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COVID-19 Vaccination and Stock Markets Performance: Empirical Evidence from African Countries

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Abstract: The unprecedented shock posed by the current pandemic on the global economy has resulted in continuous efforts by the governments, health practitioners, and policymakers to abate it, which led to the implementation of several policy responses including the COVID-19 vaccination to curb the spread, severity, and recorded cases of the pandemic. Thus, this study evaluates the impact of COVID-19 vaccination on stock markets performance of selected African countries. The analysis of the study utilizes two variants of COVID-19 vaccination indicator, namely a dummy variable and a vaccine index. The regression model shows that the COVID-19 vaccination using a dummy variable, significantly improves the returns of stock markets in Botswana, Cote D'Ivoire, and Zambia. However, the vaccine index reveals significant positive impact of vaccination on the stock market returns in Kenya, Uganda, and Zambia. In addition, the wavelet coherence analysis is utilized to examine the relationship between the variables over time and frequency domain spectrum. The result shows that the COVID-19 vaccination proxy with vaccine index significantly granger causes the stock market of the selected countries except Tunisia. The findings of the study have policy implications on portfolio management and diversification as well as government policy responses to the global pandemic.

Keywords: COVID-19 Vaccination, Stock Markets, Vaccine Index, Government Policy Response

1. Introduction

The declaration of global pandemic by the World Health Organization (WHO) on the 11th March 2020 as a result of the epidemic that erupted in Wuhan City of China led to anxiety, fear, panic, and sentiment among individuals, financial investors, business owners, and governments across the globe [32]. This outbreak is characterized as a severe respiratory-related transmissible virus known as coronavirus disease of 2019 (COVID-19) and it has been argued in the recent literature to have health, economic, and social implications [29, 30].

Being a health pandemic, its continuous spread has resulted in to increase in the rate of total confirmed and death cases from 118,319 and 4,292, respectively as at the date of its announcement as a global pandemic, to a sum of 155,679,247 total confirmed cases and 3,250,717 total death cases as at 7th May 2021.[1] However, evaluating the pandemic as an economic crisis, the fatality rates brought about different economic imbalances such as the stock market crash of March 2020, the historic collapse of crude oil price around April 2020, depreciation of exchange rates, loss of intellectual labour force, unemployment, and retrogressive economic growth, among others [22, 23]. Meanwhile, the outbreak also took a toll on the social wellbeing of the populace due to the restriction of movement, social distancing, travel ban, and restriction of commercial activity which halts economic activities and interactions among nations of the world.

These implications are connected and intertwined as one led to the other. In this spirit, several studies have investigated the resulting impact of the global pandemic on investors' returns [1,

[1] https://news.google.com/covid19/map?hl=en-NG&mid=%2Fm%2F02j71&gl=NG&ceid=NG%3Aen

3, 4, 14, 16, 17, 21] and the unequivocal evidence is that the outbreak of the COVID-19 pandemic reduces stock returns. To control this negative externality, governments across the globe adopted policies to cushion the spread of the virus which include social distancing, ban on public assembling and ceremonies, quarantine policy, COVID-19 testing, lockdown directives, travel restriction either local or international and palliative packages. Subsequently, empirical studies reveal that the implementation of these policies led to an increase in stock returns [1, 7, 26].

Despite the implementation of these policies, the pandemic continues to amplify in multitudes both in total confirmed and total death cases. Then again, the world clamor for a health-related policy by adopting the COVID-19 vaccination to control the virus to an extent. Further to this, empirical evidence by [8] shows that the global stock market reacts positively to COVID-19 vaccination. However, the position of how COVID-19 vaccination affects stock markets performance in Africa seemed not in the limelight of the global pandemic literature.

Thus, this study advances the literature on the COVID-19 pandemic by investigating the impact of COVID-19 vaccination on some major African stock market indices. Although, the outbreak of the pandemic seemed not to be too extreme in Africa, however, these nations crumbled due to overreliance on the importation of manufactured products or inputs resources from countries like China and Japan, who were among the most affected countries by COVID-19 in the world. Also, overdependence on the exportation of natural resources produces, lack of industrial/sectoral diversification, and poor health care system contributed to the economic downturn experienced by African countries during the pandemic.

Therefore, this study utilizes the heteroscedasticity consistent linear regression using Newey and West [28] standard errors [7, 26] to examine the effect of the COVID-19 vaccination on stock market returns in African countries. In the case of measuring the COVID-19 vaccination, it develops comparative measures by adopting a dummy variable and the vaccine index recently developed by [25]. Thus, the first round of the analysis uses the indicator variable as a proxy for COVID-19 vaccination following the date of the announcement of the first phase of vaccination in the countries (see Table 1). The study then utilized the vaccine index for the second round of analysis. In addition, this research examines the time-frequency domain causal relationship between COVID-19 vaccination and stock returns using the wavelet coherence methodology.

The findings of this study offer new economic implications on the effect of COVID-19 vaccination on stock market performance in Africa. More importantly, it presents adaptable policy references to governments and policymakers of these nations on how to coordinates policies to revamp the economy during a turbulent period such as the current COVID-19 pandemic since the stock market performance serves as one of the barometers for measuring the overall economic performance of any nation. Also, this study provides insightful implications to investors on portfolio management and decision making on risk management during the implementation of different economic and health policies amidst the global pandemic.

The structure of the remaining part of the paper is arranged as follows; Section 2 reviews relevant empirical literature of the COVID-19 pandemic and stock market performance; Section 3 describes the data and methodology while Section 4 presents and discusses the result and Section 5 gives the conclusion and recommendations.

2. Empirical Literature

2.1. COVID-19 Pandemic and Stock Market Performance

The effect of the ongoing global pandemic on different entities in the global economy cannot be overemphasized and the growing literature has been quite voluminous. Notable among the disruption caused by the pandemic is the stock market crash of March 2020 [22]. Further to this, empirical studies have argued the adverse impact of the COVID-19 pandemic on stock market performance from different perspectives. Categorically, the strand of studies on the link between COVID-19 pandemic and stock returns is generally classified into time series and panel data analysis. However, in either category, the performance of the stock markets is evaluated using composite, sectoral, and/or firm-level indices.

Focusing on the time series analysis studies, Baker et al. [5] examine the response of the US stock market to the COVID-19 pandemic. The analysis of the study unveils that the enormous adverse effect of the COVID-19 pandemic on the stock market performance was a result of the policy responses implemented by the US government. Iyke [18] investigates the impact of the COVID-19 pandemic on a sample of 90 US oil and gas firm returns. The study reveals evidence of heterogeneous reaction of the stock returns to COVID-19 pandemic. Meanwhile, most of the effect is attributed to returns while a smaller percentage contributes to volatility in returns. Xu [35] explores the impact of the current COVID-19 pandemic on the Canadian and the US stock markets. The study reports that there is an asymmetric impact of the pandemic on both stock markets such that growth in confirm cases lead to a reduction in stock returns and vice versa.

On the other hand, the evaluation of the impact of the COVID-19 pandemic on stock market performance has been debated on panel data analysis for different countries. For instance, Al-Awadhi et al. [1] and Ashraf [2] adopt both the total confirmed cases and the total death cases indices to evaluate the COVID-19 pandemic impact on stock market performance using panel regression. These studies reveal that the growth in the two measures of the COVID-19 pandemic adversely affects the major stock returns of the respective sampled countries. In the same manner, Harjoto et al. [15] compare the impact of the global pandemic on stock markets in the developed and emerging economies and reveals that while both confirmed and death cases are the main culprits behind markets downturn in the emerging markets, it was only the recorded cases that affect the stock markets of developed countries.

In addition, Fernandez-Perez et al. [12] account for the role of national culture on the relationship between the COVID-19 pandemic and stock returns. The panel analysis suggests the presence of huge reduction and high volatilities in stock returns of countries that are less individualist following the announcement of the outbreak. He et al. [17] examine the nexus between the global pandemic and stock returns for the most affected nations following the outbreak of the pandemic. The study records a negative relationship between the stock markets and the COVID-19 outbreak for these economies, however, there is an absence of concrete evidence that the negative impact of the pandemic on the markets supersede the global mean effect of the pandemic.

Evidence from sectoral analysis reveals that the impact of the pandemic on stock market returns differs across different industries, particularly based on essential role of direct contact in one sector than another. For example, Gu et al. [14] find evidence of a negative impact of the COVID-19 pandemic on the manufacturing industry but a positive effect is evident in the case of construction, information, technology-related, health care, and social work industries in China. Meanwhile, an event study analysis of the Chinese market by He et al. [16] indicates that energy-related industries are adversely affected while the technology, information, manufacturing, education, and health services industries were less responsive to the negative externality posed by the pandemic. Also, Lee et al. [21] reveal that the returns of the hospitality industry in China are adversely affected due to the unexpected changes in the pandemic. Ding et al. [11] in another study analyzed the behaviour of 6700 firm-level returns to the COVID-19 outbreak. The study reports that firms with strong pre-pandemic finances experience a moderate stock returns reduction compared to family-controlled firms.

Following the foregoing evidence of the unprecedented effect of the global pandemic on stock market performance, several government policies emerged and their influence on stock markets are empirically reviewed in the next sub-section.

2.2. Policy Response to COVID-19 Outbreak and Stock Market Reaction

Due to the emergence of the novel global pandemic, governments of different nationals implement policies to cushion the contagious virus. Such policies include social distancing, closure of institutions, quarantine observation, restriction of movement locally and internationally, and palliative packages provision. Following the implementation of these policies, several studies began to investigate the relevance of these policy responses to the stock market performance with evidence that stock markets react positively to government intervention policies (see among others [2, 7, 20, 26, 31].

Notwithstanding this evidence, these policies seem not effective due to daily growth in the total confirmed and death cases in the global world. Considering this, the governments, policymakers, and health advisors suggest the implementation of the COVID-19 vaccination. It is believed that vaccine taking will reduce the continuous growth in the recorded cases and death cases. However, there is public disapproval and global concern towards the adoption of the vaccination. According to DeVerna et al. [10], people were sentimental about the implementation of the COVID-19 vaccination across the globe due to the inability to access credible information on the usage and benefits of the vaccines taking.[2] While there is a paucity of empirical studies on COVID-19 vaccination and stock market performance, a recent study by Chan et al. [8] reveals that the adoption of vaccination is a life changer and that the global stock market reacts positively to the new health-related policy.

From the review of the empirical literature of COVID-19 pandemic and stock market performance, there is a very sparse discussion on the reaction of stock returns to COVID-19 vaccination, particularly in African countries. Also, the African economy has experienced unprecedented changes following the emergence of the COVID-19 outbreak. Thus, this study investigates the impact of COVID-19 vaccination on African stock markets.

3. Data and Methodology

3.1. Data Sources and Descriptive Analysis

This study utilizes high-frequency daily time series data from 4th April 2019 to 7th May 2021 for all the major stock indices of the selected countries in Africa.[3] Dataset on the stock indices and exchange rates are retrieved from the http://www.investing.com while the West Texas Intermediate (WTI) crude oil price is sourced from the US Energy Information Administration (EIA). The respective dates of the COVID-19 outbreak and vaccination in the countries are retrieved from different internet sources.

Table 1 presents the data description, summary statistics, and unit root tests. Panel A shows the major stock index of the selected countries, their exchange rates, COVID-19 outbreak, and vaccination dates. From the panel, Mauritius was the first to administer COVID-19 vaccination (26th January 2021), followed by Morocco (28th January 2021), South Africa (18th February 2021), Zimbabwe (22nd February 2021), Cote D'Ivoire (1st March 2021), Nigeria (5th March 2021), Kenya (6th March 2021), Tunisia (13th March 2021), Botswana (26th March 2021), Uganda (27th March 2021) and Zambia (14th April 2021).

Panel B shows the summary statistics and unit root tests of stock returns computed as log returns of stock prices.[4] The mean value of the series shows that the stock returns of Morocco, Nigeria, South Africa, Tunisia, and Zimbabwe are bullish while the stock market of Botswana, Cote D'Ivoire, Kenya, Mauritius, Uganda, and Zambia as well as the WTI oil price are bearish. The maximum and minimum values of the series show

[2] See among others [9, 19, 36] for a survey of empirical literature of COVID-19 vaccination-related sentiment.

[3] See Panel A of Table 1 for the list of countries and their major stock index included in this study

[4] The log return of the stock prices is computed as; $R_{STO} = \log(Sto_t / Sto_{t-1})$, where R_{STO} represents the stock returns series while Sto_t denotes stock price at time t and Sto_{t-1} is the one-time lagged stock price

dispersion from their mean and this is further complemented by the standard deviation with Zimbabwe having the largest variation and Botswana with the lowest variability. Also, the normality test based on the Jacque-Bera Statistic shows that the stock returns are not normally distributed. The unit root tests (DF-GLS and Ng-Perron) indicate that the stock returns and WTI oil price are highly significant at the level form. Thus, the stationarity of the returns series complements the use of the linear regression model.

Table 1. *Data Description, Summary Statistics and Unit Root Tests.*

Panel A: Data Description, COVID-19 Outbreak and Vaccination Dates

Country	**Major Stock Index**	**Exchange Rate**	**COVID-19 Outbreak**	**COVID-19 Vaccination**
Botswana	BSE Domestic Company	USD/BWP	30th Mar 2020	26th Mar 2021
Cote D'Ivoire	BRVM 10	USD/XOF	11th Mar 2020	1st Mar 2021
Kenya	Kenya NSE 20	USD/KES	12th Mar 2020	6th Mar 2021
Mauritius	Semdex	USD/MUR	21st Feb 2020	26th Jan 2021
Morocco	Moroccan All Share	USD/MAD	12th Mar 2020	28th Jan 2021
Nigeria	NSE All Share	USD/NGN	27th Feb 2020	5th Mar 2021
South Africa	FTSE/JSE Top 40	USD/ZAR	5th Mar 2020	18th Feb 2021
Tunisia	Tunindex	USD/TND	2nd Mar 2020	13th Mar 2021
Uganda	Uganda All Share	USD/UGX	18th Mar 2020	27th Mar 2021
Zambia	LSE All Share	USD/ZMW	18th Mar 2020	14th Apr 2021
Zimbabwe	ZSE All Share	USD/ZWL	20th Mar 2020	22nd Feb 2021

Panel B: Summary Statistics and Unit Root Tests

	Mean	**Max**	**Min**	**Std. Dev.**	**J-B**	**DF-GLS**	**Ng-Perron**
Botswana	-0.035	1.172	-2.211	0.201	34717.32***	-20.185***	-11.152***
Cote D'Ivoire	-0.047	4.743	-6.949	1.021	1101.088***	-13.660***	-10.017***
Kenya	-0.088	3.361	-5.138	0.790	1155.311***	-16.306***	-10.714***
Mauritius	-0.051	10.266	-10.104	1.062	45421.19***	-10.825***	-9.396***
Morocco	0.017	5.305	-9.232	0.965	15882.04***	-18.653***	-11.019***
Nigeria	0.057	6.048	-5.033	0.981	1020.535***	-10.345***	-8.663***
South Africa	0.036	9.057	-10.450	1.529	2636.246***	-6.981***	-5.975***
Tunisia	0.009	1.897	-4.186	0.532	5376.527***	-12.902***	-9.718***
Uganda	-0.047	4.010	-5.985	1.070	1045.272***	-16.714***	-10.778***
Zambia	-0.056	2.967	-9.214	0.717	125237.5***	-13.091***	-9.141***
Zimbabwe	0.793	120.397	-118.580	8.366	617328.6***	-20.141***	-11.217***
WTI OIL	-0.007	41.202	-64.370	5.386	55446.58***	-23.684***	-11.197***

Source: Authors' Computation

Note: The table contains the data description, COVID-19 outbreak and vaccination dates (Panel A) and the summary statistics and unit root tests (Panel B) of major stock returns of countries outlined in Panel A and WTI OIL returns. *** denotes significant level at 1%.

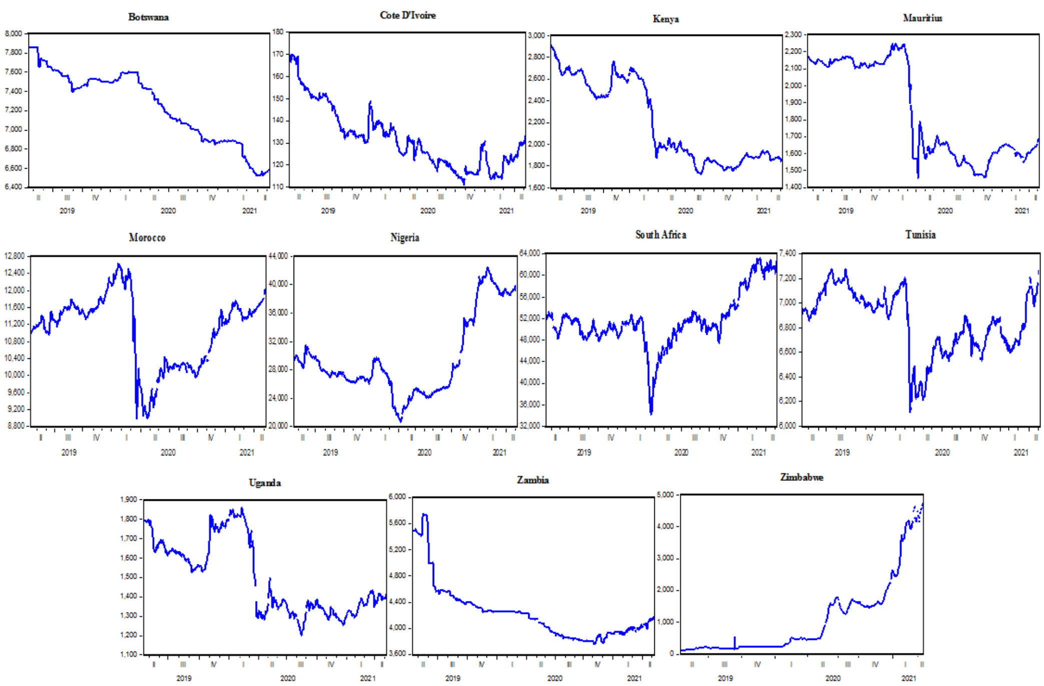

Figure 1. *Stock Prices of Selected Financial Markets in Africa.*

In addition, the graphical illustration of the stock indices which covers the pre-COVID-19 pandemic and during the COVID-19 pandemic is presented in Figure 1. The cursory visualization of the series shows that most of the stock prices plummet following the outbreak of the COVID-19 pandemic except in the case of Morocco, Nigeria, South Africa, Tunisia, and Zimbabwe. However, some of the stock indices except for Kenya and Morocco experienced upward trend following the adoption of COVID-19 vaccination.

3.2. Methodology

3.2.1. Regression Model

The empirical model of this study on the relationship between the COVID-19 vaccination and stock returns follows the prior specification of [7, 13, 26]. Thus, the ordinary least squares regression which is robust to heteroscedasticity and autocorrelation using the Newey and West [28] standard errors is specified as follows;

$$R_{STO_t} = \gamma + \sum_{i=1}^{5} \delta_i VAC_{t-1} + \delta_6 R_{STO_{t-1}} + \delta_7 VOL_{t-1} + \delta_8 R_{OIL_{t-1}} + \delta_9 R_{EXR_{t-1}} + \delta_{10} DAY1_t + \delta_{11} DAY2_t + \delta_{12} DAY4_t + \delta_{13} DAY5_t + \mu_t \quad (1)$$

where R_{STO_t} is the log returns series of stock prices; VAC_t is one of the measures of COVID-19 vaccination, i.e., i) indicator variable or ii) vaccine index. Following the previous specification of the stock return model [7, 24, 26, 27], the study controls for the effect of crude oil returns (R_{OIL}), exchange rate returns (R_{EXR}) and the day of the week effects ($DAY1_t$, $DAY2_t$, $DAY4_t$ and $DAY5_t$). $DAY1_t$,$DAY2_t$, $DAY4_t$ and $DAY5_t$ which respectively represent Monday, Tuesday, Thursday, and Friday based on dummy variables construction for the days notation.

3.2.2. Wavelet Coherence (WC)

Following the suggestion by [5] that future studies should examine the short run and long run reaction of stock markets to government-induced policies, this study specifies the relationship between the COVID-19 vaccination proxy using the vaccine index by [26] and stock market performance within time-frequency domain framework based on wavelet coherence analysis.

To express the interdependence and lead-lag causal relationship between the two variables, the study follows the bivariate specification of the wavelet coherence analysis. Thus, the relationship is first analyzed using the cross wavelet transform (CWT) and cross wavelet power (CWP) by following the prior specification of [33]. the cross wavelet transforms of the two-time signals $r(t)$ and $s(t)$ is constructed as follows;

$$N_{rs}(p,q) = N_r(p,q) N_s^*(p,q) \quad (2)$$

In equation (2), $N_r(p,q)$ and $N_s(p,q)$ denotes the respective two CWT of $r(t)$ and $s(t)$. While p represents the domain path, q shows the measured power and * denotes the combined conjugate. The CWP is computed based on the CWT as $N_r(p,q)$. In addition, the CWP spectra uncover the areas into the time-frequency arena such that the time path shows the massive mutual power that indicates the correlation that exists between the variables within the time path at different measures. In this regard, the WC captures the concurrent movement in the variables within the time and frequency dimensions. Furthermore, the adjusted coefficient of the WC as described by [34] is computed as follows;

$$Z^2(p,q) = \frac{\left|M\left(M^{-1}N_{rs}(p,q)\right)\right|^2}{M(M^{-1}|N_r(p,q)|^2)M(M^{-1}|N_s(p,q)|^2)} \quad (3)$$

Where M represents the smoothing operator and the range of the squared wavelet coherence estimate is denoted by $0 \leq Z^2(p,q) \leq 1$ with a value close to 0 indicates a weak correlation while a value close to 1 shows a strong correlation. The Monte Carlo technique is used to generate the WC following Torrence and Compo [33]'s approach.

4. Results

4.1. Regression Results

The baseline model of this study is estimated using the ordinary least squares regression and the probability values of the coefficients are generated using the Newey and West [28] standard errors which is robust to heteroscedasticity and serial correlation up to a maximum of 20 lags. The main regressor is lagged to correct for the five days of the week effects and the sum of the lagged coefficients and the probability values of the Wald test are reported with the null hypothesis that $\sum_{i=1}^{5} \delta_i = 0$.

Table 2 presents the first round of regression using a dummy variable as a proxy for COVID-19 vaccination. First, the study reports the individual effect of the lagged coefficients as well as the coefficient of the Wald test. The interpretation of the sum of the lagged coefficients is essential since the shocks of the days of the week are time-variant. It is evident that 42 out of 55 coefficients are significant, though, with different signs. The Wald test result shows that there is a significant positive impact of the COVID-19 vaccination on stock returns of investors in Botswana, Cote D'Ivoire, and Zambia while insignificant positive impact of the COVID-19 vaccination is recorded for Mauritius, South Africa, Tunisia, and Uganda and the result of Kenya, Morocco, Nigeria, and Zimbabwe reveal negative but insignificant effect.

This implies that while government interventions through the COVID-19 vaccination improves investors' returns in Botswana, Cote D'Ivoire, and Zambia, the reverse is the case for the remaining sampled countries. Similar findings are reported by [7, 26] that government intervention through lockdown significantly influences stock returns in New Zealand and G7 countries, respectively compared to the stimulus package and travel ban which yielded insignificant impact. Furthermore, the insignificant impact of COVID-19 vaccination on some African countries' stock markets corroborates with the argument put forward by [29] that most of the healthcare facilities in the continent are sub-standard and health expenses are mostly procured through out-of-pocket health expenditure. Thus, to circumvent the probable adversity of the COVID-19 pandemic on the African stock market returns, investors engage in financial divestment, hence, stock prices decline.

Furthermore, the study assesses the impact of another variant of the COVID-19 vaccination measures (i.e., vaccine index by [25]) on Africa's stock markets as shown in Table 3. In this case, 8 out of 55 coefficients of the lagged vaccine index are significant with different signs. Meanwhile, the Wald statistics shows that COVID-19 vaccination has a positive and significant impact on stock markets in Kenya, Uganda, and Zambia, however, the effect is negative but insignificant for Botswana's stock market while the influence on the other stock markets is positive but insignificant. This implies that government intervention during the COVID-19 pandemic through vaccination stimulates the stock markets in Kenya, Uganda, and Zambia. Meanwhile, the policy response does not significantly improve the stock markets of Cote D'Ivoire, Mauritius, Morocco, Nigeria, South Africa, Tunisia, and Zimbabwe while Botswana's stock market is adversely affected by the COVID-19 vaccination, though, the effect seems not significant.

Overall, it is apparent that the COVID-19 vaccination improves Zambia's stock market returns regardless of the variant of the COVID-19 vaccination employed. Using the indicator variable as a measure of vaccination, the stock markets of Botswana, Cote D'Ivoire, and Zambia react significantly to the government health-related policy while stock markets in Kenya, Uganda, and Zambia respond positively to COVID-19 vaccination proxy with the vaccine index. However, some countries' stock markets such as the Mauritius, Morocco, Nigeria, South Africa, Tunisia, and Zimbabwe do not respond significantly to vaccination.

The implication of this evidence is in different folds. First, most of these countries have only adopted the first phase of the COVID-19 vaccination, and as such its effect may not transit to the stock market immediately. Second, negative sentiment towards the adoption of this government health-related policy is one of the culprits behind its insignificant effect on the stock markets' performance. This is because financial investors are unsure about the effectiveness of this policy toward the eradication of the global pandemic due to the continuous global surge in the COVID-19 related complications. Lastly, the spillover effect of the plummeting global stock indices also influences the bid-ask decisions in the Africa's stock markets, thus, there is a high tendency that the stock markets will respond to this negative spillover amidst the COVID-19 vaccination.

Table 2. *Regression results using a dummy vaccination index.*

	Botswana	Cote D'Ivoire	Kenya	Mauritius	Morocco	Nigeria
VAC_{t-1}	0.108***	-0.722***	-0.314***	0.076	-0.200**	0.279**
	[0.029]	[0.167]	[0.067]	[0.055]	[0.092]	[0.114]
VAC_{t-2}	-0.065*	0.812***	0.110	-0.183	0.191	-2.224***
	[0.034]	[0.168]	[0.100]	[0.138]	[0.206]	[0.162]
VAC_{t-3}	-0.001	-0.240*	0.203**	-0.182	0.249**	3.083***
	[0.030]	[0.133]	[0.097]	[0.197]	[0.100]	[0.171]
VAC_{t-4}	-0.013	-0.235*	0.515***	0.284***	-0.052	-2.055***
	[0.026]	[0.138]	[0.122]	[0.095]	[0.207]	[0.164]
VAC_{t-5}	0.043**	0.633***	-0.537***	0.126	-0.216**	0.865***
	[0.018]	[0.125]	[0.099]	[0.123]	[0.098]	[0.087]
$R_{STO_{t-1}}$	0.101**	0.064	0.300***	0.320***	0.167**	0.335***
	[0.039]	[0.045]	[0.082]	[0.047]	[0.077]	[0.051]
VOL_{t-1}	-0.348	0.071***	-0.073	0.025***	-0.044	-0.062*
	[2.141]	[0.017]	[0.057]	[0.007]	[0.034]	[0.035]
$R_{OIL_{t-1}}$	-0.001	0.001	0.006	0.040**	0.043	0.018***
	[0.001]	[0.005]	[0.009]	[0.018]	[0.028]	[0.007]
$R_{EXR_{t-1}}$	0.015	-0.019	-0.045	-0.030	0.326	-0.106***
	[0.016]	[0.048]	[0.213]	[0.122]	[0.307]	[0.008]
DAY1	-0.013	-0.236*	-0.130	-0.250	-0.127	-0.190*
	[0.030]	[0.135]	[0.125]	[0.175]	[0.110]	[0.113]
DAY2	0.012	0.119	-0.132	0.010	0.217	-0.058
	[0.027]	[0.115]	[0.100]	[0.063]	[0.152]	[0.130]
DAY4	-0.017	0.099	-0.020	-0.290*	0.045	-0.006
	[0.026]	[0.118]	[0.106]	[0.157]	[0.109]	[0.107]
DAY5	0.021	0.282**	0.003	0.157	0.055	-0.077
	[0.026]	[0.112]	[0.133]	[0.134]	[0.114]	[0.115]
Cons	-0.023	-0.214***	0.041	0.024	0.021	0.172*
	[0.087]	[0.076]	[0.093]	[0.051]	[0.104]	[0.100]
Wald Test	0.071***	0.249**	-0.022	0.122	-0.028	-0.052
	[0.015]	[0.106]	[0.060]	[0.099]	[0.072]	[0.071]
R^2	-0.003	0.027	0.090	0.197	0.102	0.119

Source: Authors' Computation; Note: [·] denotes the robust standard errors. ***, **, and * are the respective significant levels at 1%, 5%, and 10%.

Table 2. *Continued.*

	South Africa	Tunisia	Uganda	Zambia	Zimbabwe
VAC_{t-1}	1.705***	-0.531***	-4.246***	1.150***	0.784
	[0.176]	[0.034]	[0.115]	[0.109]	[1.330]
VAC_{t-2}	-2.008***	0.708***	6.338***	-3.242***	2.096
	[0.292]	[0.064]	[0.214]	[0.216]	[1.625]
VAC_{t-3}	-2.539***	0.205**	-1.435***	4.817***	-3.580***
	[0.468]	[0.089]	[0.277]	[0.268]	[0.385]
VAC_{t-4}	2.842***	-0.704***	0.298*	-2.708***	5.954***
	[0.270]	[0.108]	[0.175]	[0.440]	[1.896]
VAC_{t-5}	0.035	0.467***	-0.939***	0.203	-6.208***
	[0.216]	[0.115]	[0.160]	[0.280]	[0.997]
$R_{STO_{t-1}}$	-0.084	0.316***	0.270***	-0.030	-0.516***
	[0.079]	[0.089]	[0.045]	[0.084]	[0.139]
VOL_{t-1}	0.044	-0.114*	-0.075**	0.588	-0.001***
	[0.031]	[0.062]	[0.031]	[0.623]	[0.000]
$R_{OIL_{t-1}}$	0.068**	0.000	-0.011	0.004	0.028
	[0.034]	[0.008]	[0.012]	[0.005]	[0.031]
$R_{EXR_{t-1}}$	-0.358**	-0.112	-0.610**	0.034	-0.058**
	[0.176]	[0.068]	[0.250]	[0.042]	[0.023]
DAY1	0.033	-0.087	-0.113	-0.246	-0.397
	[0.174]	[0.088]	[0.162]	[0.184]	[0.980]
DAY2	0.228	-0.111	-0.066	0.076	-0.651
	[0.247]	[0.072]	[0.134]	[0.054]	[1.182]
DAY4	0.086	-0.094	0.312**	-0.101	-1.638
	[0.238]	[0.086]	[0.122]	[0.084]	[1.539]
DAY5	0.014	-0.043	-0.069	-0.004	-0.724
	[0.184]	[0.094]	[0.143]	[0.066]	[1.541]
Cons	-0.131	0.091	0.032	-0.646	2.253
	[0.170]	[0.055]	[0.088]	[0.672]	[1.503]
Wald Test	0.035	0.144	0.016	0.220***	-0.956
	[0.119]	[0.091]	[0.080]	[0.060]	[0.957]
R^2	0.122	0.154	0.149	0.051	0.269

Source: Authors' Computation; Note: [·] denotes the robust standard errors. ***, **, and * are the respective significant levels at 1%, 5%, and 10%.

Table 3. *Regression results using the vaccine Index.*

	Botswana	Cote D'Ivoire	Kenya	Mauritius	Morocco	Nigeria
VAC_{t-1}	-0.015	-0.146	-0.046	0.088	0.087	0.243*
	[0.024]	[0.135]	[0.107]	[0.213]	[0.082]	[0.141]
VAC_{t-2}	-0.008	0.110	0.055	-0.093	0.079	0.089
	[0.017]	[0.097]	[0.047]	[0.115]	[0.086]	[0.164]
VAC_{t-3}	-0.002	0.146	0.023	-0.083	-0.059	-0.055
	[0.008]	[0.101]	[0.068]	[0.174]	[0.061]	[0.094]
VAC_{t-4}	0.010	0.126	0.022	0.254	0.015	-0.210*
	[0.010]	[0.096]	[0.058]	[0.224]	[0.059]	[0.123]
VAC_{t-5}	0.000	-0.081	0.084	0.005	-0.066	0.005
	[0.011]	[0.076]	[0.107]	[0.073]	[0.084]	[0.094]
$R_{STO_{t-1}}$	0.081**	0.025	0.345***	0.260***	0.183**	0.306***
	[0.038]	[0.060]	[0.107]	[0.052]	[0.078]	[0.067]
VOL_{t-1}	-3.457	0.019	0.042	0.006	-0.059	-0.023
	[2.961]	[0.042]	[0.054]	[0.009]	[0.043]	[0.024]
$R_{OIL_{t-1}}$	-0.001	0.001	0.006	0.035**	0.041	0.018**
	[0.001]	[0.005]	[0.010]	[0.017]	[0.028]	[0.007]
$R_{EXR_{t-1}}$	0.026	-0.015	-0.363	0.052	0.443	-0.104***
	[0.019]	[0.059]	[0.235]	[0.207]	[0.392]	[0.010]
DAY1	-0.047	-0.341	-0.108	-0.365*	-0.105	-0.075
	[0.039]	[0.223]	[0.180]	[0.194]	[0.153]	[0.137]
DAY2	-0.011	0.113	-0.139	0.040	0.294	-0.106
	[0.026]	[0.159]	[0.129]	[0.088]	[0.189]	[0.175]
DAY4	-0.018	0.169	-0.052	-0.219	0.101	-0.142
	[0.025]	[0.202]	[0.142]	[0.140]	[0.142]	[0.141]
DAY5	-0.012	0.203	0.056	-0.249	0.043	-0.170
	[0.033]	[0.170]	[0.149]	[0.182]	[0.132]	[0.177]
Cons	0.160	-0.584*	-0.492**	-0.502	-0.183	-0.039
	[0.170]	[0.351]	[0.205]	[0.400]	[0.299]	[0.422]
Wald Test	-0.015	0.154	0.138***	0.172	0.056	0.073
	[0.026]	[0.106]	[0.051]	[0.116]	[0.071]	[0.120]
R^2	-0.016	0.006	0.116	0.114	0.113	0.117

Source: Authors' Computation; Note: [·] denotes the robust standard errors. ***, **, and * are the respective significant levels at 1%, 5%, and 10%.

Table 3. *Continued.*

	South Africa	Tunisia	Uganda	Zambia	Zimbabwe
VAC_{t-1}	0.310*	-0.046	0.297	0.090*	0.568*
	[0.164]	[0.047]	[0.250]	[0.050]	[0.302]
VAC_{t-2}	-0.272	0.028	-0.070	0.098**	-0.068
	[0.233]	[0.044]	[0.108]	[0.046]	[0.192]
VAC_{t-3}	0.029	0.012	-0.038	-0.008	-0.153
	[0.160]	[0.047]	[0.183]	[0.033]	[0.252]
VAC_{t-4}	0.185*	0.093*	0.009	-0.068	0.149
	[0.110]	[0.052]	[0.105]	[0.044]	[0.305]
VAC_{t-5}	-0.109	-0.027	-0.033	-0.012	-0.439
	[0.172]	[0.035]	[0.102]	[0.042]	[0.331]
$R_{STO_{t-1}}$	-0.111	0.453***	0.268***	-0.259*	0.618***
	[0.081]	[0.123]	[0.051]	[0.142]	[0.069]
VOL_{t-1}	0.072*	0.120***	-0.066***	-3.606	-0.010
	[0.036]	[0.046]	[0.025]	[2.738]	[0.007]
$R_{OIL_{t-1}}$	0.066*	0.001	-0.014	0.000	0.001
	[0.034]	[0.007]	[0.011]	[0.002]	[0.017]
$R_{EXR_{t-1}}$	-0.461*	-0.175*	-0.737***	0.014	-0.021
	[0.244]	[0.096]	[0.201]	[0.029]	[0.014]
DAY1	0.235	-0.108	-0.065	0.109	-0.011
	[0.205]	[0.104]	[0.199]	[0.109]	[0.477]
DAY2	0.221	-0.069	-0.050	0.101	-0.035
	[0.300]	[0.081]	[0.225]	[0.079]	[0.402]
DAY4	0.276	-0.061	0.330	-0.034	0.444
	[0.321]	[0.105]	[0.204]	[0.083]	[0.569]
DAY5	-0.061	-0.022	-0.274	0.024	0.724
	[0.279]	[0.111]	[0.186]	[0.085]	[0.518]
Cons	-0.731	-0.177	-0.519*	3.489	0.170
	[0.587]	[0.234]	[0.286]	[2.962]	[1.082]
Wald Test	0.143	0.060	0.165**	0.100**	0.058
	[0.140]	[0.066]	[0.064]	[0.043]	[0.270]
R^2	0.154	0.187	0.134	0.054	0.355

Source: Authors' Computation; Note: [·] denotes the robust standard errors. ***, **, and * are the respective significant levels at 1%, 5%, and 10%.

4.2. Time-Frequency Domain Analysis Using the Wavelet Coherence

Following the suggestion put forward by [9] that future studies should investigate the effect of government policy responses to COVID-19 outbreak on stock markets through the short run and long run analysis, this study utilizes the wavelet coherence (WC) to analyze the in-phase and out-phase effects of the COVID-19 vaccination on Africa's stock market performance over different time and frequency domain resolution.

Figure 2 displays the WC for the vaccine index and stock returns of the respective countries. The vertical axis indicates the scale dimension which is partitioned into the short run (0-8), medium run (8-16), long run (16-32), and the very long run (32-64) periods while the horizontal axis reflects the period dimension of the time series frequency as 0-50=06/01/2020-23/03/2020, 50-100=24/03/2020-11/06/2020, 100-150=12/06/2020-02/09/2020, 150-200=03/09/2020-19/11/2020, 200-250=20/11/2020 -10/02/2021 and 250-300=11/02/2021-28/04/2021, but, in the case of Zimbabwe, the period scale is as follows 0-50=06/01/2020-24/03/2020, 50-100=25/03/2020-17/06/2020, 100-150=18/06/2020-14/10/2020, 150-200=15/10/2020-04/01/2021, and 200-250=05/01/2021-28/04/2021.

The scale axis reflects the time frame while the period axis represents the frequency band of the time series. Red regions are characterized with significant interdependence while the blue regions show low dependence between series and the black contour region represents the significant level at 5%. The overall significant arena is represented by all areas within the U-shaped frame which is known as the Cone of Influence (COI) region. The arrow pointing either ↗ or ↘ denotes the in-phase effect while ↖ or ↙ indicates the out-phase effect. Arrows pointing to ←, →, ↑, and ↓ signify the absence of in-phase or out-phase effects.

In the short run scale, there is evidence of in-phase effect from the COVID-19 vaccination to stock returns for Botswana, Kenya, Nigeria, Uganda, and Zimbabwe while the out-phase effect occurs in countries like Cote D'Ivoire, Kenya, and Zambia. Meanwhile, the medium run scale reflects evidence of the out-phase effect from vaccination to the stock market in Botswana and Mauritius. Furthermore, the long run scale record mixed evidence. COVID-19 vaccination has an out-phase effect on stock returns in Morocco while the in-phase effect of the vaccination is recorded in the case of South Africa. From the analysis, there is an absence of a lead/lag relationship between the variables of interest in the very long run period.

The findings imply that stock market returns have heterogeneous reaction (either in scale or period dimension) to COVID-19 vaccination in Africa. While there is reflective evidence that the COVID-19 vaccination has a transitory effect on stock markets in Botswana, Cote D'Ivoire, Kenya, Nigeria, Uganda, Zambia, and Zimbabwe, the effect is prolonged in some countries like Mauritius, Morocco, and

South Africa. However, the stock market in Tunisia does not respond to the COVID-19 vaccination. Also, the immediate reaction of the stock markets of some countries to COVID-19 vaccination is due to the recency of the policy adoption. For instance, Zambia which is among those countries whose stock markets respond immediately to vaccine taking in the first phase of her COVID-19 vaccination as of 14th April 2021.

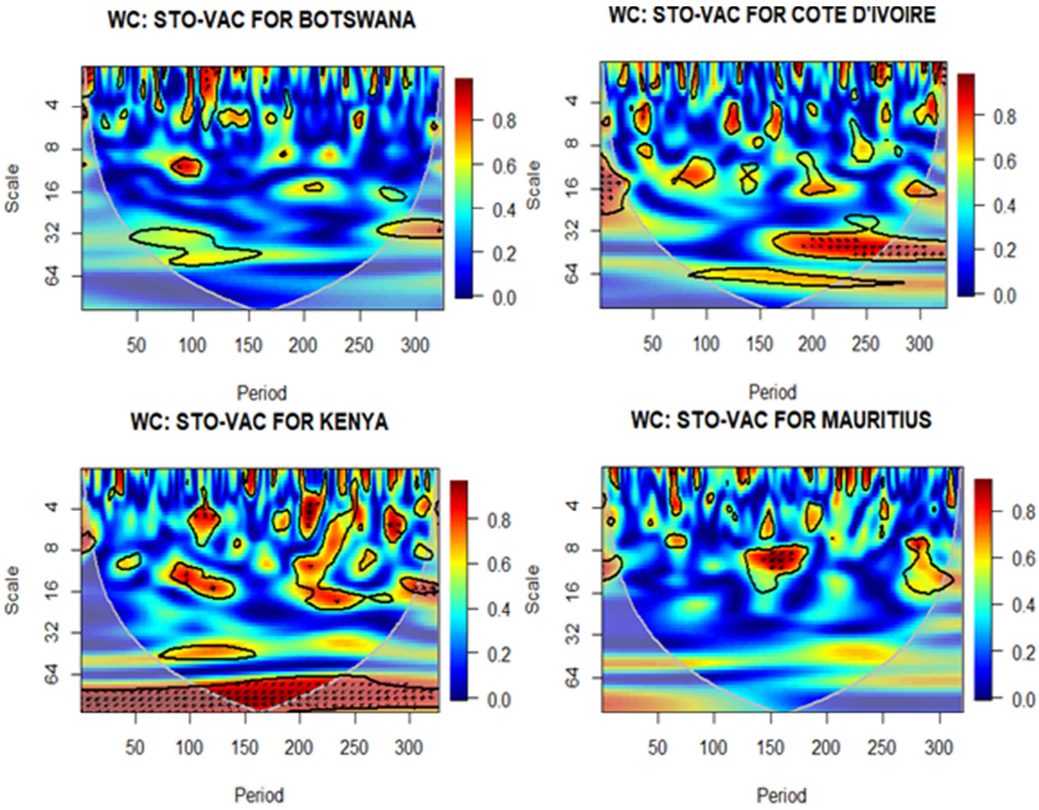

Figure 2. Wavelet Coherence of Vaccine Index and Stock Returns of Selected African countries.

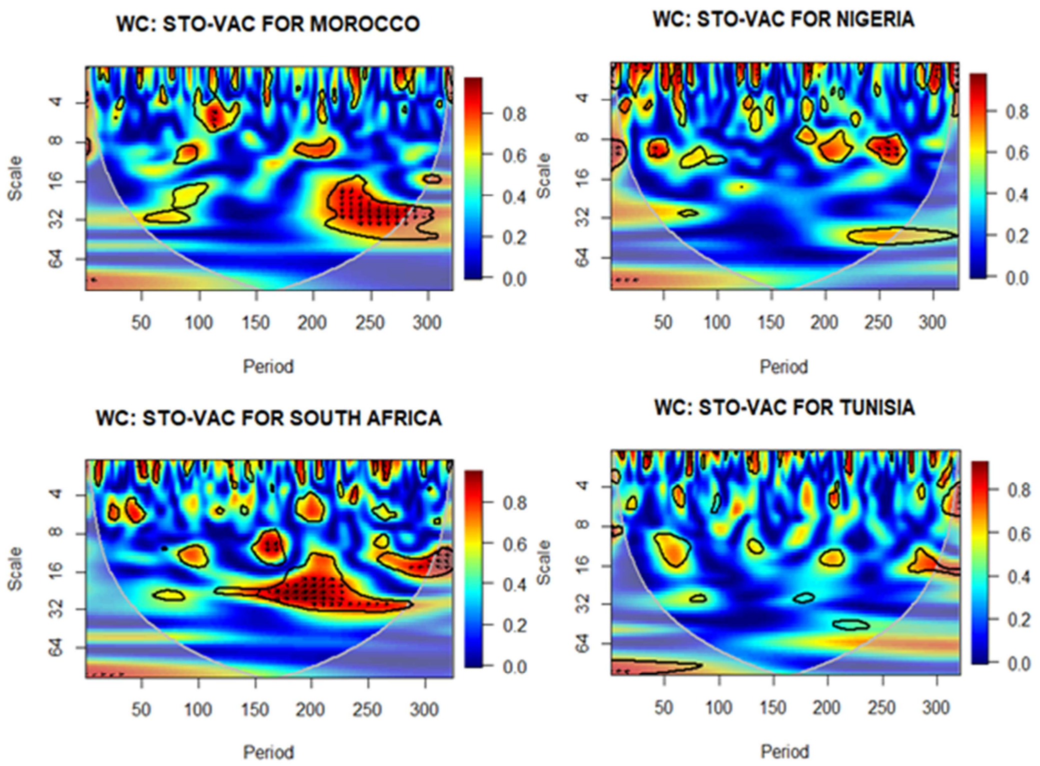

***Figure 2.** Continued.*

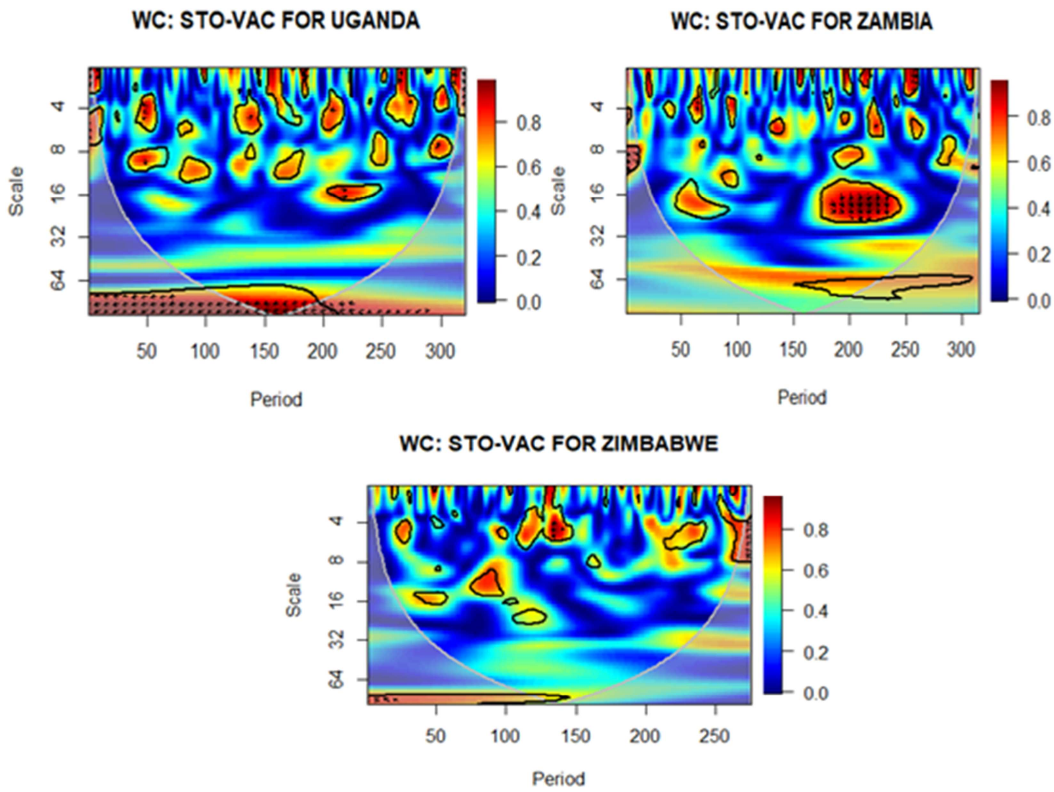

Figure 2. *Continued.*

5. Conclusion and Recommendations

The outbreak of the contagious global pandemic led to an unprecedented economic downturn in the global economy leading to the stock market crash, the oil price historic collapse, declining economic growth, unemployment as well as loss of intellectual personnel. Previous studies on the link between COVID-19 pandemic and stock market performance has documented adverse effect of the former on the latter leading to the implementation of several government-related policy responses such as social distancing policy, quarantine observation, ban on travelling either local or international, palliative packages, closure of businesses and other non-essential organization as well as the total lockdown on movement. However, these policies were not sufficient to curb the spread of the virus due to growth in the recorded cases as well as the total death cases, thus, this led to the adoption of health-related policy through the COVID-19 vaccination. Despite sentiment across the globe following the announcement of this pandemic-induced vaccination, countries of the world adopted the policy and the cases reduce gradually over time following different phases of the adoption.

This motivates the present study to examine whether the COVID-19 vaccination restores the plummeting stock markets returns in Africa. This study adopts both the heteroscedasticity-consistent regression and the wavelet coherence analysis. In the case of the former, two variant of COVID-19 vaccination measures are adopted (i.e., an indicator variable and the vaccine index). The two rounds of the analysis show that stock markets in Botswana, Cote D'Ivoire, and Zambia (using the indicator variable) and Kenya, Uganda, and Zambia (using the vaccine index) were positively affected by the COVID-19 vaccination. On the other hand, evidence from the time-frequency domain analysis shows that COVID-19 vaccination affects the stock markets at different scales and time dimensions for all the countries except for Tunisia.

Based on the foregoing evidence, the adoption of the pandemic-related vaccination is a good step to restore the global economy to the status quo. Evidence of stock market recovery following the implementation of the COVID-19 vaccination also reflects the fact that government interventions to curtail the spread, as well as the severity of the virus, is effective. In addition, this indicates that the policy has raised the investors' confidence towards investing in the financial markets during this turbulent period.

The findings of this study have some policy implications for governments and policymakers as well as financial investors in the stock markets. Focusing on governments and policymakers, it is imperative to note that the implementation of appropriate policies at the early stage of a crisis such as the current COVID-19 is germane. This is because the adoption of several policies to curb the spread of the virus before the implementation of the COVID-19 vaccination was less effective, thus, health-related policies should be adopted following the outbreak of health crisis at the early stage. Also, the formulation of a resilient framework that for better sectoral diversification and import substitution policies in

African countries would reduce the spillover effect of a global pandemic in the continent. In addition, the development of quality and affordable health infrastructures in Africa will enhance the health outcomes of citizens during a similar pandemic in the future and this is likely to reduce the huge out-of-pocket health expenditure incurred by the citizens during the pandemic, thus, having an adequate cash reserve for investment in financial assets. Furthermore, public orientation and awareness towards the implementation of the COVID-19-related policies would reduce sentiment, panic, anxiety, and fear among people amidst the outbreak of the virus and this is likely to reduce the spread and death cases recorded during the crisis.

On the other hand, investors and financial portfolio managers in the financial markets should continue to uphold their financial assets during a turbulent period for the effect of government policies to stabilize the stock market performance. Through this, investors will be able to make profitable returns in the market because the effect of the policies may take time to yield a positive feedback. Also, strategic investment diversification and risk management are important for investors during economic and health crises to acquire potential gains in the market. In addition, appropriate speculation and forecast of stock market performance during prior crises could give investors hedges in predicting the performance of the market during the ongoing pandemic.

Despite valuable and insightful evidence reported in this study, certain issues were left undiscussed for future studies. In this regard, future studies should examine the spillover and connectedness between global stock market performance and the African' stock market. Also, the analysis of the sectoral stock market reaction to COVID-19 vaccination will offer impeccable findings to investors in different industries.

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