IRJEMS International Research Journal of Economics and Management Studies
Published by Eternal Scientific Publications
ISSN: 2583 – 5238 / Volume 2 Issue 3 July 2023 / Pg. No: 61-66
Paper Id: IRJEMS-V2I3P110, Doi: 10.56472/25835238/IRJEMS-V2I3P110

Original Article

Analysis of the Link between West African Stock Markets

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Received Date: 01 July 2023 Revised Date: 05 July 2023 Accepted Date: 10 July 2023 Published Date: 21 July 2023

Abstract: *This study uses annual data from 1993 to 2020 to examine potential long- and short-term linkages and correlations between the market capitalizations of the WAEMU, Ghana, and Nigeria stock markets. According to the early test results, the Ghanaian and Nigerian stock markets exhibit strong connections with the WAEMU stock market, with correlation coefficients ranging from -0.006 to -0.614. The results of the cointegration estimates show a substitution effect between the WAEMU and Ghanaian markets and a complementarity effect between WAEMU and Nigerian markets. The findings also imply that there is a connection between the stock markets, and that connection depends on the proximity of the markets.*

Keywords: *BRVM Stock Market, Long-Term Relationship, Stock Market Integration, Johansen Cointegration.*
JEL Classification : *B26, C58, D53, F15*

I. INTRODUCTION

Many academics have been considering researching the integration of stock markets for many years. Levine (1997) asserts that the stock market, like the financial markets, serves the primary purpose of making it easier to allocate resources through distance and time in an uncertain environment. The development of the stock market aims at facilitating trade, diversifying risks, providing liquidity, and reducing information asymmetry, which will attract foreign investors and thus positively affect the level of international financial integration. In the literature, there are several studies on the integration of Asian and African emerging markets.

Using a GARCH model, De santis and Imrohoroglu (1997) demonstrated that neither country-specific risk nor global market risk is measured, leaving no room for inference regarding the effects of market liberalisation. Using the Engle-Granger cointegration test, Menon et al. (2009) investigated the connections between the stock markets of India, Hong Kong, and America. The findings show that there is no relationship between the stock markets in India and Hong Kong or America. Going in the same direction, Saha and Bhunia (2012) conducted their investigations on the Indian and South Asian markets through stock index data from August 2002 to August 2011. As a result, they argue that these markets are interconnected in the short run as well as in the long run.

Through the use of a cointegration regression, Jacob and Littleflower (2022) investigated the interdependence of six Asian and African stock markets, including those in India, China, Singapore, Japan, Indonesia, and South Africa. The findings show that, with the exception of the Chinese stock market, all markets have strong relationships with the Indian stock market. However, there is considerable correlation between the stock markets of India and Shanghai, and when the stock markets of India and Singapore are linked, there is little correlation between the stock markets of India and the United States. Significant correlation exists between the Indian and Singaporean stock markets. According to Tai (2007), market liberalisation has decreased capital costs and price volatility in the majority of countries.

Some studies have focused on the integration between Latin American stock markets, such as the study by Pegan and Soydemir (2000), which focused specifically on the US, Argentine, Brazilian, Chilean, and Mexican stock markets. The findings demonstrate that the Latin American stock markets are significantly influenced by the US stock markets, however the effects are not uniform. Furthermore, compared to other countries, the stock markets of Mexico, Chile, and Brazil are more affected by US inventions. Finally, it appears that Chile and Argentina would be more affected by a shock to the Brazilian stock market than the Mexican stock market. A fractionally integrated VECM and a multivariate GARCH model were used by Chen, Lobo, and Wong in their analysis of the relationship between the Indian and US stock markets in 2006. The findings back up the existence of market cointegration.

The Ivory Coast, like the WAEMU countries, Nigeria and Ghana, has made enormous progress in the African economy in recent decades. This progress is due to multiple economic and political reforms, notably, the strengthening of competition, the deepening of finance through innovative instruments, the easing of restrictions on foreign capital flows and the reduction of transaction costs, and the improvement of liquidity.

The goal of this research is to examine the connections between the Ghanaian and Nigerian stock markets and the WAEMU stock market. To do this, the research is structured as follows: The estimating technique to be used is presented in the second section. The findings are presented and analysed in the third section, and the conclusion and discussions are covered in the fourth and final section.

II. METHODOLOGY

This study is based on a cointegration regression in the West African zone during the period 1993 to 2020. The data to be analyzed are taken from the World Bank database (WDI).

To evaluate the causal relationships between economic growth, demography, and human capital, three cointegration estimators will be utilised. These are the Canonical Cointegration Regression (CCR) (Park, 1992), Dynamic Ordinary Least Squares (DOLS) (Stock and Watson, 1993), and Fully Modified Ordinary Least Squares (FMOLS) estimator (Phillips and Hansen, 1990). These estimation methods overcome some of the limitations of the ordinary least squares (OLS) method. Indeed, these techniques deal with the problems of serial correlation and endogeneity that could arise in the presence of cointegration.

A) Model Specification

The goal of this study is to examine the integration of the stock markets in West Africa. We will therefore use the market capitalization of domestic listed firms (as a % of GDP) as a proxy for the size of the financial market rather than the economic literature's use of stock market indexes. Following Jacob and Littleflower (2022), we will use a linear regression model that will be specified as follows :

$$WAEMU_t = \alpha_0 + \alpha_1 + GHA_t + \alpha_2 NGA_t + \varepsilon_t \quad \text{---------- (1)}$$

With :

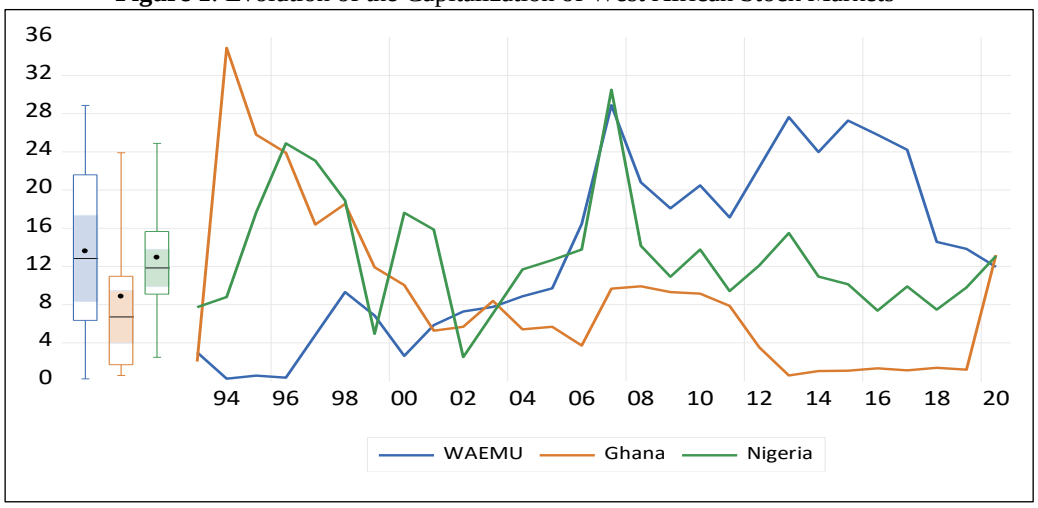
$WAEMU_t$, is the endogenous variable of the stochastic model. It represents the market capitalization of domestic companies listed on the WAEMU stock exchange ; GHA_t means the market capitalization of domestic companies listed on the Ghana Stock Exchange ; NGA_t means the market capitalization of domestic companies listed on the Nigerian Stock Exchange ; ε_t is the stochastic disturbance.

III. RESULTS

A) Preliminary Test Results

Before conducting any statistical test, the quality of the quantitative data must be checked. In the context of this study, two tests are essential: the test for measuring multicollinearity and the descriptive statistics of the variables.

Figure 1: Evolution of the Capitalization of West African Stock Markets



***Source**: Prepared by the authors based on the results of the Eviews software*

Table 1: Descriptive statistics and correlation matrix of variables

	WAEMU	GHA	NGA
Mean	13.594	8.858	12.936
Median	12.893	6.777	11.900
Maximum	28.877	34.886	30.508
Minimum	0.234	0.582	2.497
Std. Dev.	9.180	8.482	6.127
Skewness	0.145	1.441	0.999
Kurtosis	1.730	4.710	4.062
Jarque-Bera	1.977	13.115	5.981
Probability	0.371	0.001	0.050
Sum	380.650	248.047	362.235
Sum Sq. Dev.	2275.752	1942.551	1013.676
Observations	28	28	28
WAEMU	1.000		
GHA	-0.614	1.000	
NGA	-0.006	0.355	1.000

Source: *Prepared by the authors based on the results of the Eviews software*

Table 1 above shows that over the 28 years of observation, the time series behave well overall. The fact that each series' mean and median are substantially equal indicates that the data do not have any "outlier" issues. The time series, with the exception of the Ghana stock market, follow a normal distribution, which is an amazing finding from the descriptive statistics. In fact, the Jarque-Bera statistic's P-value is under the 5% cutoff. The results shed light on the unfavourable long-term relationships between the UEMOA stock market and other significant markets, particularly Ghana and Nigeria, when it comes to the correlation matrix between the series.

B) Results of the Stationarity and Cointegration Tests

The study of stationarity is essential for the validity of a time series regression. Indeed, this analysis is a priori necessary to avoid spurious regressions. In the context of our analysis, we will use formal tests, in particular the Augmented Dickey-Fuller (ADF) test of Dickey and Fuller (1981), and the Phillips-Perron (PP) test of Phillips and Perron (1988).

Table 2 : Unit Root Test (ADF & PP)

Variable	ADF-I (0)		ADF-I (1)		PP-I (0)		PP-I (1)	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
WAEMU	-1.557	0.489	-4.905	0.000	-1.540	0.4984	-4.908	0.000
Ghana	-2.541	0.117	-11.372	0.000	-1.373	0.153	-10.282	0.000
Nigeria	-0.782	0.367	-5.598	0.000	-0.883	0.324	-10.438	0.000

Source : *Prepared by the authors based on the results of the Eviews software*

We will attempt to verify the existence of one or more cointegration relationships between the series in the following as the time series are stationary in the first difference. The Johansen (1988) cointegration test has been applied in the context of this investigation.

Indeed, this test makes it possible to estimate the following stochastic model :

$$\Delta Y_t = A_0 + A_1 \Delta Y_{t-1} + A_2 \Delta Y_{t-2} + \cdots + A_p \Delta Y_{t-p+1} + \pi Y_{t-1} + \varepsilon_t \quad \text{---------- (2)}$$

Where p is a matrix written as follows : $\pi = \sum_{t-1}^{p} A_{t-1}$

To perform this test, the Johansen statistic is calculated by the following expression:

$$\lambda_{trace} = n \sum_{i=r+1}^{k} l_n(1 - \lambda_i) \text{ --------- ---------- (3)}$$

Where n is the number of observations ; r denotes the order of the matrix π ; k is the number of variables ; λ_i denotes the values of the matrix π.

Because the Johansen test is an enhanced version of the Engle-Granger test, its selection is justifiable. Choosing a dependent variable and issues brought on by errors being carried over from one step to the next are avoided. The test is therefore capable of detecting several cointegration vectors. In actuality, the Johansen test must be applied after determining the ideal number of delays based on the Akaike and Schwarz information criterion.

Table 3 : Determining the Optimal Delay

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-249.981	NA	56760.97	19.460	19.605	19.501
1	-213.598	61.570*	6957.108*	17.353*	17.934*	17.520*
2	-207.205	9.344	8790.433	17.554	18.570	17.846

Source: *Developed by the authors based on the results of the Eviews software*

The findings demonstrate that all other criteria, besides the Akaike information criterion (AIC) and the Schawrz information criterion (SC), such as the Hannan-Quinn information criterion (HQ), the Final Prediction error (FPE), and the sequential modified LR test statistic (LR), indicate an ideal delay length of 1.

Table 4 : Results of the Johansen Cointegration Test

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.561213	38.92391	29.79707	0.0034
At most 1	0.397163	15.03541	15.49471	0.0585
At most 2	0.012279	0.358284	3.841465	0.5495

Source : *Developed by the authors based on the results of the Eviews software*

The WAEMU, Ghana, and Nigeria stock markets have a cointegration vector, as shown in Table 3 above. At the 5% level of significance, the Trace statistic is sufficient to reject the null hypothesis. In particular, the variables in the study have a long-run equilibrium relationship. This justifies the choice of our estimation methods namely: FMOLS, DOLS CCR and ECM.

C) Results of the Long-Term Estimates: FMOLS, DOLS, and CCR

For the rest of our analysis, we use these three estimators because of their advantage over traditional Ordinary Least Squares estimates. Indeed, these methods present more robust and reliable results, especially in small sample sizes.

Table 5 : Results of the Cointegration Estimators

Dependent variable	WEAMU stock market					
	FMOLS		DOLS		CCR	
	Coeff	Prob.	Coeff	Prob.	Coeff.	Prob.
Ghana	-0.982*	0.0000	-1.801*	0.000	-1.016*	0.000
Nigeria	0.498	0.131	1.712*	0.008	0.584	0.141
Constante	16.282*	0.001	6.9321	0.249	15.381*	0.004
R^2 adjusted	0.417		0.678		0.396	
Note : *, **, *** denote the rejection of the null hypothesis at the 1%, 5%, and 10% significance levels respectively						

Source*: Developed by the authors based on the results of the Eviews software*

This table's findings show that the development of Ghana's stock market is statistically significant and negative at the 1% significance levels for all three estimating methodologies. This indicates that the growth of the Ghanaian stock market causes the appeal of the BRVM stock market to decline. There is therefore a substitution effect between these two markets.

Additionally, the results of the FMOLS and CCR calculations demonstrate that the growth of the Nigerian stock market has had some positive, if insignificant, influence on the growth of the BRVM stock market. However, the DOLS estimation proves the existence of a significant and positive effect. There is therefore a complementarity effect between the BRVM market and the Nigerian market.

The functioning of the stock market is typically reliant on the functioning of other stock markets around the globe. Events in history, like the Russian-Ukrainian invasion, are not an exception. Econometrically, the DOLS estimate performs better with a predictive power of 0.678 or 67.8%.

Understanding that the DOLS estimator performs better when there is a cointegrating link between the variables under study will be one of the main takeaways from this study. On the other hand, the analysis enables us to comprehend how the BRVM stock market is impacted by the policies pursued by other countries.

D) Estimation of the Error Correction Model (ECM)

The estimation of the short-term dynamics is the natural extension of cointegration, according to d'Engle and Granger (1987). Therefore, the results of the short-term estimates of the error correction model (ECM) are shown in Table 5 below, confirming the existence of a cointegrating connection.

Table 6 : Results of the Error Correction Model (ECM) Estimations

Dependent variable	**WEAMU stock market**	
Short-term estimate		
Variable	**Coefficient**	**Prob.**
D (Ghana)	-0.193**	0.089
D (Nigeria)	0.267**	0.018
RESID (-1)	-0.274**	0.029
Constante	0.341	0.656
R^2 ajusté	0.273	
Long-term estimate		
Variable	**Coefficient**	**Prob.**
Ghana	-0.759*	0.0000
Nigeria	0.364*	0.0000
Constante	15.603*	0.0002
R^2 ajusted	0.38	
Note : *, **, *** denote the rejection of the null hypothesis at the 1%, 5%, and 10% significance levels respectively		

***Source** : Prepared by the authors based on the results of the Eviews software*

Table 5 above demonstrates that, under Certirus paribus, the Nigerian stock market has positive and significant effects on BRVM in the short term, while Ghana's stock market has negative and significant effects in both the short term and the long term. On the other hand, over time all coefficients grow significantly more important; that is, they are all significant at the 1% level.

The speed of adjustment towards the equilibrium fulfilled the condition of the validation of the error correction model (RESID (-1)), i.e. it is negative and significant at the 5% threshold. It means that following a shock, the response variable of the BRVM stock market regains its equilibrium according to the frequency of 27.4 %. In other words, following a shock, the structural variables explain the BRVM's market capitalisation by 27.4% in the long term, and that the shock is completely resolved after 4 years (1/0.274=3.649).

IV. CONCLUSION

This essay's goal is to examine the ECOWAS region's stock market integration trends. In the literature on economics, this relationship has been extensively researched. It is actually obvious that the stock markets in the ECOWAS area are fully integrated and have the capacity to diversify portfolios and exhibit abnormality. To analyze this relationship, we tested three cointegration estimators [FMOLS], [DOLS], and [CCR], and the error correction model (ECM) over the period 1993-2020. According to the study's findings, the WAEMU stock market is connected to the capital markets of Ghana and Nigeria. By investing in these economies, international investors are therefore less likely to diversify their portfolios and make money over the long term. In particular, it implies that the development of the Ghanaian stock market over time and as a result of the close vicinity of the stock markets will perplex investors who will have to decide between investing in Ghana or the WAEMU zone. It is therefore appropriate for economic policymakers to take into account the proximity between stock exchanges in order to reduce the adverse effects of one on the other. As a policy implication, this study underlines that it would be wise for investors to take this interdependence into account before taking any action in the WAEMU market in order to make their assets profitable.

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