UNIVERSITY OF CAPE COAST

COVID-19 PANDEMIC AND FINANCIAL MARKETS' PERFORMANCE: THE ROLE OF DEVELOPMENT STATUS, FINANCIAL GLOBALISATION, AND TRADE OPENNESS

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BY

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Thesis submitted to the Department of Economic Studies of the School of Economics, College of Humanities and Legal Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Doctor of Philosophy Degree in Economics

SEPTEMBER 2023

DECLARATION

Candidate's Declaration

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

Candidate's Signature…… Date……

Name: Michael Insaidoo

Supervisors' Declaration

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

Principal Supervisor's Signature……. Date……

Name: William Gabriel Brafu-Insaidoo

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

Name: James Atta Peprah

ABSTRACT

This study examines the effect of development status in the relationship between COVID-19 and performance of stock markets using the Bayesian Structural Time Series and Pooled OLS estimation approaches. The study further assesses the moderating role of financial globalisation in the volatility transmission between stock and forex markets during COVID-19 period, using Panel FMOLS and Panel DOLS estimation techniques. Finally, the study investigates the moderating role of trade openness in the relationship between COVID-19 and exchange rate in Ghana, applying the FMOLS and CCR estimation techniques. The findings revealed that, stock markets in developing economies were the heaviest impacted, followed by those in emerging economies, with the ones in developed economies being the least impacted. Further, the results show a bidirectional volatility transmission between forex and stock markets, with financial globalisation playing a moderating role in this relationship. The findings further, provide evidence of trade openness serving as a conduit in reversing the adverse influence of COVID-19 on the value of the Ghana cedi. To mitigate the impact of future crisis, risk management frameworks must be improved. To harness the stabilising potential of financial globalisation in volatility transmission, asset diversification, information flow and market efficiency should be promoted in African financial markets. To ease the pressure on Ghana's exchange rate, export-oriented industries must be targeted and supported to generate the needed foreign exchange.

KEYWORDS

COVID-19 pandemic

Development Status

Financial Globalisation

Stock Market Returns

Trade Openness

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DEDICATION

To my family

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LIST OF ACRONYMS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARDL	Autoregressive Distributed Lag
ARMA	Autoregressive Moving Average
BEKK	Baba, Engle, Kraft and Kroner
BLUE	Best Linear Unbiased Estimator
BRICS	Brazil Russia India China South Africa
BSE	Bulgarian Stock Exchange
BSTS	Bayesian Structural Time Series
CADF	Cross-section Augmented Dickey Fuller
CCE	Common Correlated Effects
CCR	Canonical Cointegration Regression
CD	Cross-sectional Dependence
CIPS	Cross-section Im-Pesaran
COP	Crude Oil Price
COVID-19	Coronavirus Disease 2019
DOLS	Dynamic Ordinary Least Squares
EGARCH	Exponential Generalized Autoregressive Conditional Heteroscedastic
EMH	Efficient Market Hypothesis
FDI	Foreign Direct Investment
FG	Financial Globalisation
FIGARCH	Fractionally Integrated Generalized Autoregressive Conditional Heteroscedastic

FMOLS	Fully Modified Ordinary Least Squares
FOREX	Foreign Exchange
FTSE	Financial Times Stock Exchange
GDP	Gross Domestic Product
GFC	2007/08 Global Financial Crisis
GHS	Ghana Health Service
GHs	Ghana cedi
GMM	Generalized Method of Moments
GSE	Ghana Stock Exchange
G7	Group of Seven World's Developed Economies
ILO	International Labour Organization
IMF	International Monetary Fund
INDEX	Stock Market Price
JSE	Jamaican Stock Exchange
KOF	Konjunkturforschungsstelle
KPSS	Kwiatkowski Phillips Schmidt Shin
MASI	Moroccan All Share Index
MENA	Middle East and North Africa
NARDL	Non-Linear Autoregressive Distributed Lag
NC	Non-Crisis
NRC	National Research Council
NYSE	New York Stock Exchange
OBS	Observations
OLS	Ordinary Least Squares
PHEIC	Public Health Emergency of International Concern

SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
SD	Standard Deviation
SR	Stock Market Returns
SV	Stock Market Volatility
TO	Trade Openness
UK	United Kingdom
UNSG	United Nations Secretary-General
US	United States
VAR	Vector Autoregressive
VIF	Variance Inflation Factor
VIX	Volatility Index
WB	World Bank
WHO	World Health Organization
WTI	West Texas Intermediate
XR	Exchange Rate Returns
XV	Exchange Rate Volatility

CHAPTER ONE

INTRODUCTION

The novel coronavirus, also referred to as COVID-19 has led to unprecedented global health and economic crises resulting in a contraction of global gross domestic product (GDP) by 2.8% in 2020 (International Monetary Fund [IMF], 2023). Financial markets around the world have equally not been insulated from the ravaging impact of the pandemic. However, whilst one school of thought (Hashmi & Chang, 2021; Hashmi, Chang & Rong, 2021; Chang, Meo, Syed & Abro, 2019) contends a less protracted impact on financial markets of developed economies due to these markets' strong foundations, another group (Bilal, Nasir, Farooq & Bashir, 2022; Chahuán-Jiménez, Rubilar-Torrealba & Fuente-Mella, 2021; Szczygielski, Charteris, Bwanya & Brzeszczyński, 2023) believes otherwise, citing developed economies' deeper integration in global supply networks, higher uncertainty due to extensive media coverage on the pandemic, and dominance of service-based industries in developed economies.

Further, globalisation have occasioned an increased interest in international equity investments, leading to hike in activities in forex markets. This interdependency makes these markets vulnerable to different crisis, which occasions their increased volatility.

Moreover, Ghana, an open economy, presents an interesting case in the dynamics of the pandemic's linkage to its exchange rate due to its reliance on international trade. The pandemic induced lockdowns and travel bans disrupted global supply chain, which affected the demand and supply of foreign currencies in forex markets of economies around the world, including

Ghana. Whilst the impact of the pandemic on exchange rates is well documented, the moderating role of trade openness in this relationship is understudied. This study assesses the role of development status in the relationship between COVID-19 pandemic and performance of stock markets. To achieve this, stock markets in developed, emerging and developing economies are used, which gives this part of the study a global perspective. It also examines the moderating role of financial globalisation in the volatility transmission between stock and forex markets in Africa, which situates this part of the study in an African context. It further investigates the moderating role of trade openness in the co-movement of the pandemic and performance of exchange rate in Ghana, which gives this part of the study a country-specific perspective.

Background to the Study

The significance of the novel COVID-19 pandemic's impact on financial markets worldwide cannot be overstated. The severity and far-reaching effects of the pandemic imply that no economy is insulated from its impact. The COVID-19 pandemic is a global outbreak of coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). It originated in Wuhan, China in December 2019 and quickly spread to other parts of Asia and eventually worldwide. The World Health Organization (WHO) declared it a public health emergency of international concern (PHEIC) on January 30, 2020, and classified it as a pandemic on March 11, 2020. Over the course of the pandemic, there have been fluctuations in COVID-19 cases occurring at different times in various regions and countries.

The impact of the pandemic on economies has been unrelenting with Selmi and Bouoiyour (2020) categorizing the transmission mechanisms of the pandemic into demand, supply, and uncertainty shocks. The demand shocks can be manifested through reduction in consumer demand, and employment and income shocks. As the pandemic unfolded, government enforced lockdowns, travel limitations, and measures promoting social distancing in order to curb the transmission of the virus. As a consequence, there was a decrease in economic activity and consumer expenditure. Non-essential establishments like restaurants, hotels, and retail stores experienced notable drops in demand as individuals chose to stay at home and reduce their non-essential purchases. Kim, Koh and Zhang (2022) confirmed that, the pandemic reduced household consumption spending by almost one quarter at its peak in Singapore. Similarly, in the United States, Dong, Gozgor, Lu and Yan (2021) revealed that, personal consumption expenditures have been significantly affected by the economic shocks in the COVID-19 era.

Further, the COVID-19 pandemic caused significant employment reductions and financial instability as numerous businesses scaled down or closed temporarily or permanently. Consequently, individuals faced a decrease in their disposable income, which weakened their ability to make purchases and ultimately led to a decrease in consumer demand. Coibon, Gorodnichenko and Weber (2020) estimated 20 million job losses globally by the first month of the second quarter of 2020. Corroborating this, Kochhar (2020) asserts that unemployment rose higher in three months of COVID-19 than it did in two years of the Great Depression.

The supply shocks of the pandemic were transmitted through business closures and reduced production, and disruption to global trade and transportation. To limit the transmission of the virus, numerous economies enforced lockdown measures, leading to the shutdown of businesses. Consequently, there was a notable decrease in the ability to produce goods and a disruption in supply chains. This was confirmed by the study of Fornah, Miller, Hamilton and Borsuah (2020), that noted that the pandemic has created massive food insecurity around the world, particularly in developing economies, resulting in collapse of businesses and rising unemployment. Beckman, Baquedano and Countryman (2021) equally indicated that, the pandemic induced lockdowns resulted in a decline in global GDP of 7.2%, leading to a 27.8% rise in the number of insecure people in 2020.

Furthermore, the limitations on travel, closed borders, and enforced quarantines that were implemented during the pandemic had an impact on global trade and transportation. There was a decrease in the availability of travel through air and sea, causing delays at ports and presenting logistical difficulties that disrupted the flow of goods between economies. As a result, supply chains experienced congestion, and the delivery of products faced setbacks, which had consequences for both businesses and consumers. Weiss, Schwarzenberg, Nelson, Sutter and Sutherland (2020) estimated global trade to plummet by an annual amount of 9.2%, with trade-dependent developing and emerging economies being the most vulnerable. Bao, Ji, Lin, Perc and Kurths (2021) and Xu, Li, Chu and Dinca (2022) identified air travel as one of the hardest hits, revealing a statistically significant and negative impact of the pandemic on the industry.

The uncertainty channels of the pandemic on the economy were through health, economic, and policy. The rapid spread of the virus and the lack of initial understanding about its transmission, severity, and potential treatments created a high level of health uncertainty. This uncertainty caused fear and anxiety among individuals, leading to behavioural changes such as reduced spending, increased savings, and reluctance to engage in social and economic activities. Caggiano, Castelnuovo and Kima (2020) confirms this by indicating that the pandemic induced uncertainty shock resulted in an annual reduction of industrial production by 14%.

Further, the COVID-19 outbreak led to extensive lockdowns, travel restrictions, and interruptions in global supply chain. These actions brought about considerable economic uncertainty as companies encountered difficulties in forecasting demand, handling stock levels, and maintaining their operations. This uncertainty resulted in decreased investments, unemployment, and shut down of businesses. Corroborating this, Szczygielski, Charteris, Bwanya and Brzeszczyński (2022) revealed that the pandemic induced uncertainty negatively impacted returns of all industries and generally resulted in higher volatility.

Moreover, governments around the world enforced diverse strategies to manage the transmission of the virus, such as imposing lockdowns, issuing social distancing protocols, and implementing economic stimulus plans. The evolving nature of these measures, coupled with the uncertainty surrounding their efficacy and duration, resulted in policy uncertainty. This uncertainty made it challenging for businesses to make informed decisions and formulate future plans due to the unpredictable nature of government interventions.

Haldar and Sethi (2022) for instance established that, economic policy uncertainty fuels fluctuations in unemployment in COVID-19 affected economies.

Financial markets play a pivotal role in an economy by ensuring an efficient allocation of capital and resources. This role ranges from capital formation, risk management, price determination, and intermediation and financial intermediaries. The financial markets offer a platform where individuals, businesses, and governments can obtain funding by issuing stocks and bonds. These funds can be utilized for a range of purposes, such as developing infrastructure, conducting research and development, and expanding businesses. By directing savings towards profitable investments, financial markets play a crucial role in fostering economic growth and development (Merret, 1998; Agarwal, & Mohtadi, 2004; Kumar, & Santhya, 2020).

Further, financial markets provide individuals and businesses with the means to manage and lessen different types of risks. One way this is achieved is through individuals diversifying their investment portfolios, where they invest in various assets to decrease the risk associated with a single investment. Similarly, businesses can employ financial tools like futures contracts and options to safeguard themselves against price fluctuations in commodities or currencies. By effectively managing risks in financial markets, stability and resilience in the overall economy are improved (Hoang, Faff, & Haq, 2014). In addition, financial markets offer a mechanism for the determination of the fair value of assets. Through the interaction of buyers and sellers, these markets establish prices that reflect the interplay of demand and

supply. This process of determining prices reflects the overall judgement of the market regarding an asset's value, taking into account various factors such as anticipated cash flows, risk, and the prevailing macroeconomic condition. The accuracy of this price mechanism is crucial for effective distribution of resources and optimal allocation of capital (Gogokhiya, 2003; Biondi, Giannoccolo, & Galam, 2012; Fang, Chung, Ventre, Basios, Kanthan, Li, & Wu, 2021). Moreover, financial markets facilitate intermediation by connecting borrowers and lenders. Various financial institutions such as banks, insurance companies, and mutual funds serve as intermediaries by collecting funds from savers and then offering loans or investment opportunities to borrowers (De Haan, Oosterloo, & Shoenmaker, 2012). This intermediation function plays a vital role in ensuring efficient allocation of capital, as financial institutions evaluate the creditworthiness of borrowers, handle risks, and offer their expertise to investors (Fecht, Huang, & Martin, 2008; Kumar, & Santhya, 2020).

The pivotal role played by financial markets in the workings of an economy implies that any disruption to these markets would have significant effect on the economy's growth and development. The COVID-19 pandemic has had a significant impact on financial markets around the world. The transmission of the pandemic on the financial markets are manifested through several principal channels, including bond market fluctuations, foreign exchange market fluctuations, commodity price volatility, and stock market volatility. The bond market was not insulated from the impact of COVID-19 pandemic. The impact was orchestrated through capital flight, monetary and fiscal policies, and economic and inflation expectations. In periods of

uncertainty and risk aversion as demonstrated by COVID-19 pandemic, investors sell riskier assets and shift their attention to relatively safer assets, such as government bonds and high-quality corporate bonds (Schrimpf, Shin, & Sushko, 2020; Falato, Goldstein, & Hortaçsu, 2021). This increase demand for bonds led to higher bond prices, resulting in its increased volatility.

In addition, monetary policies, such as interest rate cuts, quantitative easing, and provision of liquidity to bond markets were implemented around the world to combat the effect of the pandemic. These policies influenced bond prices, as changes in interest rate affect the attractiveness of bonds in comparison to other investments (Nozawa, & Qiu, 2021; Andaiyani, Hidayat, Muthia, & Atiyatna, 2022). Further, the significant expansionary fiscal policies, such as stimulus packages implemented by government to support economies, implied an increased government borrowing and issuance of government bonds to finance these packages. The quantum of government debt issuance tends to affect the bond market, which reflects in fluctuation of bond prices, through the mechanism of demand and supply of bonds (Chudik, Mohaddes, & Raissi, 2021; Alberola, Arslan, Cheng, & Moessner, 2021; Gourinchas, Kalemli-Özcan, Penciakova, & Sander, 2021).

Moreover, the fluctuations in the bond market were affected by the consequences of COVID-19 through economic outlook and inflation expectations. At the start, the pandemic caused significant disruptions to economic activities, which resulted in predictions of reduced economic growth and the possibility of deflationary forces. Consequently, investors turned to bonds as a perceived secure investment, causing bond prices to increase (Schrimpf *et al*., 2020).

The foreign exchange markets of economies around the globe were not able to escape the impact of the pandemic as well. The pandemic influence on this market were through economic uncertainty, attraction to safe-haven currencies, trade disruptions, and fiscal and monetary policies. The pandemic induced health measures disrupted economic activities, heightening economic uncertainties, which led to increased volatility in the foreign exchange market. Syed, Fatima and Zaheer (2022) established that, the uncertainty created by COVID-19 shock resulted in a statistically significant and positive influence on the exchange rate in Pakistan.

Similarly, in uncertainty periods, investors look for secure investment options to safeguard their funds. Safe-haven currencies like the US dollar, Japanese yen, and Swiss franc are commonly chosen for this purpose. Miller (2020) contends that, in the midst of the pandemic, the heightened demand for US dollar led the US Federal Reserve to set up new swap lines to lend US dollar to other country's central banks. As the pandemic evolved, investors turned to these currencies, causing their value to rise and creating fluctuations in the values of other currencies (Aslam, Aziz, Nguyen, Mughal, & Khan, 2020; Narayan, 2020).

Additionally, the pandemic disrupted the global supply chains and international trade, which significantly impacted the imports and exports of various economies (Barbero, de Lucio, & Rodriguez-Crespo, 2021). The currencies of economies heavily dependent on international trade experienced significant effects due to the decline in trade.

Moreover, fluctuations in commodity prices further influenced movements in the foreign exchange (forex) market. Devpura (2021) and

Nwosa (2021) revealed a significant impact of oil price on exchange rate, whilst Sahu, Bal and Kundu (2022) revealed that gold price and exchange rate were significantly correlated during the pandemic period in India. Further, to address the economic effects of the pandemic, numerous central banks implemented monetary policy measures, such as interest rate cut and quantitative easing. These measures have the potential to impact currency values and introduce volatility in forex markets. For instance, the foreign exchange markets in Europe, according to Cepoi, Dumitrescu, Georgescu, Gherghina and Iacob (2022), responded asymmetrically to monetary policy measures that were aimed at stimulating spending and economic activities during the pandemic. Moreover, public authorities around the world implemented various fiscal stimulus measures to mitigate the economic impact of COVID-19. These measures included increased government spending, tax cuts, and financial support for affected industries. Such policies can impact currency values by influencing inflation expectations, budget deficits, and investor confidence. Azad, Serletis and Xu (2021) for instance asserts that, fiscal policies implemented in Canada during the pandemic, resulted in an increase in interest rates, drop in investments, and rise in inflation.

The global prices of commodities have been greatly influenced by the COVID-19 pandemic as well. The relationship between the pandemic and commodity prices can be understood through several channels such as supply chain disruptions, dip in demand, investor behaviour, and geopolitical factors. The COVID-19 induced health measures disrupted the production, transportation, and distribution of commodities, resulting in supply shortages and increased prices. For instance, the shutdown of mines and mineral

factories led to decrease in production of metals and minerals, influencing their market prices. Confirming this, Jowitt (2020) indicates that, the COVID-19 mitigation efforts negatively impacted mining industries, resulting in production drops and decreases in metal prices. Further, the health measures resultant effect on economic activities, significantly impeded the operations of industries such as aviation, hospitality and automotive. The downturns experienced by these industries led to plummet in demand for energy commodities, such as oil and gas. The decline in demand for these commodities contributed to a drop in their prices. Mehlig, Apsimon and Staffell (2021) confirms this by indicating that in the United Kingdom (UK), the first COVID-19 lockdown reduced demand for electricity by 15.6%, and for commercial gas by 12.0%, whilst the second lockdown produced reductions less than half. In addition, the uncertainty surrounding the pandemic created a sense of market volatility and risk aversion among investors. In such uncertain periods, investors look for safe-haven assets, such as gold, leading to an increase in its value. This is in tandem with the assertion of Cui, Wong, Wisetsri, Mabrouk, Muda, Li and Hassan (2023), that indicated that the pandemic impact on gold prices was positive both in the short and long run, proving its safe-haven propriety. On the other hand, commodities like industrial metals, considered riskier, may witness price drops as investor interest dwindles. Jowitt (2020) and Kaitwade (2021) confirms the drop in metal prices in the peak of the pandemic. Furthermore, the global health crisis worsened pre-existing geopolitical conflicts and trade disagreements, resulting in additional volatility in the prices of commodities. Steps taken by countries in reaction to the pandemic, such as imposing export limitations, tariffs, and

trade obstacles, disrupted the markets for commodities and played a role in its price fluctuations. Yan, Cai, Lin and Ambaw (2021) proves this by revealing that trade restrictions, occasioned a rise in volatility of world agricultural prices by approximately 22%.

The severity of COVID-19 pandemic which can be seen as a "Black Swan event" affected the stock market through several channels, such as disruption to economic activities, sector-specific impact, vaccine developments, and investor sentiments. The pandemic resultant health measures, led to significant disruption to economic activities globally. This was particularly worse for industries in the travel, hospitality, and retail sectors, which faced significant challenges. As a result, stock prices of companies in these sectors experienced sharp declines, leading to the general market volatility (Wu, Lee, Xing, & Ho, 2021; Lee, Lee, & Wu, 2021; Lin, & Falk, 2022; Zhong, 2022). Additionally, similar to the stock market responding negatively to unwelcome news, it equally has tendency to respond positively to positive news, such as the discovery and development of COVID-19 vaccine. Regular favourable updates regarding vaccine efficiency, distribution strategies, and advancements in vaccination drives, resulted in market surges, indicating positive outlook from investors (Hartono, 2021; Chan, Chen, Wen, & Xu, 2022). Moreover, investor sentiment and behaviour were significantly impacted by the pandemic's uncertainty and fear. As ravaging cases and deaths of COVID-19 are reported in the media, investors' sentiments would be shaped by the disease, which has the potential of significantly affecting the stock market. For instance, when a stock market is in a bullish state, risk perception is low, which would influence optimistic behaviour of investors.

On the contrary, when the market is in a bearish state, risk perception is high, which influences pessimistic behaviour of investors, resulting in their resistance to enter until the market rebound (Economou, Hassapis, & Philippas, 2018; Syriopoulos, & Bakos, 2019). This resulted in investors being cautious and risk averse, leading to higher levels of selling activity and downward trends in the market (Huynh, & Xia, 2021; Salisu, & Adediran, 2020). These pessimistic activities by investors resulted in substantial impact on the stock markets, particularly during the initial phases of the pandemic, leading to a heightened level of market volatility (Engelhardt, Krause, Neukirchen, & Posch, 2021; Insaidoo, Arthur, Amoako, & Andoh, 2021; Szczygielski *et al*., 2022). Besides the panic selling, many investors in order to reduce economic uncertainties induced risk, would rather hold assets in "safe-haven" investments (Bouoiyour, Selmi, & Wohar, 2019; Rasheed, Ahmad, & Javid, 2021). Such investors' behaviour could lead to reduction in stock market prices, resulting in poor market performance.

The COVID-19 crisis has caused substantial fluctuations in stock markets across developed, emerging, and developing economies. As evidenced in Figure 1, 2 and 3, the performance of stock markets across developed (G7) economies, emerging (BRICS plus 2 emerging markets) economies, and

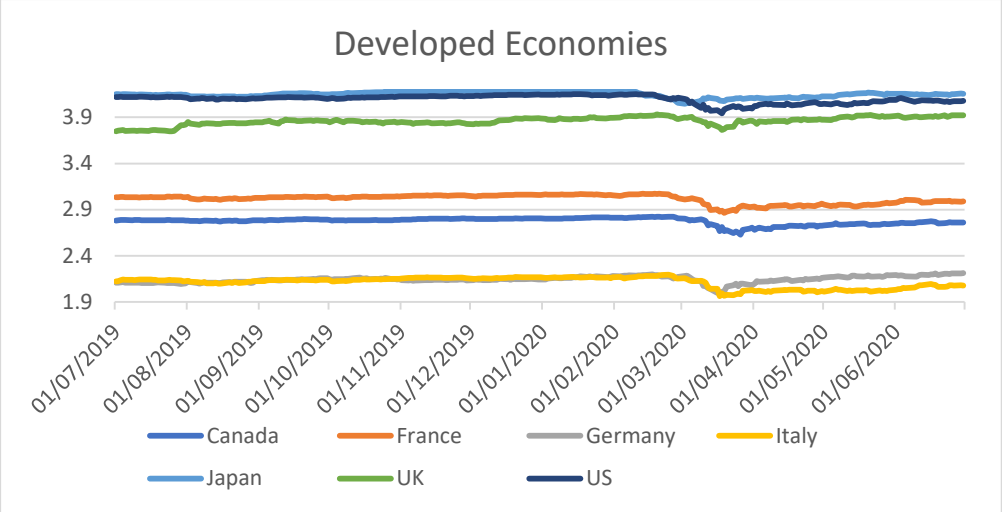

Figure 1: Logged daily indices of stock markets in developed economies (July 2019 – June 2020)

Source: Author's Construction (2023)

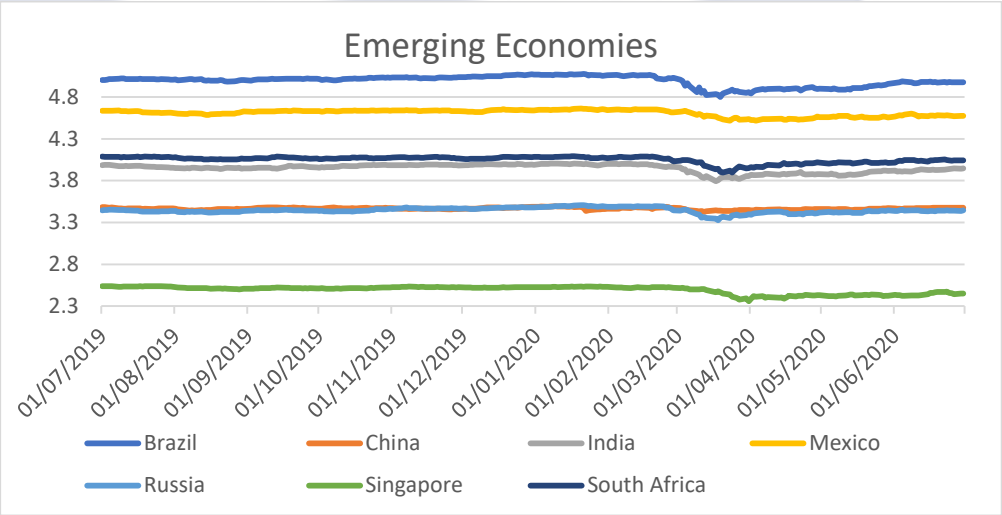

Figure 2: Logged daily indices of stock markets in emerging economies (July 2019 – June 2020)

Source: Author's Construction (2023)

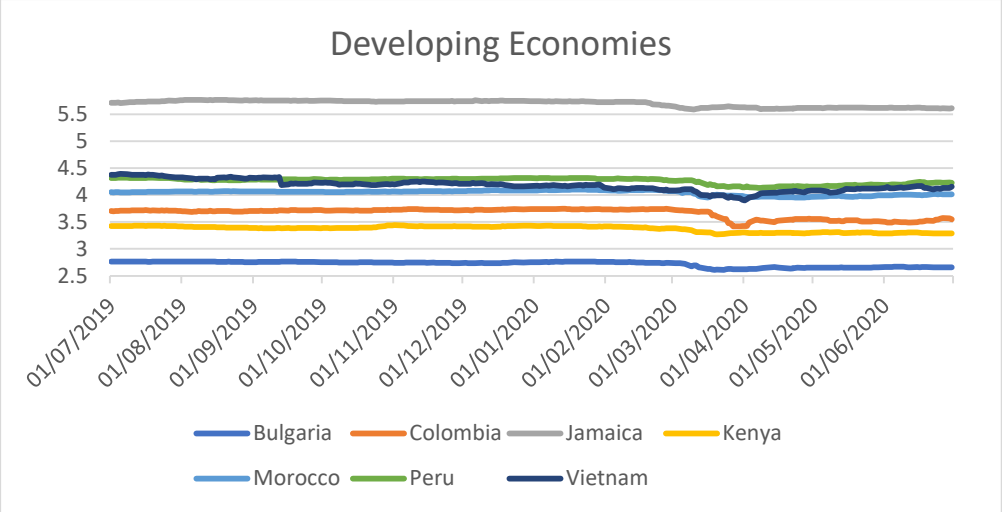

Figure 3: Logged daily indices of stock markets in developing economies (July 2019 – June 2020

Source: Author's Construction (2023)

developing economies were relatively stable in the period prior to the outbreak of COVID-19 virus. These stock markets however, witnessed sharp declines in the last month of the first quarter of 2020, coinciding with the period where WHO declared COVID-19 as a global pandemic.

Whilst COVID-19 had global ramifications on stock markets, the severity and duration of its impact could vary across economies depending on their development status. Development status refers to the level of economic advancement and maturity of a country which encompasses factors such as income per capita, industrialization, infrastructure, technology adoption, healthcare quality, education levels, and overall standard of living. Countries are often categorized as advanced, emerging, and developing based on these criteria. Economies at different development stages have varying sector compositions in their stock markets. Advanced economies may have a larger proportion of technology, healthcare, and consumer goods sectors, which were less affected or even benefited from COVID-19 (e.g., tech companies enabling

remote work).

In contrast, emerging economies might have a higher proportion of sectors like commodities or tourism, which were more severely impacted. In addition, developing economies often rely heavily on exports and global trade. Disruptions in global supply chains and reduced international demand due to COVID-19 could have a more pronounced impact on their stock markets compared to more self-sufficient or diversified advanced economies. Further, the ability of an economy to manage and respond to the healthcare crisis posed by COVID-19 also impacts investor confidence. Advanced economies generally have more robust healthcare infrastructure and resources to handle such crises, which can reassure investors and mitigate negative impacts on stock markets compared to economies with weaker healthcare systems.

Similarly, advanced economies often have greater fiscal space and policy tools to cushion the economic impact of COVID-19 through stimulus packages, monetary policy adjustments, and social safety nets. These measures can stabilize stock markets and investor sentiment to a greater extent compared to economies with more limited resources and policy options. Finally, investor sentiment and risk perception play a crucial role in stock market performance during crises. Market participants in advanced economies might have different risk tolerances and access to information compared to those in developing economies, influencing how they react to pandemic-related news and developments.

Furthermore, forex markets are linked to products and services that are traded and transacted in foreign currency. One of the counterparties of these operations are adversely impacted when there are unforeseen fluctuations in

cash flows. Profitability of financial institutions tends to be impacted by happenings in the global market due to their universal interconnectedness (Saunders, & Cornett, 2011).

Similarly, the stock market which is one of the key components of financial system, aid in the provision of funds to lacking sectors which help in enhancing productive activities of the free-enterprise sector and the minimization of risk exposure (Omet, Khasawneh, & Khasawneh, 2002). Increased international equity flows, heightens the demand and supply of currencies in which these equities are denominated, resulting in some level of interdependence between stock and forex markets.

In market economies, the mechanisms of free-floating and managed floating exchange rates, to some degree, douses the exchange rate volatility (Karoui, 2006). The presence of negative shocks whether locally or internationally implies an increased level of volatility in the markets which ultimately results in a negative impact on the performance of financial markets. Domestic stock prices and its returns are vulnerable to fluctuations in global markets and exchange rate volatility, which causes volatility in domestic stock markets. Jegajeevan (2010) posits that, financial risks are usually measured using stock market volatility, which serves as guide for portfolio selection, hedging, asset pricing, etc. Extended stock market volatility disrupts the price mechanism of the capital markets, which can result in holders of foreign equities to face greater risks of exchange rate volatility. The covariance of currency and equity returns critically determines portfolio investments performance and the use of foreign exchange as a hedge against risk by foreign investors. This interdependency is of great concern to

policymakers as capital investments needed for economic development, particularly in developing economies, are provided by these foreign investors.

In crisis periods, such as COVID-19, financial globalisation can potentially influence the volatility transmission between stock and forex markets. Financial globalisation refers to the increasing interconnectedness and integration of financial markets, institutions, and economies globally. It involves the cross-border flow of capital, the expansion of financial services across national boundaries, and the harmonization of financial regulations to facilitate global financial activities. There are several ways through which financial globalisation might affect this transmission. Due to the deepened integration, the heightened uncertainty and volatility in global financial markets occasioned by COVID-19, could quickly transmit to economies through interconnected financial channels, impacting both stock prices and exchange rates. In addition, in crisis periods, such as COVID-19, changes in investor sentiment and risk perception globally can lead to significant capital outflows or inflows in an economy's stock and forex markets, amplifying the volatility. Additionally, responses by global central banks and financial institutions to mitigate the economic impact of COVID-19, such as interest rate cuts or liquidity injections, can influence global market dynamics. These actions can affect exchange rates and investor behaviour in economy's markets, contributing to volatility.

Moreover, financial globalisation can expose economies to external shocks differently based on their sectoral composition and trade dependencies. For instance, currencies of countries reliant on commodity exports may experience greater volatility due to fluctuations in global commodity prices

during COVID-19. Further, increased financial globalisation can lead to a higher presence of foreign investors in a country's markets. Their reactions to global events, including COVID-19-related developments, can amplify volatility in both stock and forex markets as they adjust their portfolios in response to changing global conditions.

Moreover, on March 12, 2020, Ghana, an African economy, reported its first case of COVID-19 virus, which has since surged to total confirmed cases of 171,657 and 1,462 deaths as of April 24, 2023 (Ghana Health Services [GHS], 2023). The enormity of the impact of the pandemic on the economy of Ghana was reflected in the drop of its GDP growth rate from 6.51% in 2019 to 0.51% in 2020 (WB, 2023). This economic slowdown was primarily attributed to the pandemic induced disruptions to global commerce and supply chain, which had a cascading effect on Ghana, which is heavily dependent on international trade. Like other developing economies with Agricultural, Manufacturing, and Services sectors categorization, the economic sectors of Ghana were immensely impacted by the pandemic. The reduced workforce and restricted movements during lockdown conditions had an impact on agricultural production and distribution, global disruptions in supply chain had a negative impact on domestic manufacturing, due to its heavy reliance on imported raw materials, and the dominance of hotels, tourism, education, transport, restaurants, and telecommunications in the services sector resulted in its poor performance due to both domestic and international travel restrictions, and the need for physical distancing (Borgen, 2021).

An understanding of the theories underpinning the connection between COVID-19 pandemic and exchange rate movement is required in order to appreciate the linkage. In the long run, changes in exchange rates can be ascribed to alterations in market fundamentals or economic factors, including relative productivity levels, price levels, interest rates, preferences for local or foreign goods, and trade barriers (Mussa, 1984). However, there are instances where fluctuations in currency exchange rates prove to be excessively significant and sudden to be comprehensively accounted for by these factors alone. In the short run, transactions involving assets like treasury bills, bank accounts, and stocks exert significant influence on the foreign exchange markets. The interconnectedness of financial markets globally, implies that investors are able trade in local and foreign assets on a 24-hour basis, leading to instantaneous fluctuations in currency values (Jamal & Bhat, 2022).

Given the unprecedented nature of COVID-19 pandemic, the asset market approach is highly relevant for determining short-term exchange rates. Though, Ghana cedi relative to the US dollar appreciated in value in the last quarter of 2019, it took a nosedive in the latter part of the first quarter of 2020 (coinciding with the first confirmed case of COVID-19 virus in Ghana), and depreciated throughout 2020, albeit with intermittent marginal recoveries as depicted in Figure 4. Corroborating the weak performance of the Ghana cedi in

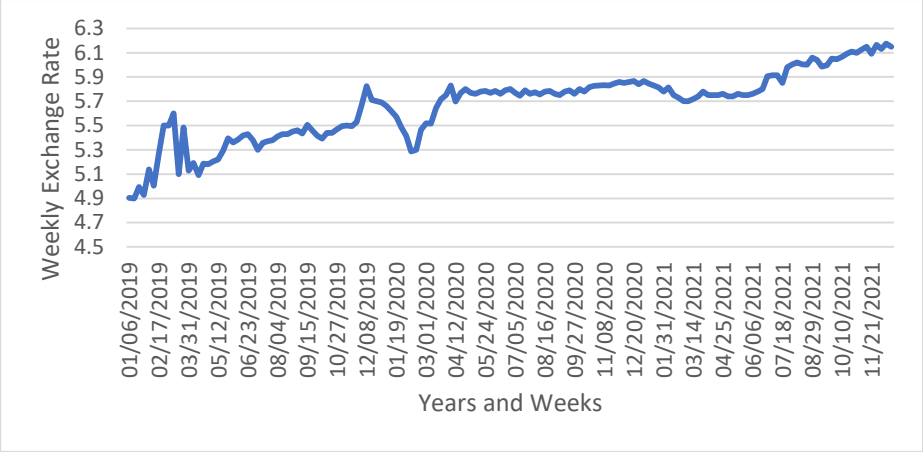

Figure 4: Weekly exchange rate, Ghana cedi vis-à-vis US dollar (2019 – 2021)
Source: Author's Construction (2023)

the wake of COVID-19, Insaidoo *et al*. (2021) noted the pandemic induced deterioration in the current account balance of African countries resulted in the depreciation of their domestic currencies.

The influence of COVID-19 on exchange rates is undeniable, however, the level of trade openness of an economy has the potential to either reduce or worsen this influence. Trade openness is the extent to which a country engages in international trade activities by importing and exporting goods and services with other countries. A higher level of trade openness indicates that a larger portion of the economy's production is involved in international trade, reflecting greater integration into the global economy. Trade openness can affect the relationship between COVID-19 and exchange rates through these means. Countries with higher trade openness are more dependent on international trade for their economic activity. During COVID-19, disruptions in global supply chains, reduced demand for exports, and changes in import patterns can directly impact these countries' exchange rates. For instance, a decrease in exports can lead to a decline in foreign currency inflows, affecting the exchange rate. Additionally, economies with high trade openness often rely

on commodity exports (such as oil, minerals, or agricultural products). Changes in global commodity prices due to COVID-19 demand shocks or supply disruptions can significantly impact the export earnings and hence the exchange rates of these countries.

Moreover, countries with high trade openness may maintain significant foreign exchange reserves to stabilize their currencies during external shocks such as COVID-19. The management and use of these reserves can influence exchange rate movements. Finally, governments of countries with high trade openness may implement policy measures such as currency interventions or adjustments in trade policies to mitigate the impact of COVID-19 on their exchange rates. These policy responses can vary depending on the country's economic structure and trade dependencies.

Statement of the Problem

The significance of the effect of the novel COVID-19 pandemic on performance of financial markets around the world cannot be emphasized enough. The widespread and profound consequences of this pandemic indicate that, no economy could remain unaffected by its impact. Stock markets in developed, emerging, and developing economies have been significantly impacted by the pandemic. Hashmi and Chang (2021), and Chang *et al.* (2019) however, asserts that, due to the strong foundations of financial markets in developed economies, the negative effects of global crisis on stock markets in these economies might have brief duration and less protracted, with these markets rebounding during economic recovery, whilst the impact of the crisis on stock markets in non-developed economies is likely to be more noticeable and enduring. Corroborating this, Hashmi *et al*. (2021) indicates that,

unfavourable events are more likely to affect the stock markets in less developed countries. This assertion is questionable due the counter-intuition by literature. The pandemic induced health measures disrupted the operations of service-based industries, which are the mainstay of developed economies, leading to poor performance of numerous companies listed on the stock markets in developed economies. Corroborating this, Bilal *et al*. (2022) revealed that, the pandemic induced measures adversely impacted the US's hospitality and entertainment stocks, in comparison to the same stocks of emerging economies, such as China, Turkey, India, Thailand, and Mexico.

Further, developed economies have higher level of integration into global supply networks, engaging in substantial imports and exports, whilst non-developed economies are relatively less dependent on international trade, prioritizing domestic consumption instead. The pandemic induced disruptions to global trade and supply chains, led to heightened unpredictability and instability in the stock markets of developed economies. Chahuán-Jiménez *et al.* (2021) confirms this by revealing that, the pandemic impact on financial markets were higher in economies with greater trade integration.

Moreover, panic selling of stocks was relatively higher in developed economies due to higher concentration of individual and institutional investors, and the extensive media coverage on the pandemic, heightening uncertainty and selling in developed economies. Szczygielski *et al*. (2023) provides evidence of this by showing that, changes in COVID-19 related Google Search Trends had greater adverse impact on stock markets in Italy, Canada, and Norway (developed economies), relative to stock markets in Malaysia, Taiwan, Qatar, and Hong Kong (non-developed economies). These

schools of thought's arguments raise the question of whether the development status of an economy influences the magnitude of the pandemic impact on its stock markets.

Further, globalisation over the past five decades have led to an increased interest in international equity investments (National Research Council [NRC], 1995). The upsurge in investments in international equity has occasioned a hike in activities in foreign currencies' market. Interdependency between returns on equity and exchange rate arises due to the heightened demand for currencies and equity. As a result of the increased interdependency, volatility transmission between stock and forex markets is heightened resulting in riskier investments in international portfolio, which further leads to poor performance of these investments (Kanas, 2000). Stock and forex markets, which are subsets of financial markets are vulnerable to different crisis, which occasions their increased volatility (Zhao, Rasoulinezhad, Sarker, & Taghizadeh-Hesary, 2022). With COVID-19 pandemic being seen as the mother of all global crisis, does the recent pandemic heightens the volatility transmission between forex and stock markets in Africa. Further, Alagidede (2008) shows, that African markets are not well integrated with each other, and additionally revealed a weak linkage between these markets and the rest of the world, indicating that Africa's market respond to local rather than global information.

In addition, financial globalisation, according to Cordella and Ospino Rojas (2017), play either a stabilizing or destabilizing role in financial market volatility. The former role provides an avenue for more efficient risk sharing, whilst the latter role provides a vehicle for contagion. Confirming this

inconclusive relationship, Gaies, Goutte and Guesmi (2020) provides empirical evidence of the stabilizing forces of financial globalisation, whilst Schmukler and Abraham (2017) showed the opposite. Pursuant to this discussion, does financial globalisation stabilizes or destabilizes the volatility transmission between stock and forex markets in Africa, during the COVID-19 pandemic period.

Moreover, Ghana, an open economy, was not insulated from the economic impact of COVID-19 pandemic. The country, highly reliant on its exports of commodities such as oil, gold, and cocoa, experienced significant disruptions in its international trade. Additionally, similar to numerous other developing economies, Ghana experienced drop in foreign direct investment (FDI) and a decline in its fiscal situation owing to the contraction of economic activities globally. Exchange rates, which is influenced by trade, FDI inflows and economic conditions, play a pivotal role in a country's economic stability and international competitiveness, by influencing prices of imports, cost of production, and determining the value of foreign currency in domestic markets. Whilst the exchange rate in Ghana is expected to be affected by COVID-19 pandemic, an empirical literature on the relationship between the pandemic and Ghana's forex market is to the best of my knowledge unresearched. Moreover, whilst one group established higher integration in international trade to be associated with depreciation of local currency, particularly in developing economies (see Gantman, & Dabós, 2018; Nkalu, Urama, & Asogwa, 2016; Lee, & Law, 2013), another group revealed the reverse, with trade openness leading to the appreciation of local currency (see Kacaribu, Sabrina, & Hasan, 2021; Bala, & Tahir, 2016; Longe, Muhammad,

Ajayi, & Omitogun, 2019). The former's findings were attributed to the general notion of trade openness weakening the real value of local currencies, particularly due to the trade deficits experienced by these economies, whilst the latter's findings were ascribed to the trade surplus experienced by the understudied economies. Trade surplus would likely imply an increase in the demand for domestic currency relative to foreign currency in the forex market, leading to the domestic currency's appreciation. Pursuant to this discussion, does the level of Ghana's trade openness influence the relationship between COVID-19 cases and exchange rates in Ghana.

This study, therefore, uses Bayesian Structural Time Series (BSTS) and Pooled Ordinary Least Squares (Pooled OLS) estimation techniques, to assess the role of development status in the relationship between COVID-19 pandemic and performance of stock markets, using seven stock markets each from developed (G7), seven emerging (BRICS plus 2 emerging economies), and seven developing economies. It also applies Panel Fully Modified Ordinary Least Squares (Panel FMOLS) and Panel Dynamic Ordinary Least Squares (Panel DOLS) estimation approaches, to examine the role of financial globalisation in the volatility transmission between stock and forex markets in Africa, during the COVID-19 period. The study further employs the Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR) approaches, to investigate the role of trade openness in the relationship between COVID-19 cases and performance of the exchange rate in Ghana.

Purpose of the Study

The purpose of the study is to examine the role of development status, financial globalisation, and trade openness in the relationship between COVID-19 pandemic and performance of financial markets.

Objectives of the Study

Specifically, this study seeks to:

1. Examine the effect of development status on the relationship between COVID-19 pandemic and performance of stock markets of 21 countries;
2. Assess the moderating role of financial globalisation in the volatility transmission between stock and forex markets in Africa, during the COVID-19 pandemic period;
3. Investigate the moderating role of trade openness in the relationship between COVID-19 cases and performance of the exchange rate in Ghana.

Hypotheses

Based on the objectives of this study, the main hypothesis the study seeks to test is that development status, financial globalisation, and trade openness does not play a role in the relationship between COVID-19 pandemic and performance of financial markets. Specific hypotheses to be tested in this study include the following:

1. H_0: Development status does not influence the effect of COVID-19 pandemic on stock market performance

   H_A: Development status influences the effect of COVID-19 pandemic on stock market performance

2. H_0: Financial globalisation does not matter in the volatility transmission between stock and forex markets in Africa, during COVID-19 pandemic period

   H_A: Financial globalisation matter in the volatility transmission between stock and forex markets in Africa during COVID-19 pandemic period

3. H_0: Trade openness does not play a moderating role in the relationship between COVID-19 cases and performance of the exchange rate in Ghana

   H_A: Trade openness play a moderating role in the relationship between COVID-19 cases and performance of the exchange rate in Ghana

Contribution to the Literature

This thesis contributes to extant literature on the relationship between COVID-19 pandemic and performance of financial markets in several ways. The contributions made by this study to literature is in three folds; role of development status in the relationship between COVID-19 pandemic and performance of stock markets, role of financial globalisation in the volatility transmission between stock and forex markets in Africa, and the role of trade openness in the relationship between COVID-19 pandemic and performance of the exchange rate in Ghana.

This study extends literature by empirically examining the arguments of Hashmi *et al*. (2021), Chang *et al*. (2019), and Hashmi and Chang (2021) of a less protracted impact of COVID-19 on financial markets of developed economies due to these markets' strong foundations, and the counter-arguments of Bilal *et al*. (2022), Chahuán-Jiménez *et al*. (2021), and

Szczygielski *et al*. (2023) of a more protracted impact of COVID-19 pandemic on financial markets of developed economies as a result of these economies' deeper integration in global supply networks, higher uncertainty due to extensive media coverage on the pandemic, and dominance of service-based industries in developed economies.

With respect to the volatility transmission between forex and stock markets, the study in addition to examining the volatility transmission between stock and forex markets in eight African countries, during the COVID-19 pandemic period, assesses the moderating role of financial globalisation in this relationship.

Finally, in relation to COVID-19 pandemic and performance of exchange rate, whilst the impact of COVID-19 pandemic on performance of exchange rates around the world is well documented (see Nwosa, 2021; Li, Su, Yaqoob, & Sajid, 2022; Kausar, Rahid, & Saddique, 2022), the moderating role of trade openness in this relationship is understudied. This study is a pioneer attempt at investigating how Ghana's degree of trade openness influences the relationship between the pandemic and its exchange rate.

Significance of the Study

This thesis contributes to the literature on COVID-19 pandemic and performance of financial markets in the following ways. The impact of COVID-19 on performance of stock markets across developed, emerging and developing economies presents an intriguing and complex area of study. By examining the variations in their responses to the pandemic, we can gain valuable insights into the resilience and vulnerabilities of different economies and devise strategies to promote more sustainable and inclusive growth in the

future. Additionally, understanding how financial globalisation influences the volatility transmission between stock and forex markets in Africa, during the COVID-19 pandemic period is essential for developing robust systems, promoting sustainable economic growth, and enhancing resilience against future shocks.

Finally, the findings would provide policymakers, economists, and stakeholders with a thorough understanding of how trade openness influences the dynamics of exchange rates during a global crisis, which would assist in developing policies and strategies that are grounded in evidence, aimed at reducing the negative impacts of the pandemic on Ghana's economy, strengthening its resilience, and fostering sustainable growth.

Scope of the Study

This study assesses the effect of development status on the relationship between COVID-19 pandemic and performance of stock markets, with specific focus on seven stock markets of developed (G7) economies, seven stock markets of emerging (BRICS plus 2 emerging economies) economies, and seven stock markets of developing economies, using daily time series data from July 16, 2019, to June 30, 2020 to assess the impact of the pandemic on individual stock markets. The stock market is used as a proxy for financial market following the work of Albulescu (2021).

For impact analysis purposes as prescribed by the Bayesian Structural Time Series technique, the period from July 16, 2019 to December 31, 2019 is approximately considered as the pre-COVID-19 period, since COVID-19 was birthed in December 2019, whilst the period January 1, 2020 to June 30, 2020 is approximately considered as the post-COVID-19 period. The study then

used panel dataset on the same 21 economies, from March 11, 2020, to December 30, 2020 to examine the role of development status in the relationship between COVID-19 pandemic and performance of regional stock returns. These 21 countries are categorized into three groups (developed, emerging and developing) of seven countries each based on the World Bank (2024) classification of economies. The dataset used in this study spans from March 11, 2020, to December 30, 2020. The dataset for this study starts from March 11, 2020, because this is the date the WHO declared COVID-19 as a global pandemic.

Whilst the health crisis, the magnitude of the COVID-19, has tendency to adversely impact financial markets, in the same vein, the discovery and distribution of COVID-19 vaccines constitute a positive news, which can translate in a positive influence on financial markets. To decouple the possible positive influence of the COVID-19 vaccine in the relationship between COVID-19 pandemic and performance of stock markets, the dataset for this study ends at December 30, 2020. This end date is due to the fact that, on December 31, 2020, WHO issued its first emergency use validation for a COVID-19 vaccine which was aimed at ensuring equitable global access to COVID-19 vaccines (see WHO, 2020).

Further, the study employed daily prices and returns of stock indices and exchange rates of eight African countries, to investigate the volatility transmission between stock and forex markets, and the moderating role of financial globalisation in this relationship, during the COVID-19 pandemic period (March 11, 2020, to December 30, 2020). The eight African countries were selected based on the availability of data on their stock index. The reason

for the duration of this study is same as the rationale provided above for objective one's panel data analysis.

Finally, the study examines the relationship between COVID-19 cases and performance of the exchange rate in Ghana, and the moderating role of trade openness in this relationship, using daily data spanning from March 19, 2020, to December 30, 2020. Ghana, an open economy is highly reliant on international trade, which influences its exchange rate. With the COVID-19 induced disruptions to the global supply chain, the exchange rate in Ghana was expected to be affected. Whilst the date for the first confirmed case of COVID-19 in Ghana was March 12, 2020, the dataset for this study starts from March 19, 2020, because this is the earliest case reported on the John Hopkins University website. The rationale for the end date of the dataset for this study is the same as the one provided above for objective one's panel data analysis.

Limitations of the study

Many studies on the impact of the COVID-19 pandemic on financial markets may have a short-term perspective, analyzing immediate reactions and trends. Similarly, due to the purpose of the study, this thesis focused on the short-term relationship between COVID-19 pandemic and performance of financial markets. However, the long-term effects and the full extent of the pandemic's impact may not be fully understood in the early stages of the pandemic, particularly due to the evolving nature of the pandemic and its measures. Further, Selmi and Bouoiyour (2020) mentions demand shocks, supply shocks and uncertainty shocks as transmission mechanisms of the pandemic on the economy. This study focused on the uncertainty induced

panic and pessimistic behaviours, that adversely impacted the performance of financial markets.

Organisation of the Study

The thesis is organized into eight chapters. Chapter One focused on introduction to this thesis. Chapter Two provides an overview of the performance of financial markets around the world. Specifically, it focuses on the performance of stock markets of seven developed (G7) economies, seven stock markets of emerging (BRICS plus 2 emerging economies) economies, and seven stock markets of developing economies. The chapter also presents an overview of the performance of stock and forex markets of eight African countries, during the COVID-19 pandemic period. The chapter concludes by providing an overview of performance of Ghana's exchange rate, exports, and imports, and FDI inflows. An assessment of theoretical and empirical literature related to this thesis is presented in Chapter Three. The focus of the review would be to highlight the key connection between COVID-19 crisis and the financial markets. Chapter Four presents the methodological approaches, with specific focus on Bayesian Structural Time Series (BSTS), Pooled Ordinary Least Squares (OLS), Panel Fully Modified Ordinary Least Squares (Panel FMOLS), Panel Dynamic Ordinary Least Squares (Panel DOLS), Fully Modified Ordinary Least Squares (FMOLS), and Canonical Cointegration Regression (CCR). The effect of development status in the relationship between COVID-19 pandemic and performance of stock markets is presented in Chapter Five. In Chapter Six, the volatility transmission between stock and forex markets, and the moderating role of financial globalisation in this relationship is presented. Chapter Seven presents the moderating role of trade

openness in the relationship between COVID-19 cases and performance of the exchange rate in Ghana. The summary, conclusions and recommendation, limitations of this study, and suggestions for future studies are presented in the final chapter, Chapter Eight.

CHAPTER TWO

OVERVIEW OF PERFORMANCE OF FINANCIAL MARKETS

Introduction

This chapter provides an overview of the performance of financial markets used in this study. To understand the impact of COVID-19 pandemic on financial markets, there is the need to put these markets' performance into perspective. This review begins with the performance of stock markets in developed economies, followed by the ones in emerging and developing economies. The stock market is used as a proxy for financial market following the work of Albulescu (2021). In addition, due to its market efficiency, broad representation, liquidity, benchmarking, and accessibility, the stock market is considered as a good proxy for financial market. This is followed by a review of the performance of stock and forex markets in eight African countries, during COVID-19 pandemic period. The chapter concludes by providing review of the performance of the exchange rate in Ghana and the macroeconomic factors that drives exchange rate, such as Foreign Direct Investment (FDI) inflows, export, and imports.

Performance of Stock Markets

Analysis of the performance of stock markets would focus on seven stock markets each from developed, emerging, and developing economies. This is in line with the objective of this study.

Performance of Stock Markets in Developed Economies

This analysis would focus on the performance of major stock markets in Canada, France, Germany, Italy, Japan, United Kingdom, and United States. In 2019, the stock markets in Developed Economies exhibited initial stability

with moderate growth as shown in Figure 5. These stock markets witnessed sustained growth, supported mostly by strong economic conditions, low interest rates, and robust corporate earnings. However, the markets' stability shifted in early 2020

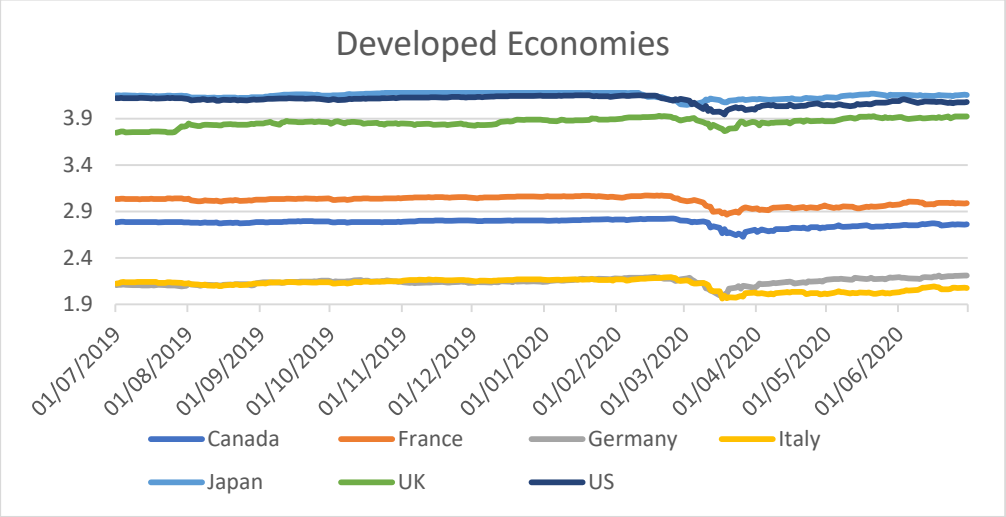

Figure 5: Logged daily indices of stock markets in developed economies (July 2019 – June 2020)

Source: Author's Construction (2023)

as the COVID-19 pandemic emerged. Concerns over the virus's impact on global economies led to a downturn in stock prices, with investors becoming increasingly risk averse. From the first quarter of 2020, these stock markets experienced sharp declines. These indices plummeted as lockdown measures were implemented worldwide, disrupting businesses and supply chains. The decline was particularly prominent in sectors directly affected by the pandemic, such as travel, hospitality, energy, and retail. Stocks in these sectors faced substantial selling pressure, resulting in significant price drops.

Performance of Stock Markets in Emerging Economies

This analysis would focus on the performance of major stock markets in Brazil, Russia, India, China, South Africa, Mexico, and Singapore. Stock

markets in Emerging Economies exhibited initial stability, with moderate gains in 2019, as depicted in Figure 6. This stability was primarily driven by positive investor sentiment, supported by rising oil prices for some oil exporting economies such as Russia and improving global economic conditions. However,

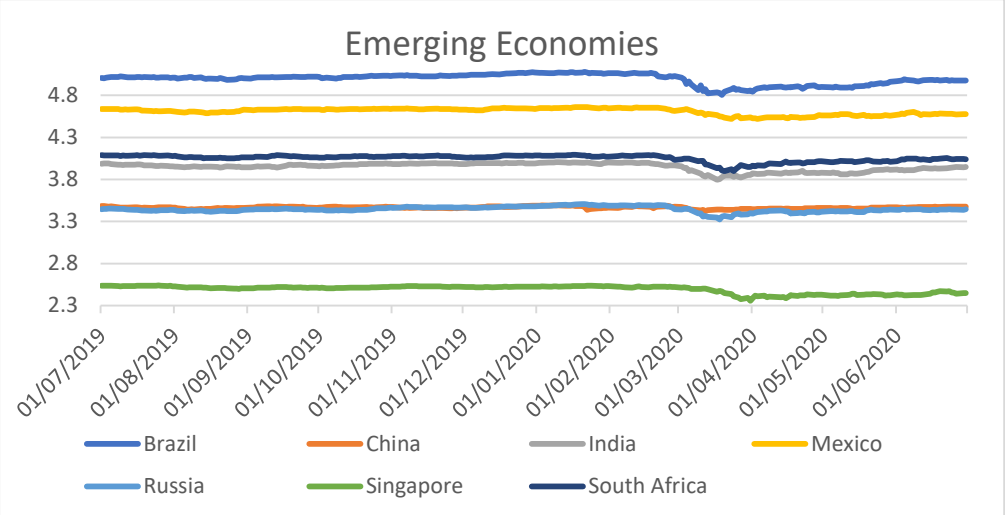

Figure 6: Logged daily indices of stock markets in emerging economies (July 2019 – June 2020)

Source: Author's Construction (2023)

in early 2020, the outbreak of the COVID-19 pandemic and its subsequent impact on the global economy triggered a downturn in stock prices. These indices witnessed significant drops as the pandemic disrupted businesses, supply chains, and consumer demand both domestically and globally. Sectors heavily affected by the pandemic such as travel, hospitality, retail, and commodities, faced substantial selling pressure, resulting in considerable declines in stock prices.

Performance of Stock Markets in Developing Economies

This analysis would focus on the performance of major stock markets in Bulgaria, Colombia, Jamaica, Kenya, Morocco, Peru, and Vietnam. The

stock markets in Developing Economies displayed stability driven by positive economic indicators and investor confidence. This stability was interlaced with

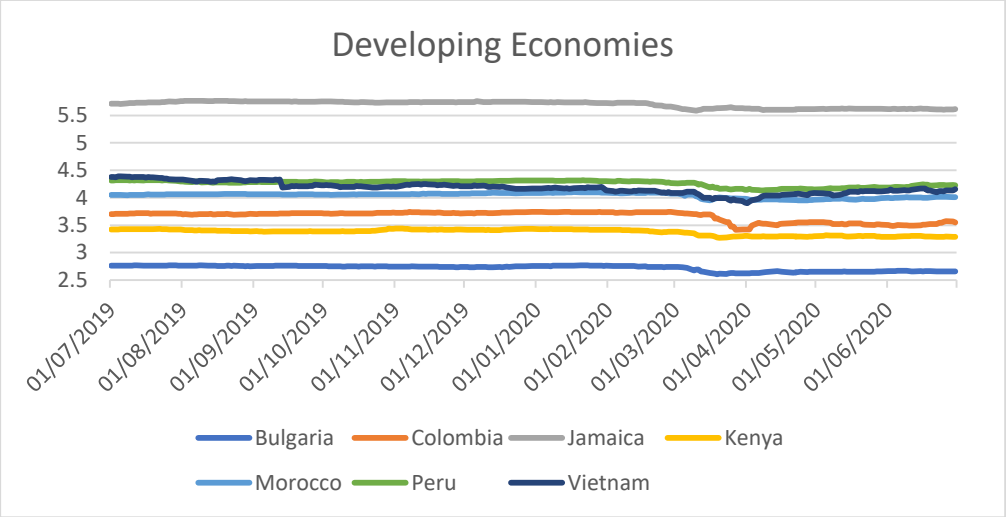

Figure 7: Logged daily indices of stock markets in developing economies (July 2019 – June 2020)

Source: Author's Construction (2023)

occasional dips in countries such as Vietnam, Kenya and Bulgaria as depicted in Figure 7. In early 2020, the stock markets experienced sharp decline due to the emergence of the COVID-19 pandemic. The outbreak led to widespread market panic and uncertainty domestically and globally. This uncertainty translated in subsequent markets sell-off.

Performance of Stock and Forex Markets in Africa in COVID-19 pandemic Period

This section presents overview of the performance of stock and forex markets for eight African countries (Botswana, Egypt, Ghana, Kenya, Mauritius, Morocco, South Africa, and Tunisia), during the COVID-19 pandemic period. The forex (exchange rate) market is considered as another

good proxy for financial market because it is considered as the biggest financial market of the world (Cuenca Montoya, & León Urrego, 2013).

Stock and Forex Market Performance of Botswana

For the COVID-19 pandemic period from March 2020 to September 2021, Botswana's stock market and exchange rates experienced fluctuations. As evidenced in Figure 8, the stock market for the first three quarters of the period

Figure 8: Daily Stock Price and Exchange Rate for Botswana (COVID-19 Period)

Source: Author's Construction (2023)

experienced downward spiral influenced by global and domestic factors, including the global economic slowdown and domestic lockdown measures. The last quarter of the period however, witnessed growth in the stock market. The forex market of Botswana enjoyed some level of appreciation in the first three quarters of the COVID-19 period, with depreciation occurring in the last quarter of the period as captured in Figure 8.

Stock and Forex Markets Performance of Egypt

The stock and forex markets of Egypt faced considerable challenges during the COVID-19 pandemic period, resulting in mixed trends influenced by global and domestic factors. In early 2020, as the pandemic spread globally, Egypt's stock market faced significant downturn as depicted in Figure 9. However, the market rebounded and for the rest of the period experienced checkered performance. For the forex market, the first quarter of COVID-19

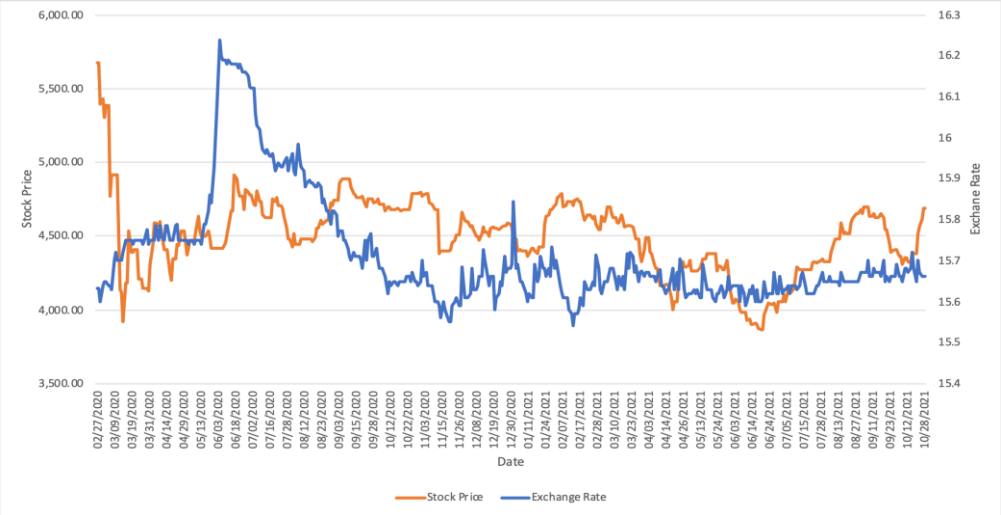

Figure 9: Daily Stock Price and Exchange Rate for Egypt (COVID-19 Period)
Source: Author's Construction (2023)

pandemic period, saw the market depreciate, with heightened depreciation in the second half of the first quarter. The second quarter recorded appreciable appreciation in the forex market, with the rest of the period witnessing stability in the performance of the forex market, albeit with occasional fluctuations.

Stock and Forex Markets Performance in Ghana

The stock market in Ghana witnessed continuous declines in the first half of the COVID-19 pandemic period, coinciding with the period where the

virus emerged in Ghana. The rest of the period saw the market rebound and post appreciable growth, albeit with occasional dips as evidenced in Figure 10. The forex market started the period with depreciation in the first two months, then for the rest of the first half of the period, attained relative stability. The Ghana

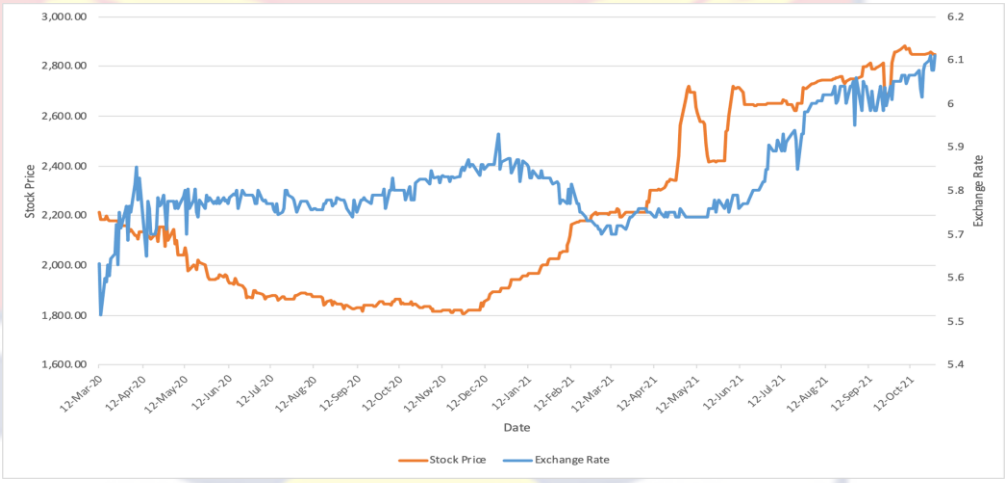

Figure 10: Daily Stock Price and Exchange Rate for Ghana (COVID-19 Period)
Source: Author's Construction (2023)

cedi started the second half on a strong footing, but subsequently depreciated for the rest of the period, though interlaced with intermittent recoveries.

Stock and Forex Markets Performance of Kenya

For the COVID-19 pandemic period, Kenya's stock market and exchange rates experienced significant fluctuations. The stock market faced initial downturn, influenced by global and domestic factors, including the global economic slowdown and domestic lockdown measures. The market recovered in the second quarter of the COVID-19 period, stabilized in the third quarter, and enjoyed appreciable growth in the last quarter, albeit with decline in the last month of the period. The forex market exhibited some depreciation due to economic conditions and government interventions. The first half of the period

Figure 11: Daily Stock Price and Exchange Rate for Kenya (COVID-19 Period)
Source: Author's Construction (2023)

saw the Kenyan forex market experience depreciation, followed by checkered performance for the rest of the period as displayed in Figure 11.

Stock and Forex Markets Performance of Mauritius

Apart from the initial rise and subsequent drop in the stock market of Mauritius in the first half of the first quarter of the COVID-19 pandemic period,

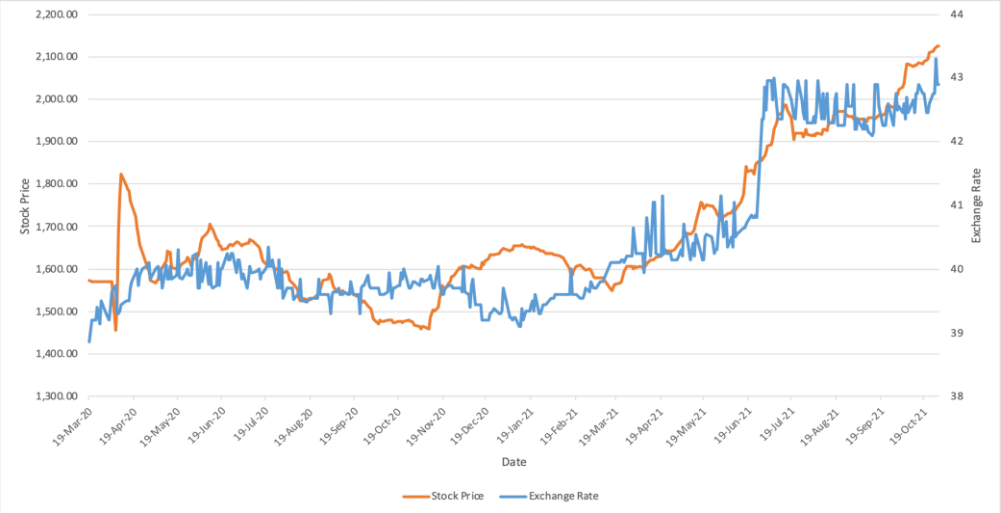

Figure 12: Daily Stock Price and Exchange Rate for Mauritius (COVID-19 Period)
Source: Author's Construction (2023)

the second and first half of the third quarter witnessed general stability, with the last quarter posting appreciable growth as evidenced in Figure 12. For the forex market of Mauritius, it depreciated in the first month of the first quarter, then achieved relative stability, until the first month of the last quarter, where it depreciated sharply and rebounded to stability till the end of the period.

Stock and Forex Markets Performance of Morocco

The first month of the COVID-19 period witnessed decline in the Moroccan stock market, which was followed by relative stability, till the first half of the second quarter. However, the rest of the period saw appreciable growth in the market as depicted in Figure 13. For the forex market of Morocco,

Figure 13: Daily Stock Price and Exchange Rate for Morocco (COVID-19 Period)

Source: Author's Construction (2023)

it depreciated in the first two months of the period, then declined till the end of the first half of the COVID-19 pandemic period. The rest of the period saw relative stability of the Moroccan forex market.

Stock and Forex Markets Performance of South Africa

For the COVID-19 pandemic period, South Africa's stock and forex markets experienced significant fluctuations. The stock market faced an initial downturn influenced by global and domestic factors, including the global economic slowdown and domestic lockdown measures. Subsequent to this, as evidenced in Figure 14, the market experienced relative growth for the rest of

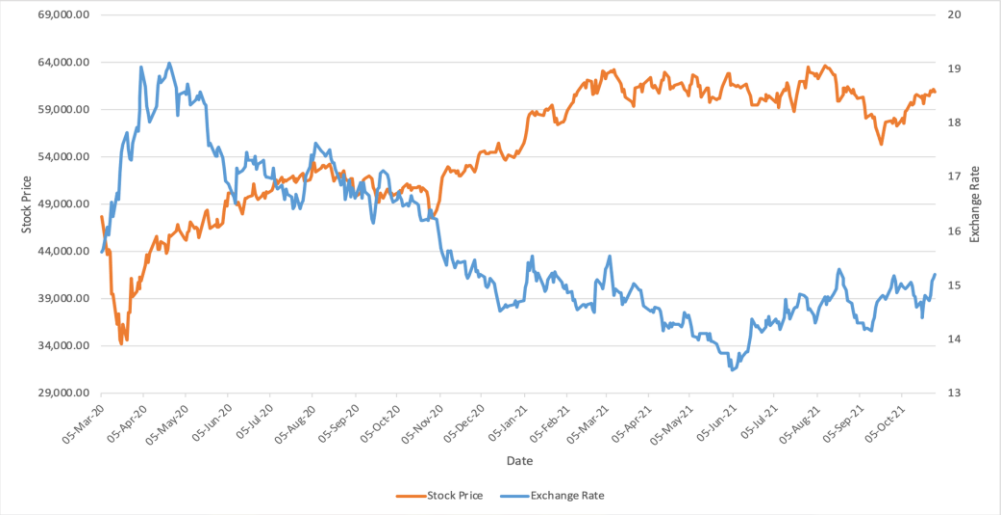

Figure 14: Daily Stock Price and Exchange Rate for South Africa (COVID-19 Period)

Source: Author's Construction (2023)

the period, albeit with noticeable declines in October 2020 and September 2021. The forex market exhibited depreciation in the initial stages due to economic conditions and government interventions. From the third month of the COVID-19 pandemic period, the forex market experienced relative appreciation, until the last quarter of the period, where the market attained relative stability.

Stock and Forex Markets Performance of Tunisia

As evidenced in Figure 15, the Tunisian stock market sharply declined in the first month of the COVID-19 period, then subsequently achieved relative

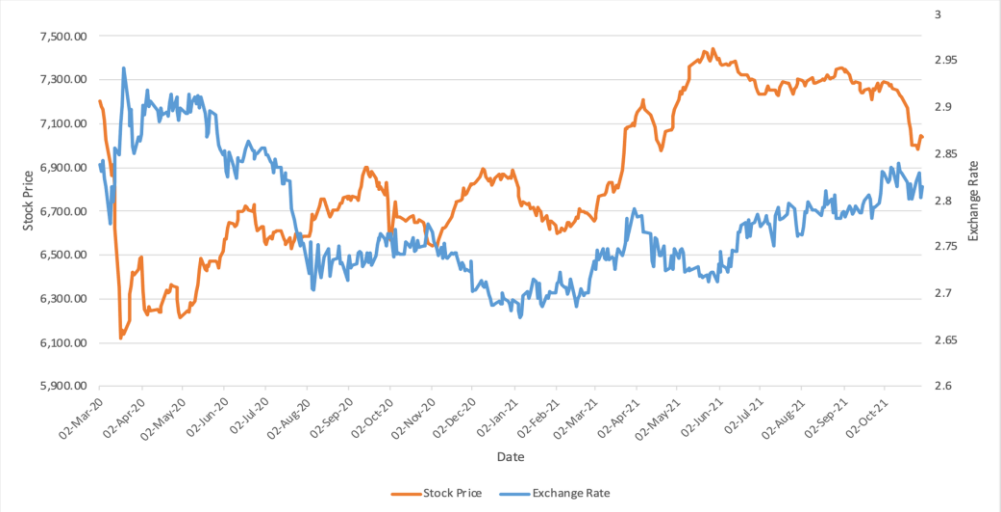

Figure 15: Daily Stock Price and Exchange Rate for Tunisia (COVID-19 Period)

Source: Author's Construction (2023)

growth, albeit with intermittent dips, ending the period with a decline. The Tunisian forex market started the period, with depreciation in the first month, then achieved appreciation for the rest of the first quarter as shown in Figure 15. For the rest of the COVID-19 pandemic period, the forex market experienced relative stability, though with intermittent fluctuations.

Performance of Ghana's Exchange Rate, Exports, Imports, and FDI

This section provides overview of the weekly performance of exchange rate in Ghana from 2019 to 2021, annual performance of exports and imports of Ghana from 2006 to 2022, and the annual performance of FDI inflows in Ghana from 2000 to 2021.

Performance of the Forex Market in Ghana

The exchange rate depicted in Figure 16 measures the amount of Ghana cedi that can be used to exchange for one (1) United States (US) dollar. This implies that, an increasing trend in the graph signals depreciation of Ghana cedi, because one would need to use more Ghana cedi to exchange for one (1) US dollar. On the contrary, a declining trend implies appreciation of Ghana cedi relative to US dollar. The first quarter of 2019, witnessed depreciation of Ghana cedi by 14.29%. In the next two months that followed, the local currency appreciated from GHs 5.60 to GHs 5.09. For the rest of the seven months in

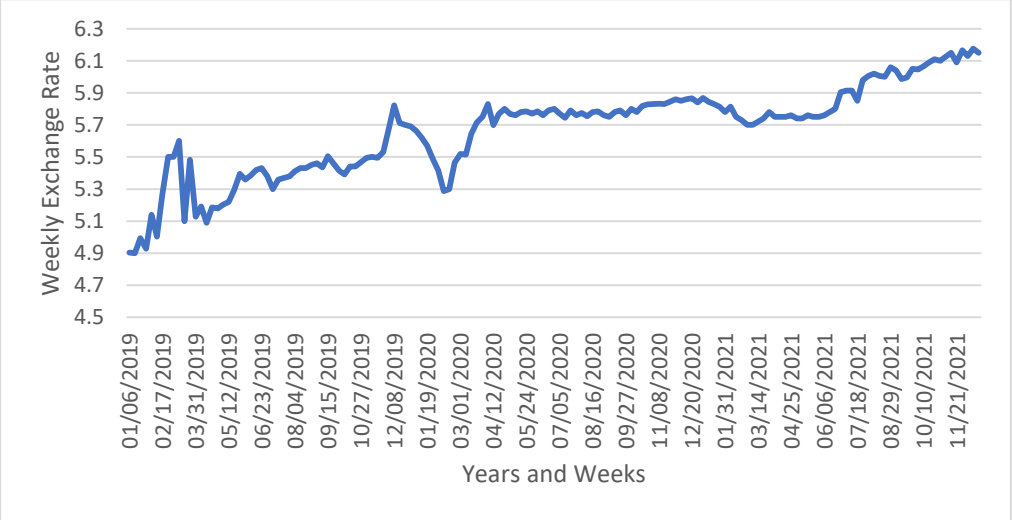

Figure 16: Weekly exchange rate, Ghana cedi vis-à-vis US dollar (2019 – 2021)

Source: Author's Construction (2023)

2019, the Ghana cedi depreciated significantly, reaching a high of GHs 5.82 by the end of 2019. The Ghana cedi appreciated in the first quarter of 2020, reaching a low of GHs 5.29 in March 2020. March and April 2020 saw the forex market sharply depreciating by 9%, coinciding with the emergence of COVID-19 virus in Ghana. Subsequently, the depreciation of the local

currency became steady through to the end of 2021, albeit, with intermittent recoveries of the Ghana cedi.

Performance of Exports and Imports of Ghana

During the period from 2006 to 2022, Ghana's annual trade, comprising of exports and imports, underwent significant developments and fluctuations. As evidenced in Figure 17, the Ghana's exports and imports, exhibited similar trends. Generally, the country's main export commodities which include gold, cocoa, oil, and timber performed creditably. Export earnings were influenced by global demand, commodity prices, and weather conditions, with gold and oil being major contributors. Similarly, Ghana's imports saw steady growth, driven

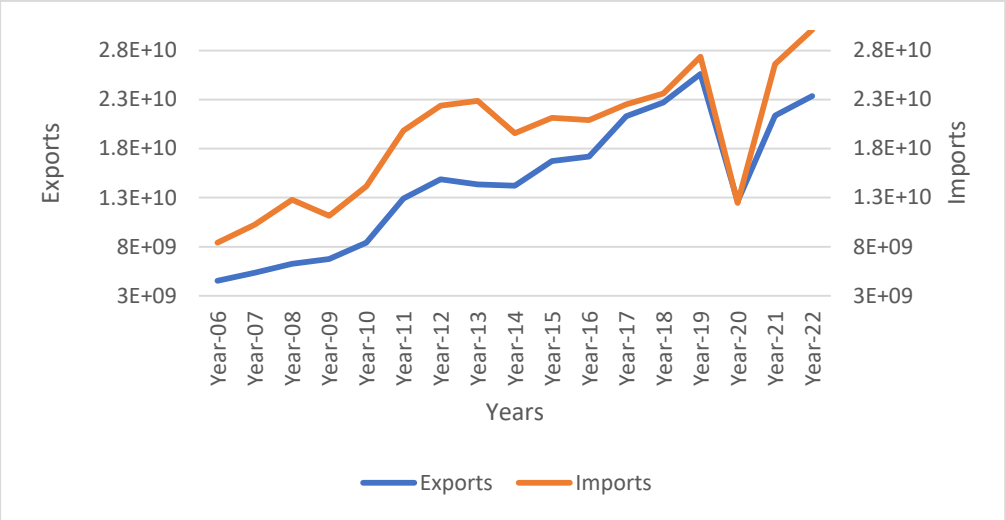

Figure 17: Annual Exports and Imports of Ghana (2006 – 2022)
Source: Author's Construction (2023)

by increasing consumer demand, industrialization, and infrastructure development. Ghana's major import items include machinery, petroleum products, and manufactured goods. Ghana's trade balance over the period, experienced fluctuations due to various factors, such as changes in commodity prices, external economic conditions, and domestic policy measures. The

balance of trade was influenced by the relative strength of exports and imports. Ghana's trade is diversified among countries in Europe, Asia, and other African nations. Notably, China, the European Union, and the United States are significant trading partners for both exports and imports, fostering economic ties with these regions.

Ghana's exports revenues are sensitive to fluctuations in international commodity prices, especially for gold, cocoa, and oil, affecting overall trade performance. In addition, external economic factors, including the 2007/08 global financial crisis and the COVID-19 pandemic, influenced Ghana's trade and investment prospects, through their impact on global demand and supply chains. Ghana's government plays a pivotal role in promoting trade and investment through trade agreements, investment incentives, and infrastructure development. Improvement in transportation networks, ports, and energy supply contributes to better trade facilitation and increased attractiveness for foreign investment.

As illustrated in Figure 17, the annual growth for Ghana's exports and imports were appreciable until 2019. Ghana's trade experienced a sharp decline in 2020, primarily due to the border closures, lockdowns, travel bans, and disruptions to global supply chains occasioned by COVID-19 pandemic. Trade recovered to its growth trajectory in 2021 and 2022. Strikingly, Ghana's trade witnessed an unusual trade surplus of approximately $196 million in 2020.

Overview of Ghana's Trade Openness

Trade openness refers to the extent to which an economy engages in international trade activities by exporting and importing goods and services

with other economies. It is usually measured as the ratio of the sum of an economy's exports and imports to its gross domestic product. As demonstrated in Figure 20, Ghana's trade openness experienced declines between 2001 and 2003, stabilized in 2004, and then increased minimally in 2005. Subsequently, it experienced sharp decline in 2006 and a minimal decline in 2007, it then witnessed general increases between 2008 and 2012, albeit with a drop in 2009.

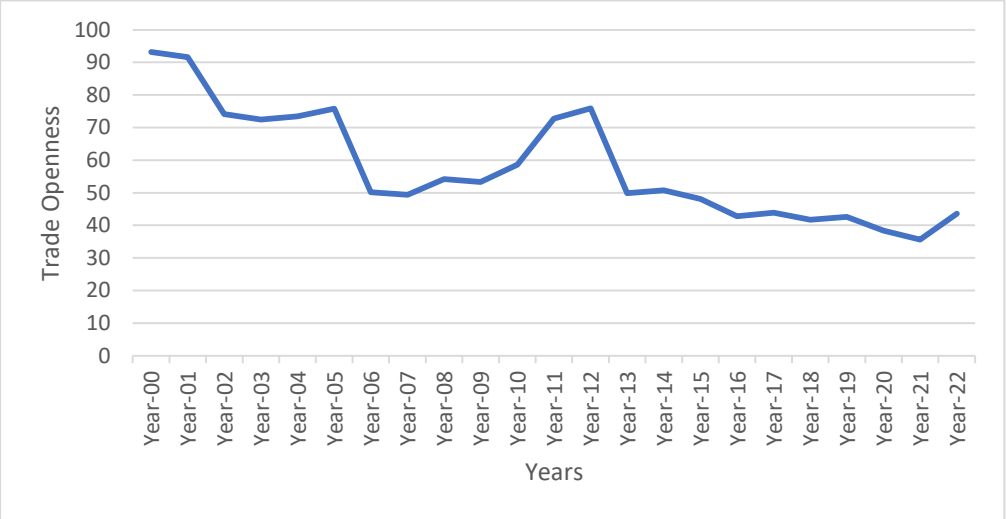

Figure 18: Trade Openness of Ghana (2000 – 2022)
Source: Author's Construction (2023)

In 2013, it witnessed a sharp decline, and experienced a checkered growth between 2014 and 2019. Ghana's trade openness experienced continuous drops in 2020 and 2021, coinciding with the incidence of COVID-19. It however witnessed a rise in 2022, providing an indication of recovery from COVID-19.

Overview of Ghana's FDI Inflows

With reference to Figure 19, Ghana's FDI inflows from 2000 to 2005 can at best be described as checkered. The subsequent three years saw the Ghanaian economy enjoy impressive FDI inflows, reflecting the country's

attractiveness as an investment destination in Sub-Saharan Africa (SSA). However, 2008 began a series of downward spiral for FDI inflows, albeit, with marginal recoveries in 2011, 2014, 2015, 2019 and 2021.

The discovery of significant oil reserves in Ghana, in the late 2000s, attracted a surge of FDI in the energy sector and related services as evidenced in Figure 19. Ghana's government over the period, implemented various investment promotion policies, such as tax incentives, streamlined procedures,

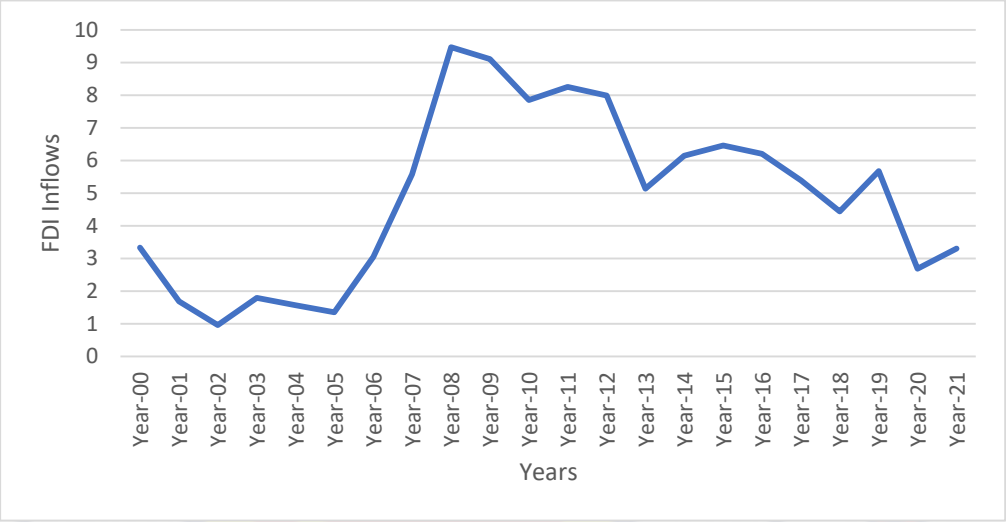

Figure 19: Annual FDI Inflows in Ghana (2000 – 2021)
Source: Author's Construction (2023)

and legal reforms, to attract foreign investors. Ghana's commitment to economic reforms, including measures to improve the business climate and facilitate foreign investment, contributed to the growth of FDI inflows. External economic events, such as the 2007/08 global financial crisis and the COVID-19 pandemic, influenced FDI inflows to Ghana, as a result of fluctuations in investor confidence as illustrated in Figure 19.

Summary

This chapter presented the overview of the performance of financial markets. The overview commenced by reviewing the performance of seven

major stock markets each from developed, emerging, and developing economies, with particular emphasis on the performance of these markets prior and at the initial stages of the COVID-19 pandemic. Subsequently, an overview of the daily stock and forex markets performances of eight African countries, were provided for the COVID-19 pandemic period. This was followed by an overview of Ghana's exchange rate performance prior and during the COVID-19 pandemic period, and an overview of the macroeconomic factors that influences Ghana's exchange rate, such as, Ghana's annual exports and imports (2006 to 2022), Ghana's annual trade openness (2000 – 2022), and annual FDI inflows in Ghana (2000 to 2021).

The overview showed that, financial markets since the emergence of the COVID-19 pandemic, has experienced intense fluctuations, which has contributed to the slowdown of economic growth and development in these economies.

CHAPTER THREE

REVIEW OF RELATED LITERATURE

Introduction

The examination of existing theoretical and empirical literature on the relationship between COVID-19 pandemic and performance of financial markets is presented in this chapter. The chapter is partitioned into two major sections. The first section captures the theoretical underpinnings connecting COVID-19 pandemic (health crisis) to performance of financial markets, whilst the review of existing empirical literature is presented in the second section.

Theoretical Review

To situate the argument within a theoretical context, this section presents an account of theoretical underpinnings that link health crisis (COVID-19 pandemic) to performance of financial markets. Therefore, the study examines theories on the link between; health crisis (COVID-19 pandemic) and performance of stock markets; stock market and forex market in turbulent periods, such as the COVID-19 pandemic, and health crisis (COVID-19 pandemic) and performance of exchange rate.

COVID-19 pandemic and performance of Stock Markets

This study is premised on the Efficient Market Hypothesis (EMH) developed by Fama (1960, 1970). This theory postulates that, current stock prices are determined by incorporating all relevant information, making the market efficient. Accordingly, the efficiency translates into stocks being traded at the fairest price, implying that, they cannot be bought underpriced, neither can they be sold overpriced. The theory posits that, significant speculative

risky investments are the only means through which investors can generate higher returns on their investments.

The EMH comes in three forms, namely, the weak, the semi-strong, and the strong form versions. The weak version of EMH, which is also known as the Random Walk Theory suggests that past stock prices does not determine current stock prices, implying that future stock prices are random, and are not driven by past prices. The advocates of this version postulates that, current happenings in the market determines current market prices, with previous or past information having no role in price determination.

The semi-strong form of EMH however, suggests that publicly available information is incorporated in the determination of stock prices in the market. Changes in in the equilibrium level of prices in the market are reflections of this information. This version posits that, relevant non-public information is not factored in stock price determination, and that this private information is the only means which can give advantage to investors who seek to earn returns above the equilibrium levels.

The strong form of EMH on the other hand, suggests that all relevant public and private information are factored in the determination of current stock prices in the market. This version postulates that inside, market, and non-market information are incorporated in current stock prices. This implies that no one has monopoly over relevant information, which makes the market perfect, making it almost impossible for investors to achieve excess returns in the market.

The more developed an economy is, the more efficient their stock market is expected to be, which implies that all information or happenings,

particularly, an event such as COVID-19 pandemic, would be quickly factored in the stock market pricing. The ready availability of COVID-19 information, including proactive stimulus packages by governments in developed economies, minimized the uncertainty, which reduced panic and irrational behaviours in stock markets in these economies.

On the contrary, in non-developed economies, where there is prevalence of information lag and lack of proactive stimulus packages by governments to mitigate the impact of the pandemic, COVID-19 induced uncertainty is intense, leading to heightened speculative and panic activities in the stock markets. This result in relatively poorer performance of stock markets in non-developing economies. Consequently, one would expect the development status of an economy to have an influence on the effect of COVID-19 pandemic on stock market performance.

The EMH provides several benefits. It provides a structured framework for comprehending market dynamics and pricing mechanisms. In addition, it suggests that stock prices encompass all publicly accessible information, minimizing opportunities for profiting from insider knowledge. Moreover, it facilitates portfolio optimization by advocating risk diversification strategies. Finally, it has been substantiated by extensive academic research and empirical investigations. However, a primary critique of EMH is its assumption that all investors possess equal access to information, which does not always hold true. Additionally, it overlooks behavioural biases like emotional decision-making, which can contribute to market inefficiencies. Moreover, it assumes frictionless markets, a condition that does not align with real-world complexities.

Volatility transmission between stock and forex markets

This study is premised on the flow-oriented model propounded by Dornbusch and Fischer (1980), and the stock-oriented model attributed to Branson and Henderson (1985), and Frankel (1983). The flow-oriented model asserts a positive co-movement of exchange rates and stock prices. The idea underlying this model is the fact that, exchange rate determines the trade balance or current account balance of a country. The model posits that the variations in the foreign exchange rate impacts on the trade balance and international competitiveness of local firms leading to an influence on real income and output.

The model explains that depreciation in the local currency makes local firms competitive with their cheaper products in the international markets translating into cheaper exports. These competitive exports drive up demand leading to an increased exports volume which translate into an appreciation of wealth of local firms, with the potential of an upsurge in the value of domestic stock prices of these local firms. In this regard, the stock market is the recipient of volatility, whilst the foreign exchange market becomes the originator. Consequently, the extent of the integration of an economy to the global financial architecture can influence the volatility transmission from the forex to the stock market in the African setting.

The flow-oriented model underscores the significance of dynamic processes within economic systems. A major advantage of this model is its adeptness at comprehensively portraying economic complexities, especially in response to shocks and shifts in expectations. It operates on the premise that agents form rational expectations and adapt their actions accordingly, thereby

offering a more realistic depiction of economic behaviour. Furthermore, the flow-oriented approach facilitates the exploration of feedback mechanisms and dynamic interplays among variables, thereby fostering a deeper and more nuanced comprehension of economic dynamics.

A notable limitation of the flow-oriented model is its assumption of perfect exchange rate flexibility, implying instantaneous adjustment to market imbalances. However, in practice, exchange rates can exhibit stickiness and may require time to adapt, potentially resulting in prolonged deviations from equilibrium rates and the risk of currency crises. Moreover, the model overlooks the influence of expectations and capital flows, which also play pivotal roles in shaping exchange rate fluctuations.

On the contrary, the stock-oriented model posits that market activities in financial assets (equity and bonds) determine the exchange rate. This model is further categorized into portfolio balance model and monetary model. The portfolio balance model establishes a negative co-movement of stock prices and exchange rates, with the causality emanating from the stock market to the forex market. The model asserts that, when domestic stock prices rise, investors who are holders of foreign and domestic assets including foreign and domestic currencies would be incentivized to increase their investments in domestic assets. To this end, foreign assets are sacrificed to raise more domestic currency for local investment purposes. The hike in domestic assets prices lead to an appreciation of investors' wealth, resulting in an increased interest in domestic assets which causes an increase in domestic interest rates. The heightened demand for local currency would results in an appreciation of the local currency. The monetary model on the other hand, postulates a weak

or no co-movement of stock prices and exchange rate. This model asserts that future expected variations in financial assets prices determines its current prices. Similarly, future expected variations in exchange rates influences its current rates. The model posits that if the factors that influences future expected changes in stock prices are different from drivers of variations in expected future exchange rates changes, then they may not be a co-movement of stock prices and exchange rate. Consequently, the extent of the integration of an economy to the global financial architecture can influence the volatility transmission from the stock to the forex market in the African setting.

One of the stock-oriented model's key advantages lies in its straightforwardness and intuitive appeal. The model offers a concise rationale for understanding exchange rate fluctuations and is user-friendly in practical applications, thus garnering popularity among economists and policymakers. Furthermore, empirical studies have shown the model's efficacy in elucidating exchange rate movements, particularly during times of heightened market volatility.

However, a drawback of this model is its incapacity to account for the influence of monetary policy on the economy. It simplifies by assuming that monetary policy has no direct impact on economic outcomes, potentially resulting in inaccurate forecasts. Moreover, the model heavily depends on assumptions regarding policymakers' behaviour, which may not consistently align with real-world scenarios.

COVID-19 pandemic and performance of Exchange rate

This study is premised on the "Flight to Safety" theory. The theory suggests that in periods of health crisis, such as, the COVID-19 pandemic,

investors generally experience heightened uncertainty and a greater inclination to avoid risks. Consequently, investors typically look for safer investment alternatives in order to safeguard their capital. This "flight to safety" theory posits that, investors in periods of uncertainty often choose to prioritize safety by divesting their investments from volatile ones, which can include assets, such as stocks, tied to the currencies of economies directly impacted by the health crisis. With the occurrence of a health crisis, such as COVID-19 pandemic, the flight to safety can be facilitated through several channels.

First, the pandemic induced health measures disrupted economic activities, which include production, consumption, and international trade. Economies that are severely impacted by the pandemic tend to experience economic downturn, drop in exports, and rise in costs of imports as a result of supply chain disruptions. These economic disruptions tend to weaken the domestic currency, resulting in downward pressure on the exchange rate.

Further, monetary policy responses by central banks can engineer a flight to safety scenario. Expansionary monetary policies, such as interest rates reduction, financial bailouts, and quantitative easing were implemented to contain the economic impact of the pandemic. These policies tend to influence the exchange rate by diminishing the domestic currency's appeal to foreign investors, resulting in a decrease in its value.

Another mechanism that fuels a flight to safety occurrence is the pandemic induced capital flights. In crisis periods, foreign investors may offload their investments, repatriate their funds, or reduce exposure to currencies of economies heavily impacted by the pandemic. This capital outflows tend to depreciate the domestic currency.

Moreover, investor sentiments in crisis periods can also drive a flight to safety phenomenon. The uncertainty surrounding the duration and severity of the crisis can prompt a rise in risk aversion, leading investors to dispose of assets denominated in the currency of the severely affected economy. In such crisis period as COVID-19, investors most likely gravitates towards safer financial assets, such as gold, bonds and the US dollars. Consequently, one would expect that during COVID-19, the shift of investors' capital from Ghana, a developing economy, in search of a relatively safer financial assets, would have an adverse effect on the exchange rate in Ghana. In addition, the extent of the integration of Ghana in global trade has the potential of either worsening the adverse effect or minimizing it.

One of the advantages of this theory can be understood through its robust capacity to elucidate market dynamics during crises. It underscores the critical roles of liquidity and creditworthiness in determining asset valuations. Moreover, empirical evidence substantiates the theory by demonstrating that investors often reallocate their portfolios towards safer instruments like government bonds when faced with heightened market volatility. This behavioural pattern carries substantial implications for asset pricing strategies and portfolio management practices.

Whilst widely acknowledged, critics contend that it oversimplifies investor behaviour. One criticism is its omission of central banks' monetary policies, which can sway investor sentiment and asset valuations. Moreover, the theory often disregards market expectations and the possibility that investors may base decisions on asset valuations rather than solely on risk aversion.

Review of Empirical Literature

Since the birthing of COVID-19 virus in December, 2019, there have been an upsurge in empirical studies on the impact of COVID-19 pandemic on financial markets. Most of these studies have focused on developed economies with very few studies focusing on developing economies. With respect to this study's COVID-19 pandemic and stock markets, this section reviews empirical studies on the following; the pandemic and stock markets in developed economies, the pandemic and stock markets in emerging economies, the pandemic and stock markets in developing economies, and comparative studies on pandemic and stock markets in developed and emerging economies.

In relation to this study's volatility transmission between forex and stock markets, this section reviews empirical literature on the following; volatility transmission between forex and stock markets in earlier crisis periods; volatility transmission between forex and stock markets in non-crisis periods; volatility transmission between forex and stock markets in the COVID-19 pandemic period, and financial globalisation and financial market volatility. With regards to this study's COVID-19 pandemic and exchange rate, this section reviews empirical studies on cross-country literature on the pandemic and performance of exchange rate; single country literature on the pandemic and exchange rate, and the nexus between trade openness and exchange rate.

COVID-19 pandemic and performance of Stock markets

COVID-19 pandemic and performance of stock markets in developed economies

Since the birthing of COVID-19 pandemic, the study on how stock markets in developed economies have been impacted by the pandemic has received considerable attention in the finance literature. For instance, using daily stock data and structural vector autoregression model, Xu (2021) investigated the reaction of stock returns in the United States and Canada to the COVID-19 pandemic. The study found negative effect of COVID-19 cases on stock markets in these countries. The study further established that, the pandemic induced uncertainty adversely impacted the stock markets, with the magnitude being smaller in the United States.

Further, using daily stock data and the vector autoregression approach, Brueckner and Vespignani (2021) assessed the relationship between COVID-19 confirmed cases and performance of the Australian stock market. The results of the study found positive impact of the pandemic on the Australian stock market performance, with a one standard deviation increase in COVID-19 cases, leading to half a percentage growth in stock market performance.

Similarly, employing the traditional *t*-tests and non-parametric Mann-Whitney tests, He, Liu, Wang and Yu (2020) investigated the direct and spillover effects of COVID-19 on stock markets of major economies. The study found negative short-term impact of COVID-19 on stock markets of France, Japan, United States and other major economies. The study further revealed a bidirectional spillover effect between Asian and European and American economies.

In a similar study, employing event studies approach to examine the potential economic impact of first confirmed case of COVID-19 in Norway, declaration of COVID-19 as a pandemic by WHO, and Norwegian government COVID-19 policies on Norwegian stock market, Zhang, Erland and Kaiser (2022) revealed negative impact of all three events on the stock market. Extending the study, the same results were established for Denmark and other Scandinavian countries.

Furthermore, using event study approach to assess the immediate reactions of eleven (11) global stock markets to first confirmed case announcement of COVID-19, Khatatbeh, Hani and Abu-Alfoul (2020) established negative responses of stock markets in all eleven countries, which included France, Switzerland, and United States. The same results were found when the WHO declaration of COVID-19 as a pandemic was used to replace the first COVID-19 case announcements.

COVID-19 pandemic and performance of stock markets in emerging economies

With regards to emerging economies, there exists an extant literature on the performance of stock markets in the wake of COVID-19 pandemic. For instance, in assessing the effect of COVID-19 pandemic on emerging stock markets between March 10 – April 30, 2020, Topcu and Gulal (2020) showed that by mid-April, the adverse effect of the pandemic on emerging stock markets had gradually eased. The findings further revealed that stock markets in Europe were the least impacted, whilst the Asian emerging stock markets were the hardest hit. The results also showed that response time by government and size of stimulus were critical in dousing the pandemic effects.

Further, using panel data regression approach to examine the impact of COVID-19 pandemic on 1318 businesses listed on the Indian Stock Market, Dharani, Hassan, Huda and Abedin (2023) showed a negative impact of COVID-19 on stock returns in India.

In a similar study, applying the Ordinary Least Squares (OLS) approach to examine the impact of COVID-19 pandemic on stock market in Malaysia, Lee, Jais and Chan (2020) revealed that, increases in COVID-19 cases resulted in an adverse effect on the performance of the Malaysian stock index. Similarly, in assessing the impact of COVID-19 outbreak on stock markets of selected economies, including Mexico, using event study methodology, Ganie, Wani and Yadav (2022) revealed amongst other findings that fall in the Mexican stock indices by around 30 percent was attributed to COVID-19 pandemic.

Additionally, applying event study methodology to examine the impact of COVID-19 pandemic on stock market in Taiwan, Lee and Lu (2021) showed that the stock returns in Taiwan have been negatively impacted by the pandemic. Moreover, using the quantile-on-quantile regression model to assess the co-movement of COVID-19 pandemic and stock market performance for four emerging economies, Insaidoo, Ullah, Dziwornu, Amoako and Abdul-Mumuni (2023) showed that, whilst both positive and negative association at different quantiles of share prices for Brazil and Kenya were revealed, negative relationships were established for India and South Africa for all quantiles of share prices.

COVID-19 pandemic and performance of stock markets in developing economies

The occurrence of COVID-19 pandemic has occasioned interest in the study of the impact of the pandemic on stock market performance in developing economies. For instance, using fixed effect panel data regression approach to examine the impact of COVID-19 outbreak on the stock returns of 23 companies listed on the Bulgarian Stock Exchange, Dospatliev, Ivanova and Varbanov (2022) revealed that, the stock returns in Bulgaria have been negatively impacted by the pandemic.

Similarly, applying linear regression analysis model to examine the impact of COVID-19 pandemic on performance of listed securities on the Nairobi Securities Exchange in Kenya, Koskei, Ooko and Chumba (2022) showed a negative association of COVID-19 with the Kenyan stock market.

Further, the Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) model was employed to assess the impact of COVID-19 pandemic on Ghana stock market by Insaidoo *et al*. (2021). The study indicates a statistically insignificant co-movement of COVID-19 and returns of Ghana stock market. The study further shows that, COVID-19 caused a rise in volatility of Ghana Stock Exchange (GSE) by 8.23%.

Similarly, using the GARCH model to assess the relationship between COVID-19 pandemic and Moroccan stock market, Beraich, Fadali and Bakir (2021) revealed significant and negative shock on the Moroccan stock index.

In addition, using panel data regression models to examine the impact of confirmed COVID-19 cases on daily stock returns of 723 listed companies in Vietnam, Anh and Gan (2021) disclosed significant and negative impact of the pandemic on stock returns in Vietnam.

Furthermore, using Bayesian Structural Time Series model to examine the impact of COVID-19 pandemic on 13 stock markets in Africa, Takyi and Bentum-Ennin (2021) showed that the performance of stock markets in Africa in general have reduced by between 2.7% and 21% in the COVID-19 and post COVID-19 period. The findings further indicate that, 10 countries' stock markets were significantly and adversely impacted by the pandemic, whilst the other three countries' stock markets were negatively affected, but the effects were not significant. The study concluded by revealing that, within the study period, there was no chance of a positive effect of the pandemic on performance of stock market being established in Africa.

COVID-19 pandemic and performance of stock markets in developed and emerging economies

Comparative studies on the impact of COVID-19 pandemic on stock market performance in developed and emerging economies have received the needed attention in the finance literature. For instance, using the (GARCH) (1, 1) approach to assess stock markets' reaction to COVID-19 pandemic focusing on emerging markets, Harjoto and Rossi (2021) revealed that, the significant adverse effect of COVID-19 pandemic was more pronounced in emerging markets than in developed ones. The study further revealed that, the energy and financial sectors in both the emerging and developed countries were the most impacted by the pandemic. The study however, found the healthcare and telecommunications for emerging markets and the developed markets' information technology sectors to have been positively impacted by COVID-19 pandemic.

In a similar study, applying multivariate regression model to examine the impact of COVID-19 pandemic on stock markets in developed and emerging countries, Harjoto, Rossi, Lee and Serji (2021) revealed negative reaction of the markets to the pandemic, with the effects being felt differently in these two economies. Whilst COVID-19 cases and deaths affected stock markets in emerging economies, only cases had influence on stock returns in developed economies.

Further, using the pandemic induced datasets and COVID-19 global fear index to examine the reaction of emerging stock markets to the COVID-19 pandemic, Salisu, Sikiru and Vo (2020) show that, developed market stocks were less vulnerable in comparison to emerging stock markets. The findings of the study in other words revealed that, the stock markets in developed economies were better hedges than the ones in emerging markets.

Similarly, using the GARCH model to examine the impact of COVID-19 pandemic on stock markets in developed and emerging markets, Bakry, Kavalmthara, Saverimuttu, Liu and Cyril (2022) established major differences in stock markets reactions to the pandemic in the two markets. The study suggested the quality of governance, and national culture as the drivers of the differences in the pandemic impact.

Volatility transmission between stock and forex markets and financial globalisation

In the finance literature, attention has been given to volatility transmissions between stock and forex markets, particularly during periods of crisis. However, the number of recent studies focusing on the volatility transmission between these markets in the wake of COVID-19 pandemic is

limited since most of the previous works focused on the impact of the novel crisis on stock and exchange rate returns and volatility (see Feng *et al*., 2021; Insaidoo *et al*., 2021; Beckmann, & Czudaj, 2022).

Volatility transmission in earlier crisis periods

In the investigation of volatility transmissions between stock and forex markets in earlier crisis periods, the GARCH (1, 1) and EGARCH (1, 1) methodologies were used to examine the transmission of asymmetric volatility between the Indian stock and forex markets during the periods before, during, and after the 2007/08 global financial crisis by Bal, Manglani and Deo (2018). The study established that, volatility spillover between stock and US dollar exchange rate was bi-directional, bi-directional and unidirectional for the pre-, during and post-crisis periods respectively. For the volatility spillover between stock and Great Britain pounds exchange rate, there was no, unidirectional, and unidirectional for the pre-, during, and post-crisis periods respectively. The study further shows unidirectional, unidirectional and bi-directional transmission of volatility between the forex and stock market of Japan for the pre-, during, and post-crisis periods respectively.

In a similar study, the EGARCH methodology was used to examine the asymmetric volatility spillover between stock and forex markets in Hungary, Poland, the Czech Republic, Romania and Croatia for the pre- and post-2007/08 global financial crisis periods by Ngo Thai (2019). The findings showed that, in Hungary and for both periods, a bi-directional volatility spillover between the two markets were established, whilst the same results were revealed in the post-crisis period for Poland. The study further revealed, a unidirectional transmission of volatility from stock to forex for the pre-crisis

period in Croatia, and from stock to forex markets for Czech Republic for both periods. The study also established an absence of volatility spillover between the two markets in the post-crisis period for Croatia.

Similarly, the Dynamic VECH-GARCH methodology was used to examine the dynamic relationship between foreign exchange and stock returns for the period 2004 to 2015, particularly assessing the impact of the 2007/08 global financial crisis on this relationship for the Middle East and North Africa (MENA) region by Ahmed (2018). The results of the study found volatility transmission between the two financial markets to be more pronounced in the crisis/post-crisis period in comparison to the pre-crisis period.

Additionally, the volatility transmission between the forex and stock prices was assessed for BRICS countries by Sui and Sun (2016). The findings show unidirectional volatility transmission from forex to stock markets in the short-run. Further, the study established that, during the 2007/08 global financial crisis, the transmission of volatility between the forex and stock markets were more pronounced.

In a similar study, daily dataset from April 2000 to September 2017 were employed to examine the transmission of volatility between the forex and stock markets of five countries in the Central and Eastern European region, using several statistical tools including GARCH- Baba, Engle, Kraft and Kroner (BEKK) approach by Hung (2022). The study showed that, in the pre-crisis period, and for Croatia, Hungary, and Czech Republic, bi-directional transmission of volatility between forex and stock markets was established. Unidirectional transmission of volatility was established from stock to forex market for Poland in the sub-prime crisis period, whilst unidirectional

volatility spillover was established from forex to stock markets for Poland and Romania in the post-crisis and pre-crisis periods respectively. In the post-crisis period, the study further showed non-transmission of volatility from stock to forex market in Hungary, and from forex to stock market in Poland.

Further, the EGARCH approach was employed to examine the volatility spillover between stock and forex markets for China for the pre- and post-subprime Asian financial crisis periods by Jebran (2018). The findings show variations in the volatility spillover depending on the period. Whilst the results indicate a unidirectional volatility spillover from forex to stock market in the pre-crisis period, a bi-directional volatility spillover was established between these markets in the post-crisis period.

Additionally, the hourly volatility spillover between the equity markets of New York, London and Tokyo and their corresponding exchange rates for the 2001 to 2013 period covering a non-crisis, euro debts crisis and GFC periods was investigated by Leung, Schiereck and Schroeder (2017). Generally, the study established heightened volatility spillovers between these two financial markets during the crisis periods. Specifically, whilst increased volatility spillover was established from London and Tokyo's equity market to New York's equity market during the euro debt crisis, and GFC period witnessed volatility spillover from the exchange rate markets to the New York's equity markets.

Volatility transmission in non-crisis periods

In the assessments of the volatility transmission between stock and forex markets for non-crisis periods, the EGARCH approach was used to assess the volatility spillover effects between stock prices and exchange rates

for 11-year period ending 2015 for Turkey by Mwambuli, Xianzhi and Kisava (2016). The results show significant volatility spillover effects between exchange rates and stock prices. The study further suggests the two markets to be informationally efficient implying that, one market has significant predictive power of equal weight to the other in the case of these two financial markets in Turkey. In a similar study, the daily returns for the 1998 to 2018 period were used to examine the volatility spillovers between the exchange rates and stock markets in China and Japan by Qin, Zhang and Zhang (2018). The findings reveal bi-directional transmission of volatility between the forex and stock markets in both countries. The study further found evidence of volatility spillover emanating from the stock market in Japan to be stronger than that from the foreign exchange market and the Chinese stock market.

Similarly, the daily data observations and FIGARCH methodology were used to assesse the volatility spillover between stock and exchange rate for oil exporting economies – Brazil and Russia by Mikhaylov (2018). The findings show a unidirectional spillover between the two financial markets for both countries, with the transmission emanating from forex to the stock market. Further, monthly data from January 2002 to June 2017 period and the Diebold and Yilmaz (2009, 2012) approach were used to examine the transmission of volatility between capital market, money market and foreign exchange market in Nigeria by Fasanya and Akinde (2019). The results show that, whilst foreign exchange market was the net giver of volatility spillovers, the stock market was the net recipient. The study further reveals significant burst in volatility spillovers in 2016, coinciding with the removal of currency peg by the Central Bank of Nigeria.

Furthermore, using monthly dataset from May 2009 to May 2020 and a set of statistical approaches including GARCH to examine the volatility spillover between exchange rate and the South African stock market, Baranidharan and Alex (2020) revealed unidirectional volatility spillover from exchange rate to the South African stock market.

Similarly, weekly datasets from April 2009 to March 2019 and the GARCH (1, 1) and EGARCH (1, 1) approaches were employed to examine the volatility spillover between stock and foreign exchange markets for the BRICS countries and Japan by Singh, Theivanayaki and Ganeshwari (2021). The GARCH results show that, in China, India and South Africa, bi-directional volatility spillover between forex and stock markets were established, with the transmission of volatility from forex to stock markets being more pronounced. The EGARCH results indicate a bi-directional volatility spillover between stock and forex markets for the BRICS countries and Japan.

Volatility transmission in COVID-19 pandemic period

The literature on examination of the volatility transmission between the stock and forex markets in the COVID-19 pandemic period is limited. Dataset spanning January 1979 to August 2021 and the EGARCH methodology were applied to investigate the inter-dependence and volatility spillovers between stock and forex markets for South Africa, incorporating the effect of COVID-19 pandemic on these relationships by Van Der Westhuizen, Van Eyden and Aye (2022). The study shows bidirectional transmission of volatility between forex and stock markets, confirming the presence of contagion between these markets. The study further confirmed that, volatility

spillovers were more pronounced during the COVID-19 pandemic period, confirming the hike in contagion during periods of turbulence.

In a similar study, the volatility spillover between stock prices and exchange rates in BRIICS economies was examined using the BEKK-GARCH approach by Rai and Garg (2022). The findings show a general transmission of volatility between the forex and stock markets in most of these economies. Specifically, the study found that, in the COVID-19 period, domestic stock returns plummeted which led to capital outflows resulting in an increase in exchange rates.

Financial globalisation and financial market volatility

Similarly, the studies on the assessment of the impact of financial globalisation on financial market volatility is limited. For instance, using the generalized method of moments (GMM) approach to explore the effects of financial globalisation on growth in developing countries, particularly considering exchange rate, Gaies *et al*. (2020) revealed negative impact of financial globalisation on exchange rate volatility.

In a similar study, using dynamic panel data framework and data over the 1995 – 2007 period to examine the impact of financial globalisation on stock market volatility, Esqueda, Assefa and Mollick (2012) revealed that, financial globalisation reduces stock market volatility in 22 emerging markets, whilst it did not have any impact on stock market volatility in 22 industrial economies. Similarly, the impact of financial globalisation on stock market volatility for the 1992 – 2016 period, using 84 countries was assessed by Cordella and Ospino Rojas (2017). The results established reduction of stock market volatility by financial globalisation in steady periods, whilst it

increases the volatility in turbulent periods. The study also indicates that, comparatively, the volatility reduction properties of financial globalisation dominate, and is more pronounced in frontier markets.

COVID-19 pandemic, performance of exchange rate and trade openness

Cross-country studies on COVID-19 pandemic and performance of exchange rate

The empirical studies examining the impact of the COVID-19 pandemic on the performance of exchange rate is still in its early stages. For multiple country studies, applying daily linear regressions and panel Vector Autoregressive (VAR) approaches to assess the impact of COVID-19 news (using COVID-19 new cases as a measure) on exchange rates for 57 countries, Aquilante, Di Pace and Masola (2022) established negative and statistically significant impact of the pandemic on the domestic exchange rate in relation to a basket of trade-weighted currencies. The study further revealed the impact to be more pronounced in floating exchange rate regime economies.

In addition, using panel fixed effect model and data from 37 countries to investigate how the exchange rates in advanced and emerging economies responded to the uncertainty caused by the COVID-19 pandemic, Sethi, Dash, Swain and Das (2021) revealed that, as the number of daily confirmed cases and deaths increased, the currency of an economy tended to depreciate. The study also found that the impact of pandemic-related uncertainty on exchange rates differed between advanced and emerging economies. In advanced economies, the exchange rate tended to appreciate under pandemic uncertainty, whereas in emerging economies, the opposite effect was observed.

Further, 20 countries and the system Generalized Method of Moments (GMM) estimation approach were used to assess the impact of COVID-19 pandemic and government interventions on exchange rate volatility by Feng, Yang, Gong and Chang (2021). In addition to other results, the study established that an increase in COVID-19 cases, occasioned a rise in exchange rate volatility, implying depreciation in the domestic currency.

In a similar study, using seven Asian countries and the Structural Vector Autoregressive (SVAR) model to examine the structural impact of COVID-19 pandemic on foreign exchange and equity markets, Narayan, Purnaningrum and Khawari (2021) amongst other principal results, revealed that a 1% increase in COVID-19 cases depreciated the Indian rupee relative to the US dollar by 4.8%. However, for the other six financial markets, the study failed to establish a significant relationship between the pandemic and their exchange rates. Moreover, using six countries, namely China, India, Brazil, Italy, Turkey, and United Kingdom and panel Autoregressive Distributed Lag (ARDL) model to examine the impact of COVID-19 pandemic on exchange rates, Jamal and Bhat (2022) showed that, an increase in the pandemic, occasioned depreciation in the exchange rates of the sample countries.

Similarly, using daily data and the ARDL model to investigate the linear relationship between COVID-19 pandemic and currencies of the most affected pandemic countries, such as China and US, Li *et al*. (2022) showed that, the exchange rates of these countries were adversely impacted by the pandemic, in both the short and long run.

Single country studies on COVID-19 pandemic and performance of exchange rate

The aforementioned empirical literature on cross-country studies is complemented by single-country studies in this study. For instance, using the VAR estimation model to examine the impact of COVID-19 pandemic on the stock market and exchange rate of South Korea, Hoshikawa and Yoshimi (2021) revealed that, the pandemic had occasioned a depreciation of the South Korean won. This according to the study was attributed to the pandemic induced capital flights in South Korea.

In addition, using robust least squares regression and vector autoregression (VAR) approaches to assess the effect of COVID-19 pandemic on Philippines financial markets, including its forex market, Camba and Camba (2020) revealed negative and statistically significant impact of the pandemic on the Philippine exchange rate, implying an appreciation of the Philippine peso. Further, using VAR estimation approach to investigate the impact of COVID-19 pandemic on oil price, exchange rate and stock market of Nigeria, Nwosa (2021) showed an adverse impact of the pandemic on Nigerian exchange rate. The study further revealed that, this impact was more pronounced in the current pandemic, in comparison to the 2009 and 2016 global recession. Additionally, using high frequency data and the ARDL estimation approach to examine the relationship between COVID-19 pandemic and the Indonesian exchange rate, Sunaryati and Munandar (2023) showed that, increases in both COVID-19 cases and deaths occasioned an increase in rupiah exchange rate, which implies its depreciation relative to the US dollar. Similarly, applying linear regression approach to analyse the impact

of COVID-19 pandemic on exchange rate of Indonesia, Wijayanti and Taufik (2022) revealed significant impact of the pandemic on the Indonesian exchange rate.

Furthermore, using a VAR model to investigate the impact of COVID-19 and oil prices on exchange rate in Colombia, Cardona-Arenas and Serna-Gómez (2020) among other findings established that, the pandemic has occasioned a depreciation of the Colombian peso relative to the US dollar.

Moreover, using a high frequency daily data and the VAR model to explore the link between COVID-19 uncertainty and exchange rate of the US dollar in terms of Pakistani rupees, Kausar *et al*. (2022) found significant and insignificant impact of the pandemic in the first and second lag respectively. The study additionally revealed that, an increase in COVID-19 uncertainty leads to an increase in the demand for US dollar, implying that the exchange rate of the US dollar in terms of rupees increases.

For country-specific studies that failed to establish linkage between the pandemic and exchange rate, applying the VAR model to assess the impact of COVID-19 pandemic on Indian stock market and exchange rate, Banerjee, Kumar and Bhattacharyya (2020) established positive correlation between COVID-19 cases and exchange rate, whilst the VAR results revealed that a rise in COVID-19 cases caused no significant change in the value of the exchange.

Similarly, using the Dynamic Ordinary Least Squares (DOLS) to examine the impact of COVID-19 pandemic on macroeconomic variables, including the forex market in Nigeria, Farayibi and Asongu (2020) in addition to other findings, revealed positive but insignificant influence of the pandemic on the exchange rate in Nigeria.

Nexus between trade openness and performance of exchange rate

The empirical literature on the nexus between trade openness and performance of exchange rates are wide-ranging, mixed, and diverse. To some, a higher integration in international trade is associated with depreciation of the local currency, particularly in developing economies, whilst others established the reverse relationship. For the former, using 101 countries and the Common Correlated Effects (CCE) Mean Group estimation technique to examine the link between real exchange rate and trade openness with other independent variables, Gantman and Dabós (2018) established that, an increase in trade openness led to the depreciation of the local currency.

Similarly, using the Generalized Method of Moments (GMM) estimation technique to assess the impact of trade openness on real exchange rate in Pakistan, Zakaria and Ghauri (2011) showed positive and significant effect of trade openness on real exchange rate, implying a depreciation of the local currency.

In a similar study on Malaysia, using ARDL approach to examine the impact of trade openness on exchange rate, Lee and Law (2013) among the principal results, revealed that, an increase in trade openness led to the depreciation of the Malaysian Ringgit.

Further, using the Ordinary Least Square (OLS) method to assess the effect of trade openness on exchange rate in Nigeria, Nkalu *et al*. (2016) revealed positive association of trade openness with Nigerian exchange rate. These findings are consistent with the general notion that trade openness weakens the real value of local currencies, particularly in developing economies, primarily due to the trade deficits experienced by these economies.

On the contrary, others have established an appreciation of the local currency attributed to trade openness. For instance, using 52 countries and a panel data estimation technique to assess the relationship between trade openness and exchange rate volatility, Kacaribu *et al*. (2021) established negative and statistically significant impact of trade openness on exchange rate volatility.

Similarly, using the ARDL approach to investigate the impact of trade openness and oil price on the fluctuation of exchange rate in Nigeria, Bala and Tahir (2016) established negative and statistically significant influence of trade openness on the Nigerian exchange rate, in both the long and short run.

In a similar study on Nigeria, using Non-Linear Autoregressive Distributed Lag (NARDL) estimation technique to analyze the impact of oil price, trade openness, and current account balances on the official exchange rate, Longe *et al*. (2019) revealed that, trade openness negatively impacted the official exchange rate of Nigerian naira to US dollar, in both the long and short run. A plausible reason for these findings in Nigeria could be attributed generally to the trade surplus experienced by the Nigerian economy. Except marginal trade deficits in 1995 and 1998, the Nigerian economy achieved annual trade surplus from 1984 to 2013. Trade surplus would likely imply an increase in the demand for the domestic currency relative to the foreign currency in the foreign exchange market leading to the former's appreciation.

Critique of the Existing Literature

Despite the upsurge in financial literature on the relationship between COVID-19 pandemic and stock market performance, the discussion and empirical evidence on the comparative study of the pandemic impact on stock

markets in developed economies, emerging economies, and developing economies are predominantly absent. The existing comparative empirical literature have focused on developed and emerging economies. By addressing the void in existing literature, this study actively adds to the discourse and advances research in the field on the role of development status in the relationship between COVID-19 pandemic and performance of stock markets.

Further, whilst empirical literature is inundated with studies on the volatility transmission between stock and forex markets, empirical studies on the moderating role of financial globalisation in this relationship is to the best of my knowledge absent. Thus, this study proposes to examine the volatility transmission between stock and forex markets using eight African countries data, during the COVID-19 pandemic period. The aim is to examine whether these economies integration in the global financial architecture enhances or reduces the volatility transmissions in the two financial markets for these African economies.

Finally, whilst the empirical literature on the impact of COVID-19 pandemic on performance of exchange rates are in its infant stage, in comparison to studies on pandemic impact on stock markets, empirical studies on the moderating role of trade openness in this relationship is to the best of my knowledge absent. Thus, this study proposes to test the role of trade openness in the relationship between COVID-19 pandemic and performance of exchange rate in Ghana. The aim is to assess whether Ghana's integration in international trade fuels or reduces the impact of COVID-19 pandemic on Ghana's exchange rate.

Summary

The review of theoretical and empirical literature indicates that COVID-19 pandemic has impacted financial markets around the globe. However, comparative empirical studies on the pandemic impacts on performance of stock markets of developed, emerging and developing economies are to the best of my knowledge non-existent. Comparative studies have focused on the impact of the pandemic on performance of stock markets of developed and emerging economies. Further, whilst empirical studies on volatility transmission between stock and forex markets abound, empirical literature on the moderating role of financial globalisation in the volatility transmission between stock and forex markets, particularly in Africa, in the COVID-19 pandemic period are to the best of my knowledge non-existent. In addition, despite the upsurge in empirical studies on the impact of COVID-19 pandemic on financial markets in Ghana, very little (or no such literature) exist on the impact of the pandemic on the exchange rate in Ghana, and the moderating role of trade openness in this relationship. Empirical studies on the impact of the pandemic on financial markets in Ghana has focused on pandemic impact on Ghana's stock market.

CHAPTER FOUR

RESEARCH METHODS

Introduction

The estimation procedures employed in this study is presented in this chapter. The chapter commences by presenting the research design for the study. Following this, the conceptual framework that indicates the linkages between COVID-19 pandemic and financial markets is presented. This is followed by description of specific empirical models that link COVID-19 pandemic to financial markets. The stock market is used as a proxy for financial market following the work of Albulescu (2021). In addition, due to its market efficiency, broad representation, liquidity, benchmarking, and accessibility, the stock market is considered as a proxy for financial market. The stock market is deemed to be efficient because stock prices reflect the collective insights, expectations, and assessments of millions of investors. The market also typically includes a wide range of companies across different sectors and industries which makes it broadly represented. It is also more liquid than other financial assets, due to investors ability to quickly buy or sell stocks. In addition, many financial instruments, use the stock market indices as benchmark for performance, and its accessibility is reflected in the wide coverage by media and its availability to wide range of investors. Furthermore, the forex (exchange rate) market is considered as another good proxy for financial market because it is considered as the biggest financial market of the world (Cuenca Montoya, & León Urrego, 2013).

Research Design

The study aimed to examine the role of development status, financial globalisation, and trade openness in the relationship between COVID-19 pandemic and performance of financial markets, and to do so, it employed a positivist approach grounded in Keynesian economics. Positivists hold the belief that social reality is stable and can be objectively observed and described without any influence or interference on the phenomena under investigation (Levin, 1988). Therefore, the positivist philosophy offers a chance for researchers to investigate social and economic processes in an unbiased way and elucidate connections between different factors. Moreover, the positivist philosophy supports the utilization of quantitative methods in research, which aligns with the objective of this thesis. It is suitable for constructing mathematical and statistical models to analyze the relationships between quantitative measurements. Accordingly, this thesis employed a quantitative approach grounded in the positivist philosophy.

The use of a quantitative approach allows the researcher to organize the social and economic aspects of the world into a causal structure and eliminates the influence of human factors by employing quantitative tools like univariate and multivariate statistical analysis to analyze data, as done in this thesis. Specifically, since the goal of the study is to explain phenomena, it adopts an explanatory research design within the framework of the quantitative approach. The explanatory design enables the researcher to determine the extent and nature of the cause-and-effect connections. It is primarily employed to investigate the impacts of specific changes on existing procedures. Given the overall aim of this study, the explanatory research design offers the most suitable method for conducting the research.

Conceptual Framework

The review of theoretical literature showed that there was not a unitary theory that linked COVID-19 pandemic to performance of financial markets. Hence, this study developed a conceptual framework that showcased the various linkages between financial markets (stock and forex markets), and how COVID-19 pandemic transmitted to affect the performance of these financial markets. The framework was adapted from the work of Lu and Lin (2021). The framework fundamentally explored the various theories connecting COVID-19 pandemic to financial markets as reviewed in the previous chapter. The framework as depicted in Figure 20, shows the uncertainty channels through which COVID-19 pandemic could affect the financial markets. From Figure 20, the birthing of COVID-19 led to uncertainty shocks, adversely impacting the stock and forex market. It can also be gleaned from Figure 20, that economic conditions of an economy can influence the relationship between COVID-19 pandemic and financial markets.

The severity of COVID-19 pandemic which can be seen as a "Black Swan event" affected financial markets around the world. Selmi and Bouoiyour (2020) identified uncertainty shocks as one of the transmission mechanisms of COVID-19 pandemic. The uncertainty shocks are manifested through health, economic and policy uncertainties. The rapid spread of the virus and the lack of initial understanding about its transmission, created health uncertainty. Further, travel restrictions, lockdowns, and disruptions to the global supply chain occasioned by the pandemic, caused economic uncertainty. In addition, the

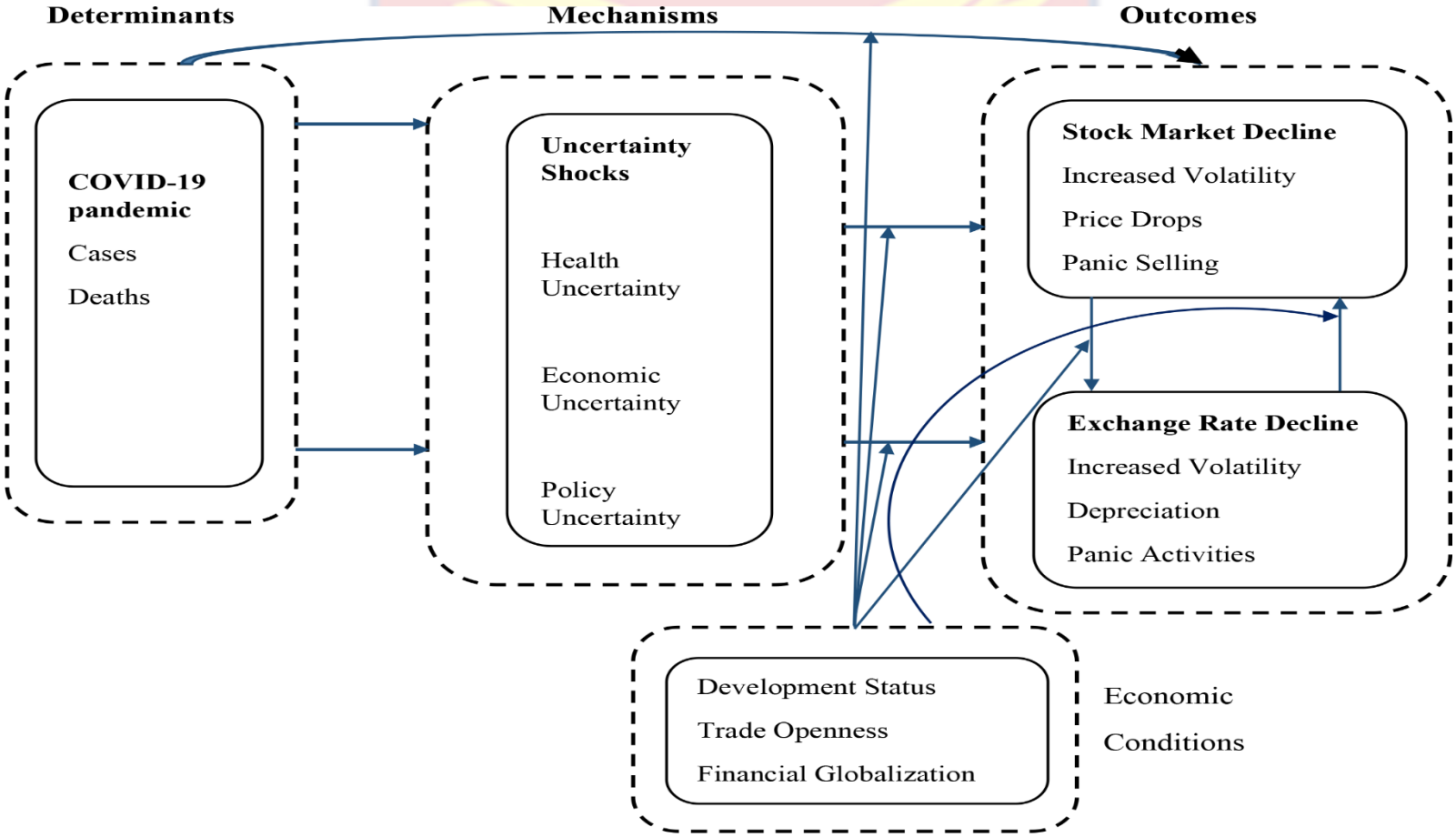

Figure 20: Transmission channel of COVID-19 pandemic

Source: Adapted from Lu and Lin (2021)

diverse strategies implemented by governments to manage the pandemic, coupled with the evolving nature of these measures, and the uncertainty surrounding their efficacy and duration, resulted in policy uncertainty. These uncertainties resulted in pessimistic and heightened panic activities by investors resulting in adverse effect on the stock and forex markets.

It can also be gleaned from Figure 20, that the economic condition of an economy has the tendency to influence the relationship between the pandemic and the financial markets. The level of development of an economy can influence the impact of the pandemic on performance of financial markets as suggested by Hashmi and Chang (2021), Hashmi *et al*. (2021), Bilal *et al*. (2022) and Szczygielski *et al*. (2023). It can also be seen from Figure 20, that there is mutual influence between the stock and forex markets. This is possible due to the flow-oriented theory propounded by Dornbusch and Fischer (1980), and the stock-oriented theory attributed to Branson and Henderson (1985) and Frankel (1983). Further, the level of an economy's financial integration in the global financial architecture can also serve as a conduit in the relationship between stock and forex markets in Africa, particularly, during the COVID-19 pandemic period. In addition, the level of an economy's integration in world trade has the tendency to influence the relationship between the pandemic and performance of forex market.

Empirical model specification

COVID-19 pandemic and performance of stock markets

Impact of COVID-19 pandemic on performance of individual stock markets

Following Takyi and Bentum-Ennin (2021), Droste, Becker, Ring and Santos (2018) and Brodersen, Gallusser, Koehler, Remy and Scott (2015), a state-spaced Bayesian Structural Time Series (BSTS) model, which is a suitable model for time series data is employed to assess the potential impact of COVID-19 pandemic on performance of individual stock markets. To estimate and quantify how the performance of the stock market has been impacted by the COVID-19 pandemic, a simplified seasonality incorporated local level model is specified as:

$$y_t = \mu_t + \tau_t + \varepsilon_t \quad (1)$$

$$\mu_{t+1} = \mu_t + w_t \quad (2)$$

$$\tau_{t+1} = -\sum_{s=0}^{s-2} + \tau_{t-s} + \upsilon_t \quad (3)$$

where in equation (1), each country's stock market index at period *t* is depicted by y_t; $\varepsilon_t \sim N(0, \sigma_\varepsilon^2)$, $w_t \sim N(0, \sigma_w^2)$, and $\upsilon_t \sim N(0, \sigma_\upsilon^2)$. In addition, μ_t in equation (2) depicts the time-varying level or mean, τ_t in equation (3) captures the seasonality, and *s* indicates the number of seasons.

The causal impact equations mentioned above evaluate the difference in occurrence of post-COVID-19 incidents between the observed stock market index time series and a predicted time series that in the non-occurrence of COVID-19 would have ensued (Droste *et al*., 2018). The workings of the posterior causal inference are as follows: First, the model estimation involves the utilization of data from the period before COVID-19. Second, the estimated model in the first step is used to derive predictions or forecasts for

the stock market index during the post-COVID-19 period. The final step involves finding the difference between the predicted or forecasted time series stock market data obtained in step two and the actual or observed post-COVID-19 period stock market time series data. The causal impact on stock market performance occasioned by COVID-19 pandemic can be observed through the difference between the actual and predicted data.

The BSTS offers several advantages which includes the capacity to manage high-dimensional data and intricate relationships. It is also flexible to accommodate diverse structures and patterns. In addition, it facilitates quantification of uncertainty, enhancing robustness in model evaluation and comparison. Moreover, its seamless integration of prior knowledge and domain expertise and it is capable of handling missing values and irregular sampling. Further, it provides interpretable results and has the ability to discern critical components. Finally, it is applicable across a broad spectrum of disciplines, including finance, economics, and marketing.

A primary limitation of BSTS is its reliance on stringent model assumptions, which may not align with real-world data conditions. Moreover, BSTS can demand substantial computational resources and extensive data for accurate modeling.

Robustness Checks

The robustness checks to assess the causal impact of the COVID-19 pandemic on stock market performance is conducted in this section. Volatility index (VIX), which is a driver of stock market performance is integrated in equation (1). The equations subsequently change as follows:

$$y_t = \mu_t + \tau_t + \beta VIX_t + \varepsilon_t \quad (4)$$

$$\mu_{t+1} = \mu_t + w_t \quad (5)$$

$$\tau_{t+1} = -\sum_{s=0}^{s-2} + \tau_{t-s} + \upsilon_t \quad (6)$$

It must be noted that the descriptions of all the variables in equations (4) to (6) remain unchanged as those in equations (1) to (3) except for the inclusion of a volatility index (VIX), an independent variable with its coefficient (β) in equation (4).

Impact of COVID-19 pandemic on performance of regional stock markets

To establish the differential impact of COVID-19 pandemic on performance of regional (Developed, Emerging, and Developing) stock markets' returns, a Pooled Ordinary Least Squares (Pooled OLS) estimation technique is employed. This estimation method is employed because of its capability to produce the best linear unbiased estimates, commonly referred to as BLUE.

Pre-diagnostic tests

Correlation matrix and Variance Inflation Factor (VIF) tests

The pairwise correlation matrix is conducted among the variables in the model. The objective of the correlation matrix is to ensure that there is no multicollinearity among the exogenous variables in the model. In addition, the direction and strength between any two variables in the model is shown by this matrix. Similarly, a VIF test, which is another tool for the detection of multicollinearity in a panel regression model is conducted.

Cross-sectional dependence (CD) tests

The dependence on cross-sections may arise as a result of factors such as financial globalisation and the movement of international capital between

countries and regions. Consequently, failing to consider the potential cross-sectionality in a panel dataset could result in unreliable and biased estimates. This study employs CD tests introduced by Pesaran, Ullah and Yamagata (2008) and Pesaran (2021) and the Langrange multiplier (LM) test attributed to Breush and Pagan (1980) to identify potential collinearity in the dataset.

Second-generation unit root tests

When CD is detected within a series, it is advisable to perform second-generation unit root tests like Cross-section Im-Pesaran (CIPS) and Cross-section Augmented Dickey Fuller (CADF) unit root tests, to assess the stationarity of the series. The tests are effective in handling cross-sectional dependence and heterogeneity.

Panel Cointegration tests

The panel cointegration tests introduced by Pedroni (1999, 2004) are conducted to test for cointegration among the variables in the model. The Pedroni (1999, 2004) panel cointegration test is a statistical test used to determine whether two or more time series are cointegrated, which means they share a long-run equilibrium relationship despite short-term deviations from this relationship. The test is used to identify cointegration among multiple time series in a panel dataset. The Pedroni (1999, 2004) test is a robust alternative to the standard cointegration test, which can be sensitive to outliers and heteroscedasticity in the data.

Estimation Technique

Pooled Ordinary Least Squares (OLS) technique

The pooled OLS used for this study is as follows:

$$\ln Returns_{it} = \alpha_{01} + \alpha_{02}\ln Cases_{it} + \alpha_{03}\ln XR_{it} + \alpha_{04}\ln COP_t + \alpha_{05}\ln VIX_t + \alpha_{06}\ln Index_{it} + \alpha_{07} DevDEV_{it} + \alpha_{08} DevEME_{it}\varepsilon_{it} \quad (7)$$

where $\ln Returns_{it}$ in equation (7) represents natural log of stock returns for respective countries at period *t*. Stock returns is measured as follows:

Stock returns = $\frac{SP_c - SP_p}{SP_p}$, where SP_c is current stock price and SP_p is previous stock price. $\ln Cases_{it}$ refers to natural log of confirmed cases of COVID-19 for respective countries at period *t*, $\ln XR_{it}$ depicts natural log of exchange rate for respective countries at period *t*, natural log of Crude Oil Price at period *t* is depicted by $\ln COP_t$, natural log of Volatility Index at period *t* is represented by $\ln VIX_t$, the natural log of share index for respective countries at period *t* is depicted by $\ln Index_{it}$, ε_{it} represents the error term, and $\alpha_{01},\ldots,\alpha_{08}$ are the regression coefficients to be estimated. $DevEME_{it}$ and $DevDEV_{it}$ are dummy variables that have been created to evaluate the role of development status in the relationship between COVID-19 pandemic cases and stock returns. $DevDEV_{it}$ takes the value 1 if the stock market is in a developing economy and takes the value 0 otherwise. In addition, $DevEME_{it}$ takes the value 1 if the stock market is in an emerging economy and takes the value 0 otherwise.

The Pooled OLS methodology is a robust technique for analyzing data from multiple groups or individuals. Its benefits in research include enhanced sample size, which leads to improved precision and reduced standard errors. By amalgamating data across diverse groups, Pooled OLS enables more

accurate estimation of population parameters. Furthermore, it exhibits greater resilience to issues like heteroskedasticity and model misspecification compared to conventional Ordinary Least Squares (OLS). This makes it particularly advantageous for studies dealing with limited data availability or substantial variability among groups or individuals.

One major limitation is the assumption of homoscedasticity, which may not always hold true. Additionally, Pooled OLS assumes that the regression coefficients are the same across all groups, which may not be the case. This can lead to biased estimates and incorrect conclusions. Furthermore, Pooled OLS is sensitive to outliers and may not be robust to non-normality.

Volatility transmission between stock and forex markets

To generate the volatility of stock and forex markets, the Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH) model attributed to Nelson (1991), which have been widely used in volatility related studies in financial literature is used (see Bal *et al*., 2018; Jebran, 2018; Ngo Thai, 2019; Insaidoo *et al*., 2021). The improved stability of optimization routines and the absence of parameter restrictions places the EGARCH model above other models. The EGARCH model is specified as:

$$In\sigma_{j,t}^2 = \omega_t + \beta_j \ln(\sigma_{j,t-1})^2 + \gamma \frac{\varepsilon_{t-1}}{\sqrt{\sigma_{t-1}^2}} + \theta \left[\frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} - \sqrt{\frac{2}{\pi}} \right] \quad (8)$$

where the conditional variance which captures a one-period ahead variance estimated on any prior important event is depicted by $\sigma_{j,t}^2$ as shown in equation (8). The conditional density function is denoted by ω_t whilst the GARCH effect which captures the model's symmetric effect is depicted by θ. β

captures the perseverance in conditional volatility, whilst the leverage effect is denoted by γ.

Pre-diagnostic tests

Correlation matrix and Variance Inflation Factor (VIF) tests

The pairwise correlation matrix as described in objective 1 is conducted among the variables in this model. VIF test which serve similar purpose as the pairwise correlation matrix is also conducted.

Cross-sectional dependence (CD) tests

The dependence on cross-sections may arise as a result of factors such as financial globalisation and the movement of international capital between countries and regions. Consequently, failing to consider the potential cross-sectionality in a panel dataset could result in unreliable and biased estimates. This study employs CD tests introduced by Pesaran *et al*. (2008) and Pesaran (2021) and the Langrange multiplier (LM) test attributed to Breush and Pagan (1980) to identify potential collinearity in the dataset.

Second-generation unit root tests

When CD is detected within a series, it is advisable to perform second-generation unit root tests like Cross-section Im-Pesaran (CIPS) and Cross-section Augmented Dickey Fuller (CADF) unit root tests, to assess the stationarity of the series. The tests are effective in handling cross-sectional dependence and heterogeneity.

Panel Cointegration tests

The panel cointegration tests introduced by Pedroni (1999, 2004) as described in objective 1 are conducted, to test for cointegration among the variables in the model.

Estimation Technique

Panel Fully Modified Ordinary Least Squares (Panel FMOLS) and Panel Dynamic Ordinary Least Squares (Panel DOLS)

In pursuit of robustness of results, two empirical approaches are used in this study. The Panel Fully Modified Ordinary Least Squares (Panel FMOLS) and the Panel Dynamic Ordinary Least Squares (Panel DOLS). Panel FMOLS was used due to its ability to manage cross-sectional dependence and heteroscedasticity, accommodate individual-specific variables, and to yield dependable and effective estimates of long-term relationships. It also has the capacity to identify and address omitted variables, and its demonstration of computational efficiency renders it suitable for extensive datasets. Despite its strengths, Panel FMOLS exhibits several limitations, which includes potential issues with instrumental variables which may impact estimate accuracy. Additionally, managing individual-specific effects can pose challenges, particularly in heterogeneous panels, and the methodology assumes linear relationships among variables, which may not universally apply.

Additionally, the Panel DOLS is applied due to its strengths in analysing dynamic relationships. A primary advantage of Panel DOLS is its capacity to incorporate both time-series and cross-sectional variations within the dataset. This feature allows for the uncovering of dynamic relationships among variables that may not be discernible through conventional cross-sectional analysis alone. Furthermore, Panel DOLS adeptly addresses challenges such as heteroskedasticity and autocorrelation, thereby enhancing the accuracy and dependability of parameter estimates in models.

However, a notable limitation of the Panel DOLS methodology pertains to its handling of issues related to endogeneity and omitted variable bias. It assumes that the slope coefficients of exogenous variables remain constant over time, a condition that may not hold universally. Moreover, the quality of data can significantly impact estimation results, especially in instances where the panel dimension is limited. The functional form of Panel FMOLS and Panel DOLS are presented as:

$$y_{it} = \gamma_i + \mathrm{j}_{it}\varphi + \cup_{it}\ i = 1, \ldots .11, t = 11\ March\ 2020 - 30\ December\ 2020 \quad (9)$$

here φ represents the slope symbol with a dimension of (m, 1), which denotes a matrix of size (1, 1), and also unveils stationary disturbance terms, whilst γ_i represents individual-fixed effects presented as a vector j_{it}(m, 1) within integrated schemes of level one, denoted as I(1) for all I, where $\mathrm{j}_{it} = \mathrm{j}_{it-1} + \cup_{it}$.

Equation (9) indicates cointegration regression which implies y_{it} is co-integrated with j_{it}. An asymptotically normal behaviour of FMOLS and DOLS estimators is reported. The equation of FMOLS rectifies the issue of serial correlation and endogeneity of OLS regression. The mathematical form of the Panel FMOLS and the Panel DOLS are presented below:

$$\zeta_{FMOLS} = [\sum_{i=1}^{N}\sum_{t=1}^{T}(\mu_{it} - \bar{\mu}_i)]\bar{1}[\sum_{i=1}^{N}\{\sum_{t=1}^{T}(\mu_{it} - \bar{\mu}_i)y_{\cdot it} + T\Delta_u\}] \quad (10)$$

where $y_{\cdot it}$ is the transformed form of the y_{it} to rectify endogeneity issue and $\Delta_{\epsilon U}$ indicates a serial correlation term. Likewise, DOLS estimator by default takes care of autocorrelation and endogeneity issue in panel data regression as follows:

$$y_{it} = \gamma_i + \varphi lr_{it} + \sum_{h=d}^{d} \mathrm{f}_{ih}\Delta r_{it+k} + v_{it}\ t = 1, \ldots, Ti = 1, \ldots, N \quad (11)$$

where υ_{it} shows the deviations, φ indicates firm-related impact and f_{ih} shows values of lag or lead of first-difference independent variables. DOLS estimator is shown as follows:

$$\zeta_{DOLS} = \sum_{t=1}^{N}\{S_{it}S'_{it}\}\,\bar{1}\,\sum_{T}^{t=1}\{S_{it}z_{.it}\} \quad (12)$$

where $S_{it} = \{l_{it} - \bar{l}_i\Delta l_{i,t-v}, \ldots, \Delta l_{i,t+v}\}$ is 2{v + 1} x 1 regressor's vector.

Furthermore, pursuant to Al-Awadhi, Alsaifi, Al-Awadhi and Alhammadi (2020) and Ashraf (2020), this study employs panel-data regression methodology due to its suitability in empirical analysis in comparison to the conventional event-study approaches. Wooldridge (2010), and Hsiao (2014) posits that the dependent and independent variables' time-variant associations are identified, and the problems of individual heterogeneity, multicollinearity, and estimation biases are minimized with the use of panel-data regression approach. To examine how the stock market volatility has been impacted by exchange rate volatility, the panel-data regression models used are as follows:

$$SV_{j,t} = \alpha_{01} + \alpha_{02}XV_{j,t} + \alpha_{03}VIX_t + \alpha_{04}SR_{j,t} + \alpha_{05}FG_{j,t} + \alpha_{06}COP_t + \varepsilon_{0j,t} \quad (13)$$

where $SV_{j,t}$ in equation (13) is stock market volatility for country j at time t, $XV_{j,t}$ depicts exchange rate volatility for country j at time t, VIX_t depicts Volatility Index at time t, $SR_{j,t}$ is stock returns for country j at time t, financial globalisation for country j at time t is depicted by $FG_{j,t}$, crude oil price at time t is represented by COP_t, α_{01},…,α_{06} are the regression coefficients to be estimated, and $\varepsilon_{0j,t}$ denotes the error term. To evaluate the moderating role of

financial globalization in the co-movement of exchange rate volatility and stock market volatility, equation (13) is modified as follows:

$$SV_{j,t} = \alpha_{11} + \alpha_{12}XV_{j,t} + \alpha_{13}VIX_t + \alpha_{14}SR_{j,t} + \alpha_{15}FG_{j,t} + \alpha_{16}COP_t + \alpha_{17}XV_{j,t} * FG_{j,t} + \varepsilon_{1j,t} \quad (14)$$

where $\alpha_{11},\ldots,\alpha_{17}$ are the regression coefficients to be estimated, $XV_{j,t} * FG_{j,t}$ is the interactive term of exchange rate volatility and financial globalisation, with all the other variables in equation (14) remaining same as the ones in equation (13).

Further, to examine the impact of stock market volatility on exchange rate volatility, reversal panel-data regression models are used as follows:

$$XV_{j,t} = \alpha_{21} + \alpha_{22}SV_{j,t} + \alpha_{23}VIX_t + \alpha_{24}XR_{j,t} + \alpha_{25}FG_{j,t} + \alpha_{26}COP_t + \varepsilon_{2j,t} \quad (15)$$

where $XR_{j,t}$ is exchange rate returns for country *j* at time *t*, $\alpha_{21},\ldots,\alpha_{26}$ are the regression coefficients to be estimated, with all the other variables in equation (15) remaining same as the ones in equation (13). Finally, to evaluate the moderating role of financial globalisation in the effect of stock market volatility on exchange rate volatility, equation (15) is modified as follows:

$$XV_{j,t} = \alpha_{31} + \alpha_{32}SV_{j,t} + \alpha_{33}VIX_t + \alpha_{34}XR_{j,t} + \alpha_{35}FG_{j,t} + \alpha_{36}COP_t + \alpha_{37}SV_{j,t} * FG_{j,t} + \varepsilon_{3j,t} \quad (16)$$

where $\alpha_{31},\ldots,\alpha_{37}$ are the regression coefficients to be estimated, $SV_{j,t} * FG_{j,t}$ is the interactive term of stock market volatility and financial globalisation, with all the other variables in equation (16) remaining same as the ones in equation (15).

Equation (14) is partially differentiated with respect to Exchange rate volatility which gave rise to equation (17). This helped us to identify the net effect of Exchange rate volatility on Stock market volatility.

$$\frac{\partial SV_{j,t}}{\partial XV_{j,t}} = a_{12} + a_{17}\overline{FG}_{j,t} \quad (17)$$

here ∂ is the difference operator; $SV_{j,t}$ is Stock market volatility; $XV_{j,t}$ is Exchange rate volatility and $\overline{FG}_{j,t}$ is the average value of financial globalisation.

Similarly, equation (16) is partially differentiated with respect to Stock market volatility which gave rise to equation (18). This helped us to identify the net effect of Stock market volatility on Exchange rate volatility.

$$\frac{\partial XV_{j,t}}{\partial SV_{j,t}} = a_{32} + a_{37}\overline{FG}_{j,t} \quad (18)$$

The definition of variables in equation (18) are the same as in equation (17).

For robustness purposes, an alternative measure of financial globalisation by the KOF Swiss Economic Institute have been used in the estimation. Financial globalisation, de jure uses three indicators in its measurement. First, investment restrictions which measures the prevalence of foreign ownership and regulations to international capital flows. Second, capital account openness which uses the Chinn-Ito index of capital account openness, and thirdly, the international investment agreements which measures the bilateral investment agreements and treaties with investment provisions.

Pre-diagnostic tests

Stationarity Test

Assessing the stationarity of specific data is crucial because if economic time series exhibit non-stationary behaviour or possess a unit root, standard t-tests and F-tests may not be suitable. This is because in such cases, the asymptotic variance of parameter estimates becomes infinite, as asserted by Fuller (1985). In conventional regression analysis, this typically results in spurious regression estimates.

To ensure the reliability of the findings derived from this study, a range of unit root tests were employed. Specifically, the study utilized two extensively used unit root tests: the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. Whilst the ADF test assumes that the time series data is non-stationary under its null hypothesis, the KPSS test, on the other hand, assumes that the time series data is stationary under its null hypothesis. The fundamental expression for the ADF test is given as follows:

$$\Delta X_t = \alpha + \delta t + \rho X_{t-1} + \sum_{i=1}^{\rho} \lambda_t \Delta X_{t-1} + \varepsilon_{1t} \quad (19)$$

where in equation (19), X_t denotes the series at time *t*, the operator Δ stands for the difference, and the parameters α, δ, ρ, and λ are the ones to be estimated, whilst ε represents the stochastic random disturbance term. The ADF conducts a hypothesis test where the null hypothesis examines whether a series includes a unit root (making it non-stationary), while the alternative hypothesis considers the absence of a unit root (making it stationary). That is:

$$H_0: \rho = 0$$

$$H_1: \rho \neq 0$$

The derivation of the KPSS test begin with the model

$$y_t = B'D_t + \mu_t + \upsilon_t \quad (20)$$

$$\mu_t = \mu_{t-1} + \varepsilon_{2t,}\ \varepsilon_{2t} \sim WN\ (0, \sigma_\varepsilon^2)$$

where D_t comprises deterministic elements such as constant or a combination of constant and time trends, μ_t follows an I(0) process and may exhibit heteroscedasticity. It is important to highlight that, μ_t is a pure random walk with an innovation variance denoted as σ_ε^2. The null hypothesis, where y_t is I(0), indicates that μ_t remains constant and possesses a unit moving average root in ARMA representations of the differenced series Δy_t. The KPSS test statistic for testing $\sigma_\varepsilon^2 = 0$ against the alternative that $\sigma_\varepsilon^2 > 0$ is given by:

$$\text{KPSS} = \left(\mathrm{T}^{-2} \sum_{t=1}^{T} \hat{S}_t^2\right) / \hat{\lambda}^2 \quad (21)$$

where $\hat{S}_t^2 = \sum_{j=1}^{t} \hat{u}_{j,}\ \hat{u}_t$ is the residual regression of y_t on D_t and $\hat{\lambda}^2$ is consistent estimate of the long-run variance of u_t using $\hat{u}_t$.

Stationarity test with structural breaks

Zivot and Andrews (2002) propose a testing approach, where the timing of the structural break in a series is considered endogenous, in contrast to the conventional assumption of exogenously determining it before conducting the testing procedure. The Zivot and Andrews test's null hypothesis states that, the variable includes a unit root with drift, assuming there are no structural breaks. Conversely, the alternative hypothesis posits that the time series is trend-stationary, and it contains a single breakpoint. This breakpoint can occur due to either a sudden shift in the level or a change in the growth

rate of the series. The timing of the break is chosen in order to minimise the one-sided t-statistic of $\hat{\alpha} = 1$ in the given equations below.

In determining the structural break, Zivot and Andrews recommended three models:

Model A

$$Y_t = \hat{\mu}^A + \hat{\theta}^A DU_t\left(\hat{T}_b\right) + \hat{\beta}^A t + \hat{\alpha}^A Y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^A \Delta Y_{t-j} + \hat{e}_t \quad (22)$$

Model B

$$Y_t = \hat{\mu}^B + \hat{\lambda}^B DT_t\left(\hat{T}_b\right) + \hat{\beta}^B t + \hat{\alpha}^B Y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^B \Delta Y_{t-j} + \hat{e}_t \quad (23)$$

Model C

$$Y_t = \hat{\mu}^C + \hat{\theta}^C DU_t\left(\hat{T}_b\right) + \hat{\beta}^C t + \hat{\lambda}^B DT_t\left(\hat{T}_b\right) + \hat{\alpha}^C Y_{t-1} + \sum_{j=1}^{k} \hat{C}_j^C \Delta Y_{t-j} + \hat{e}_t \quad (24)$$

Model A allows for a modification in the intercept only, while Model B accommodates a disrupted trend function. Model C, on the other hand, accounts for both a structural change in the intercept and a shift in the trend. DU_t and DT_t represent dummy variables that capture changes in the intercept and trend at time $\hat{T}_b$, respectively. As mentioned earlier, the alternative hypothesis in the Zivot and Andrews test suggests that the series, Y_t, exhibits stationarity (I(0)) but with a single structural break. $\hat{T}_b$ depicts the break date, and $DU_t = 1$ when $t > TB$ and zero otherwise, DT_t is equal to $(t - TB)$ if $t > TB$ and zero otherwise. If the coefficient α demonstrates statistical significance, the null hypothesis is not upheld and is, therefore, rejected. The Zivot and Andrews test identifies the time of the break point in an endogenous manner by iteratively running Models A through C. During this process, every data point can potentially serve as the break point (except for the first and last

observations), thus allowing for its dynamic determination. The optimal lag length is chosen using a general-to-specific approach.

Estimation Technique

Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR)

In pursuit of robustness of results, two empirical approaches are used in this study. The Fully Modified Ordinary Least Squares (FMOLS) approach attributed to Phillips and Hansen (1990) is first applied. The FMOLS methodology offers numerous advantages. It effectively addresses challenges such as heteroskedasticity and serial correlation in time series data, which are frequent in finance and economic studies. Moreover, FMOLS surpasses OLS (Ordinary Least Squares) in accurately estimating long-run coefficients within cointegrating relationships. Its robustness to changes in underlying variable relationships makes it a dependable option for analyzing dynamic panels. Additionally, FMOLS ensures efficient estimation by appropriately accounting for individual-specific and time-specific effects.

Despite its numerous strengths, a primary drawback of FMOLS is its sensitivity to the selection of lag length and its assumption of stability of cointegrating relationship over time, which may not hold true in all cases. This study thus employs the FMOLS technique employed by Amoako and Insaidoo (2021), where the FMOLS is obtained through initial assumptions of an n dimensional of I(1) process denoted as (y_{1t}, x'_{2t}). Subsequently, the study establishes a definition for it as:

$$y_{it} = \alpha' y_{2t} + \mu'_{it} \tag{25}$$

$$\Delta y_{2t} = \mu_{2t} \tag{26}$$

The condition in which $\mu_t = (\mu'_{1t}, \mu'_{2t})$ assumes a mean of zero and a covariance matrix Σ that is infinite but not block diagonal, with μ being weakly dependent. As a result, the estimator for fully modified ordinary least squares transforms into:

$$\hat{\psi}_{FMOLSE} = (\sum_{t=1}^{0} z_t z_t')^{-1} \left(\sum_{t=1}^{T} z_t y_t^{+} - T \begin{bmatrix} \hat{\lambda}_{12}^{+\prime} \\ 0 \end{bmatrix} \right) \quad (27)$$

where y_t^+ and $\hat{\lambda}_{12}^+$ serve to incorporate adjustments for endogeneity and serial correlation respectively, in the correction process.

To ensure resilience and prominence, the investigation employs Park's (1992) Canonical Cointegration Regression (CCR) technique to validate the findings more comprehensively. The CCR methodology offers several advantages by capturing long-term relationships among non-stationary variables, thereby enabling the estimation of equilibrium relationships over time. This approach proves valuable in analyzing complex economic systems involving multiple markets or sectors, such as financial markets or trade balances. Furthermore, this methodology aids in identifying the underlying factors influencing cointegrating relationships, offering valuable insights for policymakers and investors.

However, a significant critique is its assumption of a linear relationship between variables, which may not accurately reflect real-world dynamics. Additionally, the methodology is responsive to decisions regarding lag length and is influenced by outliers or structural breaks in the dataset. Following the work of Amoako and Insaidoo (2021), the CCR model can be expressed as:

$$\hat{\pi}_{CCRE} = (\sum_{t=1}^{T} z_t^* Z_t^*)^1 \sum_{t=1}^{T} z_t^* Y_t^* \quad (28)$$

$$y_t^* = y_t - \left(\hat{\Sigma}^{-1} \hat{\Lambda}_2 \hat{\beta} + \begin{bmatrix} 0 \\ \hat{\Omega}_{11}^{-1} \quad \hat{x}_{11} \end{bmatrix} \right)' \hat{v}_t \quad (29)$$

where the transformed data is denoted by y_t^*, and the cointegration coefficients and covariance matrix are represented by $\hat{\beta}$ and $\hat{\Sigma}_2$ respectively. Furthermore, Cholesky decomposition analysis is employed to evaluate the impact of a unit standard deviation shock from the dependent variable on the chosen independent variables.

The present study follows the empirical estimation strategy of Sunaryati and Munandar (2023) with the baseline model given as:

$$XR_t = \psi_{01} + \psi_{02}Cases_t + \psi_{03}COP_t + \psi_{04}Index_t + \psi_{05}TO_t + \varepsilon_t \quad (30)$$

where XR_t is Exchange Rate in Ghana at period *t*; $Cases_t$ is confirmed COVID-19 Cases in Ghana at period *t*; COP_t is crude oil price at period *t*; Index is stock market price of Ghana at period *t* and TO_t is Trade Openness of Ghana at period *t*.

To assess the role of Trade Openness in the relationship between COVID-19 cases and performance of Exchange rate in Ghana, equation (30) is modified as follow:

$$XR_t = \psi_{11} + \psi_{12}Cases_t + \psi_{13}COP_t + \psi_{14}Index_t + \psi_{15}TO_t + \psi_{16}Cases_t * TO_t + \varepsilon_t \quad (31)$$

where $Cases_t * TO_t$ is the interactive term of COVID-19 Cases and trade openness, with the definition of the remainder of the variables remaining the same as the ones in equation (30).

Equation (31) is partially differentiated with respect to COVID-19 cases which gave rise to equation (32). This helped us to identify the net effect of COVID-19 cases on exchange rate.

$$\frac{\partial XR_t}{\partial Cases_t} = \psi_{12} + \psi_{16}\overline{TO}_t \quad (32)$$

here ∂ is the difference operator; XR_t is Exchange Rate; $Cases_t$ is confirmed COVID-19 Cases in Ghana, and $\overline{TO}_t$ is the mean value of Trade Openness.

Data Description and Source

COVID-19 pandemic and performance of stock markets

Impact of COVID-19 pandemic on performance of individual stock markets

Historical daily stock indices of major stock markets ranging from approximately July 16, 2019, to June 30, 2020, for twenty-one (21) countries around the world are used for this study. For impact analysis purposes as prescribed by the Bayesian Structural Time Series technique, since COVID-19 was birthed in December 2019, the period from July 16, 2019 to December 31, 2019 is approximately considered as the pre-COVID-19 period, whilst the period January 1, 2020 to June 30, 2020 is approximately considered as the post-COVID-19 period. These twenty-one countries were chosen based on their development status as classified by the World Bank (2024). This classification is based on the Gross National Income (GNI) per capita, using the World Bank Atlas method which smoothens exchange rate fluctuations. Countries with GNI per capita of less than US$1,036, between US$1,036 and US$12,535, and more than US12,535 are classified as low income, middle income and high income respectively as at 2020.

To examine the role of development status in the relationship between COVID-19 and stock market performance, seven countries each from high income (developed) status, middle income (emerging) status, and low income (developing) status, resulting in a total of twenty-one (21) countries are used for this study. These twenty-one countries include, Canada, France, Germany,

Italy, Japan, United Kingdom, and United States, which are the G7 countries, represents Developed Economies in this study, Brazil, Russia, India, China, South Africa, which are the BRICS countries, plus two emerging economies, Mexico, and Singapore, represents Emerging Economies in this study, and Bulgaria, Colombia, Jamaica, Kenya, Morocco, Peru, and Vietnam, represents Developing Economies in this study.

The various stock market indices depicting stock market performances for these countries are captured in Table 1. The study uses FTSE Canada for Canada, FTSE Italy for Italy, JPX-Nikkei 400 for Japan, NYSE Composite for United States, S&P BMV IPC for Mexico, SWIX-Johannesburg for South Africa, BSE SOFIX for Bulgaria, Nairobi All Share for Kenya, S&P Lima General for Peru etc. The respective stock markets' data from each country were sourced from the web portal "www.investing.com".

In the context of the Bayesian Structural Time Series model, the respective data for each country is partitioned into two periods, pre-COVID-19 period, and post-COVID-19 period, using the first date of confirmation of COVID-19 case as the partitioning point. Table 2 presents the initial date of confirmed COVID-19 cases, the period before COVID-19, and the period after COVID-19 for every country. For instance, the United States (US) recorded its first COVID-19 case on January 21, 2020, and so, the time before COVID-19, specifically July 22, 2019, to January 20, 2020, is referred to as its pre-COVID-19 period for the US, whereas its post-COVID-19 period encompasses January 21, 2020, to April 30, 2020. Mexico's initial documented case of COVID-19 occurred on February 27, 2020. Therefore, its period before the pandemic spans from August 26, 2019 to February 26, 2020, whilst

its period after the outbreak extends from February 27, 2020 to May 29, 2020. The first case of COVID-19 in Kenya was reported on March 12, 2020. Therefore, the period from September 11, 2019 to March 11, 2020 can be considered as the pre-COVID-19 period for Kenya. On the other hand, the period from March 12, 2020 to June 30, 2020 represents Kenya's post-COVID-19 period. Similar partitioning analysis are made for the rest of the countries.

Table 1: Major stock market indices

Country	Index
Canada	FTSE Canada (FTWICANL)
France	EuroNext 100 (N100)
Germany	Deutsche Boerse AG (DB1Gn)
Italy	FTSE Italy (FTWIITAE)
Japan	JPX – Nikkei 400 (JPXNK400)
United Kingdom	London Stock Exchange Group PLC (LSEG)
United States	NYSE Composite (NYA)
Brazil	Bovespa (BVSP)
China	Shanghai Composite (SSEC)
India	National Stock Exchange India (Nifty 500)
Mexico	S&P BMV IPC (MXX)
Russia	Moscow Exchange (MOEX Russia)
Singapore	FTSE Singapore (FTWISGPL)
South Africa	SWIX – Johannesburg (JDALS)
Bulgaria	BSE SOFIX (SOFIX)
Colombia	FTSE Colombia (FTWICOLL)
Jamaica	JSE All Jamaican Composite Index (JSEAJC)
Kenya	Nairobi All Share (NASI)
Morocco	Moroccan All Share Index (MASI)
Peru	S&P Lima General (SPBLPGPT)
Vietnam	Ho Chi Minh City Securities Corp (HCM)

Source: Author's Construction (2023) based on information from www.investing.com

Table 2: Pre- and Post-COVID-19 periods

Country	First confirmed case	pre-COVID-19	post-COVID-19
Canada	25/01/2020	24/07/2019 to 24/01/2020	25/01/2020 to 30/04/2020
France	24/01/2020	23/07/2019 to 23/01/2020	24/01/2020 to 30/04/2020
Germany	27/01/2020	24/07/2019 to 24/01/2020	27/01/2020 to 27/04/2020
Italy	20/02/2020	19/08/2019 to 19/02/2020	20/02/2020 to 20/05/2020
Japan	16/01/2020	16/07/2019 to 15/01/2020	16/01/2020 to 30/04/2020
United Kingdom	30/01/2020	29/07/2019 to 29/01/2020	30/01/2020 to 30/04/2020
United States	21/01/2020	22/07/2019 to 20/01/2020	21/01/2020 to 30/04/2020
Brazil	26/02/2020	23/08/2019 to 21/02/2020	26/02/2020 to 26/05/2020
China	31/12/2019	28/06/2019 to 30/12/2019	31/12/2019 to 31/03/2020
India	30/01/2020	29/07/2019 to 29/01/2020	30/01/2020 to 30/04/2020
Mexico	27/02/2020	26/08/2019 to 26/02/2020	27/02/2020 to 31/05/2020
Russia	31/01/2020	30/07/2019 to 30/01/2020	31/01/2020 to 30/04/2020
Singapore	23/01/2020	22/07/2019 to 22/01/2020	23/01/2020 to 30/04/2020
South Africa	05/03/2020	04/09/2019 to 04/03/2020	05/03/2020 to 30/06/2020
Bulgaria	09/03/2020	09/09/2019 to 08/03/2020	09/03/2020 to 30/06/2020
Colombia	06/03/2020	05/09/2019 to 05/03/2020	06/03/2020 to 30/06/2020
Jamaica	10/03/2020	09/09/2019 to 09/03/2020	10/03/2020 to 30/06/2020
Kenya	12/03/2020	11/09/2019 to 11/03/2020	12/03/2020 to 30/06/2020
Morocco	02/03/2020	02/09/2019 to 01/03/2020	02/03/2020 to 30/06/2020
Peru	06/03/2020	05/09/2019 to 05/03/2020	06/03/2020 to 30/06/2020
Vietnam	23/01/2020	22/07/2019 to 22/01/2020	23/01/2020 to 30/04/2020

Source: Author's Construction (2023)

Impact of COVID-19 pandemic on performance of regional stock markets

To investigate the impact of COVID-19 pandemic on performance of regional stock markets, dataset on the daily stock prices, confirmed COVID-19 cases and confirmed COVID-19 deaths are compiled on the same twenty-one (21) countries. To control for individual country differences, dataset on daily global crude oil price and volatility index are equally compiled. These twenty-one countries were chosen based on data availability, development status, and continental representations. These twenty-one countries include, Canada, France, Germany, Italy, Japan, United Kingdom, and United States, which are the G7 countries, represents Developed Economies in this study, Brazil, Russia, India, China, South Africa, which are the BRICS countries, plus two emerging economies, Mexico, and Singapore, represents Emerging Economies in this study, and Bulgaria, Colombia, Jamaica, Kenya, Morocco, Peru, and Vietnam, represents Developing Economies in this study. The stock prices, crude oil prices and volatility index data are sourced from investing.com, whilst the COVID-19 cases and deaths are sourced from John Hopkins Coronavirus Resource Center and Our World in Data.

The dataset used in this study spans from March 11, 2020, to December 30, 2020. The dataset for this study starts from March 11, 2020 because this is the date the WHO declared COVID-19 as a global pandemic. Whilst the health crisis, the magnitude of the COVID-19, has tendency to adversely impact financial markets, in the same vein, the discovery and distribution of COVID-19 vaccines constitute a positive news, which can translate in a positive influence on financial markets. To decouple the possible positive influence of the COVID-19 vaccine in the relationship between

COVID-19 pandemic and performance of stock markets, the dataset for this study ends at December 30, 2020. This end date is due to the fact that, on December 31, 2020, WHO issued its first emergency use validation for a COVID-19 vaccine which was aimed at ensuring equitable global access to COVID-19 vaccines (see WHO, 2020).

Justification of variables

For this study, the variables of interest are stock market returns, and COVID-19 cases, whilst the control variables are Exchange rate, crude oil price, volatility index and share index. The stock market returns serve as the dependent variable in this study. The emergence of COVID-19 pandemic (cases) in 2020, was characterized with widespread panic activities in the financial markets. Stock prices plummeted as investors reacted to the uncertainty surrounding the virus's impact on the global economy. This reaction was driven by fear, uncertainty, and a rush to liquidity. Al-Qudah and Houcine (2022) for instance revealed, an adverse impact of increasing cases of COVID-19 on stock returns in major affected countries in the WHO regions. Exchange rate movements can reflect investor sentiment and financial flows. In periods of uncertainty, such as COVID-19, investors would seek safety in currencies of countries perceived as stable, such as the US dollar, which would impact both exchange rate and stock markets. Nwosa (2021) established this by revealing a significant impact of exchange rate fluctuations on the stock market in Nigeria.

Ashraf (2021) asserts that, in a cross-country setting, due to differences in institutional and cultural environments, investors react differently to similar events. Resultantly, this study controls for these differential reactions by using

Crude oil price and Volatility index as country fixed-effects variables. Oil prices and Volatility index have been shown to have influence on stock price. For instance, Zhu, Liu, Wang, Wei and Wei (2019) provide evidence of the US stock market being impacted by volatility index whilst, Hashmi, Chang, Huang and Uche (2022) established crude oil price to have a positive and significant effect on stock prices in Pakistan at the 10^{th} and 30^{th} quantiles, with the relationship becoming negative and significant at the 50^{th} and 80^{th} quantiles. Further, movements in the Share Index can influence investor sentiment. A rising Index often signals optimism and may attract more investment, potentially boosting stock prices and overall returns. On the other hand, a declining index may indicate pessimism and lead to selling pressure.

Volatility transmission between stock and forex markets

To assess the volatility transmission between stock markets and forex markets, during COVID-19 pandemic period, the study has compiled dataset on daily prices and returns of stock indices and exchange rates of eight African countries, namely, Botswana, Egypt, Ghana, Kenya, Mauritius, Morocco, South Africa, and Tunisia. Eleven stock markets were used for this study, with South Africa and Kenya providing three and two stock markets respectively. These African countries/stock markets were selected based on the availability of data. In the forex market, national local currencies are quoted against the US dollar, which serves as the base currency. The stock prices used for this study are quoted in local currencies. The stock indices, exchange rates and crude oil prices data are sourced from investing.com, whilst the financial globalisation index is sourced from KOF Swiss Economic Institute. The stock index of Ghana was sourced from the Ghana Stock Exchange.

The sample period for the COVID-19 period spans from March 11, 2020, to December 30, 2020. The dataset for this study starts from March 11, 2020, because this is the date the WHO declared COVID-19 as a global pandemic. Whilst the health crisis, the magnitude of the COVID-19, has tendency to adversely impact financial markets, in the same vein, the discovery and distribution of COVID-19 vaccines constitute a positive news, which can translate in a positive influence on financial markets. To decouple the possible positive influence of the COVID-19 vaccine in the volatility transmission between forex and stock markets in Africa, the dataset for this study ends at December 30, 2020. This end date is due to the fact that on December 31, 2020, WHO issued its first emergency use validation for a COVID-19 vaccine which was aimed at ensuring equitable global access to COVID-19 vaccines (see WHO, 2020). The sources of data as well as the description of variables used for the study are reported in Table 3.

Table 3: Summary of Variable Description

Variable	Measurement	Source
Stock volatility	EGARCH generated	Author's construction
Exchange rate volatility	EGARCH generated	Author's construction
Volatility Index	CBOE Volatility Index	investing.com
Stock returns	Log (stock price in period *t* /stock price in period *t* - 1)	investing.com/Author,s construction
Exchange rate returns	Log (exchange rate in period *t* /exchange rate in period *t* - 1)	investing.com/Author's construction
Financial globalisation	Financial globalisation, de facto index	2022 KOF Globalisation Index – KOF Swiss Economic Institute

Table 3 Cont'D

Crude oil price	Crude Oil WTI Futures	investing.com
SV*FG	The interactive term of stock volatility and financial globalisation	Author's construction
XV*FG	The interactive term of exchange rate volatility and financial globalisation	Author's construction

Notes: EGARCH is Exponential Generalized Autoregressive Conditional Heteroscedastic, SV is Stock Market Volatility, XV is Exchange Rate Volatility, and FG is Financial Globalisation.

Justification of variables

For this study, the variables of interest are stock market volatility, exchange rate volatility, and financial globalisation, whilst the control variables are volatility index, stock returns, exchange rate returns, and crude oil price. To examine the volatility transmission between stock and forex markets, the two dependent variables used for this study are stock market volatility and exchange rate volatility. This is in pursuant to the studies of Hung (2022), Jebran (2018), and Leung *et al*. (2017). These volatilities were measured using the EGARCH methodology.

To achieve the objectives of this study, the independent variable of interest is exchange rate volatility in a model where stock market volatility is the dependent variable, and when exchange rate volatility is the dependent variable, stock market volatility becomes the independent variable of interest. Exchange rate returns have been found to have an influence on exchange rate volatility. The local currency depreciation causes a fall in the rate of returns, which results in an increase in exchange rate volatility (Mohammed, Mohammed, & Nketiah-Amponsah, 2021). This suggests an inverse relationship between exchange rate returns and its volatility. A company's

profitability induces demand for its stocks, with higher profit levels causing an upsurge in the interest in the company's stocks (Hermuningsih, 2008). Consequently, a company's stocks with improved returns (profitability) would likely attract high demand for the company's stocks. Based on market mechanism, the surge in demand would likely cause a hike in stock price leading to its increased volatility. This implies a positive association of stock returns to its volatility.

This study attempts to investigate the reciprocal influence between the stock market volatility and exchange rate volatility. To this end, financial globalisation has been shown to have an influence on these volatilities (see Esqueda *et al*., 2012; Gaies *et al*., 2020). The KOF Swiss Economic Institute provides the financial globalisation, de facto index used in this study, which uses five indicators in its measurement. These indicators are foreign direct investment (measured as sum of stocks of assets and liabilities of foreign direct investment as a percentage of Gross Domestic Product (GDP)), portfolio investment (measured as sum of stocks of assets and liabilities of international equity portfolio investments as a percentage of GDP), international debt (measured as sum of inward and outward stocks of international portfolio debt securities and international bank loans and deposits as a percentage of GDP), international reserves (which includes foreign exchange (excluding gold), special drawing rights holdings and reserve position in the IMF as a percentage of GDP), and international income payments (measured as sum of capital and labour income to foreign nationals and from abroad as a percentage of GDP). The index scores each country out of 100, with a high score indicating how more globalized a country is.

Ashraf (2021) asserts that, in a cross-country setting, due to differences in institutional and cultural environments, investors react differently to similar events. Resultantly, this study controls for these differential reactions by using Crude oil price and Volatility index as country fixed-effects variables. Oil prices and Volatility index have been shown to have influence on these volatilities. Degiannakis, Filis and Kizys (2014) for instance, established that, fluctuations in oil price due to aggregate demand shocks reduces stock market volatility, whilst Jain and Biswal (2016) showed a positive relationship between oil price change and exchange rate. Moreover, Feng, Sun, Liu and Li (2021) established that, volatility index which depicts fear increases exchange rate volatility, whilst Zhu *et al*. (2019) provide evidence of the US stock market volatility being impacted by volatility index.

COVID-19 cases and performance of exchange rate in Ghana

This study uses daily data which spans from March 19, 2020 to December 30, 2020. The selected variables of exchange rate, and crude oil prices were sourced from the portal www.investing.com. The Ghana Stock market price was sourced from the Ghana Stock Exchange website, whilst the Trade Openness data was sourced from WB (2023). Finally, the COVID-19 confirmed cases for Ghana was sourced from the John Hopkins University Coronavirus Resource Center website. Exchange rates data that did not have corresponding COVID-19 cases data in dates were omitted. Whilst the date for the first confirmed case of COVID-19 in Ghana was March 12, 2020, the dataset for this study starts from March 19, 2020 because this is the earliest case reported on the John Hopkins University website. Whilst the health crisis, the magnitude of the COVID-19, has tendency to adversely impact financial

markets, in the same vein, the discovery and distribution of COVID-19 vaccines constitute a positive news, which can translate in a positive influence on financial markets. To decouple the possible positive influence of the COVID-19 vaccine on the exchange rate of Ghana, the dataset for this study ends at December 30, 2020. This end date is due to the fact that, on December 31, 2020, WHO issued its first emergency use validation for a COVID-19 vaccine which was aimed at ensuring equitable global access to COVID-19 vaccines (see WHO, 2020).

Definition and justification of variables

XR depicts Exchange Rate. This is a measure that captures the value of the Ghanaian cedi (GHS) to the US dollar ($). In other words, it depicts how much of Ghana cedi is used to exchange for one (1) US dollar ($). The lower the domestic currency used for the exchange, the stronger the currency in relation to the US dollar, and the better for the economy of Ghana. The confirmed cases of COVID-19 in Ghana are represented by Cases.

The drivers of exchange rate include, but not limited to interest rate, trade balances, geopolitical events, and inflation. A global health crisis, the magnitude of COVID-19 pandemic, which disrupted international trade, global supply chain, and consumer behaviours, is bound to significantly affect exchange rate in Ghana. The co-movement could be through number of transmission mechanisms, which includes economic impact, safe-haven currencies, commodity prices and monetary policy. The pandemic induced economic downturns adversely impact on investors' confidence which can lead to currency depreciation.

Further, in periods of crisis, investors gravitate towards safe-haven currencies such as the US dollar ($), which would strengthen the US dollar relative to the domestic currency. Additionally, the pandemic dampened global demand for commodities, which are mostly priced in US dollar resulting in exchange rate of developing economies, that are mostly dependent on commodities exports, being affected by fluctuations in commodity prices. Finally, monetary policies implemented by central banks to douse the economic impact of the pandemic around the globe, can affect exchange rate. These policies, such as interest rate cuts, can affect exchange rates by influencing interest rate differentials between economies.

Crude Oil WTI Futures priced in US dollar is used as a proxy for Crude Oil Price in this study. Crude Oil Price tend to influence exchange rate through channels such as trade balance, current account balance, inflation, monetary policy and market sentiment. Conventionally, increases in crude oil price tend to strengthen domestic currencies of net-exporters of oil, whilst it weakens that of the net-importers. Consistent with this, Adeniyi, Omisakin, Yaqub and Oyinlola (2012) and Musa, Campus and Tower (2020) revealed an appreciation of domestic currency vis-à-vis US dollar, as a result of rise in crude oil price in Nigeria, a net-exporter of crude oil, whilst the reverse linkage was established by Ghosh (2011) and Fowowe (2014) in India and South Africa respectively, both net-importers of crude oil.

The Ghana Stock Exchange Index measured in Ghana cedi is used as a proxy for Stock Market Price in this study. The Stock Market Price can impact Exchange Rate through channels, such as capital flows, risk perception, interest rates, trade balance, and macroeconomic factors. The findings on the

nexus of stock prices and exchange rates though, have been mixed, with Phylaktis and Ravazzolo (2005), Richards, Simpson and Evans (2007) and Kutty (2010) establishing a positive correlation in five Asian Pacific countries, Australia, and Mexico respectively, whilst a negative association were established in Philippines and Brazil by Granger, Huangb and Yang (2000) and Tabak (2006) respectively.

The ratio of the summation of exports and imports of goods and services to the Gross Domestic Product (GDP) is used as a proxy for Trade Openness in this study. The higher the Trade Openness, the deeper integrated an economy is in international trade. The level of Trade Openness can have significant impact on exchange rate, through transmission mechanisms, such as trade imbalances, supply and demand for currency, competitiveness and productivity, capital flows, economic conditions, and market expectations. The results of the empirical studies on the co-movement of trade openness and exchange rate have equally been mixed. Whilst trade openness was revealed to contribute to domestic currency depreciation, particularly in developing counties (see Gantman, & Dabós, 2018; Zakaria, & Ghauri, 2011; Lee, & Law, 2013; Nkalu *et al*., 2016), the reverse relationship was established by Kacaribu *et al*. (2021), Bala and Tahir (2016), and Longe *et al*. (2019) for 52 countries, and Nigeria respectively.

Summary

This chapter presented the models underpinning the connection between the COVID-19 pandemic and financial markets, with specific focus on the role of development status in the relationship between COVID-19 pandemic and performance of stock markets of twenty-one countries, the role

of financial globalisation in the volatility transmission between stock and forex markets in Africa, and the role of trade openness in the relationship between COVID-19 pandemic and performance of exchange rate in Ghana. The key philosophy underpinning this thesis is founded on the positivist philosophy within the framework of Keynesian economics. Resultantly, the research design was based on the quantitative research design. This study employed a number of econometric techniques in order to achieve the objectives of this thesis. To examine the impact of the pandemic on performance of individual stock markets, and on performance of regional stock markets, the study employed the Bayesian Structural Time Series (BSTS), and pooled OLS estimation approaches respectively. To analyse the moderating role of financial globalisation in the volatility transmission between stock and forex markets in Africa, during the COVID-19 period, the study employed the Panel FMOLS and Panel DOLS estimation approaches. To investigate the moderating role of trade openness in the co-movement of COVID-19 cases and performance of exchange rate in Ghana, the study employed the Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR) estimation techniques. The choices of these econometric procedures were primarily influenced by the characteristics of the data used in this study.

CHAPTER FIVE

COVID-19 PANDEMIC AND PERFORMANCE OF STOCK MARKETS: THE ROLE OF DEVELOPMENT STATUS

Introduction

The empirical analysis on the impact of COVID-19 pandemic on performance of seven stock markets each from developed, emerging and developing economies are presented in this chapter. To achieve this, the chapter is partitioned into two parts. The first part focuses on the impact of the pandemic on performance of individual stock markets, whilst the second part dwells on the pandemic impact on performance of regional stock markets. The chapter begins by analyzing the descriptive statistics of stock prices of seven stock markets each from developed, emerging, and developing economies. This is followed by the outcomes and discussions of the Bayesian posterior estimates of the causal impact of COVID-19 on performance of seven stock markets each from developed, emerging, and developing economies. The Bayesian posterior distribution graphs on the causal impact of COVID-19 on stock markets and the results of the robustness checks are then discussed. The second part of the chapter begins with the analyses of descriptive statistics for the panel dataset, followed by the presentation and discussion on the results of the pre-diagnostic tests. The chapter concludes with the presentation and discussion of the results of Pooled OLS estimation on the impact of COVID-19 pandemic on performance of regional stock markets.

Analysis of Stock Market Performance

Descriptive Statistics (Developed Economies' Stock Markets)

Table 4 provides summary statistics of daily stock prices of major stock markets in developed economies from the sample period (July 16, 2019, to June 30, 2020). The daily stock prices for Canada averaged 602.43 Canadian dollar over the sample period, with the minimum and maximum prices of 425.42 and 665.68 Canadian dollar respectively. The standard deviation of 51.10 indicates a moderate dispersion in the daily stock prices for Canada over the sample period. The skewness of -1.47 shows that daily stock prices data distribution in Canada is negatively skewed or the left tail of the data distribution is longer, whilst the kurtosis value of 4.44 reveals that the data distribution is heavy tailed over the sample period.

For France, the average, minimum, and maximum daily stock prices are 1057.93, 733.93, and 1182.10 euros respectively. The standard deviation of 109.54 shows the variability of daily stock prices data distribution for France. The negative skewness or heavy left tail of daily stock prices data distribution for France is exhibited by the skewness value of -1.30. The heavy tail of the data distribution is also demonstrated by the kurtosis value of 3.58 for France over the sample period.

The mean value of daily stock prices for Germany is 137.40 euros, with 99.08 euros recorded at its minimum, and 157.20 euros revealed at its maximum over the sample period. The standard deviation of 10.20 shows a minimal dispersion of the data distribution relative to the mean daily stock price. The skewness value of -1.02 shows that daily stock prices of Germany are negatively

Table 4: Descriptive Statistics of Stock Prices for Developed Economies

	Canada	France	Germany	Italy	Japan	UK	US
Mean	602.4303	1057.931	137.4033	131.6658	14178.64	7259.233	12772.98
Median	614.9800	1093.390	138.2000	137.9800	14342.25	7208.000	13093.80
Maximum	665.6800	1182.100	157.2000	156.0400	15619.10	8542.000	14183.20
Minimum	425.4200	733.9300	99.08000	91.66000	11118.66	5806.000	8777.400
Standard Deviation	51.10160	109.5406	10.20468	17.79632	1127.749	498.9997	1226.985
Skewness	-1.468853	-1.296743	-1.020508	-0.819590	-0.601677	0.247236	-1.295315
Kurtosis	4.438829	3.578545	5.212985	2.127561	2.466723	3.052891	3.885294
Jarque-Berra	89.61543	58.25229	72.12681	28.30285	13.93175	1.988707	61.52234
Probability	0.000000	0.000000	0.000000	0.000001	0.000944	0.369963	0.000000
Observation	201	198	191	197	193	193	197

Source: Author's Construction (2023)

skewed, or the left tail is longer. The kurtosis value of 5.21 reveals the that the data distribution of daily stock prices for Germany is heavy tailed over the sample period.

For Italy, the mean daily stock price over the sample period is 131.67 euros, the minimum price is 91.66 euros, and the maximum price is given as 156.04 euros. The minimal variability in the data distribution of daily stock prices for Italy is demonstrated by the standard deviation of 17.80. The skewness value of -0.82 indicates that the daily stock prices data distribution is skewed to the left, whilst the kurtosis value of 2.13 indicates that the data distribution for Italy is more peaked than normal over the sample period.

The average daily stock price for Japan over the sample period is recorded as 14178.64 yen, with the minimum and maximum prices of 11118.66 and 15619.10 yen respectively. The high variability of data distribution of daily stock prices in Japan is easily noticeable, exhibiting a standard deviation of 1127.75. The skewness and kurtosis values of -0.60 and 2.47 were recorded respectively, indicating the data distribution of daily stock prices to be skewed to the left and being more peaked than normal.

For the UK, 7259.23 pounds sterling, 5806.00 pounds sterling, and 8542.00 pounds sterling is recorded as the average, minimum, and maximum daily stock prices for the UK over the sample period. The standard deviation of 499.00 shows a heightened dispersion of the data distribution for the daily stock prices for the UK from the mean price. The skewness of 0.25 shows that the distribution is positively skewed or skewed to the right, and the kurtosis value of 3.05 indicates that the data distribution of daily stock prices for UK over the sample period is heavy tailed.

The average daily stock price for the US over the sample period is recorded as 12772.98 dollars. The daily stock prices for the US exhibits significant fluctuations across a broad range, peaking at 14183.20 dollars, and achieving a minimum value of 8777.40 dollars over the sample period. The standard deviation of 1226.99 indicates intense dispersion of the daily stock prices data distribution of the US from the mean price over the sample period. The skewness and kurtosis of -1.30 and 3.89 respectively shows that the distribution is skewed to the left and the data distribution is heavy tailed.

Descriptive Statistics (Emerging Economies' Stock Markets)

Table 5 provides summary statistics of daily stock prices of major stock markets in emerging economies from the sample period (July 16, 2019, to June 30, 2020). The daily stock prices for Brazil averaged 99909.23 Brazilian Real over the sample period, with the minimum and maximum prices of 425.42 and 665.68 Brazilian Real respectively. The standard deviation of 15347.70 indicates intense dispersion in the daily stock prices for Brazil over the sample period. The skewness of -0.71 shows that daily stock prices data distribution in Brazil is negatively skewed or the left tail of the data distribution is longer, whilst the kurtosis value of 2.11 reveals that the data distribution is heavy tailed over the sample period.

For China, the average, minimum, and maximum daily stock prices are 2936.69, 2660.17, and 3115.57 yuan respectively. The standard deviation of 88.26 shows the variability of daily stock prices data distribution for China. The negative skewness or heavy left tail of daily stock prices data distribution for China is exhibited by the skewness value of -0.50. The heavy tail of the data

Table 5: Descriptive Statistics of Stock Prices for Emerging Economies

	Brazil	China	India	Mexico	Russia	Singapore	SA
Mean	99909.23	2936.693	9118.929	41215.84	2815.484	318.1385	11204.56
Median	104745.0	2937.620	9440.725	42968.52	2799.990	329.1300	11630.48
Maximum	119528.0	3115.570	10118.70	45902.68	3219.920	345.8100	12356.45
Minimum	63570.00	2660.170	6243.000	32964.22	2112.640	228.7700	7903.430
Standard Deviation	15347.70	88.25658	948.9075	3821.010	226.8351	28.57433	1014.486
Skewness	-0.712646	-0.498017	-1.305279	-0.846190	-0.450024	-1.533960	-1.219091
Kurtosis	2.113623	3.263414	3.695120	2.138546	2.864165	3.890036	3.853962
Jarque-Berra	21.95008	8.182158	55.95290	28.54950	6.593790	86.31138	57.00692
Probability	0.000017	0.016721	0.000000	0.000001	0.036778	0.000000	0.000000
Observation	187	185	184	190	191	203	205

Source: Author's Construction (2023)

distribution is also demonstrated by the kurtosis value of 3.26 for China over the sample period.

The mean value of daily stock prices for India is 9118.93 rupees, with 6243.00 rupees recorded at its minimum, and 10118.70 rupees revealed at its maximum over the sample period. The standard deviation of 948.91 shows dispersion of data distribution relative to the mean daily stock price. The skewness value of -1.31 shows that daily stock prices of India are negatively skewed, or the left tail is longer. The kurtosis value of 3.70 reveals that the data distribution of daily stock prices for India is heavy tailed over the sample period. For Mexico, the mean daily stock price over the sample period is 41215.84 pesos, the minimum price is 32964.22 pesos, and the maximum price is given as 45902.68 pesos. The heightened variability in data distribution of daily stock prices for Mexico is demonstrated by the standard deviation of 3821.01. The skewness value of -0.85 indicates that daily stock prices data distribution is skewed to the left, whilst the kurtosis value of 2.14 indicates that data distribution for Mexico is more peaked than normal over the sample period.The average daily stock price for Russia over the sample period is recorded as 2815.48 rubles, with the minimum and maximum prices of 2112.64 and 3219.92 rubles respectively. The variability of data distribution of daily stock prices in Russia is easily noticeable, exhibiting a standard deviation of 226.84. The skewness and kurtosis values of -0.45 and 2.86 were recorded respectively, indicating the data distribution of daily stock prices to be skewed to the left and being more peaked than normal.

For Singapore, 318.14 Singapore dollars, 228.77 Singapore dollars, and 345.81 Singapore dollar is recorded as the average, minimum, and

maximum daily stock prices for the Singapore over the sample period. The standard deviation of 28.57 shows moderate dispersion of the data distribution for the daily stock prices for Singapore from the mean price. The skewness of -1.53 shows that the distribution is negatively skewed or skewed to the left, and the kurtosis value of 3.89 indicates that the data distribution of daily stock prices for Singapore over the sample period is heavy tailed.

The average daily stock price for South Africa over the sample period is recorded as 11204.56 rand. The daily stock prices for South Africa exhibits significant fluctuations across a broad range, peaking at 12356.45 rand, and achieving a minimum value of 7903.43 over the sample period. The standard deviation of 1014.49 indicates intense dispersion of the daily stock prices data distribution of South Africa from the mean price over the sample period. The skewness and kurtosis of -1.22 and 3.85 respectively shows that the distribution is skewed to the left and the data distribution is heavy tailed.

Descriptive Statistics (Developing Economies' Stock Markets)

Table 6 provides summary statistics of daily stock prices of major stock markets in developing economies from the sample period (July 16, 2019, to June 30, 2020). The daily stock prices for Bulgaria averaged 518.31 Bulgarian Lev over the sample period, with the minimum and maximum prices of 405.80 and 585.73 Bulgarian Lev respectively. The standard deviation of 58.02 indicates a moderate dispersion in the daily stock prices for Bulgaria over the sample period. The skewness of -0.51 shows that daily stock prices data distribution in Bulgaria is negatively skewed or the left tail of the data distribution is longer, whilst the kurtosis value of 1.54 reveals that the data distribution is close to a normal distribution over the sample period.

Table 6: Descriptive Statistics of Stock Prices for Developing Economies

	Bulgaria	Colombia	Jamaica	Kenya	Morocco	Peru	Vietnam
Mean	518.3140	4547.095	816758.0	149.6232	11075.39	18123.02	15514.96
Median	548.1400	5170.050	539033.0	148.0300	11530.23	19363.90	15729.00
Maximum	585.7300	5537.060	56411536	171.3600	12633.57	20734.74	23000.00
Minimum	405.8000	2618.860	383874.0	124.3000	8987.890	13538.79	7904.000
Standard Deviation	58.02323	981.6091	4070583.	11.86744	1138.203	2275.996	3541.172
Skewness	-0.513542	-0.526656	13.52192	0.010947	-0.485419	-0.657666	0.063360
Kurtosis	1.541025	1.470682	185.0799	1.866731	1.738882	1.834446	2.444664
Jarque-Berra	26.26396	30.60347	268251.8	10.49236	22.26879	26.51000	2.636205
Probability	0.000002	0.000000	0.000000	0.005268	0.000015	0.000002	0.267643
Observation	198	213	190	196	211	206	195

Source: Author's Construction (2023)

For Colombia, the average, minimum, and maximum daily stock prices are 4547.10, 2618.86, and 5537.06 Colombian pesos respectively. The standard deviation of 981.61 shows the high variability of daily stock prices data distribution for Colombia. The negative skewness or heavy left tail of daily stock prices data distribution for Colombia is exhibited by the skewness value of -0.52. The close to normal distribution of the daily stock prices data distribution for Colombia is also demonstrated by the kurtosis value of 1.47 over the sample period. The mean value of daily stock prices for Jamaica is 816758.00 Jamaican dollars, with 383874.00 Jamaican dollars recorded as its minimum, and 56411536.00 Jamaican dollars revealed as its maximum over the sample period.

The standard deviation of 4070583.00 shows an overly intense dispersion of the data distribution relative to the mean daily stock price. The skewness value of 13.52 shows that daily stock prices of Jamaica are positively skewed, or the right tail is longer. The kurtosis value of 185.08 reveals the that the data distribution of daily stock prices for Jamaica is heavy tailed over the sample period.

For Kenya, the mean daily stock price over the sample period is 149.62 Kenyan shillings, the minimum price is 124.30 Kenyan shillings, and the maximum price is given as 171.36 Kenyan shillings. The minimal variability in the data distribution of daily stock prices for Kenya is demonstrated by the standard deviation of 11.87. The skewness value of 0.11 indicates that the daily stock prices data distribution is skewed to the right, whilst the kurtosis value of 1.87 indicates that the data distribution for Kenya is close to a normal distribution over the sample period.

For Morocco, 11075.39 dirhams, 8987.89 dirhams, and 12633.57 dirhams is recorded as the average, minimum, and maximum daily stock prices for Morocco over the sample period. The standard deviation of 1138.20 shows a heightened dispersion of the data distribution for the daily stock prices for Morocco from the mean price. The skewness of -0.49 shows that the distribution is negatively skewed or skewed to the left, and the kurtosis value of 1.74 indicates that the data distribution of daily stock prices for Morocco is close to normal distribution over the sample period.

The average daily stock price for Peru over the sample period is recorded as 18123.02 Peruvian soles, with the minimum and maximum prices of 13538.79 and 20734.74 Peruvian soles respectively. The high variability of data distribution of daily stock prices in Peru is easily noticeable, exhibiting a standard deviation of 2276.00. The skewness and kurtosis values of -0.66 and 1.83 were recorded respectively, indicating the data distribution of daily stock prices to be skewed to the left and close to normal distribution.

The average daily stock price for the Vietnam over the sample period is recorded as 15514.96 Vietnamese dongs. The daily stock prices for the Vietnam exhibits significant fluctuations across a broad range, peaking at 23000.00 Vietnamese dongs, and achieving a minimum value of 15729.00 Vietnamese dongs over the sample period. The standard deviation of 3541.17 indicates intense dispersion of the daily stock prices data distribution of Peru from the mean price over the sample period. The skewness and kurtosis of 0.06 and 2.44 respectively shows that the distribution is skewed to the right and the data distribution is heavy tailed.

Bayesian Posterior Estimation Results (Impact on performance of individual stock markets)

This section presents results of the Bayesian posterior estimation of the impact of COVID-19 pandemic on stock prices of twenty-one economies. The Bayesian posterior estimation is based on equation (1), (2), and (3). The Bayesian posterior distribution graphs are discussed in this section, whilst the graphs are presented in Figure A1, A2 and A3 in Appendix A. The COVID-19 pandemic causal impact on performance of individual stock markets of twenty-one (21) selected countries are illustrated by these results. The average effects are the focus of the discussion on posterior estimates, whilst the cumulative effects are presented in Table A1 in Appendix A. Table 7, 8, and 9 present the outcomes of the posterior estimates regarding the effect of the COVID-19 pandemic on the performance of stock markets in developed, emerging, and developing economies respectively. The average value of the actual data is captured by column 1, whilst the average value of the forecasted data is captured by column 2. The absolute effect and relative effects of COVID-19 pandemic on stock markets are captured by column 3, and column 4 respectively.

Impact of COVID-19 pandemic on Stock Prices in Developed Economies

This section presents the results and discussion on the impact of the pandemic on the performance of the seven stock markets in developed economies. In the period after COVID-19, the average performance of the stock market for Canada and France are about 568 and 975 respectively. On the contrary, if COVID-19 had not happened, the expected average values of stock market performance would have been 652 and 1154 respectively, with standard deviations of 10 and 30 respectively. In absolute terms, the pandemic has

occasioned a significant drop in stock markets performance in Canada and France by about 85 and 179 respectively. This translates, in relative terms, to 13% and 15% respective declines in stock markets performance of these countries. The posterior tail-area probability value of 0.001 for both countries show a 99.9% unlikelihood of a positive influence of the pandemic on the stock market performance in Canada and France. The negative impact of COVID-19 on stock markets in Canada and France can be attributed to the economic uncertainty induced by the pandemic. This uncertainty led to reduction in consumer spending, supply chain disruptions, and lower corporate earnings. This poor performance would result in adverse effect on stock prices of these businesses. The results on stock market performance in Canada is in tandem with the findings of Xu (2021), whilst France's results corroborate the findings of He *et al*. (2020), and Khatatbeh *et al*. (2020).

Further, for Germany and Italy, in the absence of COVID-19, their respective forecasted average values of stock market performance would have been 149 and 156. However, in the presence of COVID-19, the mean values of stock market performance stood at 137 and 110 respectively. In absolute terms, Germany's stock market performance dropped by about 12, representing a relative significant decline of 7.9%, whilst the performance of the stock market in Italy plummeted by about 45 in absolute terms, translating in a significant decline of 29% in relative terms. The posterior tail-area probability value of 0.001 for both countries show a 99.9% unlikelihood of a positive influence of the pandemic on the stock market performance in Germany and Italy. The adverse impact of COVID-19 on stock markets in Germany and Italy could be as a result of certain industries, such as travel, hospitality, and entertainment

Table 7: Results of posterior estimates (inference) of the causal impact of COVID-19 on stock market performance of Developed Economies

	Average			
	Actual (1)	Prediction (2)	Absolute Effect (3)	Relative Effect (4)
Canada	568	652 (10) [631, 673]	85 (10) [-105, -64]	-13%** (1.4%) [-16%, -10%] P = 0.001
France	975	1154 (30) [1095, 1213]	-179 (30) [-238, -121]	-15%** (2.2%) [-20%, -11%] P = 0.001
Germany	137	149 (3.6) [143, 157]	-12 (3.6) [-20, -5.2]	7.9%** (2.2%) [-12%, -3.6%] P = 0.001
Italy	110	156 (4.3) [147, 164]	-45 (4.3) [-54, -37]	-29%** (1.9%) [-33%, -25%] P = 0.001
Japan	13633	15510 (368) [14828, 16218]	-1877 (368) [-2585, -1195]	-12%** (2.1%) [-16%, -8.1%] P = 0.001
United Kingdom	7483	7788 (242) [7310, 8264]	-305 (242) [-781, -173]	-3.8% (3%) [-9.4%, -2.4%] P = 0.081
United States	11971	14161 (276) [13639, 14720]	-2190 (276) [-2749, -1668]	-15%** (1.6%) [-19%, 12%] P = 0.001

Note: The values in parentheses are standard deviations, whilst those in brackets indicate 95% confidence interval. ** represents 5% significance level, whilst p refers to the Posterior tail-area probability.
Source: Author's Construction (2023)

being heavily affected by COVID-19 restrictions and consumer behaviour changes. Decreased demand and operational disruptions in these sectors resulted in decline in overall market performance.

Moreover, the actual mean values and COVID-19 induced forecasted mean values for Japan was 13633 and 15510 respectively, and the United States' was 11971 and 14161 respectively. In absolute terms, the stock market performance of Japan, and the United States has witnessed significant decline of 1877, and 2190 respectively, which represents 12%, and 15% drops respectively, in relative terms, for these countries. The posterior tail-area probability value of 0.001 for both countries indicate a 0.1% chance of a positive effect of the pandemic on stock market performance in these countries. Weakened investor sentiment and loss of confidence in the market as a result of COVID-19 could be the underpinning rationale for the adverse impact of the pandemic on stock markets in Japan and the United States. Prolonged economic impacts of pandemic lockdowns led to selling pressure as investors adjusted their portfolios in response to perceived risks. Japan's results support the findings of He *et al*. (2020), whilst our findings on United States corroborate the findings of Xu (2021), He *et al*. (2020), and Khatatbeh *et al*. (2020). Whilst our results show an adverse pandemic impact on stock market performance in the United Kingdom, the probability value of 0.081 for posterior tail-area indicates an insignificant relationship.

Impact of COVID-19 pandemic on Stock Prices in Emerging Economies

From Table 8, the stock market performance during COVID-19 period had mean values of 1.2e+05 and 8402 for Brazil and India respectively. The respective forecasted mean values in the absence of the pandemic would have

been 1.1e+05 and 10010. This implies a strikingly significant rise in stock market performance by 10181 in absolute terms, which translates to 9.3% increase in relative terms for Brazil, and a significant fall in India's stock market performance by 1609 in absolute terms which represents a 16% drop in relative terms. The posterior tail-area probability values of 0.032 and 0.001 for Brazil and India respectively, indicate a high unlikelihood of a negative relationship for Brazil, and a high unlikelihood of a positive relationship for India. The adverse impact of the pandemic on stock market in India can be attributed to heightened economic uncertainty resulting from COVID-19. Sock markets in India could be adversely affected due to reduction in consumer spending, supply chain disruptions, and lower corporate earnings occasioned by COVID-19. On the contrary, the positive impact of COVID-19 on stock market in Brazil can be attributed to hike in some commodity prices during the pandemic. Brazil is a major exporter of commodities, such as soybeans, iron ore, and oil. Global demand for these commodities remained resilient during COVID-19. This boosted revenues for Brazilian commodity exporters, leading to positive influence on their stock prices. The result for Brazil is in tandem with the findings of Brueckner and Vespignani (2021), that established a positive association of COVID-19 pandemic with stock market performance in Australia, whilst India's results are in consonance with the findings of Dharani *et al*. (2023).

Similarly, the post-COVID-19 period witnessed average values of stock market performance of 36353 and 2698 for Mexico and Russia respectively. If COVID-19 had not occurred, the respective predicted mean values of stock market performance would have been 42985 and 3115. In absolute terms,

Table 8: Results of posterior estimates (inference) of the causal impact of COVID-19 on stock market performance of Emerging Economies

	Average			
	Actual	Prediction	Absolute Effect	Relative Effect
	(1)	(2)	(3)	(4)
Brazil	1.2e+05	1.1e+05 (5366) [101973, 1.2e+05]	10181 (5366) [-734, 20607]	9.3%** (5.3%) [-0.6%, 20%] P = 0.032
China	2942	2937 (11) [2917, 2958]	5 (11) [-16, 25]	0.17% (0.36%) [-0.53%, 0.87%] P = 0.330
India	8402	10010 (259) [9521, 10488]	-1609 (259) [-2086, -1119]	-16%** (2.2%) [-20%, -12%] P = 0.001
Mexico	36353	42985 (1345) [40249, 45684]	-6632 (1345) [-9331, -3896]	-15%** (2.7%) [-20%, -9.7%] P = 0.001
Russia	2698	3115 (81) [2955, 3277]	-417 (81) [-579, -258]	-13%** (2.3%) [-18%, -8.7%] P = 0.001
Singapore	293	333 (1.3) [331, 336]	-41 (1.3) [-43, -38]	-12%** (0.34%) [-13%, -12%] P = 0.001
South Africa	10146	11870 (48) [11781, 11962]	-1724 (48) [-1816, -1635]	-15%** (0.34%) [-15%, -14%] P = 0.001

Note: The values in parentheses are standard deviations, whilst those in brackets indicate 95% confidence interval. ** represents 5% significance level, whilst p refers to the Posterior tail-area probability.
Source: Author's Construction (2023)

Mexico's stock market performance has significantly declined by 6632, which is 15% dip in relative terms, whilst Russia's has significantly dropped by 417 in absolute terms, which is 13% drop in relative terms. The posterior tail-area probability value of 0.001for both countries, imply an almost impossible chance of a positive effect of the pandemic on the stock market performance in these countries. The underpinning rationale for the negative impact of COVID-19 on these stock markets could be as a result of their dependence on global trade. Many emerging economies, such as Russia and Mexico rely heavily on global trade and commodity exports. COVID-19 caused global demand shocks and supply chain disruptions, impacting export-oriented industries. This led to reduced revenues and profitability for companies in these sectors, which resultantly affected their stock prices. Mexico's results corroborate the findings of Ganie *et al*. (2022).

Furthermore, the COVID-19 induced average values of stock market performance for Singapore, and South Africa stood at 293, and 10146 respectively. In the absence of the pandemic, the respective forecasted mean values would have been 333, and 11870. This implies that the performance of Singapore's stock market has dropped by 41 in absolute terms, translating in a 12% dip in relative terms, and South Africa's has significantly declined by 1724 in absolute terms representing 15% drop in relative terms. The 0.001 probability value for posterior tail-area for both countries, indicate a high unlikelihood of a positive association of COVID-19 with stock markets' performance in these countries. The withdrawals of foreign investments could be sighted as the probable cause of the negative impact of the pandemic on stock markets in Singapore and South Africa. During periods of uncertainty,

global investors often withdraw capital from riskier assets, including stocks in emerging markets. This can lead to capital outflows, currency depreciation, and downward pressure on stock prices in these economies. Our findings on South Africa are in tandem with the findings of Takyi and Bentum-Ennin (2021) where they established a negative but insignificant relationship.

Though, the results on China show a positive association of COVID-19 pandemic with Chinese stock market performance, the posterior tail-area probability of 0.330 indicate an insignificant relationship. This is in tandem with the findings of Ngwakwe (2020), who established a positive correlation of the pandemic with the Chinese stock market.

Impact of COVID-19 pandemic on Stock Prices in Developing Economies

From Table 9, 447 and 3357 are the actual mean values of stock market performance for Bulgaria and Colombia respectively, during the post-COVID-19 period. Without COVID-19, the forecasted mean values of stock market performance for Bulgaria and Colombia would have been 562 and 5313 respectively. This translates to significant fall in stock market performance in Bulgaria by 115 in absolute terms, which represents 21% dip in relative terms, and a drop in Colombia's by 1956 in absolute terms, which is 37% drop in relative terms. The probability value of 0.001 for posterior tail-area for both countries, almost rule out the possibility of a positive influence of COVID-19 on performance of stock markets in these countries. The negative impact of COVID-19 on stock markets in Bulgaria and Colombia can be attributed to currency depreciation and inflationary pressures. COVID-19 induced economic shocks led to currency depreciation in developing economies, which made imported goods more expensive, contributing to inflation. This eroded consumer purchasing

power and corporate profitability, which led to the adverse impact on stock market performance. The Bulgaria result is in tandem with the findings of Dospatliev *et al*. (2022).

Further, the Jamaican and Kenyan stock markets witnessed average values of performance of 427217 and 1986 respectively, amidst the COVID-19 era. Without the presence of the pandemic, the respective predicted mean values would have been 545429 and 2554. In absolute terms, Jamaica stock market performance significantly dipped by 118212 representing 22% drop in relative terms, and Kenya's significantly plummeted by 568 in absolute terms, translating in a 22% dip in relative terms. The posterior tail-area probability values of 0.018 and 0.001 for Jamaica and Kenya respectively indicate an almost no chance of positive relationship between the pandemic and stock market performance of these countries. High debt levels and fiscal challenges could be the reasons for the negative impact of the pandemic on stock markets in Jamaica and Kenya. These countries could have entered the pandemic with elevated levels of public debts. COVID-19 compelled governments to implement fiscal stimulus measures to support healthcare systems to mitigate economic downturns. However, increased borrowings resulted in debt unsustainability and credit unworthiness, affecting investor confidence and stock market stability. The findings on Kenya corroborate the findings of Koskei *et al*. (2022), and Takyi and Bentum-Ennin (2021).

Similarly, the average values of the COVID-19 induced stock market performance for Morocco, Peru, and Vietnam stood at 9859, 15446, and 11536 respectively. In the absence of COVID-19, the respective forecasted mean values would have been 12294, 19793, and 15618. This implies that Morocco's

Table 9: Results of posterior estimates (inference) of the causal impact of COVID-19 on stock market performance of Developing Economies

	Average			
	Actual (1)	Prediction (2)	Absolute Effect (3)	Relative Effect (4)
Bulgaria	447	562 (2.2) [558, 566]	-115 (2.2) [-120, -111]	-21%** (0.31%) [-21%, -20%] P = 0.001
Colombia	3357	5313 (25) [5265, 5359]	-1956 (25) [-2002, -1908]	-37%** (0.29%) [-37%, -36%] P = 0.001
Jamaica	427217	545429 (3769) [5.3e+05, 5.4e+05]	-118212 (3769) [-123827, -111252]	-22% (0.55%) [-23%, -21%] P = 0.018
Kenya	1986	2554 (18) [2519, 2589]	-568 (18) [-603, -533]	-22%** (0.56%) [-23%, -21%] P = 0.001
Morocco	9859	12294 (235) [11827, 12741]	-2435 (235) [-2882, -1969]	-20% (1.5%) [-23%, -17%] P = 0.001
Peru	15446	19793 (89) [19619, 19967]	-4347 (89) [-4520, -4173]	-22%** (0.35%) [-23%, -21%] P = 0.001
Vietnam	11536	15618 (1837) [11910, 19189]	-4082 (1837) - [-7653, -374]	25%** (9.8%) [-40%, -3.1%] P = 0.020

Note: The values in parentheses are standard deviations, whilst those in brackets indicate 95% confidence interval. ** represents 5% significance level, whilst p refers to the Posterior tail-area probability.
Source: Author's Construction (2023)

stock market performance has significantly fallen by 2435 in absolute terms which connotes to 20% dip in relative terms, Peru's has declined by 4347 in absolute terms, translating into 22% drop in relative terms, and Vietnam's has dipped by 4082 in absolute terms, depicting a 25% reduction in relative terms. The probability value of 0.001 for posterior tail-area for Morocco and Peru, and 0.020 for Vietnam demonstrate a high unlikelihood of positive influence of the pandemic on stock market performance in these countries. The negative impact of COVID-19 on stock markets in these economies could be attributed to sectoral vulnerabilities in these economies in crisis periods. Certain sectors, such as tourism, hospitality, retail, and small businesses in developing economies were affected by lockdowns, travel restrictions, and changes in consumer behaviour. Companies in these sectors experienced severe revenue declines, layoffs, and financial distress, which negatively impacted their stock prices. Morocco's findings support the results of Beraich *et al*. (2021), whilst the findings on Vietnam are in tandem with the findings of Anh and Gan (2021).

Bayesian posterior distribution graphs (Impact on performance of individual stock markets)

The discussion on the posterior distribution graphs for all countries is presented in this section. These graphs depict the COVID-19 pandemic impact on performance of stock markets. Figure A1, A2, and A3 captures the posterior distribution graphs for developed, emerging, and developing countries respectively as shown in Appendix A. To explain the graph, black lines illustrate the time-path of actual values, whilst the blue-dotted lines represent the forecasted or predicted values. The original panel illustrates the disparity

between the two lines, which represents the average impact of the COVID-19 pandemic on stock market performance. The pointwise panel captures this impact, whilst the cumulative panel portrays the overall cumulative effect of the pandemic. Additionally, the 95% confidence interval is depicted by the blue areas.

Judging from the pointwise and cumulative panels in Figure A1, A2, and A3, it can be observed that the COVID-19 pandemic impact on stock market performance in all countries is statistically significant, except the United Kingdom and China. This is because in the periods following the COVID-19 pandemic, the blue lines within the 95% confidence interval for the other 19 countries are below zero in all cases, which further confirms the quantitative results established above.

Comparatively, for developed (G7) economies, stock market performance for Italy was the one with the heaviest adverse impact of 29% in relative terms, followed by France's 15% dip, United States (-15%), Canada (-13%), Japan (-12%), and Germany's of -7.9%. For emerging economies, the Singaporean stock market performance has been least affected by the COVID-19 pandemic, with 12% decline in relative terms, followed by Russia (-13%), Mexico (-15%), South Africa (-15%), and India's with 16% drop. Strikingly, Brazil's stock market was positively impacted by the pandemic by 9.3% in relative terms. For developing economies, Colombia's stock market performance was the hardest hit by the pandemic, with a 37% dip in relative terms, followed by Vietnam's 25% drop, Jamaica (-22%), Kenya (-22%), Peru (-22%), Bulgaria (-21%), and Morocco's dip of 20%.

Results of Robustness Checks

The results of equations (4) to (6) estimations are presented in Table A2 (see Appendix A). By controlling for VIX, it can be observed that the results in Table A2 are similar to the results in Table 7, 8 and 9, which confirms the robustness of the results of this study.

Pooled OLS estimation results (Impact on regional stock markets)

This section presents results of the pooled OLS estimation of the impact of COVID-19 pandemic on performance of regional stock markets.

Analysis of Descriptive Statistics (Panel Dataset)

Table 10 reports a set of descriptive statistics on daily stock returns, confirmed daily COVID-19 cases, daily exchange rates, daily Crude Oil Price, daily Volatility index and daily Share Index. The average stock returns recorded for the 21 stock markets is given as 0.001121, with minimum and maximum

Table 10: Descriptive statistics (Panel Dataset)

Variable	Mean	Max	Min	SD	OBS
Returns	0.001121	0.1667	-0.1700	0.0183	4088
Cases	9147.234	240266	1	21768.55	4088
ExRate	998.0875	23642.5	0.2246	4249.213	4088
COP	37.03018	49.10	10.01	8.4734	4088
VIX	30.6988	82.69	20.57	11.1524	4088
Share Index	30377.77	456962	91.6600	86255.91	4088

Note: Standard Deviation is denoted by SD, observations are depicted by OBS, ExRate is Exchange Rate, COP is Crude Oil Price, VIX is Volatility Index, Min is Minimum, and Max is Maximum
Source: Author's Construction (2023)

and maximum stock returns of -0.1700 and 0.1667 respectively. The standard deviation of stock returns is given as 0.0183, indicating a mild variability of the series. The average confirmed daily cases of COVID-19 for the 21 countries is given as 9147.234, with minimum, maximum, and standard deviation of 1, 240266 and 21768.55 respectively. The average Exchange rate is 998.0875, with standard deviation of 4249.213, minimum Exchange rate of 0.22460 and maximum Exchange rate of 23642.50. The average, standard deviation, minimum, and maximum Crude Oil Price is given as 37.0569, 8.4734, 10.01 and 49.10 respectively. The minimum and maximum Volatility index recorded is 20.57 and 82.69 respectively, with a mean index of 30.6988 and standard deviation of 11.1524. The mean, minimum, maximum and standard deviation of Share Index is given as 30377.77, 91.66, 456962 and 86255.91 respectively.

Results of Pre-diagnostic Tests

In Table A3 (see Appendix A), the study reports on the results of the pairwise correlation matrix. The objective of the correlation matrix is to ensure that, there is no multicollinearity among the exogenous variables in the model. In addition, the direction and strength between any two variables in the model is shown by this matrix. The results in Table A3 clearly suggest that the exogenous variables generally show strong correlation and no problem of multicollinearity. According to Krammer (2010), the absence of multicollinearity is affirmed, when the correlation coefficient among independent variables remains below 0.85. Examination of the correlation matrix in Table A3 for this study reveals that, all coefficients are below 0.85, thereby indicating the absence of multicollinearity concerns. Similarly, Table

A4 (see Appendix A) reports on the results of the variance inflation factor (VIF), which is another tool for the detection of multicollinearity in a regression model. A VIF value equal or less than 10 indicate an absence of multicollinearity, which implies consistency in the standard errors of the estimated model. From Table A4, the VIF for the variables ranges from 1.01 to 1.95. This indicates the absence of multicollinearity and thus, suggests that the standard errors of the estimated model are consistent. The estimated model regressed stock returns on all variables in model 7.

The results of the panel cross-sectional dependence (CD) test presented in Table A5 (see Appendix A), indicate that, even at the 10% level of significance, the study failed to reject the null hypothesis of CD. This implies the absence of CD. Despite this result, the study went ahead to conduct the second-generation unit root test.

The second-generation unit root test, specifically Cross-section Augmented Dickey-Fuller (CADF) was conducted. The findings indicate that, all the variables, except for natural log of Stock returns, natural log of exchange rate and natural log of Share Index, exhibit stationarity at level. Natural logs of Stock market returns, exchange rate and Share Index became stationary at first difference. The results of the CADF test are presented in Table A6 (see Appendix A).

After performing unit root tests, the study utilized the Pedroni (1999, 2004) panel cointegration tests to determine the presence of cointegration relationship among the variables in the model. Table A7 (see Appendix A) reports the findings of the panel cointegration tests. As evidenced in Table A7, nine of the eleven statistics demonstrates statistically significant values at a

1% significance level, providing evidence of a long-term relationship among these variables. Consequently, the null hypothesis of no cointegration among the variables in the model is rejected.

Impact of COVID-19 pandemic on performance of regional stock markets

Table 11 reports the main empirical results of the pooled OLS on the effect of COVID-19 pandemic on performance of regional Stock returns. For model 7, COVID-19 cases have negative, but insignificant relationship with Stock returns. Economic disruptions and heightened uncertainty during COVID-19 could have accounted for this result. COVID-19 resulted in widespread economic disruption due to the health measures, such as lockdowns, physical distancing etc. implemented by countries to curb the virus spread. This uncertainty caused investors to reassess growth prospects, leading to selling pressure on stocks. This result is in tandem with the findings of Al-Qudah and Houcine (2022), that established an adverse impact of increasing cases of COVID-19 on stock returns in major affected countries in the WHO regions. Further, for model 7, the results show a positive and significant association of

Table 11: Pooled OLS Results

Variables	**Model 7**
ln*Cases*	-0.0132
	(0.0107)
ln*ExRate*	0.0778***
	(0.0104)
ln*COP*	-0.1782
	(0.1099)
ln*VIX*	0.9416***
	(0.1198)
ln*Index*	0.2044***

Table 11 Cont'D

	(0.0138)
Development Status	
Developing	-0.5909***
	(0.0743)
Emerging	-0.3211***
	(0.0657)
Constants	-8.4964***
	(0.7432)
Observations	1,584
R^2	0.2564
Adjusted R^2	0.2531

Notes: Values in the parenthesis are the robust standard error; *** p< 0.01, ** p< 0.05, * p<0.10.

Source: Author's Construction (2023)

exchange rate with stock returns. A rise in exchange rate (currency depreciation) by 1 percent, results in an increase in stock returns by 7.78 percent. Export competitiveness of these countries could be the underpinning reason for this result. A depreciating currency makes exports cheaper for foreign buyers. Export-oriented businesses benefits from such a phenomenon. Higher export revenues improve corporate earnings, which boosts the stock prices of these businesses. This result contradicts the findings of Nwosa (2021) which established an adverse impact of exchange rate on stock market in Nigeria during COVID-19.

Moreover, the results of model 7 show significant and negative influence of Crude oil price on Stock returns. A 1 percent increase in crude oil price would lead to a drop in stock returns by 17.82 percent. This result can be attributed to increased cost of production as a result of crude oil price hikes. Many businesses and industries rely on energy for their production and

operation. When oil price rise, it increases the cost of production and transportation for these businesses. This can lead to lower profit margins, which reduces corporate earnings. Investors anticipation of lower profitability can lead to selling pressure, causing stock prices to decline. This result contradicts the findings of Hashmi *et al*. (2022), which established a positive and significant association of crude oil prices with stock prices in Pakistan at the 10^{th} and 30^{th} quantiles.

In addition, the results of model 7 show volatility index have positive and significant relationship with stock returns. A rise in volatility index by 1 percent would lead to a 94.16 percent increase in stock returns. The global economic uncertainty could have accounted for this result. COVID-19 created widespread economic uncertainty globally. COVID-19 induced disruptions led to heightened volatility in financial markets in countries that were dependents on exports, commodities, and international trade. The volatility index, which is a measure of global market uncertainty, influenced investor sentiment and trading behaviours in stock markets. This result is in tandem with the findings of Zhu *et al*. (2019), that provides evidence of the US stock market being impacted by volatility index.

Additionally, the results of model 7 show a positive and significant association of share index with stock returns. A 1 percent rise in share index would lead to a 20.44 percent increase in stock market returns. A contributing factor to this result could be the sectoral contributions to the market index. Share indices are usually made up of a range of sectors. During the pandemic, certain sectors such as travel, hospitality, and retail faced significant challenges due to lockdowns and restrictions. In contrast, sectors such as

technology (including e-commerce and digital services), healthcare (including pharmaceuticals and medical devices), and consumer staples (such as groceries and household goods) experienced heightened demand or were less affected. The inclusion of these resilient or thriving sectors within indices played a crucial role in minimizing overall market declines and bolstering positive stock market performance.

Comparative analysis of the impact of COVID-19 pandemic on performance of regional stock markets

This section presents and discusses the role of development status in the relationship between COVID-19 cases and stock returns. To assess the differential effect of COVID-19 cases on stock returns, the dataset is divided into three groups (Developed Economies, Emerging Economies, and Developing Economies) according to the development status of the economy, with the results of model 7 showing this differential effect. Using stock markets in developed economies as the reference point, the negative effect of COVID-19 cases on stock returns in developing economies is 59.09 percent more than the ones in developed economies. Similarly, the negative effect of COVID-19 cases on stock returns in emerging economies is 32.11 percent more than the stock markets in developed economies.

Based on the differential effect of COVID-19 cases on stock returns above, stock markets in Developing Economies were the heaviest impacted, followed by stock markets in Emerging Economies, with stock markets in Developed Economies being the least impacted. This result is in tandem with the findings of Harjoto and Rossi (2021), which established that, the negative effect of COVID-19 pandemic on stock markets was more pronounced in

emerging markets than in developed ones. As evidenced from this result, the assertion of stock markets in developed economies being better hedges in the face of crisis (COVID-19 pandemic) due to their strong market foundation as espoused by Chang *et al*., (2019); Hashmi and Chang, (2021); and Hashmi *et al*., (2021) is supported by the findings of this study. Evidently, whilst stock markets in Developing Economies are the worst performers, the ones in Developed Economies outperformed those in Emerging economies.

A plausible reason for this finding could be due to the level of development of healthcare and infrastructure. Developed economies usually possesses stronger healthcare systems and infrastructure, enabling more effective responses to health crisis, such as COVID-19. This would likely bolster investor confidence and resilience in developed market stock indices, contrasting with developing economies, where healthcare and infrastructure may be less robust and less capable of managing the crisis impact. This is corroborated by the findings of Uddin, Chowdhury, Anderson and Chaudhuri (2021) which established that higher infrastructure quality could likely reduce stock market volatility by 76.88 percent and an effective healthcare system have significant impact on investors' sentiment, which could lead to the reduction of stock market volatility by 67.39 percent. In addition, an underpinning rationale for stock markets in developing economies being worst impacted by the pandemic could be attributed to capital outflows during COVID-19. During periods of uncertainty, investors tend to withdraw capital from riskier non-developed markets. This flight to safety exacerbated capital outflows from non-developed economies, exerting pressure on their currencies and stock markets. This is confirmed by the findings of Beirne, Renzhi,

Sugandi and Volz (2021) which established that capital outflows contributed to the impact of COVID-19 on stock markets in emerging economies being heavier than the ones in developed economies.

Further, another likely reason for the worst performance of stock markets in developing economies could be attributed to policy responses and stimulus measures by governments around the globe in the wake of the pandemic. Developed economies had more flexibility in fiscal policy and tools to implement expansive economic stimulus packages to supports businesses and households during the pandemic. This proactive approach mitigated economic disruptions and stabilized financial markets; a capability that developing economies with constrained fiscal capacities found harder to achieve. This is supported by the findings of YH Saif-Alyousfi (2022), and Chang, Feng and Zheng (2021) that established that stringent policy responses by governments resulted in significant rise in stock returns.

Theoretically, the findings of this study support the Efficient Market Hypothesis (EMH) theory. It is the contention of this study that, in Developed Economies, information regarding COVID-19 news and policy responses is readily available. As a result, when COVID-19 pandemic occurred, investors in these economies would be privier to the pandemic related news, including proactive stimulus packages, which dampens uncertainty, leading to reduction in speculative and panic activities in stock markets. This ready pandemic related information which includes positive news of stimulus packages is therefore incorporated in the determination of stock prices, resulting in the relatively better performance of stock markets in Developed Economies, during COVID-19. On the other hand, in non-Developed Economies, the

prevalence of information lag and the initial lack of monetary and fiscal stimulus packages, resulted in heightened uncertainty in these markets. These resulted in the price determination of these markets being heavily influenced by speculative and panic behaviours. This resulted in relatively significant drop in stock prices, leading to relatively poor performance of stock markets in non-Developed Economies, during COVID-19 pandemic period.

Summary

This chapter examined the impact of COVID-19 pandemic on performance of individual and regional stock markets, using twenty-one (21) stock markets from developed, emerging, and developing economies. Evidence from the results indicate that, the performance of stock markets in these economies have been negatively and significantly impacted by COVID-19 pandemic. Specifically, in relative terms, for the developed economies, Italy was the worst impacted by the pandemic, with the least impacted being Germany (-7.9%). For emerging economies, India (-16%) was the hardest hit by the pandemic, with Brazil being positively impacted by the pandemic by 9.3 percent. For developing economies, the adverse impact of 37% in Colombia is the heaviest, with the least impacted being -20 percent in Morocco.

With respect to the differential effect of COVID-19 on regional stock markets, the stock markets in developing economies are established to be worst affected. Using stock markets in developed economies as the reference point, the negative effect of COVID-19 cases on stock market returns in developing economies is 59.09 percent more than the ones in developed economies. Similarly, the negative effect of COVID-19 cases on stock market

returns in emerging economies is 32.11 percent more than the stock markets in developed economies. Evidently, whilst stock markets in developing economies are the worst performers, the ones in developed economies outperformed those in emerging economies.

CHAPTER SIX

VOLATILITY TRANSMISSION BETWEEN STOCK AND FOREX MARKETS IN AFRICA: THE ROLE OF FINANCIAL GLOBALISATION

Introduction

This chapter examines the transmission of volatility between stock and forex markets and assesses the moderating role of financial globalisation in this transmission in 8 selected African countries, during the COVID-19 pandemic period. The chapter begins by analyzing the descriptive statistics of stock market volatility, exchange rate volatility, volatility index, stock returns, exchange rate returns, financial globalisation and crude oil price, during the COVID-19 pandemic period. This is then followed by an analysis of the results of the pre-diagnostic tests. Following this, the results of the estimates of the effect of exchange rate volatility on stock market volatility are presented and discussed. Further, the results of the estimates of the influence of stock market volatility on exchange rate volatility are presented and discussed. Finally, the results of the estimates of the moderating role of financial globalisation in the co-movement of stock market volatility and exchange rate volatility are presented and discussed.

Analysis of Descriptive Statistics

Table 12 reports a set of descriptive statistics on stock market volatility, exchange rate volatility, volatility index, stock returns, exchange rate returns, financial globalisation, and crude oil price, during the COVID-19 period. The average volatility recorded for the stock and forex markets is 0.0001 and 0.0000 respectively, with minimum volatility of 0.0000 for both

markets. The standard deviations of stock and forex markets are given as 0.0002 and 0.0000 respectively. The maximum volatility for stock and forex markets are given as 0.0019 and 0.0003 respectively. The average, standard deviation, minimum, and maximum volatility index is given as 27.0613, 5.0491, 19.9700 and 45.4100 respectively. The average return for the stock markets is given as 0.0004, with minimum, maximum, and standard deviation of -0.1723, 0.1027, and 0.0108 respectively. The average return for the forex markets is -0.0005, with standard

Table 12: Descriptive statistics during COVID-19 pandemic period

Variable	Mean	Max	Min	SD	OBS
SV	0.0001	0.0019	0.0000	0.0002	2255
XV	0.0000	0.0003	0.0000	0.0000	2255
VIX	27.0613	45.4100	19.9700	5.0491	2255
SR	0.0004	0.1027	-0.1723	0.0108	2255
XR	-0.0005	0.0396	-0.0284	0.0062	2255
FG	57.1737	99.000	29.9260	19.8762	2255
COP	39.9119	53.5700	12.3400	7.9963	2255

Notes: Standard Deviation is denoted by SD, observations are depicted by OBS, SV is Stock market volatility, XV is Exchange rate volatility, VIX is Volatility index, SR is Stock returns, XR is Exchange rate returns, FG is Financial globalisation, COP is Crude Oil Price, Min is Minimum, and Max is Maximum

Source: Author's Construction (2023)

deviation of 0.0062, minimum returns of -0.0284 and maximum returns of 0.0396. The minimum and maximum index of financial globalisation achieved is 29.9260 and 99.0000 respectively, with a mean index of 57.1737 and standard deviation of 19.8762. Fluctuations in crude oil price in this period is

demonstrated by a standard deviation of 7.9963, with a mean, minimum and maximum prices of $39.91, $12.34 and $53.57 respectively.

Results of Pre-diagnostic Tests

In Table B1 (see Appendix B), the study reports on the results of the pairwise correlation matrix for the COVID-19 pandemic period. The objective of the correlation matrix is to ensure that, there is no multicollinearity among the exogenous variables in the model. In addition, the direction and strength between any two variables in the model is shown by this matrix. The results in Table B1 clearly suggest that the exogenous variables generally show strong correlation and no problem of multicollinearity. According to Krammer (2010), the absence of multicollinearity is affirmed when the correlation coefficient among independent variables remains below 0.85. Examination of the correlation matrix in Table B1 for this study reveals that, all coefficients are below 0.85, thereby indicating an absence of multicollinearity concerns.

Similarly, Table B2 (see Appendix B) reports on the results of the variance inflation factor (VIF), which is another tool for the detection of multicollinearity in a regression model. A VIF value equal or less than 10 indicate an absence of multicollinearity, which implies consistency in the standard errors of the estimated model. From Table B2, the VIF for the variables for the COVID-19 pandemic period are close to 1. This indicates an absence of multicollinearity and thus, suggests that the standard errors of the estimated model are consistent. The estimated model regressed stock market volatility on all variables in model 13, and model 15 regressed exchange rate volatility on all variables.

The results of the panel cross-sectional dependence (CD) test presented in Table B3 (see Appendix B), indicate that, even at the 1% level of significance, the null hypothesis of CD is rejected for Stock market volatility, Exchange rate volatility, Volatility index and Crude oil price. This rejection implies the presence of CD and also suggests that the first-generation panel unit root framework is not suitable for this study. However, the results indicate that Stock market returns and Exchange rate returns does not suffer from CD. As highlighted by Breitung and Pesaran (2008), CD can emerge due to spatial spillover effects and unobservable factors among nations and regions.

The second-generation unit root tests, specifically (Cross-section Augmented Dickey-Fuller (CADF) and Cross-section Im-Pesaran (CIPS) were conducted. The findings indicate that all the variables, except for financial globalisation and Crude oil price, exhibits stationarity at level. Financial globalisation became stationary at first difference. The results of the CADF and CIPS tests are presented in Table B4 (see Appendix B).

After performing unit root tests, we utilized the Pedroni (1999, 2004) panel cointegration tests to determine the presence of cointegration relationship among the variables in the model. Table B5 (see Appendix B) reports the findings of the panel cointegration tests. As evidenced in Table B5, all eleven statistics demonstrates statistically significant values at a 1% significance level, providing evidence of a long-term relationship among these variables. Consequently, the null hypothesis of no cointegration among the variables in the model is rejected.

Drivers of Stock Market Volatility

Table 13 reports the main empirical results of the Panel FMOLS and Panel DOLS, using stock market volatility as the dependent variable. Model 13 is the baseline specification. For model 13 and model 14 for both methodologies, volatility index has positive and significant relationship with stock market volatility. The global economic uncertainty could have accounted for this result. COVID-19 created widespread economic uncertainty globally, affecting both developed and developing economies. In Africa, where many countries are dependents on exports, commodities, and international trade, disruptions caused by COVID-19 led to heightened volatility in financial markets. The volatility index, which is a measure of global market uncertainty, influenced investor sentiment and trading behaviours in African stock markets. This result is in tandem with the findings of Zhu *et al*. (2019), that provides evidence of the US stock market volatility being impacted by volatility index.

Further, model 13 and model 14 for both Panel FMOLS and Panel DOLS results show a positive and significant association of stock market returns with stock market volatility. This might be attributed to the pandemic impact on corporate earnings. Companies in vulnerable sectors such as tourism, hospitality, and commodities, experienced significant declines in revenue and profitability, leading to negative stock returns. These challenges contributed to heightened uncertainty and volatility in African stock markets as investors reassessed earnings and adjusted their portfolios accordingly. This result corroborates the findings of AM Al-Rjoub and Azzam (2012), that found a positive association of stock returns with stock market volatility in Jordan.

In addition, the results of model 13 and model 14 for both methodologies show significant and positive influence of financial globalisation on stock market volatility. This might be due to African markets being more susceptible to global economic shocks and financial contagion through interconnected financial channels during periods of heightened uncertainty, such as the COVID-19 pandemic. This result contradicts the findings of Cordella and Ospino Rojas (2017), which using 84 countries revealed that financial globalisation reduces stock market volatility.

Additionally, model 13 and model 14 results for both methodologies indicate significant and negative influence of crude oil price on stock market volatility. The negative impact of crude oil price fluctuations on stock market volatility reflects the continent's heavy dependency on commodities, particularly oil, for economic stability. Changes in oil prices significantly affected fiscal balances, sectoral performance, currency values, and investor sentiment, which led to the stock market volatility being affected. This result is in consonance with the findings of Degiannakis *et al*. (2014).

Volatility transmission from forex to stock market

As shown in the results of model 13 for both Panel FMOLS and Panel DOLS from Table 13, the exchange rate volatility enters positive and significant, showing a positive co-movement of the two volatilities. The positive influence of exchange rate volatility on stock market volatility can be understood through the lens of increased economic uncertainty, foreign exchange exposures of local businesses, shifts in global capital flows, and interconnectedness with global financial markets. These factors contribute to heightened volatility in African stock markets during periods of exchange rate

instability. This finding mirrors the results of Sui and Sun (2016), that established volatility transmission from forex to stock market for BRICS countries during the 2007/08 global financial crisis period. This result is also in tandem with the findings of Mikhaylov (2018), Fasanya and Akinde (2019), and Baranidharan and Alex (2020), that showed transmission of volatility from forex to stock market for Brazil and Russia, Nigeria, and South Africa respectively, in a non-crisis period. This result also confirms the findings of Van

Table 13: Panel FMOLS and Panel DOLS Results (Stock volatility as the dependent variable)

	Panel FMOLS		Panel DOLS	
Variables	Model 13	Model 14	Model 13	Model 14
Exchange Rate vol.	0.2764**	-5.5915***	0.3845***	-6.3464***
	(0.1336)	(0.5826)	(0.1346)	(0.7831)
Volatility Index	0.0000**	0.0000**	0.0000*	0.0000**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock returns	0.0007**	0.0007**	0.0013**	0.0009*
	(0.0003)	(0.0003)	(0.0006)	(0.0005)
Fin. Globalisation	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Crude Oil price	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
XV*FG		0.0883***		0.1019***
		(0.0089)		(0.0115)
Observations	2255	2255	2255	2255
R^2	0.4396	0.4657	0.6951	0.7633
Adjusted R^2	0.4358	0.4619	0.6682	0.7381
SER	0.0001	0.0001	0.0000	0.0000
LRV	0.0000	0.0000	0.0000	0.0000
Net Effect	-	-0.5431	-	-0.5204

Notes: Values in the parenthesis are the robust standard error; *** p< 0.01, ** p< 0.05, * p<0.10, XV*FG represents an interaction term of Exchange Rate volatility and Financial Globalisation
Source: Author's Construction (2023)

Der Westhuizen *et al*. (2022) and Rai and Garg (2022) that found positive volatility spillover emanating from the forex market for the South Africa and BRIICS countries respectively, in the COVID-19 pandemic period.

On the contrary, the results of model 14 for both methodologies indicative negative and significant association of exchange rate volatility with stock market volatility as evidenced in Table 13. The study includes an interaction term (exchange rate volatility*financial globalisation) in model 14 to examine the moderating role of financial globalisation in the relationship between exchange rate volatility and stock market volatility. The results of model 14 in both the Panel FMOLS and Panel DOLS show that, financial globalisation moderates a significant and positive influence of exchange rate volatility on stock market volatility.

Drivers of Exchange Rate Volatility

Table 14 reports the Panel FMOLS and Panel DOLS empirical results, using exchange rate volatility as the dependent variable. Model 15 is the baseline specification. Whilst the results of both models for the Panel FMOLS indicate positive and insignificant relationship between volatility index and exchange rate volatility, the results of both models for the Panel DOLS show negative and insignificant association of volatility index and exchange rate volatility. This is in contrast with the findings of Feng *et al*. (2021), that established significant and positive relationship between volatility index and exchange rate volatility.

Further, the results of both models and methodologies, reveal significant and negative influence of exchange rate returns on exchange rate volatility. This negative influence can be attributed to proactive policy

interventions, international support, adjustments in trade dynamics, and stability measures implemented by governments and central banks. These measures were aimed at mitigating market uncertainty, restore economic stability, and reduce fluctuations in exchange rates, contributing to lower exchange rate volatility during COVID-19 period. This result mirrors the findings of Mohammed *et al*. (2021), which established a negative relationship in Ghana.

Moreover, the results of both models and methodologies, show the existence of significant and positive relationship between financial globalisation and exchange rate volatility. The positive influence can be understood through increased capital flows, dependency on external financing, integration into global supply chains, exchange rate pass-through effects, and the challenges posed to policy responses. These factors highlight the interconnectedness of African economies with global financial markets, which amplified exchange rate volatility during periods of economic uncertainty and global shocks like the COVID-19 pandemic. This result is in contrast with the findings of Gaies *et al*. (2020), which established a negative association in selected emerging and developing countries.

Additionally, the results of both models and methodologies provide evidence of significant and negative influence of crude oil price and exchange rate volatility. The negative influence can be attributed to economic dependencies on oil revenues, implications for balance of payments and fiscal positions, inflation dynamics, monetary policy responses, and broader market sentiment affecting investor confidence. These factors highlight the vulnerability of African economies to fluctuations in global oil markets, which

exacerbated exchange rate volatility during periods of oil price instability such as the COVID-19 pandemic. This result contradicts the findings of Jain and Biswal (2016), and Alam, Uddin and Jamil (2020), that revealed a positive association in India, but corroborates the study of Jawadi, Louhichi, Ameur and Cheffou (2016), that established an inverse relationship in the US.

Volatility transmission from stock to forex market

The results of both models and methodologies as presented in Table 14, show significant and positive co-movement of stock market volatility and exchange rate volatility. Global financial market interconnections can be the rationale behind this result. African financial markets are increasingly interconnected with global markets. Stock market volatility in major global financial centers can spill over into African markets through cross-border capital flows and investor sentiment contagion. During COVID-19, rapid movements in global stock markets influenced local market dynamics, including exchange rate volatility, as investors adjusted their portfolios based on global risk perceptions. This result contradicts the findings of Sui and Sun (2016), that found no evidence of transmission of volatility from stock to forex markets in

Table 14: Panel FMOLS and Panel DOLS Results (Exchange Rate volatility as the dependent variable)

	Panel FMOLS		Panel DOLS	
Variables	Model 15	Model 16	Model 15	Model 16
Stock volatility	0.0188**	0.0789***	0.0524***	0.1835***
	(0.0095)	(0.0267)	(0.0137)	(0.0411)
Volatility Index	0.0000	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exch. Rate returns	-0.0004**	-0.0004**	-0.0006*	-0.0004
	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Fin. Globalisation	0.0000***	0.0000**	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Crude Oil price	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SV*FG		-0.0008**		-0.0014**
		(0.0003)		(0.0005)
Observations	2255	2255	2255	2255
R^2	0.6317	0.6328	0.7209	0.7569
Adjusted R^2	0.6292	0.6301	0.6963	0.7309
SER	0.0000	0.0000	0.0000	0.0000
LRV	0.0000	0.0000	0.0000	0.0000
Net Effect		0.0332		0.1035

Notes: Values in the parenthesis are the robust standard error; *** p< 0.01, ** p< 0.05, * p<0.10, SV*FG represents an interaction term of Stock volatility and Financial Globalisation
Source: Author's Construction (2023)

BRICS countries during the 2007/08 GFC period. This results also confirm the findings of Qin *et al*. (2018) and Singh *et al*. (2021), that showed positive transmission of volatility from stock to forex markets in China and Japan, and in India, China and South Africa respectively, in a tranquil period, and the findings of Van Der Westhuizen *et al*. (2022), which established transmission of volatility from stock to forex markets in South Africa in the COVID-19 pandemic period.

The study includes an interaction term (stock market volatility* financial globalisation) in model 16 to examine the moderating role of financial globalisation in the influence of stock market volatility on exchange rate volatility. The results of model 16 in both methodologies show that, financial globalisation has significant and positive moderating role in the co-movement of stock market volatility and exchange rate volatility.

Volatility transmission between forex and stock markets

As evidenced from the results of Table 13 and Table 14, transmission of volatility between stock and forex markets is bidirectional in the COVID-19 pandemic period. The bidirectional volatility transmission established is in tandem with the findings of Bal *et al*. (2018), that revealed significant association of stock and forex market volatility during the 2007/08 GFC period, and the findings of Qin *et al*. (2018) and Singh *et al*. (2021), that established significant relationship between forex and stock markets during tranquil periods.

Theoretically, the bidirectional transmission of volatility between forex and stock markets in Africa as established by this study backs the theories of both "stock-oriented" and "flow-oriented" models. Whilst the former model posits that stock prices persuade the exchange rate, the persuasion of the stock prices by the exchange rate as stipulated by the latter model is supported by this study. An economic rationale underpinning this result may be sourced from the informational transmission workings of the "flow-oriented" model, which posits that the real income and output of an economy are affected, through the effect of exchange rate fluctuations on the competitiveness of local firms in the international markets.

In addition, as the present value of future cash flows determines stock prices, the stock market eventually responds to the fluctuations in the exchange rate. The stock markets reactions to changes in the exchange rate during crisis periods are not surprising, particularly in the COVID-19 pandemic period. For the former, Do, Brooks and Treepongkaruna (2015) asserts that, the continuous and significant real growth rate in the US between 2002 to middle of 2009 strengthened the US dollar which is the world base currency. Similarly, Miller (2020) posits that the safe-haven property of the US dollar was highly exhibited due to its high demand during the COVID-19 crisis. These phenomena underpin the noticeable informational flows from forex to stock markets during crisis periods as expected.

Financial globalisation and its moderating role

For the direct effect, financial globalisation is revealed to have significant and positive influence on stock market volatility. This implies that in turbulent periods, such as COVID-19 crisis, in the African setting, financial globalisation serves as a vehicle of contagion in increasing stock market volatility. Further, financial globalisation indirect effect via the forex market is positive in the COVID-19 pandemic period. This implies that, the positive direct influence of financial globalisation on stock market volatility is reinforced by the positive indirect influence of financial globalisation on stock market volatility via exchange rate volatility. This finding is in conformity with the study of Cordella and Ospino Rojas (2017), which asserts that in steady periods, financial globalisation plays a stabilizing role, and becomes a destabilizing force in turbulent periods. A plausible reason could be that, when external shocks (COVID-19 pandemic) are more pronounced than domestic

shocks, then financial globalisation becomes a source of instability, through a contagion vehicle.

On the flipside, the results of this study show that, financial globalisation directly has a positive influence on exchange rate volatility in the COVID-19 period. This contradicts the findings of Gaies *et al*. (2020), which established a negative association in selected emerging and developing countries. Finally, on the indirect effect of financial globalisation, via the stock market, a negative influence is established. This implies that, whilst financial globalisation directly increases the exchange rate volatility, its indirect influence through the stock market volatility reduces the exchange rate volatility. A possible reason for this could be that the stabilizing effect of stock market on forex volatility is strong enough to absorb the destabilizing influence of financial globalisation on exchange rate volatility.

The consolidated effects of exchange rate volatility and financial globalisation, and stock market volatility and financial globalisation are fundamental to the behaviour of stock market volatility, and exchange rate volatility respectively. To assess the magnitude of this effect, the study calculates the net effect of exchange rate volatility on stock market volatility when financial globalisation index is used as moderation variable as described in equation (17), and the net effect of stock market volatility on exchange rate volatility when financial globalisation index is used as moderation variable as shown in equation (18).

Starting with net effect of Exchange rate volatility on stock market volatility when financial globalisation is used as moderation variable, the

study found the net effect to be -0.5431 and -0.5204 for the Panel FMOLS and Panel DOLS approaches respectively, as shown below.

$$\frac{\partial SV_{j,t}}{\partial XV_{j,t}} = a_{13} + a_{17}\overline{FG}_{j,t} = -0.5.5915 + (0.0883 \times 57.1737)$$

$$= -0.5431 \text{ (Panel FMOLS)}$$

$$\frac{\partial SV_{j,t}}{\partial XV_{j,t}} = a_{13} + a_{17}\overline{FG}_{j,t} = -6.3464 + (0.1019 \times 57.1737)$$

$$= -0.5204 \text{ (Panel DOLS)}$$

The result of -0.5431 (Panel FMOLS) and -0.5204 (Panel DOLS) indicate that in the presence of financial globalisation, a unit increase in exchange rate volatility decreases stock market volatility by between 0.5204 to 0.5431 units. This implies that the stabilizing properties of financial globalisation was strong enough to reinforce the dousing influence of exchange rate volatility on stock market volatility.

Similar computation was used for the net effect of stock market volatility on exchange rate volatility when financial globalisation is used as a moderation variable. Calculating the net effect of Stock market volatility on Exchange rate volatility when financial globalisation is used as moderation variable, the study found the net effect to be 0.0332 and 0.1035 for the Panel FMOLS and Panel DOLS approaches respectively, as shown below.

$$\frac{\partial XV_{j,t}}{\partial SV_{j,t}} = a_{33} + a_{37}\overline{FG}_{j,t} = 0.0789 + (-0.0008 \times 57.1737)$$

$$= 0.0332 \text{ (Panel FMOLS)}$$

$$\frac{\partial XV_{j,t}}{\partial SV_{j,t}} = a_{33} + a_{37}\overline{FG}_{j,t} = 0.1835 + (-0.0014 \times 57.1737)$$

$$= 0.1035 \text{ (Panel DOLS)}$$

The results of 0.0332 (Panel FMOLS) and 0.1035 (Panel DOLS) as shown above suggest that in the presence of financial globalisation, a unit increase in stock market volatility increases exchange rate volatility by between 0.0332 to 0.1035 units. This implies that the stabilizing properties of financial globalisation was not strong enough to douse the positive influence of stock market volatility on exchange rate volatility.

Results of Robustness Checks

For the robustness checks, the financial globalisation, de jure index was used in the estimations. The results of the financial globalisation, de jure index incorporated estimations are presented in Table B3 and Table B4 in Appendix B. The results are similar to the main results of this study, except for model 14 using the Panel FMOLS approach, where the interactive term has a negative influence on stock market volatility, and for model 13 and model 14, using the Panel DOLS approach, where volatility index and stock market returns are insignificant, and for model 15, using the Panel DOLS, where the crude oil price is established to be insignificant.

Summary

This chapter examined the reciprocal volatility transmission between stock and forex markets of eight African countries and assessed the moderating role of financial globalisation in this relationship, during the COVID-19 pandemic period. The results reveal a bidirectional volatility transmission in the COVID-19 pandemic period. The results further established that, financial globalisation reduces the volatility transmission from forex to stock markets, whilst it heightens the volatility transmission from stock to forex markets in Africa, during the COVID-19 pandemic period.

CHAPTER SEVEN

COVID-19 PANDEMIC AND PERFORMANCE OF EXCHANGE RATE IN GHANA: THE ROLE OF TRADE OPENNESS

Introduction

This chapter examines the relationship between COVID-19 pandemic and performance of exchange rate in Ghana and assesses the moderating role of trade openness in this relationship. The chapter commences by examining the summary statistics of Ghana's exchange rates, confirmed COVID-19 cases in Ghana, crude oil price, stock prices in Ghana, and Ghana's trade openness. The results of the unit root test (ADF and KPSS) are then discussed. This is followed by discussion of the cointegration test results. Following this, the results of the unit root test with structural breaks are discussed. The results of the Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR) are then presented and discussed. Finally, the results of the Cholesky decomposition analysis are discussed.

Analysis of Descriptive Statistics

Table 15 displays the average summary statistics of the variables, computed from March 19, 2020, to December 30, 2020. The average value of the Exchange Rate (XR) is GHs 5.78, with a standard deviation of 0.05. The average number of confirmed COVID-19 cases (Cases) in Ghana is around 266.91, with the highest recorded count of 1,385 cases. The variability of COVID-19 cases in Ghana is easily noticeable, exhibiting a standard deviation of 268.86. A recorded average of $36.41 per barrel is observed for the Crude Oil Price (COP), with a maximum price of $49.10 and a standard deviation of 8.37. The stock market price (Index) of Ghana exhibits significant fluctuations

across a broad range, reaching a peak of GHs 2,180.90. On average, the price hovers

Table 15: Descriptive statistics

Variable	Mean	Max	Min	SD	OBS
XR	5.783989	5.930000	5.605600	0.047949	122
Cases	266.9098	1385.000	1.000000	268.8615	122
COP	36.41402	49.10000	12.34000	8.374504	122
Index	1930.286	2180.900	1810.090	114.1317	122
TO	50.04795	58.37545	42.77474	4.510502	122

Note: Standard Deviation is denoted by SD, whilst observations are depicted by OBS, XR is Exchange rate, Cases is confirmed COVID-19 cases, COP is Crude oil price, Index is Stock market price, TO is Trade Openness, Min is Minimum, and Max is Maximum
Source: Author's Construction (2023)

around GHs 1,930.29, whilst the minimum price recorded is GHs 1,810.09. Ghana's trade openness (TO) has exhibited a moderate level of integration into international trade, as evidenced by an average of 50.05 percent over the given period.

Results of Stationarity Tests

Unit root tests are performed to validate the utilization of the chosen series and demonstrate their stationarity, ensuring that they do not yield misleading outcomes. To ensure unbiasedness and robustness of the unit root test, this study employs two distinct types of unit root tests. Dickey and Fuller's (1981) Augmented Dickey-Fuller (ADF) test, and Kwiatkowski's *et al*. (1992) Kwiatkowski-Phillips-Schmidt-Shin (KPSS) statistic are applied in this study. The ADF and KPSS tests differ primarily in their null hypotheses. The ADF test assumes the presence of a unit root as its null hypothesis,

whereas the KPSS test assumes stationarity as its null hypothesis. Furthermore, the ADF relies on MacKinnon's (1991) work for determining the critical values. The basis for the critical value employed in the KPSS unit root test, however, stems from the work of Kwiatkowski *et al*. (1992). The initial step in performing the ADF test involves utilizing the Akaike Information Criterion (AIC) to determine the lag order selection. Initially, the tests were carried out at different stages, starting with an intercept and subsequently incorporating both an intercept and a trend. At the levels, COVID-19 cases and stock market price variables achieved stationarity under the intercept, whilst exchange rate variable is stationary under the intercept and trend. Nevertheless, upon applying the first differencing technique, all the variables exhibited stationarity, both with intercept and with intercept and trend. This study conducted a second test utilizing the KPSS, which employs the Bartlett Kernel estimation method with Newey-West bandwidth. According to the findings of the KPSS test, all variables exhibit stationarity when considering both intercept and intercept with trend at different levels. The outcomes of both tests serve to strengthen the evidence that the series are stationary, thereby allowing its usage without concern for generating misleading outcomes. The results of the stationarity tests are presented in Table C1 (see Appendix C).

Results of Cointegration Test

The study employs the Johansen multivariate test to examine the presence or otherwise of cointegration among the variables, thereby determining the presence or absence of a long-term convergence between the selected variables. According to the data presented in Table C2 (see Appendix

C), the Trace test results indicate that, there is a maximum of three cointegration equations. The maximum eigen value test on the other hand confirms the presence of two cointegrating equations. The implication of this test result is that there is unlikely to be any short-term convergence of the series, but it does provide evidence that, the series will eventually converge in the long run. The results of the cointegration tests are presented in Table C2 (see Appendix C).

Results of the Structural Break Test

To ensure all potential break points in the series are detected, the study also conducted a Zivot and Andrews' (2002) unit root structural test. The Zivot and Andrews test, which compares a null hypothesis of a unit root with structural break to an alternative hypothesis of no unit root with a structural break is conducted. The examination for structural breaks is conducted in three different ways. The first step involves performing the task using an intercept only, followed by executing it with a trend component, and ultimately combining both intercept and trend to accomplish the task. Based on the findings presented in Table C3 (see Appendix C), the null hypothesis of no unit root with a structural break including an intercept cannot be dismissed for the variables of exchange rate, COVID-19 cases, crude oil price, and trade openness. This holds true even when considering different levels of significance, as well as, when using both trend-only and intercept-with-trend models. However, the three models of intercept, trend, and under intercept and trend do not support the acceptance of the null hypothesis that there is no unit root with a structural break for stock market price.

COVID-19 cases and performance of exchange rate in Ghana

The influence of COVID-19 cases, crude oil price, stock market price, trade openness, and the interactive term of COVID-19 cases and trade openness on exchange rate is presented in Table 16. For the baseline equation, the results show a positive correlation between COVID-19 cases and exchange rate for both models. This implies that, COVID-19 cases results, in a simultaneous appreciation and depreciation of the US dollar and Ghana cedi respectively. Economic uncertainty is a likely determinant of this result. The global pandemic brought about substantial economic turmoil worldwide, resulting in heightened levels of unpredictability. In periods of uncertainty, investors tend to shift their investments from more risky assets to safer alternatives. Developing economies are often regarded as riskier investment prospects due to factors like less robust healthcare systems, elevated poverty rates, and limited fiscal capabilities to address crises. Consequently, investors might divest their holdings in these countries, leading to a decline in demand for their currency and a depreciation of exchange rates.

Another likely contributing factor to this result is decline in Foreign Direct Investment (FDI). Developing economies frequently depend on FDI to fund their development initiatives and stimulate economic expansion. However, the onset of the COVID-19 pandemic resulted in a decrease in FDI, as companies scaled down their activities, delayed investment schemes, or shifted resources towards more secure markets. Consequently, the diminished influx of foreign currency diminishes the demand for the domestic currency, exerting downward pressure on the exchange rate.

Another possible reason for this result is drop in export revenue in the height of the pandemic. Many developing economies rely significantly on exports as a driving force for their economic expansion. The COVID-19 pandemic brought about disruptions in international supply chains, reduced demand for products and services, and resulted in widespread lockdowns and trade restrictions. Consequently, export earnings experienced a decline, which had adverse effects on the balance of payments. The decrease in foreign currency inflows from exports created pressure on the exchange rate, ultimately causing its depreciation.

Further, capital flight is a likely driver of this result. In periods of crisis, there is a possibility that investors will participate in capital flight, which refers to the swift movement of money and assets away from a specific economy. The COVID-19 pandemic's unpredictability had a substantial impact on capital flight from developing economies. As a result, investors transferred their capital to safer assets in more economically stable countries, leading to reduction in demand for local currency and a decline in the exchange rate. This finding is in tandem with the results of Hoshikawa and Yoshimi (2021) on South Korea, Sunaryati and Munandar (2023) on Indonesia, Kausar *et al*. (2022) on Pakistan, and Cardona-Arenas and Serna-Gómez (2020) on Colombia. However, the result is in contrast with the findings of Camba and Camba (2020) on Philippines.

The impact of crude oil price on exchange rate is positive but insignificant. This could imply that in the long run, an increase in crude oil price, strengthens the US dollar and simultaneously weakens the domestic currency (Ghana cedi). This could be attributed to the fact that when crude oil

price increases, net oil importers such as Ghana may experience rise in import expenses. This could translate in a trade imbalance leading to a current account deficit. This scenario would put undue pressure on the domestic currency causing the exchange rate to decrease.

Another plausible reason for the adverse impact of crude oil price on Ghana's exchange rate could be attributed to economic slowdown experienced by net-oil importers occasioned by surge in crude oil price. Due to the dependent on crude oil by industries in these economies, a higher energy cost has the tendency to disrupts economic activities. A slowdown in economic growth can weaken the domestic currency as investors seek better investment opportunities elsewhere.

Another contributing factor for the adverse influence of crude oil price on exchange rate is inflationary pressures. Crude oil plays a vital role in the manufacturing of diverse products and services. When its price rises, production expenses escalate across multiple industries. As a result, businesses may transfer these augmented costs to consumers by raising prices, which ultimately contributes to inflation. The presence of high inflation gradually diminishes the buying power of a currency, thereby reducing its value in the foreign exchange market. This finding is consistent with the works of Ghosh (2011), Muhammad, Suleiman and Kouhy (2012), and Fowowe (2014) on India, Nigeria and South Africa respectively, whilst it is at variance with the findings of Adeniyi *et al*. (2012), Narayan, Narayan and Prasad (2008), and Musa *et al*. (2020) on Nigeria, Fiji, and Nigeria respectively.

For both methodologies, a positive impact of stock market price on exchange rate is recorded, which implies that the US dollar is strengthened at

the detriment of the Ghana cedi. The results suggest that GHS 1 increase in stock market price accounts for GHS 0.02 increase in the exchange rate of the US dollar relative to the Ghana cedi per the FMOLS and CCR models. Capital

Table 16: Long run estimates of the relationship between COVID-19 cases and performance of exchange rate in Ghana

	FMOLS		CCR	
	Model 30	**Model 31**	**Model 30**	**Model 31**
Cases	0.0000*	0.0006*	0.0000*	0.0006*
	(0.0000)	(0.0003)	(0.0000)	(0.0003)
COP	0.0005	0.0007	0.0005	0.0001
	(0.0011)	(0.0011)	(0.0011)	(0.0011)
Index	0.0002**	0.0002***	0.0002**	0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
TO	0.0108***	0.0126***	0.0109***	0.0128***
	(0.0018)	(0.0021)	(0.0019)	(0.0022)
Cases*TO		-0.0001*		-0.0001
		(0.0000)		(0.0000)
Constant	4.8483***	4.6953***	4.8318***	4.6674***
	(0.2217)	(0.2341)	(0.2364)	(0.2534)
R-Sqaured	0.5249	0.5318	0.5245	0.5300
Adj. R-Squared	0.5086	0.5114	0.5081	0.5096
SER	0.0317	0.0317	0.0318	0.0318
LRV	0.0019	0.0018	0.0019	0.0018

Note: ***, **, * represents rejection of the null hypothesis at the 1%, 5%, and 10% significance levels respectively, whilst values in bracket represents Standard Errors

Source: Author's Construction (2023)

outflows can be the underpinning rationale for the adverse effect of the stock market price on exchange rate of Ghana. Investors may grow worried about the economy's well-being and the profitability of their investments when stock market prices decline. Consequently, they might decide to sell their stocks and relocate their capital elsewhere, triggering a substantial outflow of foreign currency, ultimately weakening the exchange rate. Further, the perception of

economic well-being and investor trust can be influenced by the sentiment among investors and the performance of the stock market. When stock market prices experience a significant drop, it can diminish investor sentiment and generate a pessimistic outlook regarding the economic future of an economy, with the tendency of this loss of confidence being extended to the local currency. Additionally, developing economies, such as Ghana frequently depend on external loans to fund their development initiatives and fulfil their debt responsibilities. A decline in stock market values can present difficulties for Ghana in terms of accessing global capital markets or refinancing their current debts. When investors perceive heightened risks, they might request elevated interest rates or decline lending altogether. As a result, borrowing expenses increase, and the nation's creditworthiness weakens, further straining the exchange rate. Whilst this finding is in consonance with the results of Phylaktis and Ravazzolo (2005), Kutty (2010), and Richards *et al*. (2007) on five Asian countries, Mexico and Australia respectively, it is at variance with the findings of Tabak (2006) and Granger *et al*. (2000) on Brazil and Philippines respectively.

Lastly, trade openness exhibits a positive correlation with exchange rate at the 1 percent significance level for both FMOLS and CCR models. The results suggest that a rise in trade openness causes an appreciation of the US dollar at the expense of the Ghana cedi. A contributing factor to this result lies in trade imbalances. Increased imports resulting from trade openness can contribute to a trade deficit. When an economy imports a greater quantity of goods and services compared to its exports, it generates a need for foreign currency to cover those imports. This heightened demand for foreign currency

exerts downward pressure on the domestic currency, leading to depreciation of the exchange rate.

Another contributing reason for this result is heavy dependence on imports by developing economies such as Ghana. Developing economies frequently depend on imports to obtain vital goods and technologies that they lack the ability to produce domestically. When an economy embraces trade openness, it can become increasingly reliant on imported products, particularly when there is a limited capacity for domestic production. This dependence on imports can stimulate a higher demand for foreign currency, ultimately resulting in a depreciation of the economy's domestic currency.

Financial vulnerabilities could be another driver for this result. Increased trade integration can make a developing nation susceptible to financial risks, such as currency speculation and capital outflows. When investors perceive economic uncertainties within the economy, particularly as a result of the COVID-19 pandemic, they may opt to withdraw their investments, resulting in a depreciation of the domestic currency. Consequently, this can amplify the vulnerability of the economy's exchange rate and heighten its exposure to economic shocks. The works of Hoshikawa and Yoshimi (2021) on South Korea, Sunaryati and Munandar (2023) on Indonesia, Kausar *et al*. (2022) on Pakistan, and Cardona-Arenas and Serna-Gómez (2020) are in conformity with this finding. However, the results of the study of Camba and Camba (2020) on Philippines are at variance with this finding.

Trade openness and its moderating role

For the direct effect, trade openness is established to have a positive and significant effect on exchange rate in the COVID-19 pandemic period. This implies that trade openness strengthens the US dollar and weakens the domestic Ghana cedi. Plausible drivers of this result lie in trade imbalances or dependence on imports causing a greater demand for the US dollar, or increased capital flights due to the financial vulnerabilities of trade integrated developing economies, such as Ghana, particularly in periods of uncertainty. However, trade openness indirect effect via COVID-19 cases is negative. This implies that the interaction term negatively influences the exchange rate by simultaneously strengthening the domestic Ghana cedi and weakening the US dollar. A plausible reason for this is due to the unusual trade surplus experienced by Ghana in 2020, which doused the demand for the US dollar.

The consolidated effects of COVID-19 cases and trade openness is fundamental in comprehending the behaviour of the exchange rate in Ghana, particularly in the wake of the COVID-19 pandemic. To assess the magnitude of this effect, the study calculates the net impact of COVID-19 cases on exchange rate when trade openness is used as moderation variable as described in equation (31). The net effect of COVID-19 cases on exchange rate when trade openness is used as moderation variable is established as -0.0044 for the FMOLS model.

$$\frac{\partial XR_t}{\partial Cases_t} = \psi_{12} + \psi_{16}\overline{TO}_t = 0.0006 + (-0.0001 \times 50.04795) = -0.0044$$

The result of -0.0044 as shown above suggest that in the presence of trade openness, a unit increase in COVID-19 cases reduces exchange rate by 0.0044 units. This implies that the adverse influence of the pandemic on

exchange rate in Ghana is overturned when trade openness moderates this relationship. In order words, trade openness reverses COVID-19 cases' unconditional positive effect on exchange rate. The unusual trade surplus achieved by Ghana in 2020, which likely dampened the demand for US dollar, could be a determinant for this finding.

Analysis of Cholesky decomposition results

The estimation of Cholesky decomposition analysis aims to capture the response of COVID-19 cases, crude oil price, stock market price, and trade openness to a shock or impulse of one standard deviation emitted by the exchange rate in Ghana. Gleaning from Table C4 (see Appendix C), the changes in COVID-19 cases that occurs in response to a shock emanating from exchange rate, rises gradually from approximately 0.27 percent in the 2nd period to 0.34 percent in the 9th period, then steadily drops from 0.33 percent in the 10th period to 0.31 percent in the 18th period, and thereafter steadily increases from 0.31 percent in the 19th period to 0.34 percent by the 25th period. Further, crude oil price responds by approximately 1.78 percent in the 2nd period, then gradually rises to 3.37 percent in the 13th period, and subsequently drops steadily from 3.36 percent in the 14th period to 3.06 percent by the 25th period. Additionally, stock market price drops steadily from 4.63 percent in the 2nd period to 4.54 percent in the 4th period, and thereafter rises from 5.18 percent in the 5th period to 19.75 percent by the 25th period. Finally, the response of trade openness to exchange rate shocks is chequered within the first five periods, and then subsequently increases steadily from 2.38 percent in the 6th period to 4.38 percent by the 25th period. Overall, stock

market price has the highest response to exchange rate shocks in the 25th period.

Summary

This chapter examined the relationship between COVID-19 cases and performance of exchange rate in Ghana and assessed the moderating role of trade openness in this relationship. The results revealed that, an increase in COVID-19 cases lead to an upward trend in the exchange rate of Ghana, implying that the pandemic strengthens the US dollar at the expense of the domestic Ghana cedi. However, trade openness indirect effect via COVID-19 cases is negative, signaling that the interaction term of COVID-19 cases and trade openness negatively influences the exchange rate by strengthening the Ghana cedi to the detriment of the US dollar.

CHAPTER EIGHT

SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

Introduction

The objective of this chapter is to provide summary of the entire thesis, present the main conclusions of the study and offer some policy recommendations. The summary of the thesis is presented in the first section, which is subsequently followed by the conclusions drawn from the study. This is followed by the policy recommendations which are based on the conclusions drawn from the study. The chapter ends by presenting the direction for future research.

Summary

The COVID-19 induced health measures, such as lockdowns, stay-at-home, travel ban, physical distancing, border closure etc., implemented by governments around the globe, resulted in disruptions to economic activities leading to contraction in global economic growth. Economies around the world could not escape the ravaging impact of the pandemic due to its enormity. Similarly, various sectors within an economy have not been insulated from the impacts of the pandemic. Stock markets in developed, emerging and developing economies have been significantly impacted by the pandemic. However, whilst one school of thought contends a less protracted pandemic impact on financial markets in developed economies due to these markets' strong foundations, another group believes otherwise, citing developed economies' deeper integration in global supply networks, higher uncertainty due to extensive media coverage on the pandemic, and dominance of service-based industries in developed economies. Further, globalisation

have occasioned an increased interest in international equity investments, leading to hike in activities in forex markets. This interdependency makes these markets vulnerable to different crisis, which occasions their increased volatility. Moreover, Ghana, an open economy, presents an interesting case in the dynamics of the pandemic's linkage to its exchange rate due to its reliance on international trade. The pandemic induced lockdowns and travel bans disrupted global supply chain, which affected the demand and supply of foreign currencies in forex markets of economies around the world, including Ghana. Whilst the impact of the pandemic on exchange rates is well documented, the moderating role of trade openness in this relationship is understudied.

The present study therefore examined the role of development status in the relationship between COVID-19 pandemic and performance of stock markets from 21 economies, categorized into seven developed, seven emerging, and seven developing economies. To examine the impacts of the pandemic on individual stock markets, the study used daily stock indices of major stock markets of twenty-one (21) countries, which spanned from July 16, 2019, to June 30, 2020, and applied the Bayesian Structural Time Series (BSTS) estimation technique. To examine the differential impacts of the pandemic on regional stock markets, the study used daily panel dataset on the same 21 economies, spanning from March 11, 2020, to December 30, 2020, and applied a Pooled OLS estimation technique. Prior to the estimation of the Pooled OLS, pre-diagnostic tests, including pairwise correlation matrices, Variance Inflation Factor, Cross-sectional dependence tests, second-generation unit root tests, panel cointegration tests were conducted.

The results of the BSTS show that the performance of stock markets in most of the twenty-one economies have been negatively and significantly impacted by COVID-19 pandemic. Specifically, in relative terms for the developed economies, Italy was the worst impacted by the pandemic, a decline of 29%, with the least being Germany (-7.9%). For emerging economies, India was the hardest hit by the pandemic, a reduction of 16% in relative terms, with Singapore experiencing the least decline of 12%. Strikingly, the pandemic has occasioned an increase in the stock market performance of Brazil by 9.3%. For developing economies, the adverse impact of 37% in Colombia is the heaviest, with the least impacted being -20% in Morocco.

The results of the Pooled OLS show that, the negative effect of COVID-19 cases on stock returns in developing economies is 59.09 percent more than the ones in developed economies. Similarly, the negative effect of COVID-19 cases on stock returns in emerging economies is 32.11 percent more than the stock markets in developed economies. Evidently, whilst stock markets in developing economies are the worst performers, the ones in developed economies outperformed those in emerging economies.

The study also assessed the reciprocal volatility transmission between stock and forex markets in Africa and examined the moderating role of financial globalisation in this relationship in the COVID-19 period. To this end, the study used daily prices and returns of stock indices and exchange rates of eight African countries, namely, Botswana, Egypt, Ghana, Kenya, Mauritius, Morocco, South Africa, and Tunisia. However, eleven stock markets were used for this study, with South Africa and Kenya providing three and two stock markets respectively. The study also used daily datasets on

volatility index, crude oil price and financial globalisation index. The COVID-19 period spanned from March 11, 2020, to December 30, 2020.

To achieve the objective of the study, EGARCH was used to measure the volatility of stock and exchange rate returns. To ensure that there is no multicollinearity among the exogenous variables in the model, pairwise correlation matrices and Variance Inflation Factor (VIF) tests were conducted. In addition, the cross-sectional dependence (CD) tests, second-generation unit root tests, and panel cointegration tests were conducted. Further, to ensure robustness of results, the Panel Fully Modified Ordinary Least Squares (Panel FMOLS) and Panel Dynamic Ordinary Least Squares (Panel DOLS) methodologies were employed. The results of the pairwise correlation matrices and the VIF generally showed strong correlation of exogenous variables and the absence of multicollinearity problem. The results of the other pre-diagnostic tests provide evidence of the presence of cross-dependence amongst the variables, with all variables becoming stationary at first difference and the presence of cointegration amongst the variables.

The results of the Panel FMOLS and Panel DOLS reveal a bidirectional volatility transmission between the stock and forex markets in Africa, during the COVID-19 pandemic period. Further, the results show a positive association of volatility index, stock returns, and financial globalization with stock market volatility. In addition, negative correlation between crude oil price and stock market volatility was established. Moreover, the results provide evidence of negative association of exchange rate returns and crude oil price with exchange rate volatility. Additionally, a positive relationship is established between financial globalisation and exchange rate

volatility. The results further established that, financial globalisation reduces the volatility transmission from forex to stock markets, whilst it heightens the volatility transmission from stock to forex markets in Africa, during the COVID-19 pandemic period.

The final part of the thesis examined the moderating role of trade openness in the relationship between COVID-19 cases and exchange rate in Ghana. To this end, the study used daily time series data on exchange rates in Ghana, confirmed COVID-19 cases in Ghana, crude oil price, stock market price of Ghana, and Ghana's trade openness for the period, March 19, 2020, to December 30, 2020. Though, Ghana's first confirmed case of the virus was on March 12, 2020, the start date of March 19, 2020, is due to the availability of data. The data end date of December 30, 2020, is due to the study's intents of decoupling the possible positive influence of COVID-19 vaccine on Ghana's exchange rate, as December 31, 2020, is the point where WHO initiated processes to ensure the equitable global access to COVID-19 vaccines.

To determine the stationarity or otherwise of the datasets, the ADF and KPSS unit root tests were conducted. In addition, to determine presence or absence of a long-term convergence between the variables, a cointegration test was conducted. Further, to determine the existence or otherwise of structural breaks in the variables, the Zivot-Andrews structural break test was conducted. Additionally, to capture the response of COVID-19 cases, crude oil price, stock market price, and trade openness to a shock or impulse of one standard deviation emitted by the exchange rate, the Cholesky decomposition analysis was conducted. Finally, to achieve the objective of the study and to ensure robustness of results, the study employed the Fully Modified Ordinary Least

Squares (FMOLS) and the Canonical Cointegration Regression (CCR) estimation techniques.

The results of the ADF and KPSS tests revealed that the variables used in our estimation were both I(1) and I(0) variables. The results of the structural break test established the existence of structural breaks in all the variables. The results of the cointegration test provided evidence of the non-existence of a short-term convergence of the series, but a convergence of the series in the long run was revealed. The results of the Cholesky decomposition analysis indicate the various changes to the variables at different percentiles in different periods occasioned by a shock to the exchange rate.

The results of the FMOLS and CCR revealed that, in the long run, an increase in COVID-19 cases led to depreciation of Ghana cedi relative to the US dollar. Furthermore, the results revealed an existence of positive correlation between crude oil price and exchange rate, although the relationship was shown to be statistically insignificant. Moreover, the study found that stock market price contributed to the depreciation of the exchange rate of Ghana relative to the US dollar. Trade openness was also found to be positively related to exchange rate, implying that the more trade integrated Ghana is in global trade, the more the Ghana cedi became weakened relative to the US dollar. However, trade openness indirect effect via COVID-19 cases was negative, signaling that the interaction term of COVID-19 cases and trade openness negatively influenced the exchange rate by strengthening the Ghana cedi to the detriment of the US dollar.

Key Findings

The key findings of this study revealed that, development status influences the relationship between COVID-19 pandemic and performance of stock markets, financial globalisation moderates the volatility transmission between stock and forex in Africa, during the COVID-19 pandemic period and trade openness moderates the relationship between COVID-19 pandemic and performance of exchange rate in Ghana. The following are the specific findings of the study:

1. 18 out of the 21 stock markets were adversely impacted by COVID-19 pandemic, with positive impact being established in 1 stock market, whilst the results for the other 2 stock markets were insignificant.
2. Whilst stock markets in developing economies are the worst performers in the wake of COVID-19 pandemic, the ones in developed economies outperformed those in emerging economies.
3. Bidirectional volatility transmission between stock and forex markets in the COVID-19 pandemic period.
4. Positive association of volatility index, stock returns, and financial globalization with stock market volatility.
5. Negative correlation between crude oil price and stock market volatility was established.
6. Negative association of exchange rate returns and crude oil price with exchange rate volatility.
7. Stock market volatility and Exchange rate volatility has been positively impacted by financial globalisation in the COVID-19 pandemic period.

8. Financial globalization moderates the volatility transmission between stock and forex markets by reducing the volatility transmission from forex to stock markets, whilst it heightens the volatility transmission from stock to forex markets, during the COVID-19 pandemic period.
9. COVID-19 cases have caused depreciation of the Ghana cedi relative to the US dollar.
10. Stock market price contributed to the depreciation of the exchange rate in Ghana relative to the US dollar.
11. Trade openness caused the Ghana cedi to depreciate relative to the US dollar.
12. Trade openness moderated the co-movement of COVID-19 cases and exchange rate of Ghana by strengthening the Ghana cedi at the expense of the US dollar.

Conclusions

The main purpose of the study was to assess the role of development status, financial globalisation and trade openness in the relationship between COVID-19 pandemic and performance of financial markets. To this end, daily time series data, panel datasets and estimation techniques such as Bayesian Structural Time Series (BSTS), Pooled OLS, Exponential Generalized Autoregressive Conditional Heteroscedastic (EGARCH), Panel Fully Modified Ordinary Least Squares (Panel FMOLS), Panel Dynamic Ordinary Least Squares (Panel DOLS), Fully Modified Ordinary Least Squares (FMOLS) and Canonical Cointegration Regression (CCR) were used. In addition, several theories were utilized to achieve the objectives of this study.

The first objective of this study was premised on the Efficient Market Hypothesis (EMH), which postulates that, current stock prices are determined by incorporating all relevant information, making the market efficient. The findings of this study support the EMH theory. It is the contention of this study that, in Developed Economies, information regarding COVID-19 news and policy responses is readily available. As a result, when COVID-19 pandemic occurred, investors in these economies would be privier to the pandemic related news, including proactive monetary and fiscal stimulus packages, which dampens uncertainty, leading to reduction in speculative and panic activities in stock markets. This ready pandemic related information which includes positive news of stimulus packages is therefore incorporated in the determination of stock prices, resulting in the relatively better performance of stock markets in Developed Economies, during COVID-19.

On the other hand, in non-Developed Economies, the prevalence of information lag and the initial lack of monetary and fiscal stimulus packages, resulted in heightened uncertainty in these markets. These resulted in the price determination of these markets being heavily influenced by speculative and panic behaviours. This results in relatively significant drop in stock prices, leading to relatively poor performance of stock markets in non-Developed Economies, during COVID-19 pandemic period. These findings equally confirm the hypothesis of the study of development status influencing the effect of COVID-19 pandemic on stock market performance.

The second objective of this study is premised on two theories, the flow-oriented and stock-oriented models. Whilst the former asserts a positive co-movement of exchange rate and stock prices, the latter postulates that

market activities in financial assets determine the exchange rate. The results of this study indicate a bidirectional volatility transmission between the forex and stock markets, which backs the theories of both flow-oriented and stock-oriented models. The hypothesis of this study of financial globalisation playing a role in the volatility transmission between the forex and stock market is confirmed by the results of this study. The results revealed that, financial globalisation reduces the volatility transmission from forex to stock markets, whilst it heightens the volatility transmission from stock to forex markets in Africa, during COVID-19 pandemic period.

The third objective of the study is premised on the flight to safety theory, which suggests that in periods of health crisis, investors generally experience heightened uncertainty and a greater inclination to avoid risk, which leads to the demand for relatively safer assets by investors. The findings of this study which establishes an adverse effect of COVID-19 cases on exchange rate in Ghana confirms the flight to safety theory. This study contends that investors shifted their investments from developing economies, such as Ghana, which is associated with riskier investment prospects during crisis periods, such as COVID-19. The result of this study further provide evidence that in Ghana, trade openness serves as a conduit in reversing the adverse influence of COVID-19 pandemic on the value of the Ghana cedi, which confirms the hypothesis of trade openness playing a moderating role in the relationship between COVID-19 cases and performance of exchange rate in Ghana.

Recommendations

In view of the findings of this thesis and the conclusions drawn, the following policy recommendations are made.

1. One of the possible factors for the better performance of stock markets in developed economies, in comparison to non-developed economies' stock markets, in the wake of COVID-19 pandemic, is due to the proactive stimulus packages implemented in developed economies to minimize the uncertainties occasioned by the pandemic. Developed economies were able to swiftly implement these policies because of the fiscal space they enjoy. For developing economies to have the fiscal space to be able to promptly roll out stimulus measures in crisis periods, their government, through the central banks must set aside a portion of their revenues in a stabilization fund. Developing economies with enacted stabilization funds must strengthen them. These economies can then fall on these funds to swiftly implement measures to douse uncertainties in the wake of future crisis.
2. It is crucial for both developed and non-developed economies to strengthen their existing measures aimed at cushioning these economies against risks. This would mitigate the impact of future crisis. To this end, governments, through central banks and financial institutions should work together to assess vulnerabilities, enhance stress testing methodologies, and develop contingency plans. These plans could include the introduction of remote trading system to minimize disruptions, boosting liquidity reserves to mitigate market volatility, strengthening risk management strategies to safeguard

investors, provision of emergency funding for small businesses and industries, and performance of routine market surveillance to identify and address possible risks. These would help minimize the negative effects of future shocks on stock markets, regardless of their origin.

3. In addition to the stability benefit that financial globalisation offer, it can also introduce challenges, such as the rapid transmission of shocks across borders as evidenced in the results of this study. Therefore, to harness the stabilising potential of financial globalization in this relationship, asset diversification, information flow, and market efficiency should be promoted by central banks, commercial banks, and stock exchanges in African financial markets. Investors must be encouraged to diversify their portfolios across different asset classes, including stocks and forex, to reduce risk exposure during crises. Improve information flow by enhancing transparency in both stock and forex markets by requiring timely and accurate reporting of financial information in African financial markets. Market efficiency in African financial markets can be improved through investment in advanced technology for trading platforms, clearing, and settlement systems to enhance efficiency and reduce operational risks. The markets can also develop algorithms that would aid in identifying emerging risks and trigger automatic responses to mitigate them. These measures would provide an enabling environment for financial globalization to play its stabilizing role in the volatility transmission between financial markets in Africa, particularly in crisis periods.

4. Further, to ease the pressure on the exchange rate, particularly in crisis periods, Ghana Export Promotion Authority (GEPA) and the National Export Support Institution of the Ministry of Trade and Industry (MOTI) must target and support export-oriented industries with productivity enhancing incentives to earn more foreign exchange. These incentives could include tax exemptions, duty-free imports of key raw materials and machinery, and government backed loan facilities. In addition, the provision of financial assistance, training, and marketing supports by GEPA can be enhanced. In addition, greater attention must be given to the non-traditional exports due to its relatively more foreign exchange earning potential. GEPA and MOTI must lay emphasis on liaising with industries to add value to non-traditional exports, such as agricultural products, textiles, beads, and services to generate more foreign exchange. Again, agricultural productivity for local consumption can be enhanced with significant investment in modern agricultural techniques, irrigation systems, and infrastructure by the Ministry of Food and Agriculture (MOFA) and MOTI. This would reduce Ghana's dependence on import, which would reduce the demand for foreign exchange leading to the strengthening of the Ghana cedi.
5. To avoid drastic and persistent stock price fluctuations with its attendant's spillover effect on the exchange rate, particularly in crisis periods, the Securities and Exchange Commission (SEC), the regulatory body in Ghana, can introduce a circuit breaker system where the stock exchange is temporarily halted in periods of excessive

price movements. Additionally, to boost investor confidence and douse uncertainty, the SEC should ensure timely and accurate publications of financial statements and prospects by listed firms on the Ghana Stock Exchange.

6. It is important for GEPA, MOTI, Bank of Ghana (BoG), and other financial institutions to promote the adoption of efficient strategies for managing exchange rate risk among Ghanaian businesses involved in international trade. Encouraging the use of financial derivatives such as forward contracts or options can help them safeguard against fluctuations in exchange rates. To facilitate this, GEPA, MOTI and BoG can play a pivotal role by offering information, training, and incentives that promote the adoption of these risk management practices.

Direction for Future Research

Future research should focus on the impact of the discovery and administration of COVID-19 vaccines on the performance of financial markets. Whilst the emergence of COVID-19 pandemic, which is an unwelcome event adversely impacted financial markets, COVID-19 vaccines represent good news, and are expected to share a positive relationship with performance of financial market. This examination would provide useful insight on the connection between the pandemic, its vaccines and performance of financial markets. Furthermore, future research should focus on how job losses and income drop (demand shocks), and business closures and travel restrictions (supply shocks) impacted the performance of financial markets.

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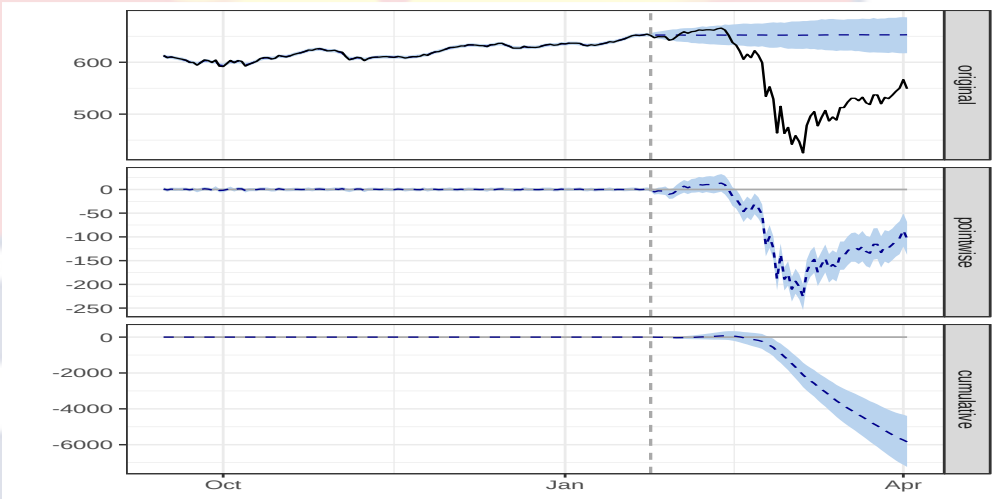
APPENDICES

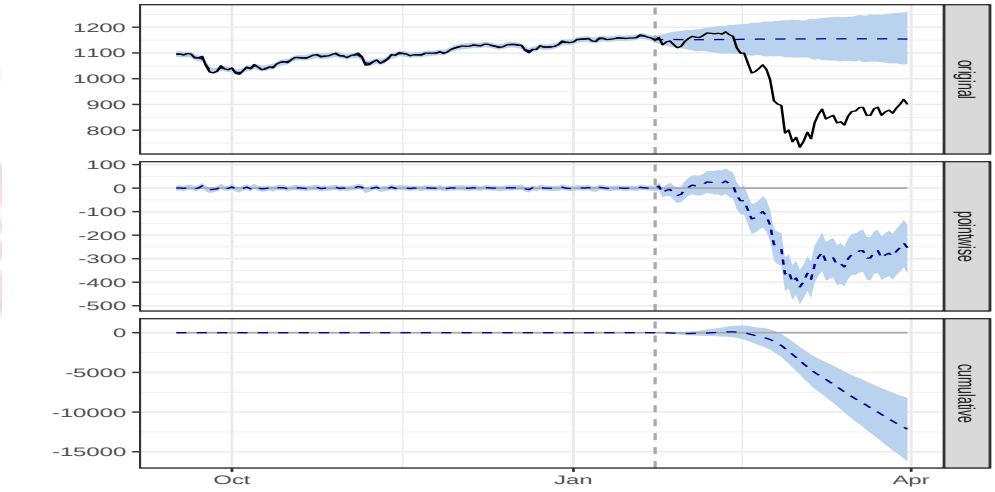
Appendix A: COVID-19 pandemic and Performance of Stock Markets: the role of development status

Figure A1: Bayesian posterior distribution graphs for causal impact of COVID-19 for Developed Economies

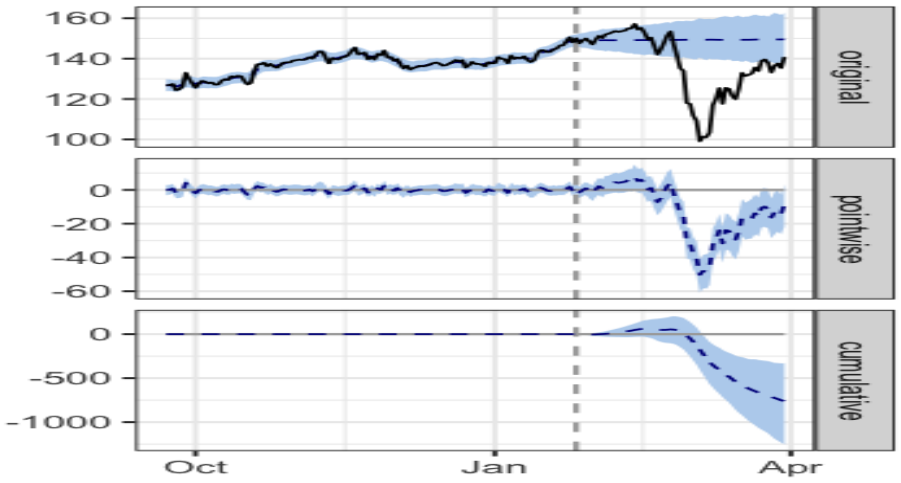
Posterior Distribution Graph for Canada



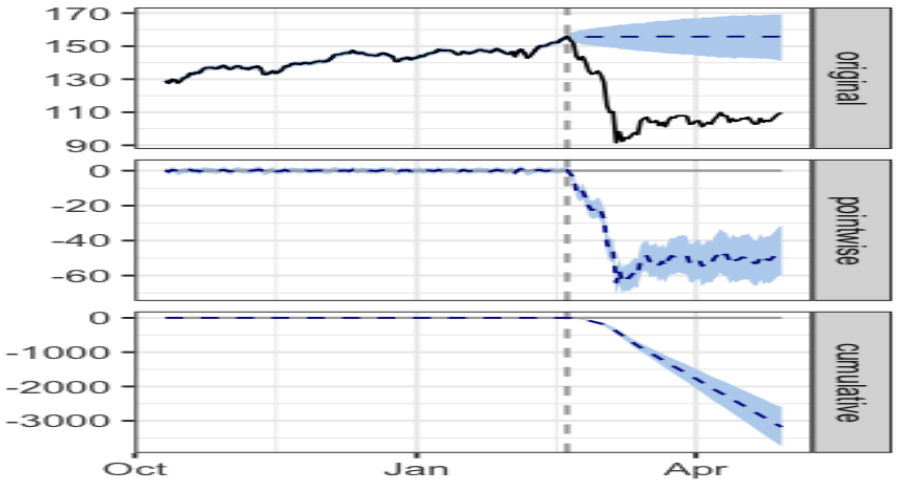
Posterior Distribution Graph for France



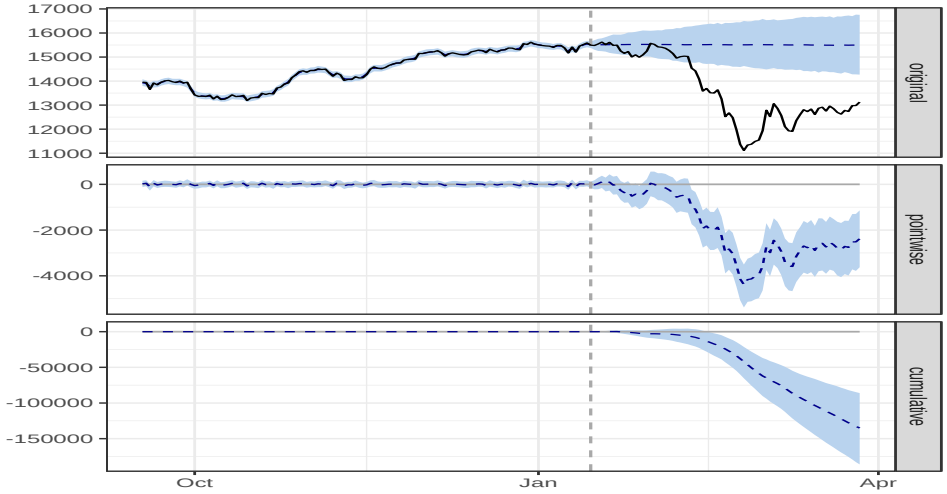
Posterior Distribution Graph for Germany



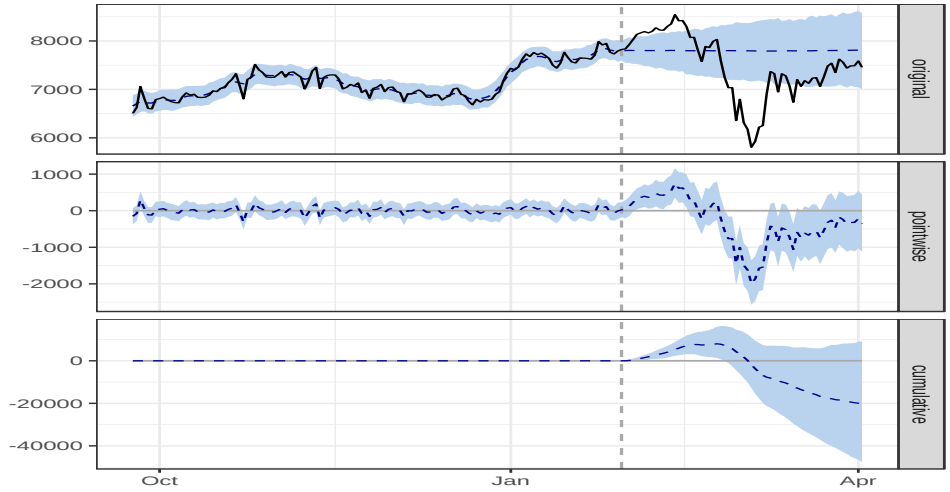
Posterior Distribution Graph for Italy



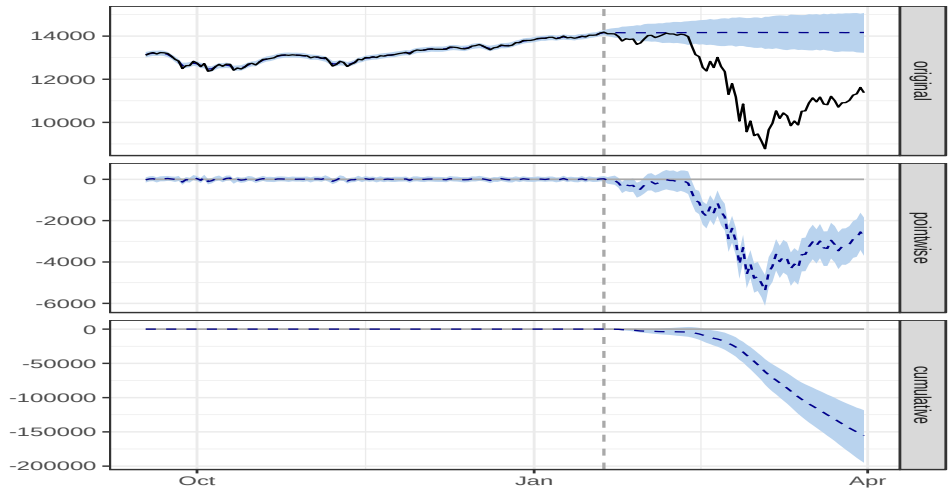
Posterior Distribution Graph for Japan



Posterior Distribution Graph for United Kingdom



Posterior Distribution Graph for United States

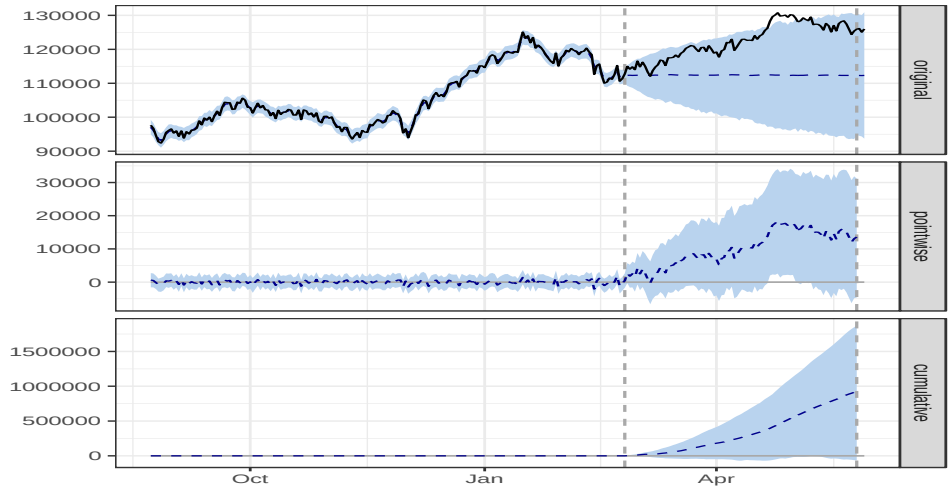


Note: The actual values are depicted by the black horizontal lines, whilst the predicted values are represented by the blue-dotted horizontal lines on the original panel.

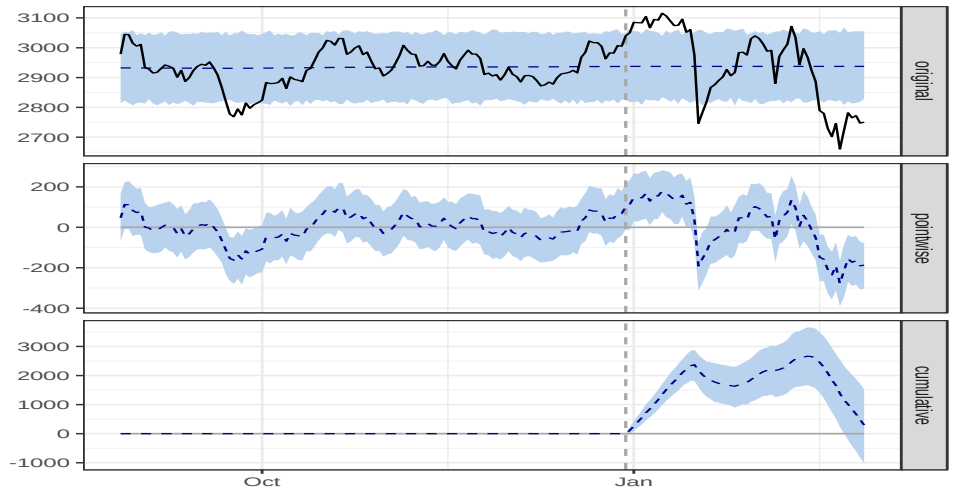
Source: Author's Construction (2023)

Figure A2: Bayesian posterior distribution graphs for causal impact of COVID-19 for Emerging Economies

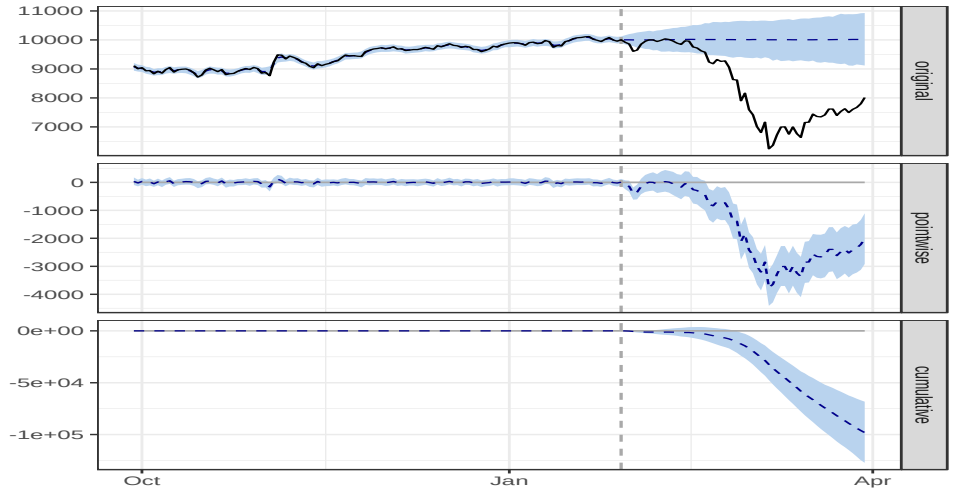
Posterior Distribution Graph for Brazil



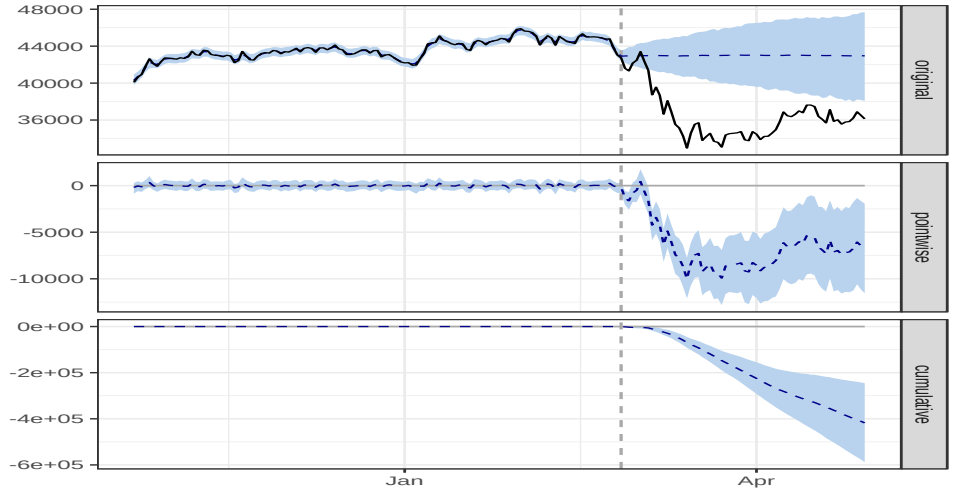
Posterior Distribution Graph for China



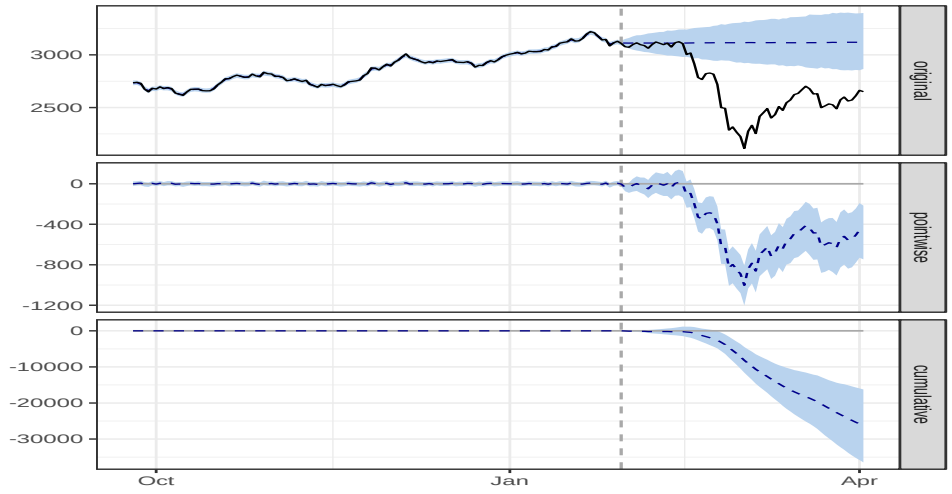
Posterior Distribution Graph for India



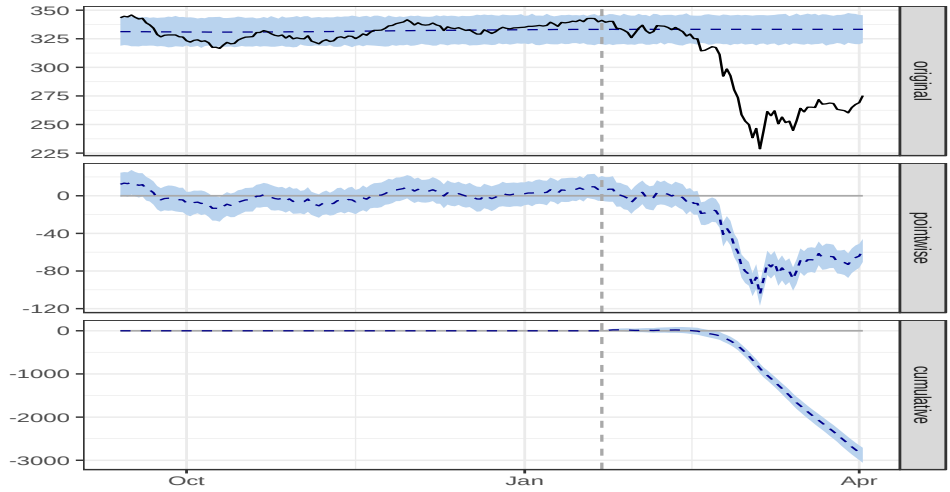
Posterior Distribution Graph for Mexico



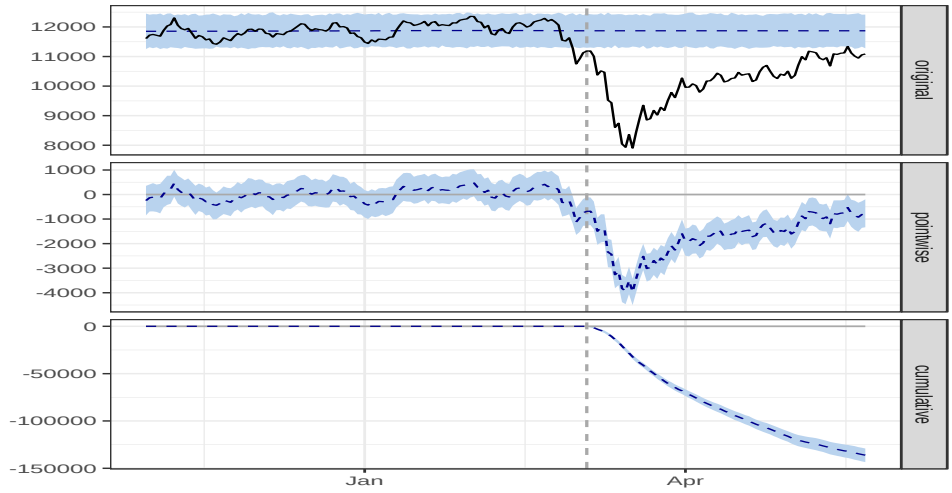
Posterior Distribution Graph for Russia



Posterior Distribution Graph for Singapore



Posterior Distribution Graph for South Africa

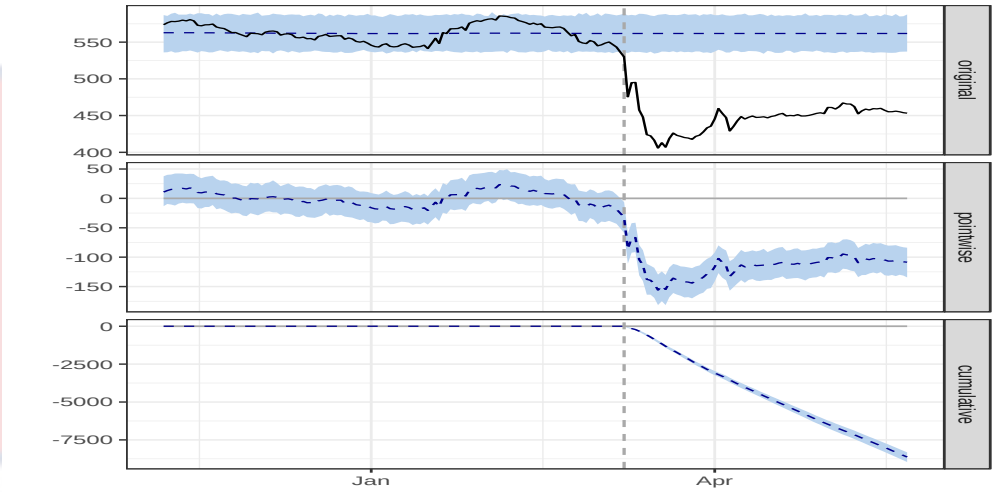


Note: The actual values are depicted by the black horizontal lines, whilst the predicted values are represented by the blue-dotted horizontal lines on the original panel.

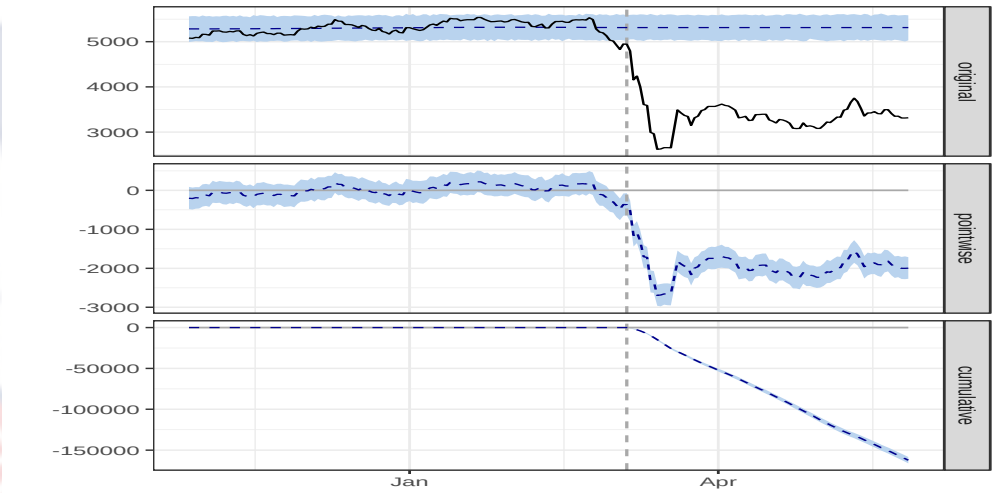
Source: Author's Construction (2023)

Figure A3: Bayesian posterior distribution graphs for the causal impact of COVID-19 for Developing Economies

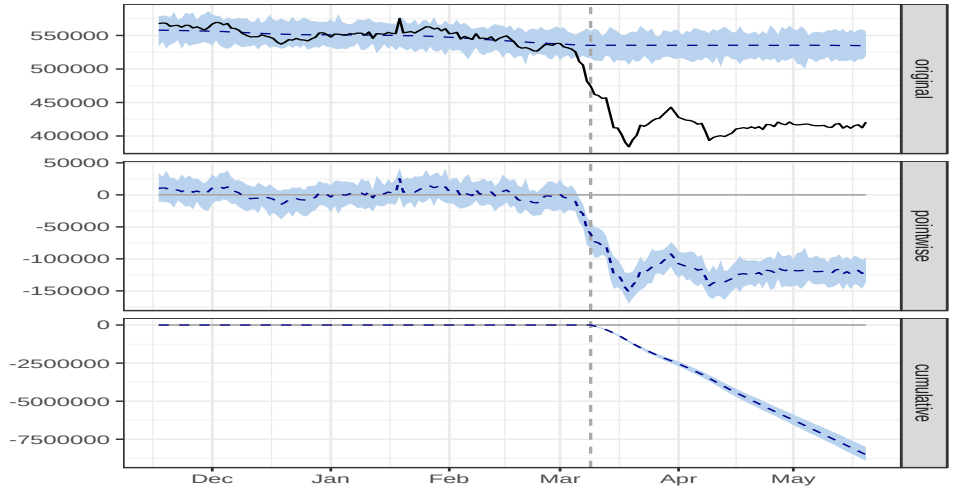
Posterior Distribution Graph for Bulgaria



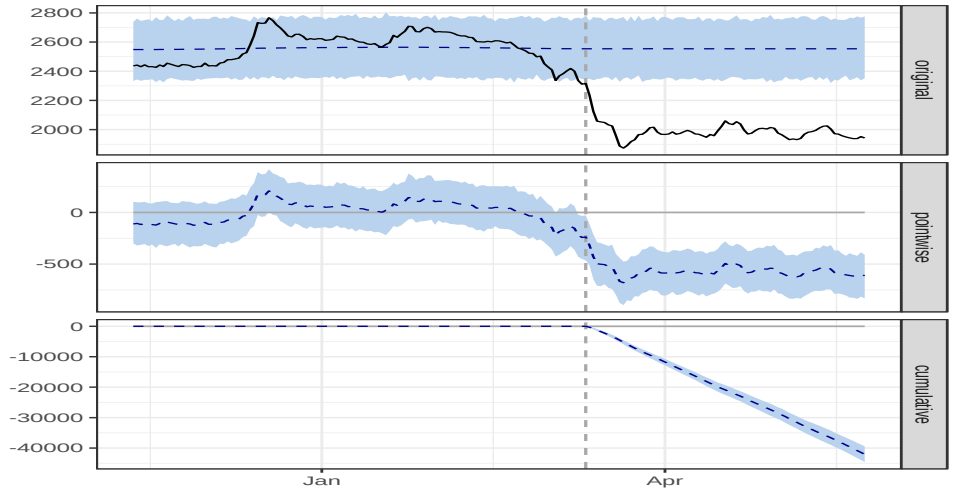
Posterior Distribution Graph for Colombia



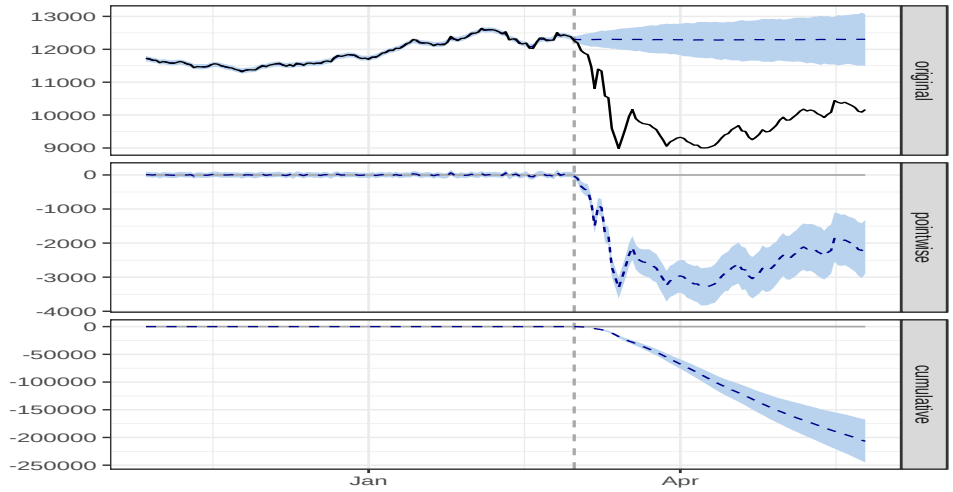
Posterior Distribution Graph for Jamaica



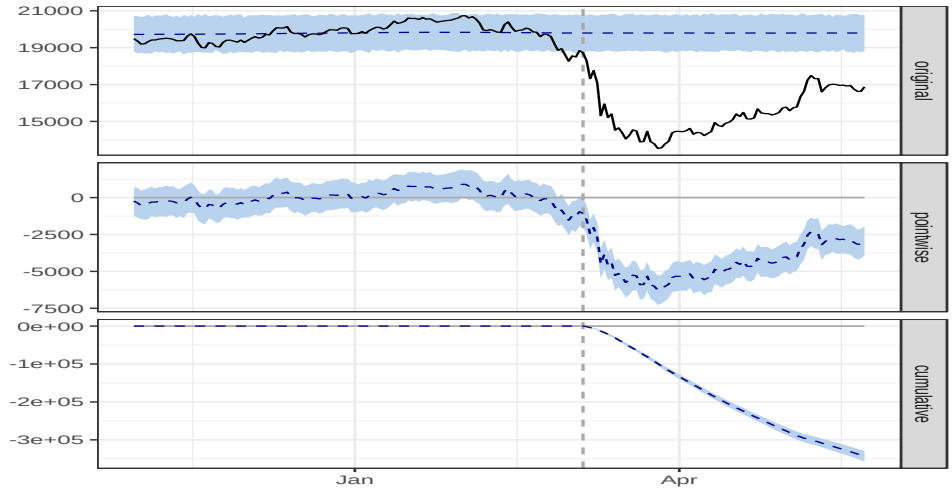
Posterior Distribution Graph for Kenya



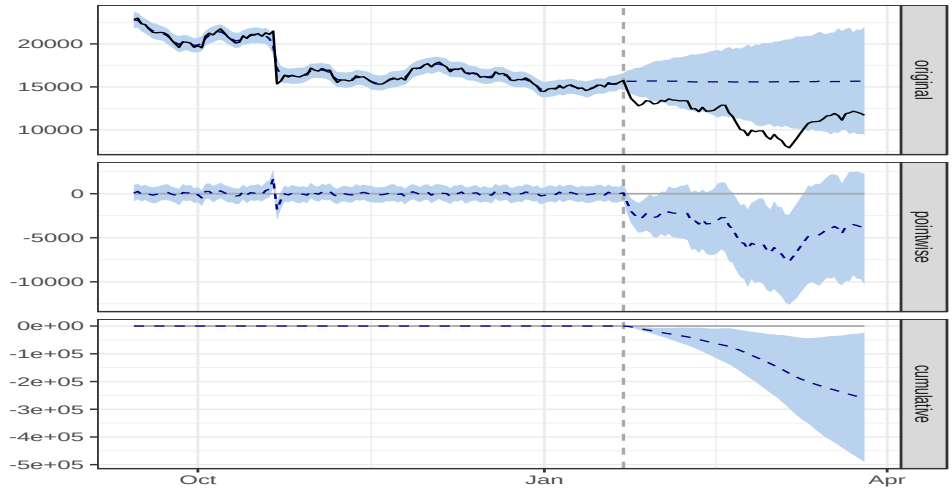
Posterior Distribution Graph for Morocco



Posterior Distribution Graph for Peru



Posterior Distribution Graph for Vietnam



Note: The actual values are depicted by the black horizontal lines, whilst the predicted values are represented by the blue-dotted horizontal lines on the original panel.

Source: Author's Construction (2023)

Table A1: Results of posterior estimates (inference) of the causal impact of COVID-19 on stock market performance

	Cumulative			
	Actual (1)	Prediction (2)	Absolute Effect (3)	Relative Effect (4)
Developed Economies				
Canada	39174	45017 (720) [43572, 46416]	-5843 (720) [-7242, -4399]	-13%** (1.4%) [-16%, -10%] P = 0.001
Germany	8794	9554 (232.3) [9124, 10050]	-760 (232.3) [-1256, -329.8]	-7.9%** (2.2%) [-12%, -3.6%] P = 0.001
France	66290	78439 (2018) [74493, 82477]	-12149 (2018) [-16187, -8203]	-15%** (2.2%) [-20%, -11%] P = 0.001
Italy	7721	10902 (297.5) [10320, 11470]	-3181 (297.5) [-3749, -2599]	-29%** (1.9%) [-33%, -25%] P = 0.001
Japan	981596	1116720 (26461)- [1067649, 1167726]	135123 (26461) [-186129, -86052]	-12%** (2.1%) [-16%, -8.1%] P = 0.001
United Kingdom	478920	498410 (15496) [467846, 528874]	-19490 (15496) [-49954, 11074]	-3.8% (3%) [-9.4%, 2.4%] P = 0.081
United States	849962	1005464 (19562) [968393, 1045116]	-155501 (19562) [-195154, -118430]	-15%** (1.6%) [-19%, -12%] P = 0.001

Table A1 Cont'D

Emerging Economies				
Brazil	1.1e+07	1.0e07 (488298) [9279587, 1.1e+07]	926513 (488298) [-66800, 1875236]	9.3%** (5.3%) [-0.6%, 20%] P = 0.032
China	173604	173308 (627) [172101, 174522]	296 (627) [-918, 1503]	0.17% (0.36%) [-0.53%, 0.87%] P = 0.33
India	512493	610629 (15810) [580780, 639742]	-98136 (15810) [-127249, -68287]	-16%** (2.2%) [-20%, -12%] P = 0.001
Mexico	2290224	2708070 (84710) [2535698, 2878093]	-417846 (84710) [-587869, -245474]	-15%** (2.7%) [-20%, -9.7%] P = 0.001
Russia	169951	196218 (5107) [186195, 206430]	-26268 (5107) [-36479, -16244]	-13%** (2.3%) [-18%, -8.7%] P = 0.001
Singapore	20786	23661 (92.9) [23496, 23845]	-2876 (92.9) [-3059, -2710]	-12%** (0.34%) [-13%, -12%] P = 0.001
South Africa	801538	937724 (3758) [930683, 945004]	-136186 (3758) [-143466, -129145]	-15%** (0.34%) [-15%, -14%] P = 0.001
Developing Economies				
Bulgaria	33500	42136 (166.1) [41826, 42465]	-8635 (166.1) [-8964, -8326]	-21%** (0.31%) [-21%, -20%] P = 0.001
Colombia	278592	440974 (2058) [436960, 444786]	-162382 (2058) [-166194, -158368]	-37%** (0.29%) [-37%, -36%] P = 0.001
Jamaica	3.0e+07	3.9e+07 (271340)	-8511265 (271340)	-22%** (0.55%)

Table A1 Cont'D

		[3.8e+07, 3.9e+07]	[-8915560,-8010130]	[-23%, -21%]
				P = 0.018
Kenya	146946	189008 (1354)	-42062 (1354)	-22%** (0.56%)
		[186373, 191570]	[-44624, -39427]	[-23%, -21%]
				P = 0.001
Morocco	838008	1044961 (19951)	-206954 (19951)	-20%** (1.5%)
		[1005336, 1082945]	[-244937,-167329]	[-23%, -17%]
				P = 0.001
Peru	1220244	1563659 (7067)	-343415 (7067)	-22%** (0.35%)
		[1549909, 1577356]	[-357112, -329665]	[-23%, -21%]
				P = 0.001
Vietnam	738294	999571 (117573)	-261277 (117573)	-25%** (9.8%)
		[762253, 1228080]	[-489786, -23959]	[-40%, -3.1%]
				P = 0.020

Table A1 Cont'D

Note: The values in parentheses are standard deviations, whilst those in brackets indicate 95% confidence interval. ** represents 5% significance level, whilst p refers to the Posterior tail-area probability.

Source: Author's Computation (2023)

Table A2: Robustness checks results of posterior estimates of the causal impact of COVID-19 on stock market performance

	Average			
	Actual (1)	Prediction (2)	Abs. Effect (3)	Relative Effect (4)
Developed Economies				
Canada	568	646 (7.4) [632, 661]	-78 (7.4) [-93, -64]	-12%** (1%) [-14%, -10%] P = 0.001
France	975	1020 (21) [982, 1061]	-45 (21) [-87, -7.3]	-4.4%** (1.9%) [-8.2%, -0.74%] P = 0.009
Germany	137	146 (3.3) [140, 152]	-8.4 (3.3) [-14, -2.3]	-5.7%** (2.1%) [-9.5%, -1.7%] P = 0.005
Italy	110	154 (3) [148, 159]	-44 (3) [-49, -37]	-28%** (1.4%) [-31%, -25%] P = 0.001
Japan	13633	13985 (324) [13366, 14641]	-352 (324) [-1007, 268]	-2.5% (2.3%) [-6.9%, 2%] P = 0.131
UK	7483	7778 (230) [7330, 8271]	-295 (230) [-788, 153]	-3.7% (2.8%) [-9.5%, 2.1%] P = 0.091
United States	11971	12267 (207) [11872, 12675]	-295 (207) [-704, 99]	-2.4% (1.6%) [-5.6%, 0.84%] P = 0.077
Emerging Economies				
Brazil	1.2e+05	1.1e+05 (3858) [104716, 1.2e+05]	10418 (3858) [3032, 17864]	9.4%** (3.8%) [2.5%, 17%] P = 0.006
China	2942	2899 (12) [2876, 2923]	43 (12) [19, 66]	1.5%** (0.43%) [0.67%, 2.3%] P = 0.001
India	8402	9375 (225) [8966, 9845]	-974 (225) [-1444, -565]	-10%** (2.1%) [-15%, -6.3%] P = 0.001
Mexico	36353	39974 (685) [38665, 41288]	-3621 (685) [-4935, -2312]	-9%** (1.6%) [-12%, -6%] P = 0.001
Russia	2698	2840 (85) [2686, 3004]	-143 (85) [-307, 11]	-5%** (2.8%) [-10%, 0.42%] P = 0.035
Singapore	293	323 (5.6) [313, 335]	-31 (5.6) [-42, -20]	-9.5%** (1.6%) [-13%, -6.4%] P = 0.001

Table A2 Cont'D

South Africa	10146	10815 (82) [10646, 10972]	-669 (82) [-826, -500]	-6.2%** (0.71%) [-7.5%, -4.7%] P = 0.001
Developing Economies				
Bulgaria	447	537 (8.5) [523, 556]	-90 (8.5) [-109, -77]	-17%** (1.3%) [-20%, -15%] P = 0.015
Colombia	3357	5045 (121) [4809, 5285]	-1689 (121) [-1929, -1452]	-33%** (1.6%) [-36%, -30%] P = 0.001
Jamaica	4.2e+05	4.8e+05 (19901) [4.4e+05,5.2e+05]	-66745 (19901) [-104742,-26976]	-14%** (3.6%) [-20%, 6.1%] P = 0.003
Kenya	1986	2330 (79) [2164, 2484]	-345 (79) [-498, -178]	-15%** (2.9%) [-20%, -8.2%] P = 0.003
Morocco	9859	12389 (158) [12078, 12694]	-2530 (158) [-2836, -2219]	-20%** (1%) [-22%, -18%] P = 0.001
Peru	15446	18465 (175) [18116, 18799]	-3019 (175) [-3353, -2670]	-16%** (0.8%) [-18%, -15%] P = 0.001
Vietnam	11536	14361 (1685) [10804, 17498]	-2826 (1685) [-5963, 732]	-18%** (10%) [-34%, 6.8%] P = 0.048

Note: The values in parentheses are standard deviations, whilst those in brackets indicate 95% confidence interval. ** represents 5% significance level, whilst p refers to the Posterior tail-area probability.
Source: Author's Construction (2023)

Table A3: Pairwise Correlation Matrix

Variables	ln*Returns*	ln*Cases*	ln*ExRate*	ln*COP*	ln*VIX*	ln*Index*
ln*Returns*	1.0000					
ln*Cases*	-0.0026	1.0000				
ln*ExRate*	0.1682***	-0.2569***	1.0000			
ln*COP*	-0.2183***	0.2141***	0.0112	1.0000		
ln*VIX*	0.2845***	-0.2691***	-0.0069	-0.7028***	1.0000	
ln*Index*	0.3662***	0.0565***	0.2694***	0.0350**	-0.0304*	1.0000

Notes: *** p< 0.01, ** p< 0.05, * p<0.10

Source: Author's Construction (2023)

Table A4: Variance Inflation Factor

Variable	Model 7
ln*VIX*	2.03
ln*COP*	1.99
In*Cases*	1.22
In*ExRate*	1.20
In*Index*	1.15
Mean VIF	**1.52**

Source: Author's Construction (2023)

Table A5: Cross-sectional dependence results

Variables	Statistic	Probability
Breusch-Pagan	190.3269	0.4797
Pesaran Scaled LM	0.016769	0.9866
Pesaran CD	-0.441665	0.6587

Notes: *** p< 0.01, ** p< 0.05, * p<0.10

Source: Author's Construction (2023)

Table A6: CADF unit root test results

	CADF	
Variables	Level	1st difference
ln*Returns*	9.800	-23.967***
ln*Cases*	-3.777***	-
ln*ExRate*	4.028	-17.249***
ln*COP*	-19.820***	-
ln*VIX*	-16.126***	-

Table A6 Cont'D

In*Index*	5.315	-20.273***

Notes: *** p< 0.01

Source: Author's Construction (2023)

Table A7: Pedroni panel cointegration test results

Within Dimension (Panel)	Statistics	Weighted Statistics
v-statistic	62.533***	54.404***
rho-statistic	-30.357***	-26.394***
PP-statistic	-19.884***	-15.364***
ADF-statistic	-2.386***	0.078
Between Dimension (Group)		
rho-statistic	-25.913***	
PP-statistic	-19.088***	
ADF-statistic	3.045	

Notes: *** p< 0.01, ** p< 0.05, * p<0.10

Source: Author's Construction (2023)

Appendix B: Volatility transmission between stock and forex markets in Africa: the role of financial globalisation

Table B1: Pairwise Correlation Matrix

Variables	SV	XV	VIX	SR	XR	FG	COP
COVID-19 period							
SV	1.0000						
XV	0.2426***	1.0000					
VIX	0.3280***	0.1216***	1.0000				
SR	0.0009	0.0499**	-0.0802***	1.0000			
XR	0.0091	-0.0913***	0.0874***	-0.0791***	1.0000		
FG	0.2055***	0.4861***	-0.0000	0.0252	-0.0364*	1.0000	
COP	-0.4601***	-0.1927***	-0.6061***	0.0379*	0.0100	-0.0050	1.0000

Notes: *** p< 0.01, ** p< 0.05, * p<0.10, SV represents Stock volatility, XV denoted Exchange Rate volatility, VIX refers to Volatility Index, SR depicts Stock returns, XR represents Exchange Rate returns, FG is Financial Globalisation, and COP depicts Crude Oil price.
Source: Author's Construction (2023)

Table B2: Variance Inflation Factor

Variable	Model 13	Variable	Model 15
Crude Oil Price	1.63	Crude Oil Price	1.82
Volatility Index	1.59	Volatility Index	1.61
Exch. Rate Volatility	1.38	Stock volatility	1.35
Fin. Globalisation	1.32	Fin. Globalisation	1.06
Stock returns	1.01	Exch. Rate Volatility	1.02
Mean VIF	**1.39**	**Mean VIF**	**1.37**

Notes: Model 13 uses Stock volatility as the dependent variable, and Model 15 uses Exchange Rate volatility as the dependent variable

Source: Author's Construction (2023)

Table B3: Cross-sectional dependence results

Variables	Breusch-Pagan LM	Pesaran Scaled LM	Pesaran CD
SV_{it}	405.5294***	33.42167***	1.445496
XV_{it}	1152.636***	104.6555***	0.620734
VIX_t	353.0414***	28.41713***	7.966238***
SR_{it}	63.82323	0.841262	0.371058
XR_{it}	58.72863	0.355511	-0.631068
COP_t	650.6563***	56.79360***	12.22301***

Note: *** $p< 0.01$

Source: Author's Construction (2023)

Table B4: CADF and CIPS unit root test results

	CADF		CIPS	
Variables	Level	1st diff.	Level	1st diff.
SV_{it}	-3.534***	-6.090***	-2.942***	-6.190***
XV_{it}	-4.002***	-6.190***	-4.364***	-6.190***
VIX_t	-6.190***	-6.190***	-6.190***	-6.190***
SR_{it}	-6.190***	-6.190***	-6.190***	-6.190***
XR_{it}	-6.190***	-6.190***	-6.190***	-6.190***
COP_t	2.610	2.610	2.610	2.610
FG_{it}	0.514	-4.590***	0.511	-4.590***

Note: *** p< 0.01

Source: Author's Construction (2023)

Table B5: Pedroni panel cointegration test results

Within Dimension (Panel)	Statistics	Weighted Statistics
v-statistic	4.424***	1.716***
rho-statistic	-29.770***	-30.550***
PP-statistic	-21.622***	-21.111***
ADF-statistic	-4.305***	-11.073***
Between Dimension (Group)		
rho-statistic	-34.346***	
PP-statistic	-24.482***	
ADF-statistic	-7.511***	

Note: *** p< 0.01

Source: Author's Construction (2023)

Table B6: Panel FMOLS and Panel DOLS Results (Stock volatility as the dependent variable)

	Panel FMOLS		Panel DOLS	
Variables	**Model 13**	**Model 14**	**Model 13**	**Model 14**
Exchange Rate vol.	0.8886***	1.8114***	1.0871***	-1.7648**
	(0.1365)	(0.4226)	(0.1229)	(0.7136)
Volatility Index	0.0000**	0.0000**	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Stock returns	0.0009**	0.0008*	-0.0004	-0.0005
	(0.0004)	(0.0004)	(0.0006)	(0.0006)
Fin. Globalisation	0.0000***	0.0000***	0.0000***	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Crude Oil price	-0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
XV*FG		-0.0243**		0.0768***
		(0.0106)		(0.0182)
Observations	2255	2255	2255	2255
R^2	0.3923	0.3887	0.7192	0.7192
Adjusted R^2	0.3878	0.3839	0.6943	0.6888
SER	0.0001	0.0001	0.0000	0.0000
LRV	0.0000	0.0000	0.0000	0.0000
Net Effect		0.4221		2.6261

Notes: Values in the parenthesis are the robust standard error; *** p< 0.01, ** p< 0.05, * p<0.10, XV*FG represents an interaction term of Exchange Rate volatility and Financial Globalisation
Source: Author's Construction (2023)

Table B7: Panel FMOLS and Panel DOLS Results (Exchange Rate volatility as the dependent variable)

	Panel FMOLS		Panel DOLS	
Variables	**Model 15**	**Model 16**	**Model 15**	**Model 16**
Stock volatility	0.0694***	0.6942***	0.1260***	0.7798***
	(0.0106)	(0.0451)	(0.0149)	(0.0501)
Volatility Index	-0.0000	-0.0000	0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Exch. Rate returns	-0.0006**	-0.0004*	-0.0008*	-0.0001
	(0.0002)	(0.0002)	(0.0004)	(0.0003)
Fin. Globalisation	0.0000***	0.0000***	0.0000	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Crude Oil price	-0.0000*	0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
SV*FG		-0.0109***		-0.0117***
		(0.0007)		(0.0009)
Observations	2255	2255	2255	2255
R^2	0.4465	0.5446	0.6129	0.7463
Adjusted R^2	0.4424	0.5410	0.5785	0.7191
SER	0.0000	0.0000	0.0000	0.0000
LRV	0.0000	0.0000	0.0000	0.0000
Net Effect		-0.5590		0.1109

Notes: Values in the parenthesis are the robust standard error; *** p< 0.01, ** p< 0.05, * p<0.10, SV*FG represents an interaction term of Stock volatility and Financial Globalisation
Source: Author's Construction (2023)

Appendix C: COVID-19 cases and performance of Exchange rate in Ghana: the role of trade openness

Table C1: Unit root test

	ADF		KPSS	
	Intercept	Intercept & Trend	Intercept	Intercept & Trend
XR	-1.6499	-4.5564***	1.0124	0.1710
D(XR)	-7.5556***	-7.5106***	0.1575	0.1191
Casas	-3.0499**	-3.0788	0.2118	0.2135
D(Cases)	-17.7948***	-17.7451***	0.0835	0.0464
COP	-1.3817	-2.2056	0.9754	0.2120
D(COP)	-6.7452***	-6.7184***	0.0697	0.0722
Index	-2.8111*	-0.0999	1.0423	0.3171
D(Index)	-10.8057***	-11.7066***	0.7177	0.0668
TO	1.5495	-1.5399	1.3204	0.2389
D(TO)	-11.8434***	-12.0670***	0.2896	0.0427

Note: ***, **, * represents rejection of the null hypothesis at the 1%, 5%, and 10% significance levels respectively. Augmented Dickey–Fuller is depicted by ADF, whilst Kwiatkowski-Phillips-Schmidt-Shin is depicted by KPSS

Source: Author's Construction (2023)

Table C2: Johansen Cointegration Test

Hypothesized no. of CE(s)	Trace statistic	Maximum eigen value test
None	154.0772***	73.38128***
At most 1	80.69593***	32.99808*
At most 2	47.69784*	23.34738

Note: *** and * depicts 1% and 10% significance levels respectively

Source: Author's construction (2023)

Table C3: Zivot-Andrews unit root test with structural break

Variable	Intercept	Trend	Intercept and trend
XR	-5.844***(23/10/20)	-6.138***(01/10/20)	-6.140***(04/09/20)
Cases	-5.026***(07/08/20)	-3.386(08/07/20)	-5.778***(07/08/20)
COP	-4.179(14/05/20)	-3.497(08/06/20)	-4.032**(14/05/20)
Index	-2.495(08/05/20)	-2.355(26/06/20)	-2.513(08/05/20)
TO	-2.910**(22/10/20)	-3.345***(02/10/20)	-3.373(29/09/20)

Note: ***, ** represents rejection of the null hypothesis at the 1%, and 5% significance levels respectively.

Source: Author's Construction (2023)

Table C4: Cholesky decomposition analysis

Period	S.E.	XR	Cases	COP	Index	TO
1	0.024976	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.026162	91.23281	0.273507	1.783051	4.625944	2.084690
3	0.028857	91.87135	0.257097	1.583391	4.574671	1.713492
4	0.029142	90.62178	0.291304	2.318509	4.535714	2.232695
5	0.029876	89.89214	0.311517	2.437313	5.175570	2.183461
6	0.030089	89.05625	0.323207	2.802044	5.435653	2.382847
7	0.030443	87.98821	0.332432	2.946307	6.304515	2.428537
8	0.030663	86.98445	0.335672	3.128962	7.000945	2.549974
9	0.030922	85.86277	0.336424	3.220729	7.956525	2.623555
10	0.031139	84.80759	0.334620	3.302105	8.831933	2.723752
11	0.031364	83.73404	0.331382	3.341372	9.783883	2.809318
12	0.031571	82.71758	0.327442	3.365519	10.68319	2.906266
13	0.031776	81.72369	0.323258	3.368996	11.58388	3.000175
14	0.031971	80.77817	0.319433	3.361945	12.44009	3.100357
15	0.032162	79.86638	0.316206	3.344869	13.27094	3.201605
16	0.032345	78.99522	0.313924	3.322102	14.06153	3.307222
17	0.032524	78.15754	0.312693	3.294964	14.81956	3.415241
18	0.032697	77.35383	0.312661	3.265507	15.54123	3.526769
19	0.032866	76.57993	0.313839	3.234736	16.23050	3.640997
20	0.033031	75.83447	0.316242	3.203670	16.88738	3.758232
21	0.033192	75.11471	0.319819	3.172908	17.51448	3.878087
22	0.033350	74.41897	0.324510	3.142946	18.11299	4.000589
23	0.033505	73.74526	0.330226	3.114090	18.68491	4.125516
24	0.033657	73.09207	0.336876	3.086556	19.23169	4.252804
25	0.033806	72.45790	0.344354	3.060466	19.75497	4.382304

Cholesky ordering XR, Cases, COP, Index, TO
Source: Author's Construction (2023)