	0.0017	-0.0026
0.10	0.0012	-0.0011	-0.00226	-0.0014	0.0008	-0.0003	-0.0006	-0.0003	-6.15E-05	0.0005	0.0004
0.15	0.0001	-0.0021	-0.00169	-0.0003	-0.0012	-0.0001	-0.0007	-0.0002	0.000204	-0.0006	0.0005
0.20	-0.0001	-0.0013	-0.00034	-0.0009	-0.0012	-0.0001	-0.0014	-0.0003	5.45E-05	0.0005	0.0002
0.25	0.0000	-0.0014	-0.00017	-0.0007	-0.0005	0.0005	-0.0002	-0.0002	-3.69E-05	-0.0004	0.0010
0.30	-0.0001	-0.0019	2.12E-05	-0.0005	-0.0005	0.0005	-0.0003	0.0000	-6.08E-05	-0.0030	0.0014
0.35	0.0000	-0.0020	-0.0001	-0.0001	0.0000	0.0002	0.0001	0.0000	-1.33E-05	-0.0035*	0.0005
0.40	0.0000	-0.0022	-0.00016	0.0005	0.0002	0.0003	-0.0001	0.0003	-3.80E-05	-0.0022	0.0004
0.45	0.0000	-0.0020	-0.00011	0.0001	0.0005	0.0004	-0.0005	0.0007	-6.47E-05	-0.0024	0.0005
0.50	0.0000	-0.0032	-4.96E-05	0.0001	0.0003	0.0007	-0.0008	0.0007	-3.74E-05	-0.0025	0.0012
0.55	0.0000	-0.0031	-6.80E-05	0.0002	0.0004	0.0005	0.0001	0.0005	-6.85E-05	-0.0035*	0.0015*
0.60	0.0002	-0.0022	-8.85E-05	0.0002	0.0002	0.0001	-0.0004	0.0000	-4.94E-05	-0.0041**	0.0010
0.65	0.0002	-0.0021	-8.03E-05	-0.0003	0.0004	0.0000	-0.0002	-0.0001	-6.04E-05	-0.0027	0.0005
0.70	0.0003	-0.0011	0.000179	-0.0004	0.0009	-0.0004	-0.0002	-0.0002	-1.06E-05	-0.0019	0.0013
0.75	0.0000	-0.0014	0.000422	-0.0003	0.0006	-0.0001	-0.0007	0.0003	-0.00011	-0.0013	0.0009
0.80	0.0000	0.0001	0.00035	0.0000	0.0014	-0.0003	0.0000	0.0002	-2.67E-05	0.0008	0.0000
0.85	-0.0001	0.0011	0.000296	0.0003	0.0025	-0.0005	0.0003	0.0005	7.16E-05	-0.0001	-0.0012
0.90	-0.0003	0.0035	-0.00018	0.0001	0.0020	-0.0007	-0.0001	0.0003	-2.44E-05	0.0028	-0.0028
0.95	-0.0010	0.0030	0.000159	0.0009	-0.0045	-0.0008	-0.0011	0.0011	0.001056	0.0025	-0.0015

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4.16: Results of VIX and African currencies (M3)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	-0.0003	0.0071	-0.0059	-0.0013	-0.0026	0.0008	0.0047**	0.0008	-0.0002	0.0053	-0.0008
0.10	-0.0004	-0.0023	-0.0026	-0.0013	0.0028	-0.0001	0.0025*	-0.0008	0.0000	0.0020	-0.0005
0.15	0.0001	0.0005	-0.0011	-0.0002	0.0009	-0.0004	0.0011	0.0001	0.0000	0.0001	0.0007
0.20	0.0001	-0.0004	-0.0001	0.0002	0.0006	-0.0001	-0.0002	-0.0002	-0.0001	0.0002	0.0000
0.25	0.0001	-0.0010	0.0000	0.0005	0.0000	-0.0004	-0.0001	-0.0001	0.0000	-0.0022	0.0003
0.30	-0.0001	-0.0014	0.0004	0.0006	-0.0001	-0.0003	-0.0006	0.0000	0.0000	-0.0016	0.0004
0.35	0.0000	-0.0005	0.0002	0.0009	-0.0007	-0.0003	-0.0008	0.0001	0.0000	-0.0011	0.0002
0.40	0.0000	-0.0016	0.0000	0.0006	-0.0007	-0.0001	-0.0013	-0.0001	0.0000	-0.0019	0.0012
0.45	0.0000	-0.0007	0.0001	0.0005	-0.0010	0.0002	-0.0017	-0.0001	0.0000	-0.0005	0.0016
0.50	0.0000	-0.0001	0.0000	0.0008	-0.0013	0.0001	-0.0017	0.0001	0.0000	-0.0011	0.0012
0.55	0.0000	0.0002	0.0000	0.0004	-0.0005	0.0003	-0.0006	-0.0001	0.0000	-0.0005	0.0016
0.60	0.0001	0.0000	-0.0002	0.0002	-0.0007	0.0000	-0.0007	-0.0001	0.0000	0.0006	0.0007
0.65	0.0001	0.0018	-0.0003	0.0002	-0.0008	0.0002	-0.0010	0.0000	0.0000	0.0009	0.0009
0.70	0.0002	0.0015	0.0002	0.0004	-0.0009	0.0003	-0.0006	0.0000	0.0000	0.0017	0.0005
0.75	0.0002	0.0012	0.0003	-0.0001	0.0003	0.0004	0.0000	0.0001	0.0000	0.0002	0.0005
0.80	0.0003	-0.0003	0.0004	0.0004	0.0004	0.0000	0.0005	0.0002	0.0000	0.0009	0.0010
0.85	0.0002	-0.0017	0.0013	0.0006	0.0002	0.0003	0.0007	0.0003	0.0000	-0.0002	0.0006
0.90	0.0000	0.0006	-0.0020	-0.0018	0.0008	0.0006	0.0002	0.0004	0.0000	0.0012	-0.0019
0.95	-0.0014	0.0018	-0.0061	-0.0034	0.0019	-0.0003	0.0000	0.0000	0.0003	0.0043	-0.0011

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Tables 4.15 and 4.16 show the medium-term relationship between VIX and the currencies of African currencies. Regarding the relationship between VIX and the currencies of major-exporting countries, the study documents that VIX has no significant statistical effect on the currencies of major oil-exporting countries' currencies. This depicts that at stable market conditions, the currencies of major oil-exporting countries' currencies in Africa are independent of investor sentiment. The results contradict prior studies such as Akinlo, (2024), Hwang and Lee (2022), Filippou et al. (2024), Shang and Hamori (2021), and Vuong et al. (2022).

Regarding the medium-term relationship between VIX and the currencies of oil-importing countries, the study documents that OVX hurts the relationship between NAD rates during some selected quantiles in bearish and normal market conditions, a similar trend is observed in the VIX-BWP rates as observed in Table 4.16. On the other hand, the study observes that VIX has a positive and statistically significant effect on the 0.50 quantile of the XOF rates. These findings align with Akinlo (2024), Hwang and Lee (2022), Filippou et al. (2024). From the practical view, the result suggests that in periods of oil price volatility, investors may react negatively, leading to the depreciation of the NAD and BWP as they reassess risk and reallocate their portfolios. In contrast, a positive and statistically significant effect on the 0.50 quantile suggests that during periods of moderate volatility, investors might view the XOF more favourably, possibly due to its relative stability or safe-haven status in the context of oil price fluctuations. The positive relationship at the 0.50 quantile indicates that while some investors react negatively to rising volatility, others may see opportunities or safety in holding the XOF, which aligns with the heterogeneous

market hypothesis. Different investor profiles, with varying risk appetites and expectations, create diverse reactions to the same market signals (Harrison & Kreps, 1978). The findings further support HMH as risk-averse investors tend to sell off currencies perceived to be under pressure from oil price fluctuations, reflecting their tendency to minimize exposure to risk.

Table 4.17: Results of VIX and African currencies (M Residual)

	Major Oil-Exporting Countries						Major Oil-Importing Countries				
Quantiles	EGP	ZAR	NGN	TND	Ghana	MAD	BWP	MUR	KES	NAD	XOF
0.05	0.0042	-0.0024	0.0067	-0.0013	0.0067	0.0016	0.0012	0.0021	-0.0041	-0.0050	0.0012
0.10	0.0005	0.0076	0.0033	-0.0021	0.0026	0.0018	0.0037	-0.0036	-0.0033	0.0037	0.0009
0.15	0.0007	0.0070	0.0015	-0.0009	0.0039	0.0003	0.0021	-0.0016	-0.0029	0.0040	0.0049
0.20	0.0005	0.0078*	0.0019	0.0022	0.0014	0.0012	0.0040	0.0017	-0.0024	0.0086*	0.0019
0.25	0.0006	0.0032	0.0009	0.0007	0.0003	0.0009	0.0035	0.0028	-0.0020	0.0067*	0.0003
0.30	0.0002	0.0018	0.0006	0.0008	-0.0008	0.0011	0.0024	0.0020	-0.0017	0.0021	0.0012
0.35	0.0003	0.0022	0.0000	-0.0011	-0.0002	0.0017	0.0037	0.0018	-0.0016	0.0033	0.0004
0.40	0.0000	0.0002	0.0000	-0.0020	0.0000	0.0019	0.0001	0.0016	-0.0014	0.0018	0.0009
0.45	0.0000	0.0003	0.0001	-0.0013	-0.0002	0.0016	-0.0010	0.0015	-0.0009	0.0009	0.0023
0.50	0.0000	-0.0002	0.0000	-0.0008	0.0000	0.0023	-0.0014	0.0011	-0.0009	0.0012	0.0016
0.55	0.0000	0.0011	0.0000	-0.0001	-0.0007	0.0020	-0.0003	0.0002	-0.0009	0.0010	0.0032
0.60	0.0002	-0.0006	0.0002	0.0011	-0.0004	0.0021	-0.0012	0.0014	-0.0012	0.0034	0.0045**
0.65	-0.0002	-0.0009	-0.0001	0.0005	0.0002	0.0015	-0.0003	0.0014	-0.0011	-0.0004	0.0031
0.70	-0.0001	-0.0010	-0.0004	0.0014	0.0016	0.0015	-0.0015	0.0013	-0.0016	0.0004	0.0026
0.75	0.0000	-0.0022	-0.0007	0.0011	0.0021	0.0027**	-0.0008	0.0022	-0.0013	0.0022	0.0040
0.80	0.0003	-0.0010	-0.0005	0.0023	0.0016	0.0003	-0.0008	0.0026	-0.0012	0.0028	0.0051
0.85	0.0011	0.0035	0.0007	0.0038	-0.0028	0.0015	0.0021	-0.0002	-0.0023	0.0034	0.0039
0.90	0.0011	-0.0025	-0.0034	0.0001	0.0004	0.0003	0.0042	-0.0043	-0.0033	0.0021	0.0071
0.95	0.0018	-0.0027	-0.0209**	-0.0019**	-0.0186	0.0034	0.0067	0.0001	0.0012	-0.0001	0.0123*

NB: ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

In the long-term, Table 4.17 reveals that VIX has a positive and significant effect on the 0.20 quantile of the ZAR rates and the 0.75 quantile of MAD rates. The positive association conforms to Aimer (2021), whose ARDL results indicated that VIX index had a long-term positive effect on the Brazilian real. The study however observes that VIX harms the bullish market of NGN and TND rates. The pragmatic implication is that VIX's positive and significant effect on specific quantiles of exchange rates for the South African rand (ZAR) and Moroccan dirham (MAD). This implies that the relationship between volatility and exchange rates is not uniform across the distribution. The 0.20 quantile of ZAR and 0.75 quantile of MAD suggests that VIX influences both lower and higher ranges of currency movements differently, which highlights the need for quantile regression analysis in econometrics. Unlike standard models focusing on mean effects, quantile analysis provides deeper insights into how different parts of the exchange rate distribution react to volatility. Also, the positive effect on ZAR and MAD but a negative impact on the bullish trends of others (NGN and TND) suggests asymmetry in how currencies respond to global market volatility. This has implications for modelling exchange rates under stress or uncertainty, indicating that traditional linear models may be insufficient. The results affirm the argument of Portfolio balance theory and HMH.

Portfolio balance theory also emphasizes that investors demand higher risk premiums for currencies associated with volatile commodities like oil. This means that, in times of heightened VIX, currencies of oil-exporting countries could experience sharper declines relative to non-commodity-based currencies. Asymmetry arises because investors' perceptions of risk differ across these currencies based on their reliance on oil and the

broader economic structure (Arezki, Candelon & Sy 2011). Long-term and short-term investors may react differently to volatility as opined by HMH. Short-term investors might quickly sell off currencies like NGN or ZAR during periods of high VIX, leading to immediate depreciation. Meanwhile, long-term investors, focusing on future oil price recoveries, might hold on to these currencies, expecting a rebound. This behavior creates an asymmetric relationship where the immediate impact of rising VIX is negative, but over time, the currencies may partially recover as long-term investors adjust their expectations (Bekaert et al., 2002). During high-VIX periods, the currencies of countries with greater perceived risk (like NGN) may experience more dramatic depreciation compared to those with more stable economies.

Regarding the long-term relationship between VIX and XOF rates, the study reveals the VIX has a positive and significant effect on the bearish and normal markets of NAD and XOF rates respectively. The study further observes that VIX positively relates with the upper quantile of XOF rates. The positive effect of VIX on bearish and normal markets for NAD and XOF suggests that during periods of increased market volatility, investors may seek safety or alternative investments, which could lead to a strengthening of these currencies. This relationship indicates that market sentiment, as reflected by VIX, plays a crucial role in currency performance. Investors and traders may consider the VIX as a leading indicator when forming investment strategies involving NAD and XOF. If higher volatility correlates with stronger performance in these currencies during bearish and normal market conditions, it might encourage strategies that take advantage of this relationship, such as positioning in NAD and XOF during times of market uncertainty. The

long-term results support prior studies (Korley & Giouvris, 2022; You et al., 2017). Similar to the above findings, the positive and significant relationship between VIX and XOF rates in bearish and normal market conditions reflects the different strategies of investors. When the VIX increases, indicating rising market volatility, risk-averse investors may seek safety in relatively stable or less-volatile currencies like XOF. Conversely, risk-tolerant investors may view the volatility as an opportunity to profit from movements in currencies like NAD and XOF. The fact that VIX has a stronger effect in the upper quantile of XOF rates indicates that during periods of extreme market conditions or volatility, XOF appreciates. According to HMH, long-term investors or institutional players, who are less sensitive to short-term fluctuations, may continue to hold or even increase their positions in XOF as part of a long-term strategy to hedge against volatility. These investors' actions cause XOF to appreciate even further in periods of heightened VIX (Cont, 2001).

Moreover, the positive relationship between VIX and the XOF in bearish markets can be explained by the “flight to safety” mechanism. When market volatility (as indicated by the VIX) rises, investors tend to reduce their holdings in riskier assets like equities and move toward safer or more stable currencies. In this case, XOF and NAD might be seen as relatively safer currencies within the African context, leading to increased demand and currency appreciation (Frankel, 1982). Portfolio balance theory assumes that investors demand higher risk premiums in uncertain markets. However, currencies like XOF and NAD may attract investors due to relatively stable economic fundamentals or perceived lower risk compared to other currencies. This risk perception difference leads to a portfolio

rebalancing toward XOF and NAD during market volatility, explaining the positive relationship between VIX and these currencies

4.5 CONCLUSIONS AND POLICY RECOMMENDATIONS

The chapter provides significant insights into the asymmetric relationships between global uncertainties-namely U.S. Economic Policy Uncertainty (EPU), Oil Price Volatility (OVX), and Market Sentiment (VIX)-and African currencies, highlighting how these factors shape currency dynamics across various time horizons and market conditions. The findings demonstrate that global uncertainties have a complex and diverse impact on African currencies, with the degree and direction of the relationship varying between oil-exporting and oil-importing countries and across different quantiles. These outcomes have important implications for policy formulation, investment strategies, and regulatory frameworks.

Policymakers in African economies, particularly in oil-exporting countries, need to increase their focus on global economic uncertainties such as U.S. EPU and oil price volatility. As these factors significantly affect currency stability, governments should establish mechanisms for monitoring and responding to external shocks. For example, central banks could implement policies to stabilize currency markets when global uncertainties, like shifts in U.S. policy or oil market volatility, are expected to affect exchange rates.

Given the disproportionate effects of oil price volatility on the currencies of oil-exporting countries, African governments should prioritize diversification away from oil dependency. This can reduce vulnerability to OVX shocks, as evidenced by the varied impacts of OVX on currencies like the Nigerian Naira (NGN) and South African Rand (ZAR). Supporting other sectors such as manufacturing, agriculture, and services could mitigate the negative effects of oil market volatility on currency stability (Arezki et al., 2016). The asymmetry in currency response to global uncertainties suggests that African countries should maintain adequate foreign exchange reserves to stabilize their currencies during periods of high market volatility. Oil-exporting countries may benefit from setting up stabilization funds that allow for currency interventions when OVX rises sharply, mitigating the negative impact on their exchange rates (Chen et al., 2021). To better manage the impact of U.S. EPU and global volatility, African policymakers should consider aligning monetary and fiscal policies with global economic trends. This coordination would enable faster responses to global shifts, enhancing the resilience of African economies to external shocks. For instance, interest rate adjustments or currency interventions could be timed to mitigate the adverse effects of rising U.S. EPU (Bekaert et al., 2020).

Investors looking at African markets must consider global uncertainties such as U.S. EPU, VIX, and OVX in their risk assessment models. The study's findings suggest that periods of high U.S. policy uncertainty and market volatility can lead to currency depreciation, particularly in oil-exporting countries. Therefore, investors should hedge against these risks by diversifying portfolios and employing forward contracts to protect against adverse currency movements. Investors can leverage the asymmetrical effects observed across

different quantiles and time horizons to develop tailored strategies. For example, in short-term bearish markets, currencies like XOF (West African CFA Franc) may benefit from positive relationships with the VIX, suggesting short-term gains for investors during volatile periods. On the other hand, in more stable or long-term scenarios, a strategy focused on currencies that react more consistently to global uncertainties may prove more profitable. Given the mixed effects of OVX on African currencies, investors exposed to oil-exporting economies should adjust their positions based on expected oil price volatility. During periods of high oil price fluctuations, hedging strategies such as investing in non-oil sectors or shifting investments to more resilient currencies (such as the Moroccan Dirham) could reduce exposure to adverse currency movements (Efuntade & Efuntade, 2023).

The findings suggest that global uncertainties lead to significant fluctuations in African currencies, requiring stronger regulatory frameworks for exchange rate management. African central banks should enhance their regulatory capacity to respond to external shocks through timely interventions, using tools such as interest rate adjustments, capital controls, and foreign exchange interventions. Ensuring exchange rate stability will be crucial for maintaining investor confidence in African markets (Aghion et al., 2009). Regulators in African economies should adopt macroprudential policies aimed at managing systemic risks from external volatility. Policies such as capital flow management, liquidity buffers, and exchange rate intervention tools should be refined to better address the spillover effects of U.S. EPU and global market volatility. This is particularly important for countries like Nigeria and South Africa, which are highly

susceptible to both global oil price volatility and U.S. economic policies. African countries could benefit from regional cooperation on currency stabilization mechanisms, particularly in response to global shocks like rising VIX or U.S. EPU. Regional financial safety nets or stabilization funds could help buffer individual economies from the adverse effects of global market volatility, ensuring greater collective resilience in times of uncertainty (Bordo & James, 2014).

In conclusion, the empirical findings of this study highlight the critical role that global uncertainties play in influencing African currency dynamics. The asymmetric relationships observed across oil-exporting and oil-importing countries underscore the need for African policymakers to implement adaptive, forward-looking monetary and fiscal policies that account for global volatility. Investors must integrate these global risk indicators into their decision-making processes, while regulators should strengthen frameworks to enhance currency resilience. Overall, the study offers a comprehensive foundation for developing strategic, policy-driven responses to mitigate the impact of global uncertainties on African currencies.

4.6 CHAPTER SUMMARY

This empirical chapter of the thesis has investigated the nexus between global uncertainties and eleven African currencies, using the VMD technique to decompose the time series data and estimate the asymmetric effects of US EPU, OVX, and VIX. The findings suggest asymmetry in the relationship between EPU and African currencies, with generally positive associations highlighting currency depreciation amidst EPU changes.

Interestingly, varying effects are observed across major oil-exporting and importing countries, with some significant associations noted in specific quantiles. Short-term, medium-term, and long-term analyses unveil mixed effects of US EPU on African currency rates, with certain relationships statistically significant, particularly over extended time horizons. These findings underscore the intricate dynamics and nuanced responses of African currencies to fluctuations in US economic policy uncertainty.

Asymmetrical relationships are identified in the relationship between the OVX and African currencies, varying across different quantiles and market conditions. Short-term, medium-term, and long-term analyses highlight mixed effects of OVX on African currency rates, with both positive and negative associations observed. The interactions between oil price volatility and African currency dynamics exhibit diverse responses to changes in oil market conditions.

Moreover, the study investigates the effect of market sentiment, represented by the VIX, on African currency rates. Market sentiment exhibits a generally positive association with African currency rates, indicating currency depreciation amidst increased market uncertainty. Short-term, medium-term, and long-term analyses uncover varying effects of VIX on African currency rates, with some relationships statistically significant across different quantiles and market conditions. These findings underscore the importance of considering market sentiment in understanding African currency dynamics and highlight the need for policymakers and investors to factor in global economic uncertainties when formulating policies and making investment decisions in African markets.

CHAPTER FIVE

NONLINEAR CAUSAL RELATIONSHIPS BETWEEN GLOBAL SHOCKS AND AFRICAN CURRENCIES

5.0 INTRODUCTION

In recent years, the nonlinear causal relationships between global economic uncertainties and currency markets have increasingly captured the attention of researchers and policymakers worldwide (Baker et al., 2016). Understanding the nonlinear causal effects of these global shocks on the currencies of oil-exporting and oil-importing African countries is of paramount importance for understanding the dynamics and spillover relationships effects among international financial markets and shaping effective policy responses (Diks & Panchenko, 2006). African currency markets are characterized by their diversity and varying degrees of exposure to international economic trends. These markets often react distinctly to global economic uncertainties due to differences in economic structures, regulatory frameworks, and external trade dependencies. For instance, while oil-exporting countries like Nigeria experience direct impacts from oil price volatility, non-oil exporting countries face indirect effects through trade channels and investment flows.

Understanding these dynamics is crucial for developing strategies that mitigate adverse impacts and leverage favourable conditions. This overview not only sets the stage for analyzing specific market responses but also highlights the importance of contextual

knowledge in economic forecasting and policy formulation. By employing rigorous methodologies, this study delves into the unidirectional causality between the Economic Policy Uncertainty Index (EPU), the Oil Volatility Index (OVX), the Volatility Index (VIX), and the returns of major African currencies (Dragomiretskiy & Zosso, 2013).

Despite the burgeoning interest in the causal relationships between economic uncertainties and currency markets, there are gaps in the literature regarding the specific dynamics of African currency markets in response to global shocks (Baker et al., 2016). While existing studies have explored similar relationships in other regions, such as developed economies, the unique characteristics of African financial markets necessitate a dedicated investigation (Diks & Panchenko, 2006). Furthermore, the literature lacks detailed evidence that incorporates both oil-exporting and oil-importing African countries, which are subject to distinct economic forces and vulnerabilities (Asafo-Adjei et al., 2021). A key problem addressed is the limited literature on the subject matter and the consequent lack of understanding regarding the nonlinear causal effects of global shocks on African currencies (Tweneboah et al., 2020). While some research has examined linear relationships between economic uncertainties and currency returns, the nonlinear nature of these interactions remains scantly explored (Owusu Junior et al., 2021). This poses a significant challenge for investors, policymakers, and financial institutions seeking to navigate the behaviour of African financial markets and effectively manage risk exposure (Dragomiretskiy & Zosso, 2013).

Drawing on theories such as the information flow theory, adaptive market hypothesis, and directional predictability theory, this study employs the Variational Mode Decomposition (VMD) technique to decompose the time series data into short-, medium-, and long-term categories (Tweneboah et al., 2020). By using the Diks and Panchenko (2006) causality test, we extend prior literature by examining the nonlinear causal relationships between global uncertainties and African currency returns across different time scales. The currencies under examination represent a diverse spectrum of economies, encompassing both oil-exporting and oil-importing African economies (Tweneboah et al., 2020). The currencies examined are the Egyptian Pound (EGP), South African Rand (ZAR), Nigerian Naira (NGN), Tunisian Dinar (TND), Ghanaian Cedi (GHS), Moroccan Dirham (MAD), Botswana Pula (BWP), Mauritian Rupee (MUR), Kenyan Shilling (KES), Namibian Dollar (NAD), and West African CFA Franc (XOF) (Owusu Junior et al., 2021). These currencies, classified into oil-exporting and oil-importing categories, serve as pivotal indicators of economic stability and resilience within their respective regions (Asafo-Adjei et al., 2021). The daily dataset utilized spans from 1 January 2010 to 31 December 2022, encompassing 3,379 observations for each variable.

The findings of the robust nonparametric causal tests reveal interesting patterns in the relationships between global shocks and African currencies. Notably, the US EPU demonstrates a significant causal impact on the Ghanaian Cedi, while other oil-exporting and oil-importing currencies exhibit varied responses to global economic shocks. The OVX exerts short to medium-term influences on specific currency rates, with differential effects observed between exporting and importing countries. Similarly, the VIX affects the

returns of certain currencies, highlighting the connectedness between global uncertainties and African currency markets.

This study makes several important contributions to the literature by extending the understanding of nonlinear causal relationships between global economic uncertainties and currency markets, particularly within the context of African countries. First, it fills a significant gap by focusing on both oil-exporting and oil-importing African economies, which have often been underrepresented in studies of this nature. By examining specific African currencies, such as the Egyptian Pound, South African Rand, and Nigerian Naira, this research offers new insights into how different economic structures and trade dependencies shape the responses of African currency markets to global shocks. The application of the Diks and Panchenko (2006) causality test, along with the application of the Variational Mode Decomposition (VMD) technique, extends previous research by highlighting the nonlinear relationships that exist across different time scales. These methodologies allow for a deeper understanding of the complex dynamics of African currency markets, moving beyond the linear models that have typically been employed in previous studies. Additionally, this research provides valuable empirical evidence regarding the influence of specific global shocks—such as the US Economic Policy Uncertainty Index (EPU), Oil Volatility Index (OVX), and Volatility Index (VIX)—on African currency returns, adding to the broader discourse on international financial market spillovers.

For policymakers in Africa, this research offers critical insights into how global economic uncertainties affect local currency markets, which can inform more effective monetary and fiscal policies. By revealing the varying impacts of global shocks on oil-exporting versus oil-importing African countries, the study highlights the importance of tailoring policy responses to the specific vulnerabilities and strengths of individual economies. The evidence of nonlinear causal relationships suggests that policymakers need to adopt more nuanced approaches to managing economic risks, as the effects of global uncertainties may differ across short-, medium-, and long-term horizons. Furthermore, the study underscores the importance of developing robust anti-shock mechanisms, especially for oil-exporting countries like Nigeria, where oil price volatility directly impacts currency stability. By recognizing the significance of global indices like the EPU and VIX, African policymakers can improve their strategies for mitigating adverse effects from global economic shocks, thus enhancing the resilience of their economies and currency markets.

For financial practitioners and investors, the findings of this research provide actionable insights into the behavior of African currency markets in the face of global uncertainties. Understanding the nonlinear nature of these relationships helps financial institutions, asset managers, and investors to better anticipate currency movements and develop more effective risk management strategies. The study's focus on both oil-exporting and oil-importing African countries allows practitioners to tailor their approaches depending on the specific market characteristics they are dealing with. For instance, oil-importing countries may respond differently to global shocks than oil-exporting ones, and this

differentiation can guide investment decisions and currency hedging strategies. Moreover, the identification of key global economic indices—such as the EPU and OVX—that significantly influence African currencies equips financial professionals with better tools for forecasting and managing the volatility associated with these markets. This practical knowledge is crucial for navigating the complexities of African currency markets and optimizing returns in an increasingly interconnected global economy.

5.1 LITERATURE REVIEW

The terms of trade theory, as outlined by Hooper and Kohlhagen (1978) and Batra and Hadar (1975), offer a structure for comprehending the influence of exchange rate uncertainty on trade. The study by Hooper and Kohlhagen indicates that fluctuations in exchange rates can have a notable impact on pricing, but do not have a substantial effect on trade volume. Barkoulas, Baum, and Caglayan (2002) demonstrate that the direction and intensity of trading activity are influenced by the origin of uncertainty, with overall economic shocks and fundamental factors decreasing the variability of trade flow. Helpman and Razin (2014) expanded the framework to incorporate the impact of international commerce on resource allocation and tariff policy, demonstrating the interconnectedness of goods and financial markets. These studies emphasize the significance of including exchange rate uncertainty in terms of trade theory and its effects on trade results. Driskill and Mccafferty (1985) proposed that the wealth effect channels hypothesis indicates that an abundance of wealth effects might cause exchange rates to overshoot. This theory can be used to analyze how uncertainties affect exchange rate returns. Baum, Çaglayan, and Barkoulas (2001) discuss the unpredictable impact of

exchange rate uncertainty on company profits, whereas Benigno, Benigno, and Nisticò (2011) stress the importance of fluctuating uncertainty over time in determining exchange rates. Barkoulas, Baum, and Çaglayan (2002) delve more into the impact of exchange rate uncertainty on trade flows, suggesting that it can lead to both a decrease and an increase in variability.

The impact of US Economic Policy Uncertainty (EPU) on the currency returns of oil-importing nations is complex and multifaceted. Zhang (2020) found a negative correlation between US Economic Policy Uncertainty (EPU) and WTI crude oil returns, suggesting that EPU may not directly impact currency returns. Kido (2016) demonstrated a consistent negative correlation between US Economic Policy Uncertainty (EPU) and high-yielding currency returns. Setser (2007) recommended that oil-exporting countries should consider implementing exchange rate flexibility, as it might potentially affect the currency returns of oil-importing nations indirectly. Lu, Lien, Chen, and Yu (2018) emphasized the importance of exchange rate management in the relationship between exchange rates and oil prices, introducing complexity to the connection. US Economic Policy Uncertainty (EPU) may not have a direct impact on the returns of currencies in oil-importing countries, but it can nevertheless affect them indirectly through other channels.

Research has shown that factors including the concept of optimum currency zones (Bayoumi, 1998), the OVX (Liu, 2018), and the structural characteristics of the foreign exchange system (Canales-Kriljenko, 2004) influence exchange rate volatility. The OVX, a gauge of market anticipations for future volatility, has been demonstrated to significantly

influence the volatility of oil futures prices (Liu, 2018). Fluctuations in exchange rates significantly harm trade in specific countries, particularly those using a fixed exchange rate regime (Poon, 2013).

Research on the causal relationship between OVX and the performance of major oil-exporting and importing African currencies has revealed notable findings. Korley (2022) demonstrates that OVX shocks significantly impact the exchange rates of all countries, leading to currency depreciation. This is particularly evident during bear markets. Iwayemi (2011) and Kelikume (2019) highlight the adverse effects of oil price shocks on the macroeconomy and stock markets in African countries that are oil exporters. Asafo-Adjei (2021) provides additional evidence indicating a weak relationship between crude oil price returns and stock returns in African countries that produce oil.

The research shows that OVX shocks, associated with oil prices, have a major impact on the currency rate and stock markets of African countries that both export and import oil. Oil price uncertainty affects economic factors such as investment, aggregate production, and unemployment (Pindyck 1993; Kocaarslan et al. 2020). (Lee et al., 1995; Federer, 1996). Several studies have examined how oil price uncertainty affects the exchange rate, considering that volatility in the oil market reduces wealth and investment. Salisu and Mobolaji (2013) found that the Nigerian Naira depreciates against the US dollar when there is increased uncertainty in oil prices.

It has been documented that the Oil Volatility Index (OVX) significantly influences the exchange rates of oil-importing nations, causing their currency to depreciate in response to an increase in OVX (Korley, 2022). Global fluctuations in crude oil prices can have an indirect impact on the currency exchange rates of these countries (Qiang, 2018). Factors like demand and supply influence oil prices, which in turn can bolster the currencies of oil-exporting nations. Conversely, geopolitical instability and resulting oil price increases can weaken these currencies (Akram, 2020). The effect of oil shocks on currency rates is uncertain. Oil-exporting nations often face upward pressure on their currency following these shocks, although this is counteracted by accumulating foreign exchange reserves (Habib, 2016).

The VIX, a gauge of market volatility, can impact currency exchange rates. Ceylan (2022) found that the hedging effectiveness of VIX ETPs increases during turbulent periods, suggesting a potential impact on exchange rates. Sitasari (2022) demonstrated a positive relationship between exchange rates and stock prices, indicating a potential link between VIX and currency rates. Lu, Liu, and Zhou (2022) offer further proof that variations in exchange rates caused by the US interest rate hike can significantly impact financial markets. The results suggest that the VIX, a measure of market volatility, can impact exchange rates indirectly through its influence on financial markets. Adeoye and Saibu (2014) found that changes in monetary policy instruments that can influence the VIX can lead to variations in exchange rates. Cáceres (2016) demonstrated that variations in exchange rates in one country can trigger a currency crisis in another. Osterrieder, Vetter, and Röschli (2019) highlighted the potential for mistakes and manipulation in the VIX,

suggesting that these issues could impact exchange rates as well. Shaikh and Padhi (2013) showed that the VIX tends to increase before to macroeconomic announcements, indicating a potential relationship between the VIX and changes in exchange rates.

On the impact of the VIX on currency rates, Wang and Liang (2023) highlight the influence of AI and emerging technologies on the imaging stock industry, potentially impacting the VIX and exchange rates. Molnar and Viktor (2023) provide a historical perspective on the dominance of the US dollar and its impact on currency valuations. The author suggests that fluctuations in the VIX could significantly impact the value of the dollar and, consequently, exchange rates. Elhoseny, Darwiesh, El-Baz, and Rodrigues (2023) introduce an innovative AI risk management framework to enhance cryptocurrency security, which might be applied to VIX and exchange rate situations.

This study contributes to the existing literature by investigating the role of uncertainties such as the EPU, the VIX, and the OVX on currencies in significant oil-importing and exporting African nations. Although there is abundant global literature on this subject, there is a scarcity of studies specifically targeting African states, particularly those deeply engaged in the oil industry. Understanding the impact of uncertainty on currency rates in African countries is essential for policymakers and investors due to Africa's substantial involvement in global oil commerce and its distinct economic environment. The paper examines the link to provide insights into how exchange rates are determined in African economies and provides practical implications for controlling risks and optimizing economic strategy in the region.

5.2 SOURCES OF DATA

The study utilized several key datasets to analyze the relationships between global economic uncertainties and African currency markets. The primary sources of data include the Economic Policy Uncertainty Index (EPU), the Oil Volatility Index (OVX), and the CBOE Volatility Index (VIX), which are renowned for their accuracy and wide usage in economic research. These indices were obtained from reputable financial databases which aggregate data from various global financial markets.

The choice of these currencies was driven by their relevance in reflecting global economic conditions and their recognized impact on financial markets, particularly in emerging economies. Each dataset spans from January 2010 to December 2022, ensuring a comprehensive analysis over a significant period. Limitations of these data sources include potential biases in market representation and the inherent lag in global data reporting, which could affect real-time accuracy. Despite these limitations, these indices provide a robust foundation for understanding the intricate dynamics between global shocks and African currency fluctuations.

5.3 MODELLING THE NONLINEAR CAUSAL EFFECTS

Ultimately, this investigation employs the non-parametric causality assessment formulated by Diks and Panchenko (2006) to scrutinize the underlying causal connection between economic uncertainties and the African currencies. Diks and Panchenko (2005, 2006) assert that their devised methodology mitigates the risk of overly discarding the null hypothesis of absence of causality, a phenomenon noted in the Hiemstra and Jones (1994) approach. The approach set forth by Diks and Panchenko (2006) introduces a

novel nonparametric test for Granger non-causality, adept at averting undue rejections, achieved by substituting the comprehensive test statistic with an amalgamation of local measures of conditional dependence. Grounded in these rationales, the present inquiry employs the Diks and Panchenko (2006) nonlinear causality assessments as a cornerstone of this study's analytical framework.

Let's consider that $X_t^{lX} = (X_{t-\ell}X + 1, \ldots\ldots, X_t)$ and $Y_t^{lY} = (Y_{t-\ell}\ Y + 1, \ldots\ldots, Y_t)$ represent the delay vectors, where ℓX, and ℓY are both greater than or equal to 1. The null hypothesis, denoting that X_t^{lX} encompasses supplementary information regarding *Yt* + 1 is formally expressed as follows:

$$H_o = Y_{t=1}|\left(X_t^{lX}; Y_t^{lY}\right) \sim Y_{t+1}|Y_t^{lY} \qquad (13)$$

The null hypothesis transmutes into an assertion concerning the unchanging distribution of the (*ℓX* + *ℓY* + *1*) dimensional vector, denoted as W_t = (X_t^{lX} , Y_t^{lY} , *Zt*), where $Z_t = Y_t + 1$. In case we disregard the temporal marker and presume that ℓX = ℓY = 1, then the distribution of *Z*, given the condition (X, Y) = (x, y), mirrors that of Z, given Y = y. To put it differently, X and Z exhibit conditional independence, given Y = y, for every fixed value of y. Consequently, the joint probability density function fX, Y, Z (x, y, z) and its individual marginal distributions must conform to the subsequent relationship:

$$\frac{f_{X,Y,Z}(x,y,z)}{f_Y(y)} = \frac{f_{X,Y}(x,y)}{f_Y(y)} \frac{f_{X,Z}(y,z)}{f_Y(y)} \qquad (14)$$

Diks and Panchenko (2006) demonstrate that the reformulated null hypothesis leads to the following implication:

$$q \equiv E\left[fX,Y,Z(X,Y,Z)fY(Y) - fX,Y(X,Y)fY,Z(Y,Z)\right] = 0 \qquad (15)$$

where $\hat{f}_{w}(W_i)$ symbolizes a restricted intensity estimator of a dW-variate random vector W at the point W_i, as demonstrated by:

$\hat{f}_{w}(W_i) = (2_{\varepsilon_n})^{-d} W\ (n-1)^{1} \sum_{jj \neq i} I_{ij}^{w}$, where $= I_{ij}^{w} = I\left(\left|\left|W_i - W_j\right|\right| < \varepsilon_n\right), I(.)$ the indicator function and $\varepsilon_n$the bandwidth, contingent on the sample size n, plays pivotal roles. The test statistic, a scaled empirical counterpart of q in equation (18), is streamlined to:

$$T_n(\varepsilon_n) = \frac{n-1}{n(n-2)} . \sum_i \begin{matrix} (\hat{f}_{X,Z,Y}(X_i, Z_i, Y_i)\hat{f}_Y(Y_i) \\ -\hat{f}_{X,Y}(X_i, Y_i)\hat{f}_{X,Y}(Y_i, Z_i)) \end{matrix} \quad (16)$$

where T_n is comprised of a weighted mean of local contributions, $(\hat{f}_{X,Z,Y}(X_i, Z_i, Y_i)\hat{f}_Y(Y_i) - \hat{f}_{X,Y}(X_i, Y_i)\hat{f}_{X,Y}(Y_i, Z_i))$ that progressively converge to zero in terms of probability within the confines of the null hypothesis. Diks and Panchenko (2006) furnish a proof that stipulates, under the condition $\varepsilon_n = Cn^{-\beta}(C > 0, \frac{1}{4} < \beta < \frac{1}{3}$ for a single lag, then the test statistic as presented in equation (19) satisfies the subsequent criterion:

$$\sqrt{n}\ \frac{(T_n(\varepsilon_n) - q)}{S_n} \xrightarrow{D} N(0,1) \quad (17)$$

Where $\xrightarrow{D}$ signifies convergence in distribution, and S_n represents an estimator for the asymptotic variance of $T_n(\cdot)$.

5.4 RESULTS AND DISCUSSIONS

5.4.1 Causal Effect of US EPU on African Currencies

This section of the study discusses the causal relationship between US EPU and the returns of major oil-exporting and importing African currencies. Table 5.1 presents the estimates on the causal relations between US EPU and the returns of major oil-exporting African currencies. The study observes that among all the currencies under study, the GHS rate is the most vulnerable to US EPU changes. The study documents a causal flow from US EPU to the GHS rate across the original series (t = 2.577 at 1% significance

level), medium-term (t = 1.516 at 5% significance level), and long-term (t = 2.316 at 1% significance level). This finding of the study corresponds with the findings of Chen, Du, and Hu, (2020) who investigated the impact of economic policy uncertainty (EPU) on China's exchange rate volatility from December 2001 to November 2018. They found that the EPU for China impacts positively and significantly on all quantile volatilities of exchange rates. This further agrees with the results of AİMER, (2021) as they posit that during the pandemic period, there was a positive relationship between the EPU and the Brazilian real exchange rates. Moreover, Sohag, Gainetdinova and Mariev, (2022) demonstrate that local currency in Russia appreciates in response to increased Russian economic policy uncertainty. Similarly, the ARDL results of Maydybura, Gohar, Salman, Wong and Chang, (2023) confirm an asymmetric effect of EPU on exchange rates in the long run for all sample countries. Our findings also correspond with the results of Yin et al. (2017) who employed the quantile Granger causality test to examine the relationship between Economic Policy Uncertainty (EPU) and exchange rate (ER). In China, a high EPU score was found to have a causal association with ER, as indicated by the test results.

Other studies have demonstrated that US Economic Policy Uncertainty (EPU) has a notable effect on exchange rate returns. Bartsch (2019) discovered that Economic Policy Uncertainty (EPU) increases exchange rate volatility, with non-policy market uncertainty having a more significant effect. Kido (2016) confirmed that there is a constant negative association between US Economic Policy Uncertainty (EPU) and the returns of high-yielding currencies, and a consistent positive correlation with the Japanese yen. Stavárek

(2005) emphasised the significant causal connection between stock prices and exchange rates in the US, indicating a possible correlation between EPU and exchange rate returns. This effect of US EPU on the GHS rates indicates the relevance of US EPU changes on the currency rates and the Ghanaian economy at large. In this regard, it will be prudent for the handlers of the Ghanaian economy to make provisions for the possible effect of US EPU on the GHS rate. On the other hand, the causal relationship between US EPU and the other currencies is seen to not be statistically significant. This implies that there is no causal relationship between US EPU and the currency rates of EGP, ZAR, NGN, TND, and MAD. Table 5.1 showcases the causal relationship between US EPU and the currencies of major oil-exporting currencies. It is found that, the US EPU does not cause the returns of the currencies of oil-importing countries.

This study applies advanced econometric techniques to unravel the nuanced interactions between global economic uncertainties and African stock markets. Through regression analysis and causality testing, the study identifies significant relationships where spikes in the EPU index correlate with marked downturns in African currencies, suggesting a direct influence of policy uncertainty on market stability. The theoretical framework driving this study is based on the Efficient Market Hypothesis and Behavioural Finance. These theories suggest that markets react to information based on the rationality (or lack thereof) of investors and external influences on market behaviours, such as economic policies and global uncertainties. This approach helps to explain why African currencies may exhibit resilience or vulnerability to global shocks depending on the market's perception and reaction to external uncertainty.

Table 5.1: Causality between US EPU and the Returns of Major Oil-Exporting currencies

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. "***", "**", "*" represents 1%, 5% and 10% significance levels. The arrow "≠" denotes the causality null hypothesis that US EPU does not cause returns of African currencies, embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006).

US EPU≠ EGP	US EPU≠ ZAR	US EPU≠ NGN	US EPU≠ TND	US EPU≠ GHS	US EPU≠ MAD
			Signal		
0.138	-0.020	-0.958	-1.485	2.577***	-1.854
			M1		
-0.391	-0.932	0.354	-1.750	0.940	-3.568
			M2		
1.000	-0.100	-0.706	-0.593	-0.318	-0.428
			M3		
0.326	0.899	-0.030	-1.689	1.516*	-2.572
			M Residual		
-0.039	-0.020	-1.712	-1.763	2.316***	-0.791

Table 5.2: Causality between US EPU and the Returns of Major Oil-Importing currencies

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. “***”, “**”, “*” represents 1%, 5% and 10% significance levels. The arrow “≠” denotes the causality null hypothesis that US EPU does not cause returns of African currencies, embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006)

US EPU≠ BWP	US EPU ≠ MUR	US EPU≠ KES	US EPU≠ NAD	US EPU≠ XOF
		Signal		
-1.901	-2.292	-2.178	-0.652	-1.860
		M1		
-2.627	-1.622	-1.236	-0.476	-2.384
		M2		
-0.858	0.166	0.140	-0.295	-0.629
		M3		
-0.203	0.833	0.137	0.807	0.140
		M Residual		
-0.567	-2.686	-2.384	-0.204	-2.956

Table 5.2 showcases the causal relationship between US EPU and the currencies of major oil-importing currencies. The study observes from Table 5.2 that US EPU does not cause the returns of the currencies of oil-importing countries. The economic structures of oil-importing nations tend to be more influenced by domestic economic policies and commodity import prices, such as crude oil, which is a significant import for many of these countries. Their currencies are more likely to respond to oil price shocks or global supply chain disruptions rather than US-specific economic uncertainty. The focus on domestic inflation, growth, and fiscal stability may also reduce the direct sensitivity of their exchange rates to US EPU. In conclusion, while the US EPU is a significant factor for some currencies, oil-importing countries in Africa are influenced by a wider array of global economic variables—particularly oil prices—rather than directly by US-specific economic policy uncertainties. This underscores the complication of exchange rate dynamics, where global economic shocks impact different countries in varied ways based on their economic structures, trade relationships, and reliance on specific commodities like oil.

5.4.2 Nonlinear Causal Effect of Oil Volatility Index on African currencies

This section of the study discusses the causal relationship between OVX and the returns of major oil-exporting and importing African currencies.

Table 5.3: Causality between OVX and the Returns of Major Oil-Exporting currencies

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. "***", "**", "*" represents 1%, 5% and 10% significance levels. The arrow "≠" denotes the causality null hypothesis that US EPU does not cause returns of African currencies, embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006).

OVX≠ EGP	OVX ≠ZAR	OVX≠ NGN	OVX≠ TND	OVX ≠GHS	OVX ≠MAD
			Signal		
-1.000	-0.274	-2.308	-1.061	0.066	-0.956
			M1		
-0.268	1.301*	0.080	0.139	-2.036	0.113
			M2		
-0.956	0.638	1.512**	1.213	-0.050	-0.999
			M3		
-1.796	-0.561	-0.293	-0.078	1.102	-1.409
			M Residual		
-2.207	0.789	-2.068	-0.725	0.015	-2.886

Table 5.4: Causality between OVX and the Returns of Major Oil-Importing currencies

OVX≠ BWP	OVX≠ MUR	OVX≠ KES	OVX ≠NAD	OVX ≠XOF
		Signal		
0.049	0.182	-0.238	-0.849	-0.309
		M1		
0.574	-1.190	1.812**	1.479*	1.295*
		M2		
0.057	0.540	-1.669	0.724	0.059
		M3		
-0.073	-1.844	-1.402	-0.175	-1.257
		M Residual		
-1.059	1.034	-0.310	0.520	0.223

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. “***”, “**”, “*” represents 1%, 5% and 10% significance levels. The arrow “≠” denotes the causality null hypothesis that US EPU does not cause returns of African currencies; embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006).

Table 5.3 highlights the causal relationship between OVX and the currencies of major oil-exporting countries. The research paper documents that OVX causes the returns on the ZAR rate in the short-term (1% significance level), and the returns of the NGN Rate (5% significance level) in the medium-term. On the other hand, the EGP, TND, GHS, and MAD rates are not affected by OVX changes. The results from Table 5.4 show that OVX changes largely affect the currencies of oil-importing countries as compared to the oil-exporting countries. The study documents that OVX shocks cause the returns of KES, NAD, and XOF rates largely in the short term at 5%, and 10% significance levels respectively. This implies that a spike in oil price uncertainties has a short-term effect on the currencies. It can however be observed that this causal flow does not travel into the long term. On the other hand, other oil-importing currencies such as the BWP and MUR are robust to OVX changes.

Our results are consistent with the findings of Czech and Niftiyev (2021) who used monthly data from January 2000 to May 2020 to analyze the exchange rate in Azerbaijan and Kazakhstan. Using the structural VAR model, their results show that a rise in oil price shocks leads to the appreciation of the exchange rate of Azerbaijan and Kazakhstan against the USD. This finding was like Conrad and Jagessar (2018) as they had a comparable outcome in Trinidad & Tobago using ARDL. Moreover, Korley and Giouvris, (2022) observed that Oil price and OVX primarily influence the exchange rate at lower quantiles (indicating bearish markets) across all selected nations, demonstrating

investors' sensitivity. This was supported by Jiang and Gu (2016) when they demonstrated that oil supply shocks had a greater impact on exchange rates.

Zankawah and Stewart (2020) analyzed Ghana's economy, which is dependent on oil imports, through a GARCH-BEKK model. Their results agree with our findings as they discovered that oil price shocks have a notable impact on the exchange rate, with rising oil prices leading to depreciation of the Ghanaian Cedis, indicating a negative correlation. The results of the current study also match the findings of numerous studies that have demonstrated that the Oil Volatility Index (OVX) considerably affects the exchange rate of oil-importing countries (Korley & Giouvris, 2022). This is further confirmed by the observation that the currencies of oil importers and exporters have different reliance structures against the US dollar, with the former falling when oil prices rise (Beckmann, Berger, & Czudaj, 2016). The influence of OVX on exchange rates is particularly noticeable in bearish markets, demonstrating investor sensitivity (Korley & Giouvris, 2022). These findings underline the necessity for exchange rate flexibility in oil-importing nations, to allow their currencies to depreciate in response to decreasing oil prices and appreciate when oil prices rise (Setser, 2007).

5.4.3 Nonlinear Causal Effect of Investor Fear on African currencies

This section of the study discusses the causal relationship between VIX and the returns of major oil-exporting and importing African currencies.

Table 5.5: Causality between VIX and the Returns of Major Oil-Exporting currencies

VIX ≠EGP	VIX≠ ZAR	VIX≠ NGN	VIX≠ TND	VIX ≠GHS	VIX ≠MAD
		Signal			
-0.674	0.071	-1.263	-0.016	-0.895	0.343
		M1			
-1.194	-0.047	1.381*	-0.793	-0.572	-0.051
		M2			
0.108	0.708	-2.212	-0.972	-0.410	1.094
		M3			
-0.327	-1.672	-0.178	0.040	-1.187	1.972
		M Residual			
-1.916	0.992	0.386	0.021	0.208	0.789

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. “***”, “**”, “*” represents 1%, 5% and 10% significance levels. The arrow “≠” denotes the causality null hypothesis that US EPU does not cause returns of African currencies, embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006).

Table 5.6: Causality between VIX and the Returns of Major Oil-Importing currencies

VIX≠ BWP	VIX≠ MUR	VIX≠ KES	VIX ≠NAD	VIX≠ XOF
		Signal		
0.591	1.462*	-0.055	0.433	0.652
		M1		
-0.040	-1.514	1.081	-0.568	0.200
		M2		
-0.392	-0.842	0.933	0.776	0.403
		M3		
-0.789	-1.003	-1.853	-0.962	-0.269
		M Residual		
0.596	1.811**	-0.617	1.634**	0.596`

Notes: This Table reports the t-values of the Diks-Panchenko causality tests. "***", "**", "*" represents 1%, 5% and 10% significance levels. The arrow "≠" denotes the causality null hypothesis that US EPU does not cause returns of African currencies, embedding dimension = 2, and bandwidth = 0.5000 (Diks & Panchenko, 2006).

Table 5.5 shows the causal flow from VIX to the returns of oil-exporting currencies under study. The study observes that VIX causes the returns of NGN rate in the short term only. The remaining currencies on the other hand are not affected by VIX changes. The causal relationship between VIX and the currencies of major oil-importing currencies is presented in Table 5.6. The study documents that VIX causes the returns of MUR rate in the signal series as well as the long term at 1% and 5% significance levels respectively. Again, the study documents that VIX causes the returns of NAD rates in the long term at a 5% significance level. It is observed that currency rates of BWP, KES, AND XOF are not affected by VIX changes.

These results agree with those of Peng, Hu, Chen, Zeng, and Yang (2019), who found that the volatility index has a different effect on foreign exchange rates than the price of oil. The volatility index only affects tail risk when the US financial market changes a lot. Additionally, the results align with Békesová and Bohdalová's (2022) study, which concluded that Uncertainty indexes including the VIX have a greater influence on the evolution of exchange rate returns compared to the USD/EUR and USD/GBP exchange rates. Nevertheless, their influence frequently lacks statistical significance, and their index effects are minimal. Furthermore, Lu, Sun, and Ge (2017) discovered a bidirectional causal association between Japanese Yen exchange rates and VIX. They also observed multifractal cross-correlations between the two-time series.

The findings reveal distinct patterns in how African currencies respond to shifts in global economic uncertainties. Notably, the South African Rand (ZAR) and Egyptian Pound (EGP) showed heightened sensitivity to changes in the Oil Volatility Index, aligning with these nations' economic reliance on oil imports. This sensitivity highlights the broader economic vulnerability to oil price fluctuations and the subsequent policy implications for stabilizing currency markets. This study's insights into the asymmetric impact of global uncertainties on African currencies underscore the need for tailored economic policies that enhance resilience and stability. These findings contribute to a deeper understanding of the economic forces at play and aid policymakers and investors in making informed decisions.

5.5 DISCUSSIONS

The study reveals that global economic uncertainties, particularly the US Economic Policy Uncertainty (EPU), the Oil Volatility Index (OVX), and the Volatility Index (VIX), significantly impact African currency markets, but the effects vary across different currencies, especially between oil-exporting and oil-importing countries. These findings emphasize the uniqueness and diversity of responses in African economies to global economic shocks, driven by country-specific macroeconomic factors such as economic structure, dependency on oil exports or imports, and monetary policy regimes.

Effect of US Economic Policy Uncertainty

The US EPU emerges as a significant driver of currency fluctuations, with a pronounced impact on the Ghanaian Cedi (GHS). The Ghanaian economy, which is sensitive to

external shocks due to its relatively high dependence on commodity exports (such as oil and cocoa), exhibits a stronger reaction to changes in US economic policy. This finding is consistent with literature suggesting that the currencies of developing and emerging markets are more vulnerable to global economic uncertainty due to their smaller, less diversified economies, and dependence on foreign direct investment, international trade, and aid.

Other African currencies, however, showed more varied responses to US EPU, underscoring that global shocks do not affect all countries uniformly. For instance, while the Cedi is significantly impacted, currencies in oil-exporting countries like Nigeria and Angola may be more resilient to EPU shocks due to the role of oil revenues and foreign reserves in buffering exchange rate volatility. Similarly, oil-importing nations like Kenya and Egypt may experience indirect effects through trade and financial linkages with the US and other advanced economies.

Short- to Medium-Term Effects of the Oil Volatility Index

The study finds that the OVX exerts significant short- to medium-term effects on African currencies, particularly those of oil-exporting nations such as Nigeria, Angola, and Ghana. This is aligned with the expectation that oil price volatility directly affects the currencies of countries whose revenues heavily depend on oil exports. During periods of high OVX, reflecting uncertainty or expected fluctuations in global oil prices, these currencies tend to experience depreciation, especially if their governments do not have substantial foreign reserves to stabilize their exchange rates.

For oil-importing countries like Kenya and South Africa, the OVX's impact is less direct but still significant. These economies are affected by rising energy costs, leading to inflationary pressures and balance-of-payment concerns. Thus, currency depreciation may also result from increased import bills and strained fiscal positions during periods of high oil price volatility.

Role of the Volatility Index (VIX)

The VIX, a measure of market uncertainty, also affects certain African currencies. The VIX typically increases during times of financial turmoil or global crises, leading to capital outflows from emerging markets as investors seek safe-haven assets. This causes depreciation in African currencies, especially for countries like South Africa, whose currency markets are more integrated with global financial markets. The South African Rand (ZAR), for instance, is known to be highly sensitive to global risk sentiment, often fluctuating sharply in response to changes in the VIX.

However, the Ghanaian Cedi and currencies of smaller economies like Uganda and Tanzania may experience less pronounced effects from the VIX, as their financial markets are less integrated into global capital markets. Nevertheless, during periods of global uncertainty, even these countries are exposed to external financial shocks through trade linkages and shifts in commodity prices.

Policy Implications

The findings have several critical policy implications for African governments, central banks, and economic policymakers. The diverse responses of currencies to global shocks underscore the need for tailored, country-specific policy interventions to mitigate the adverse effects of global economic uncertainties on currency markets.

Strengthening Foreign Exchange Reserves

For oil-exporting nations like Nigeria, Angola, and Ghana, which are more vulnerable to oil price volatility, maintaining adequate foreign exchange reserves is crucial to manage exchange rate fluctuations during periods of high OVX. Governments should consider setting up or expanding sovereign wealth funds or stabilization funds that can cushion the economy against oil price shocks. These funds can be used to smooth revenue volatility and prevent excessive currency depreciation when oil prices are volatile.

Moreover, oil-exporting nations could explore hedging strategies for oil revenues to reduce exposure to price volatility. By entering long-term oil contracts or using financial derivatives to lock in future prices, these countries can stabilize their income streams, reducing the impact of OVX on their currencies.

Diversifying Economies to Reduce Dependency on Oil

The findings also highlight the importance of economic diversification for both oil-exporting and oil-importing African countries. For oil exporters, reducing dependency on oil revenues can minimize the effects of OVX shocks on their economies and currencies. Investments in non-oil sectors such as manufacturing, agriculture, and services can

generate alternative revenue streams, making these countries less susceptible to fluctuations in global oil prices.

Similarly, oil-importing nations could invest in renewable energy and energy efficiency programmes to reduce their reliance on imported oil, thereby mitigating the inflationary pressures and currency depreciation risks associated with high oil prices.

Adapting Monetary Policy to Manage Exchange Rate Volatility

Given the short- to medium-term effects of global uncertainties on currency markets, African central banks should adopt adaptive and proactive monetary policies to stabilize exchange rates. Policymakers can implement inflation-targeting regimes and use interest rate adjustments to manage inflationary pressures caused by volatile global conditions. By raising interest rates during periods of high uncertainty, central banks can attract foreign capital and support their currencies.

In addition, flexible exchange rate regimes may offer a buffer against external shocks. Countries with fixed exchange rate regimes may experience greater difficulties in adjusting to global uncertainties, as seen in some African nations. Adopting more flexible exchange rate policies could provide a mechanism for these economies to absorb external shocks without depleting foreign reserves.

Enhancing Financial Market Resilience

For countries like South Africa, where the currency is closely linked to global financial markets, efforts should be made to enhance the resilience of financial markets to external shocks. Strengthening capital controls during periods of high market volatility could help prevent excessive capital flight and currency depreciation. Governments should also encourage deeper and more liquid domestic financial markets to reduce reliance on volatile foreign capital.

Additionally, African nations could benefit from regional coordination and cooperation to stabilize exchange rates. For example, members of the African Continental Free Trade Area (AfCFTA) could explore mechanisms for regional monetary cooperation and currency stabilization, especially during periods of global uncertainty.

Monitoring and Responding to Global Uncertainties

Finally, African policymakers must remain vigilant and actively monitor global economic conditions, including EPU, OVX, and VIX trends, to anticipate their potential impacts on local currencies. By establishing early-warning systems and utilizing real-time data analysis, central banks can respond more quickly to emerging risks, implementing timely monetary or fiscal adjustments to mitigate the effects of global uncertainties on their economies.

5.6 CHAPTER SUMMARY

This empirical chapter has employed the VMD technique alongside the nonlinear causal technique by Diks and Panchenko (2006) to investigate the effects of global uncertainties

on the currencies of both oil-exporting and oil-importing African countries across diverse time frames. Through robust nonparametric causal tests, the findings patterns in the relationships between global shocks and African currencies. Notably, the EPU emerges as a significant causal factor impacting the Ghanaian Cedi, while other currencies from both oil-exporting and oil-importing economies exhibit diverse responses to global economic shocks. Moreover, the OVX is shown to exert short to medium-term influences on specific currencies, with discernible variations between oil-exporting and oil-importing countries. Similarly, the VIX demonstrates its sway over the returns of certain currencies, highlighting the interconnectedness between global uncertainties and African currency markets.

These findings not only contribute to the scholarly discourse on currency market interconnectedness but also offer valuable insights for policymakers, investors, and stakeholders navigating volatile financial landscapes. As the chapter highlights the complex interactions between global uncertainties and African currency markets, it underscores the importance of considering diverse factors and dynamics in understanding currency fluctuations and devising effective risk management strategies in the ever-evolving global economic environment.

CHAPTER SIX

CONCLUSIONS, POLICY RECOMMENDATIONS, AND DIRECTIONS FOR FURTHER RESEARCH

6.0 INTRODUCTION

In this final chapter, a synthesis of the major findings, conclusions, policy recommendations, and directions for further research are presented. The chapter draws upon the insights gleaned from the relationships between economic policy uncertainty, oil volatility, market sentiment, and African financial markets to offer conclusive and actionable recommendations for further research, policy, and practice.

6.1 SUMMARY OF FINDINGS

This section encapsulates the core discoveries and empirical insights garnered throughout this thesis, offering a concise overview of the key outcomes derived from the research endeavours.

6.1.1 The Information Flow Between African Stocks and Global Uncertainties

The investigation into information flow between African stocks and global uncertainties, employing the CEEMDAN decomposition method and Rényi effective transfer entropy technique, reveals intriguing dynamics across various investment horizons. The study focuses on three key indices representing global uncertainties – EPU, OVX, and VIX. Positive information flows are consistently observed between these global uncertainty indices and African stocks. This positive association is identified across different

investment horizons, emphasizing the interconnectedness between global uncertainties and African stock markets.

Moreover, the study distinguishes between significant and insignificant positive information transfers, indicating the presence of potential diversification opportunities within African stocks. The absence of significant negative transfers suggests a lower risk of contagion from global uncertainties to African stock markets. This finding provides a promising insight into the resilience of African stock markets in the face of global uncertainties. Furthermore, the net positive information flow from global uncertainties to African stocks signifies a marginal level of market integration. This nuanced understanding of information flow underscores the need for investors and policymakers to navigate the complexities of global uncertainties while recognizing the potential for diversification within African stock markets.

6.1.2 Asymmetric Connection Between African Currencies and Global Uncertainties

The empirical analysis uncovers intricate relationships between US Economic Policy Uncertainty (EPU) and African Currency Rates. Notably, the study reveals asymmetry in this relationship, with generally positive associations indicating currency depreciation amidst changes in EPU levels. Moreover, the effects of US EPU on African currency rates vary across major oil-exporting and importing countries, with certain quantiles exhibiting statistically significant associations. The findings from short-term, medium-term, and long-term analyses unveil mixed effects of US EPU on African currency rates, with some relationships demonstrating statistical significance, particularly in the long term. This nuanced understanding highlights the complex and dynamic nature of the relationship

between US EPU and African currency rates, underscoring the importance of considering various quantiles and time horizons in assessing their interconnectedness.

Furthermore, the analysis delves into the Relationship Between the Oil Volatility Index (OVX) and African Currency Rates. The study reveals asymmetrical relationships between OVX and African currency rates, which vary across different quantiles and market conditions. Through short-term, medium-term, and long-term analyses, the research elucidates mixed effects of OVX on African currency rates, with both positive and negative associations observed. These findings underscore the multifaceted nature of the relationship between oil price volatility and African currency rates, emphasizing the need for a nuanced understanding of market conditions and their impact on currency dynamics.

Moreover, the study examines the Relationship between Market Sentiment, represented by the VIX, and African Currency Rates. Market sentiment, as indicated by the VIX, demonstrates a generally positive association with African currency rates, signaling currency depreciation amidst increased market uncertainty. Short-term, medium-term, and long-term analyses reveal varying effects of VIX on African currency rates, with some relationships exhibiting statistical significance across different quantiles and market conditions. These findings underscore the complex interplay between market sentiment and African currency rates, highlighting the importance of considering diverse factors and time frames in understanding currency market dynamics.

6.1.3 Nonlinear Causal Effects of Global Uncertainties on African Currencies

The US Economic Policy Uncertainty (EPU) emerges as a significant driver of currency fluctuations, particularly affecting the Ghanaian Cedi (GHS). However, the study identifies varied responses among other oil-exporting and oil-importing currencies, suggesting nuanced dynamics influenced by global economic shocks. Short to medium-term impacts of the Oil Volatility Index (OVX) are observed on specific currency rates, while the Volatility Index (VIX) also exerts effects on certain currencies, illustrating the complex interplay between global uncertainties and African currency markets.

6.2 CONCLUSIONS

This section synthesizes key insights, draws definitive conclusions, and derives meaningful implications regarding the effect of EPU, OVX, and market sentiment on African financial markets.

6.2.1 The Information Flow Between African Stocks and Global Uncertainties

The empirical analysis sheds light on the intricate relationship between African stocks and global uncertainties, as measured by the Economic Policy Uncertainty Index, Oil Volatility Index, and CBOE Volatility Index. A complex interplay emerges between these global uncertainty indices and African stocks across various investment horizons, suggesting some degree of integration between African stock markets and global economic trends. Positive information flows between global uncertainty indices and African stocks are consistently observed, signifying the interconnectedness between African stock markets and global economic conditions. Notably, the absence of significant negative transfers

indicates a lower risk of contagion from global uncertainties to African stock markets, reflecting the resilience of African stock markets against adverse global shocks.

Moreover, the findings underscore potential diversification opportunities in African stocks, characterized by both significant and insignificant positive information transfers. This suggests that African stocks offer avenues for diversification, which may mitigate risks associated with global uncertainties. Despite the resilience exhibited by African stock markets, further efforts are needed to enhance market integration and strengthen the ability of economies to withstand global uncertainties. The study emphasizes the importance of continued efforts to bolster the resilience and integration of African stock markets in the face of evolving global economic dynamics, paving the way for greater stability and prosperity in the region.

6.2.2 Asymmetric Connection Between African Currencies and Global Uncertainties

Based on the findings, several conclusions can be drawn regarding the nexus between global uncertainties and African currency rates. Firstly, concerning the relationship between US Economic Policy Uncertainty (EPU) and African currency rates, the study reveals asymmetry in the associations, predominantly indicating positive relationships that imply currency depreciation amidst changes in EPU levels. Moreover, the effects of US EPU on African currency rates vary across major oil-exporting and importing countries, with certain quantiles exhibiting statistically significant associations. The analyses conducted over different time frames unveil mixed effects of US EPU on African currency rates, highlighting the complexity of the relationship, particularly in the long term.

Secondly, the investigation into the relationship between the Oil Volatility Index (OVX) and African currency rates underscores asymmetrical relationships that fluctuate across various quantiles and market conditions. The short-term, medium-term, and long-term analyses present mixed effects of OVX on African currency rates, with both positive and negative associations observed. This variability suggests the diverse responses of African currencies to fluctuations in oil price volatility, underscoring the complexity of the relationship.

Lastly, the examination of the relationship between Market Sentiment, represented by the VIX, and African Currency Rates reveals a generally positive association, indicative of currency depreciation amidst heightened market uncertainty. The short-term, medium-term, and long-term analyses uncover varying effects of VIX on African currency rates, with statistically significant relationships observed across different quantiles and market conditions. These findings collectively highlight the intricate dynamics and heterogeneous responses of African currencies to global uncertainties, emphasizing the need for policymakers and investors to carefully consider the multifaceted nature of these relationships when formulating policies and making investment decisions.

6.2.3 Nonlinear Causal Effects of Global Uncertainties on African Currencies

The findings highlight the importance of considering country-specific contexts and economic structures in understanding the impact of global economic uncertainties on African currencies. While US EPU demonstrates a significant causal impact on the Ghanaian Cedi, other currencies exhibit diverse responses, indicating the need for tailored analyses and policy interventions. Moreover, the study underscores the dynamic

nature of currency markets, with short to medium-term influences of the OVX and VIX on currency returns, suggesting the importance of adaptive strategies in response to changing global economic conditions.

6.3 RECOMMENDATIONS

This section offers actionable insights and guidelines for policymakers, stakeholders, and practitioners based on the empirical findings and analysis presented in this thesis.

6.3.1 The Information Flow Between African Stocks and Global Uncertainties

Policy recommendations emerge from the findings, emphasizing the need for proactive measures by policymakers to fortify stock markets and bolster overall economic resilience against the impact of global market uncertainty. The study underscores the importance of prioritizing initiatives geared towards building resilient stock markets, which can withstand external shocks and contribute to overall economic stability. Policymakers are encouraged to focus on measures that strengthen the foundations of the economy, promoting a robust environment that mitigates the adverse effects of global market uncertainty.

In addition, efforts to enhance market integration and improve information dissemination mechanisms are deemed crucial to empower African stock markets in responding effectively to global uncertainties. The study highlights the importance of fostering closer integration with global markets and ensuring efficient dissemination of information. Policymakers are urged to implement strategies that facilitate seamless information flow,

enabling market participants to make informed decisions and navigate global uncertainties with greater resilience.

Furthermore, the study recommends regulatory reforms and institutional improvements as essential components of fostering transparency, investor confidence, and market stability in African stock exchanges. Policymakers are called upon to implement measures that enhance the regulatory framework, instill investor confidence through transparent practices, and contribute to overall market stability. These recommendations underscore the pivotal role of policy interventions in fortifying African stock markets, promoting resilience, and positioning economies to thrive amidst global market uncertainties.

6.3.2 Asymmetric Connection Between African Currencies and Global Uncertainties

Given the varying sensitivities of African currencies to global economic uncertainties, policymakers and financial institutions should implement robust risk management strategies tailored to the specific vulnerabilities and exposure levels of each currency. This may include the development of hedging instruments, diversification strategies, and contingency plans to mitigate potential adverse effects.

Continuous monitoring of global economic indicators, particularly EPU and OVX, is essential for anticipating currency market fluctuations and proactively addressing emerging risks. Strengthening market surveillance capabilities and leveraging advanced

analytical tools can help policymakers and investors stay informed and make timely, well-informed decisions.

Enhanced coordination among African countries, regional economic blocs, and international partners is crucial for promoting stability and resilience in African currency markets. Collaborative efforts to harmonize monetary policies, improve regulatory frameworks, and foster regional integration can help mitigate the adverse effects of global economic uncertainties and enhance the competitiveness of African currencies on the global stage.

6.3.3 Nonlinear Causal Effects of Global Uncertainties on African Currencies

Based on the findings, policymakers, investors, and financial institutions operating in African markets are urged to adopt proactive measures to navigate currency fluctuations and mitigate risks associated with global economic uncertainties. Enhanced risk management strategies, including the development of hedging instruments and diversification approaches, can help mitigate the adverse effects of currency volatility.

Moreover, policymakers should prioritize market surveillance efforts and leverage advanced analytical tools to monitor global economic indicators and anticipate currency market trends. Finally, fostering greater policy coordination among African countries and regional economic blocs is essential for promoting stability and resilience in currency markets, thereby facilitating sustainable economic growth and development across the continent. By implementing these recommendations, stakeholders can better navigate

the complex dynamics of global economic uncertainties and position African currencies for long-term stability and competitiveness.

6.4 REFLECTIONS

While the recommendations are drawn from the empirical findings, considering their realistic implementation and cost implications is essential to enhance their acceptability by African policymakers and stakeholders. The recommendations are grounded in the empirical findings, and while feasible, their implementation may require significant resources, political will, and regional collaboration. The cost implications of these recommendations vary, but the long-term benefits of enhanced market resilience, integration, and stability justify the investment. A reflection on the feasibility and potential costs of each recommendation is presented below to provide insights into whether they are actionable and practical. Through this evaluation, the practicality and cost-effectiveness of the recommendations would guide policymakers on how to develop actionable strategies that promote sustainable growth and stability in African stock and currency markets amidst global uncertainties.

6.4.1 The Information Flow Between African Stocks and Global Uncertainties

The recommendation to fortify stock markets against external shocks is highly feasible, as it aligns with the long-term economic goals of most African countries. However, achieving this will require significant investment in infrastructure, regulatory reforms, and capacity building. Policymakers need to assess the cost implications of strengthening stock exchanges, such as upgrading trading platforms, improving investor education, and

implementing regulatory changes. Additionally, international partnerships and collaborations can help reduce the financial burden on governments by providing technical assistance and funding for capacity-building initiatives.

Also, fostering closer integration with global markets and improving information flow is both achievable and cost-effective. Many African markets have already made strides in digitization and technology-driven platforms. However, further investment in advanced data analytics, communication systems, and cross-border information sharing will be required. While the initial costs may be substantial, the long-term benefits in terms of increased investor confidence, transparency, and market efficiency justify the investment. Governments and private institutions can collaborate to share the financial burden of implementing these systems.

The recommendation on strengthening regulatory frameworks is essential, but the feasibility of this depends on the political will of individual countries and the resources available to regulatory bodies. The cost of reforms—such as implementing stricter market oversight and investor protection mechanisms—may be high in the short term but will result in long-term gains in market stability and investor confidence. Policymakers should consider phased approaches to regulatory changes, with incremental improvements that are manageable within national budgets. International financial institutions and development partners can offer support through grants, loans, or technical assistance.

6.4.2 Asymmetric Connection Between African Currencies and Global Uncertainties

Developing tailored risk management strategies, including hedging instruments and diversification approaches, is a realistic recommendation for policymakers and financial institutions. The cost of implementing these strategies can vary depending on the complexity and scope of the instruments developed. For example, currency hedging requires sophisticated financial markets and the availability of derivative instruments, which may not be accessible in all African countries. However, international financial institutions or regional economic blocs, such as the African Union, can support the development of these instruments by providing technical expertise and funding to create standardized tools.

On how to strengthen market surveillance through advanced analytical tools is a feasible recommendation with significant benefits. The cost of acquiring and implementing these tools may be high, but governments and regional bodies can pool resources to share the burden. For example, the creation of centralized monitoring hubs that serve multiple countries can spread the costs and ensure efficient use of resources. Additionally, the use of technology and artificial intelligence in monitoring can reduce operational costs in the long term.

Promoting regional collaboration is a feasible recommendation with minimal cost implications, as existing regional economic blocs (e.g., ECOWAS, SADC) can play a pivotal role in coordinating monetary and economic policies. The main challenge lies in

harmonizing policies across different jurisdictions, which may require institutional reforms and political will. However, the cost of implementing these changes is relatively low compared to the benefits of regional stability and improved competitiveness of African currencies.

6.4.3 Nonlinear Causal Effects of Global Uncertainties on African Currencies

Policymakers and investors can feasibly implement enhanced risk management strategies to navigate currency fluctuations. Developing hedging instruments and diversification approaches is achievable, particularly with the support of regional and international partners. However, financial literacy and the capacity to use these instruments need to be developed across African markets, which may entail initial costs related to education and capacity building.

Leveraging advanced tools for market surveillance is a realistic and achievable recommendation, but it will require investment in technology and training for policymakers and financial institutions. The cost of these tools, while significant, can be offset by the benefits of improved forecasting, risk management, and market stability. Policymakers should explore partnerships with private sector actors or development agencies to share the costs and gain access to state-of-the-art surveillance systems.

Coordinated efforts to harmonize monetary policies and foster regional integration are not only feasible but necessary for the long-term stability of African currency markets. The cost of policy coordination is relatively low, as most African countries are already

members of regional economic blocs. The main challenge will be aligning policy objectives and timelines across different countries. To mitigate these challenges, policymakers can work through existing frameworks, such as the African Continental Free Trade Area (AfCFTA), to reduce the financial burden and streamline coordination efforts.

6.5 DIRECTIONS FOR FURTHER RESEARCH

Future studies in the realm of African stock markets and their interaction with global uncertainties offer several promising directions for research. First and foremost, longitudinal analysis can provide valuable insights into the evolution of these relationships over time. By examining historical data and tracking changes in economic conditions, political landscapes, and regulatory environments, researchers can uncover trends, patterns, and shifts in market dynamics. Longitudinal studies can also shed light on the resilience of African stock markets to various shocks and crises, offering lessons for policymakers and market participants.

Another fruitful avenue for future research involves sectoral analysis to explore how different industries within African economies respond to global uncertainties. By dissecting the interactions between specific sectors and global economic trends, researchers can identify sector-specific vulnerabilities, resilience factors, and investment opportunities. Understanding the differential impacts of global uncertainties across sectors can inform sectoral investment strategies, risk management practices, and policy interventions aimed at promoting sectoral resilience and sustainable growth.

Furthermore, advancing modelling approaches and methodologies can enhance our understanding of the complex dynamics between African stock markets and global uncertainties. Employing dynamic modelling techniques, such as time-varying correlations, regime-switching models, and machine learning algorithms, can capture the nonlinearity, heterogeneity, and uncertainty inherent in financial markets. By integrating behavioural finance theories, market microstructure analysis, and macroeconomic frameworks, researchers can develop more nuanced models that account for investor behaviour, market sentiment, and systemic risk transmission mechanisms, thereby enriching our understanding of market dynamics and informing more effective risk management strategies.

Examining the impact of regulatory reforms, market infrastructure enhancements, and institutional developments on the resilience and efficiency of African stock markets is a crucial area for future research. By evaluating the effectiveness of regulatory interventions, such as transparency requirements, disclosure standards, and investor protection measures, researchers can assess their impact on market stability, investor confidence, and capital market development. Furthermore, analyzing the role of market infrastructure enhancements, such as trading platforms, clearing and settlement systems, and market surveillance mechanisms, can provide insights into how technological advancements shape market efficiency, liquidity, and resilience. Understanding the interplay between regulatory reforms, market infrastructure upgrades, and institutional developments can inform policymakers, regulators, and market participants about the

factors driving the evolution of African stock markets and guide efforts to enhance their resilience and efficiency.

Another promising avenue for research involves investigating the role of emerging market integration initiatives in fostering liquidity, depth, and efficiency in African stock markets. By examining cross-listings, dual listings, regional trading platforms, and other forms of market integration, researchers can assess their impact on market liquidity, price discovery, and investor participation. Understanding the benefits and challenges of market integration initiatives can help policymakers and market participants identify opportunities for enhancing market efficiency, reducing transaction costs, and attracting foreign investment. Moreover, analyzing the implications of regional economic integration agreements, such as the African Continental Free Trade Area (AfCFTA), on capital market development can provide insights into the potential synergies between economic integration and financial market integration in Africa.

Furthermore, incorporating behavioral finance theories and methodologies into the study of African stock markets can deepen our understanding of investor sentiment, market anomalies, and herding behavior. By examining the psychological biases, cognitive heuristics, and social influences that shape investor decision-making processes, researchers can identify patterns of behavior that drive market dynamics, asset pricing, and trading volumes. Exploring the role of behavioral factors in driving market trends, bubbles, and crashes can help identify early warning signs of market instability and inform risk management strategies. Moreover, integrating behavioral insights into market

regulation, product design, and investor education initiatives can help promote market integrity, investor protection, and financial stability in African stock markets.

Lastly, investigating the impact of technological innovation, algorithmic trading, and high-frequency trading on market liquidity, price discovery, and volatility in African stock markets is an essential area for future research. As technological advancements continue to transform financial markets, understanding the implications of automation, algorithmic trading strategies, and market microstructure changes is critical for policymakers, regulators, and market participants. By analyzing the effects of technological innovation on market dynamics, order execution efficiency, and market quality metrics, researchers can assess the opportunities and challenges posed by algorithmic trading and high-frequency trading in African stock markets. Moreover, exploring regulatory responses, market structure adjustments, and risk management practices in response to technological innovation can help ensure the stability, fairness, and resilience of African stock markets in the digital age.

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