RANDOM WALK BEHAVIOUR OF THE AFRICAN STOCK MARKETS IN THE PRESENCE OF STRUCTURAL BREAKS /CHANGES

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Abstract- The research work was set out to investigate the specific panel of seven African stock markets betweenthe period of 1988 to 2014 with a view to determining their Weak Form efficiencies and more importantly examining the structural breaks within this period. The existing methods on Seemingly Unrelated Regression Augmented Dickey Fuller Test, Variance Ratio Tests, and Perron Break Test were implemented in the investigation.The results suggested that the null of unit root cannot be rejected at 5% critical level of significance for all the countries. There were all evidences from the Variance Ratio Tests to accept the null that all the markets follow a random walk behavior. Results of the Structural Break Testgave supporting evidence at 1% level of significant to reject the null of unit root process for Nigeria as against regime wise level stationarity with a single structural change suspected at 2006 and the null of unit root process may also be rejected for Botswana as against the trend level stationarity in the presence of a single structural change at same year. In similar vein, the results gave evidence to support the rejection of the null of unit root as against trend stationary with two structural changes for Nigeria, Botswana,Egypt and Ghana at 1% level of significances. This research work interprets this phenomenon as aftermath of global financial crisis. However, all the markets investigated are not badly affected during the period investigated, though their trends are slightly destructed.

keywords- Weak Form Efficiency, Seemingly Unrelated Regression Augmented Dickey Fuller Test, Variance Ratio Tests, Structural Break Test.

I. INTRODUCTION

Seemingly Unrelated Regression Augmented Dickey Fuller (SURADF) test by Breuer et al.(2001 and 2002) is used to explore the random walk behavior of the African Stock Markets between the period of 1988-2014 (26years).Unlike the earlier tests implemented in the existing literature, this identifies which particular series in a panel that are having unit root and the ones that are stationary. Random walk property constitutes one of the properties of efficient stock markets. The present work focuses on the weak-form efficient version, which asserts that security prices fully reflect all information contained in the past price history of the market. The stock market value is used as a proxy to market broad indicator such as the market share all index for all the countries under study. The specific unit-root test (SURADF test) identifies which of the series in the panel of stock market values are stationary and the ones that are not. The ones that are stationary are term as a mean reverted stock markets, this means that these markets are not efficient. For such markets, there will be need for more vibrant trading activities between the potential investors and market financial operators. On the other hand however, those markets that are evidenced with a unit root process are said to possess that property of stock markets that reflect all information contained in the past history of the market. Variance ratio tests such as Lo and Mackinlay (1989) test and Kim (2006) bootstrapping tests were also carried out to test this property of capital markets. Finally, the structural break tests of Perron (2006) was used to examine the breaks in these markets for the period under study.

However, as for the coverage, this work selected seven African stock markets based on the performance of their stock market values for the periods under investigation. Thus, on this basis, the stock markets of Botswana, Egypt, Ghana, Kenya, Morocco, Nigeria and South Africa are included in the coverage. For more details see Nile Capital Management (2011).Capital Market Authority, CMA (2010) describes the boom period of Sub-Sahara African (SSA) as period between the years 2000 and 2007. The report informs that a robust growth and abundant global liquidity are recorded during this period. Thus, the region as of the time attracted an increasing number of investors in search of high yields. As a result, private capital inflows, including foreign direct investment, portfolio equity flows and debt flows experienced remarkable increases. Private capital inflows took off, driven by a number of domestic and external factors that contributed towards enhancing the region's attractiveness for foreign investors in search of high yields. However, the financial turmoil originating from the developed countries in August 2007 spreads at the rates that are unprecedented to developing countries, and hence, the secondary effects of the global financial crisis have quickly been felt by the most under developed SSA countries (Macias and Massa, 2009). SSA's market growth dropped from 6.9% in 2007 to 5.5% in 2008.This should not be astonishing for a good follower of equity –asset returns of the stock markets, as they have their unique characteristic behaviors

called the stylized facts. For details on this, see Engle (2001) and (Babayemi and Asare, 2010).As proclaimed by Papell and Prodan (2012) that identifying a single episode is appropriate for the interest of analyzing the effect of a particular financial crisis, the research used empirical application of the SURADF and some panel ratio tests to exploit random walk behaviour of all the African Stock Markets under investigation within the period of study.

This constitutes one of the properties of an efficient stock market.The recent related works to this research include Babayemi and Asare (2014), Adusei (2013),Ogboi and Oladipo (2012), Laurent et al (2011), Ndako (2010), Apergis et al. (2007), Christopoulos and Tsionas (2004), Keith and Graham (2005),Bokpin (2008), Macias and Massa (2009) and Olugbenga (2011) but are completely different in terms of coverage, method and presentation. The research however, aimed at investigating the panel of the seven African stock markets mentionedearlier with a view to determining their weak form efficiency and more importantly examining the structural breaks within this period as to confirm whether their effects could be attributed to the financial crisis era.

II. METHODOLOGY

2.1 Data

The African Stock Market Values of the following countries are included in the research: (i) Botswana (ii) Egypt (iii) Ghana (iv) Kenya (v) Morocco (vi) Nigeria and (vii) South Africa. These countries are included on basis of the performance their market capitalization to GDP for the period under investigation. The data are annually periodic and span through 1988-2014. They are collected from the WORLD BANK DATABANK and IMF DATABANK; their websites are www.worldbank.org and www.imf.org respectively.

2.2 SURADF TEST

This work introduces an error generating process with a level shift under the null of SURADF test as West (1988) specifies that with inclusion of intercept as only deterministic variable will improve the model and the critical values will be much more stable in as much as the number of replications for the simulation is large. Kim and Perron (2009) also stress the importance of including the level shift under both the null and alternative hypotheses in modelling unit root/structural break procedures. They argue that excluding the shift under the null hypothesis means that a level shift must be viewed as coming from the tail of the distribution of the generating process, and a slope change involves errors with different mean in some subsample. With the level shifts that may be affecting the regimes of different countries under investigation, one may not have but to include the intercept. The SURADF model is based on the following system of ADF equations:

$$\begin{cases} \Delta y_{1,t} = \mu_1 + \pi_1 y_{1,t-1} + \sum_{i=1}^{p_1} \delta_{1,i} \Delta y_{1,t-i} + e_{1,t} t = 1, \dots, T \\ \Delta y_{2,t} = \mu_2 + \pi_2 y_{2,t-1} + \sum_{i=1}^{p_2} \delta_{2,i} \Delta y_{2,t-i} + e_{2,t} t = 1, \dots, T \\ \dots \\ \Delta y_{N,t} = \mu_N + \pi_N y_{N,t-1} + \sum_{i=1}^{p_N} \delta_{N,i} \Delta y_{N,t-i} + e_{N,t} t = 1, \dots, T \end{cases} \quad \dots(3.1)$$

where, μ_i is the level shift introduced to the ith Country and $\pi_j = \rho_j - 1$and $\rho_j$is the autoregressive coefficient for series j (j=1,...N). This system is estimated by the SUR procedure and the null and the alternative hypotheses are tested individually as:

$$\begin{cases} H_0^1: \pi_1 = 0; H_A^1: \pi_1 < 0 \\ H_0^2: \pi_2 = 0; H_A^2: \pi_2 < 0 \\ \dots \\ H_0^N: \pi_N = 0; H_A^N: \pi_N < 0 \end{cases} \quad \dots(3.2)$$

With the test statistics computed from SUR estimates of system (3.1) and the criticalvalues are generated by Monte Carlo simulations.

2.3 PERRON BREAK TEST

The null hypothesis of Perron break test Perron, (2006) is a unit root process with a break and the alternative is a trend-stationary process with a break. The test has two versions, called additive and innovational outlier models, respectively. In the case of additive outlier, the break occurs instantly and is independent of the dynamics of the series. In the innovational outlier model, there is a period of transition during which the series responds to the shock to the trend function in the same way that it does to shocks to its own innovation process. Obviously, a market value shift develops within a certain transitional period. So the work goes with the innovational outlier model. The testing procedure consists of two stages: determining the break date, and using it in the data generating process. The break date is determined by minimizing the sum of squared residuals from regression of the model:

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \quad \dots(3.3)$$

where, $DU_t = 1, DT_t = t - T_1 \; if \; t > T_1$ and 0 otherwise. The immediate impact of the change in the intercept of the trend function is θ and immeadiate impact of the change in slope is γ, βt is the trend quantity, e_t is the term, $e_t \sim i.i.d.(0, \sigma_e^2)$. The test considers the the minimal value of the t-statistic for testing that $\alpha = 1$ over all possible break date in some pre-specified range for the break fraction$[\epsilon, 1 - \epsilon]$ with a popular choice of ϵ as 0.15. Denote the

resulting test by $t_\alpha^* = inf_{\lambda_1 \in [\epsilon, 1-\epsilon]} t_\alpha(\lambda_1)$, $t_\alpha(\lambda_1)$ is the t-statistic for testing $\alpha = 1$ in equation (3.3) when the break date $T_1 = [T\lambda_1]$ is used. The limit distribution of the test is

$$t_\alpha^* \Rightarrow \inf_{\lambda_1 \in [\epsilon, 1-\epsilon]} \frac{\int_0^1 W^*(r,\lambda_1) dW(r)}{\left[\int_0^1 W^*(r,\lambda_1)^2 dr\right]^{\frac{1}{2}}},$$

where, $W^*(r, \lambda_1)$ is the residual function from a Wiener process W(r) on the relevant continuous time version of the deterministic components.

III. RESULTS AND DISCUSSION

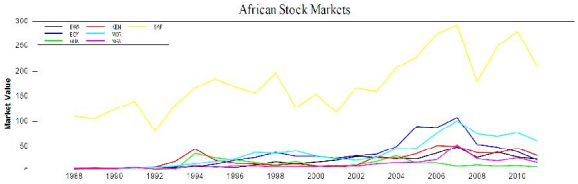

Fig. 3.1 Movement Pattern of the Market Values of the Countries under Study

The movement of the lines in Fig. 4.1, displayed the stock market values across the panel and showed that the movement is more pronounced in South Africa stock market while little or no much fluctuation was noticed in other African countries. An upward and steady trend is noticed in this market. This is not astonishing, as South Africa has the largest market capitalization in Africa. CMA (2010) assessed her market capital base to the tune of $180 billion.

The simulated 5% critical values of $SURADF_m$ for the stock markets of the seven countries are given thus:

Table 3.1SURADF Test with 5% critical values for the African Stock Markets

Country	Test Statistic	Critical Value
Botswana	-3.486	-11.363
Egypt		-4.615
Ghana		-2.474
Kenya		-3.303
Morocco		-3.275
Nigeria		-3.238
South Africa		-4.358
		-15.987
		-8.497
		-14.378
		-14.134
		-7.611
		-71.294

Table 3.2 Results of Variance Ratio Tests

Max|z|	p-value	df		
Lo and Mackinlay; Fisher Combined	4.5144	0.9915	14	
User Specified Lags: 2, 4, 8, 16				
Null Hypothesis: MKT_VAL is a martingale				
Cross-section Joint Tests				**Obs**
BWA	0.97430.798426			
EGY	1.2129	0.6395		26
GHA	1.3874	0.5146		26
KEN	0.8603	0.8612		26
MOR	0.7140	0.9242		26
NGA	0.9566	0.8088		26
SAF	1.2422	0.6186		26
Kim Wild Bootstrapping; Fisher Combined	7.8396	0.8975	14	
User Specified Lags: 2, 4, 8, 16				
Replicates=5000, distr=Normal				
Null Hypothesis: MKT_VAL is a martingale				
Cross-section Joint Tests				
BWA	1.14930.530426			
EGY	0.9654	0.9050		26
GHA	1.7996	0.2750		26
KEN	1.2559	0.7086		26
MOR	0.9037	0.6420		26
NGA	1.1033	0.7788		26
SAF	1.5024	0.2892		26

The results of the specific panel unit root presented in Table 3.1 suggest that the null of unit root (random walk) cannot be rejected for all the countries. In the context of the institutional characteristics of the various stock exchanges and the economies in which they operate, this indicates that absolute size (in terms of capitalization and turnover) and the rate of growth of market liquidity seem to be moving towards weak form efficiency. This confirms the work of Keith and Graham (2005), their study of random walk behavior of some African stock markets using GARCH models and this indicates that the South Africa, Egypt, Morocco and Nigeria stock markets are weak form efficient, nevertheless the stock market of Kenya is found inefficient in their result and. Since market efficiency evolves with time, and then the two results tend to be commendable for two different time domains.

The results of the test from our study are not amazing as it is expected that emerging stock markets (like African Stock Markets) are likely to more efficient as the markets operate and its microstructures develop over a certain period. Again, there is no equilibrium certainty of the markets in the presence of financial crisis.Variance ratio tests are also used to verify the random walk behavior of these financial markets. Lo and Mackinlay (1989) and Kim (2006) variance ratio tests were used in panel setting.

The results in Table 3.2 reveal that there are all evidences to accept the null that all the markets follow a random walk behavior. By the assumption of these tests if the set of data follow random walk, the variance of the K period difference should be K times the variance of the one - period difference and these markets in panel suggest having substantial p-values to support this argument.

Table 3.3 Results of Unit Root including One structural break

African Stock Market	αBreaky	k	t_α		
ur1 test including One Structural Change					
BWA	-0.307	2006:01	21.84	1	-2.397
EGY	-0.240	2004:01	44.51	2	-1.992
GHA	-0.480	1993:01	30.06	0	-2.620
KEN	-0.260	1993:01	23.83	0	-1.811
MOR	-0.143	2005:01	34.16	3	-1.538
NGA	-0.479	2006:01	35.41	2	-5.133***
SAF	-0.340	1993:01	17.13	0	-2.107
ur3 test including One structural change					
BWA	-0.969	2006:01	22.56	0	-4.877*
EGY	-0.834	2002:01	-28.31	3	-2.946
GHA	-0.524	2003:01	18.16	0	-2.777
KEN	-0.561	1993:01	33.55	0	-3.475
MOR	-1.054	2004:01	-31.12	3	-3.466
NGA	-0.817	2006:01	41.39	2	-4.637
SAF	-0.977	2006:01	76.02	0	-4.172

Let *, ** and *** represent 10%, 5% and 1% level of significant flyers.

ur1 test with t_α= -4.20 (10%), -4.46 (5%) and -5.05 (1%)

ur3 test with t_α= -4.72 (10%), -5.02 (5%) and -5.61 (1%)

Table 3.4 Results of Unit Root including two structural breaks

African Stock Market	αBreak 1		γ_1Break 2	γ_2	k	t_α	
ur2 test including two structural changes							
BWA	-0.316	2001:01	9.89	2006:01	22.75	1	-2.50
EGY	-0.305	2004:01	40.11	2010:01	-67.15	3	-2.66
GHA	-0.527	2003:01	14 .78	2005:01	2.34	0	-3.02
KEN	-0.309	2005:01	19.36	2007:01	-6.40	0	-2.28
MOR	-0.182	2006:01	31.74	2008:01	1.58	0	-2.15
NGA	-0.532	2006:01	36.30	2009:01	11.23	0	-5.76**
SAF	-0.417	2006:01	61.83	2008:01	73.64	0	-2.42
ur4 test including two structural changes							
BWA	-1.116	1999:01	-6.33	2006:01	21.51	0	-5.87*
EGY	-1.693	2003:01	-34.57	2009:01	53.93	3	-9.87***
GHA	-1.945	1993:01	-20.49	2002:01	-16.42	3	-7.53***
KEN	-0.578	1993:01	34.36	2005:01	20.10	0	-4.37
MOR	-1.158	1995:01	-7.11	2004:01	-37.17	3	-4.21
NGA	-0.730	2006:01	34.30	2009:01	11.10	0	-6.99***
SAF	-1.187	1997:01	80.46	2006:01	101.47	0	-5.09

Let *, ** and *** represent 10%, 5% and 1% level of significant flyers.
ur2 test with t_α= -5.24 (10%), -5.51 (5%) and -6.06 (1%)
ur4 test with t_α=-5.69 (10%), -5.96 (5%) and -6.45 (1%)

ur1: Perron Break Test that allows the test of null of unit root against regime wise level stationarity with one structural change
ur2: Perron Break Test that allows the test of null of unit root against regime wise level stationarity with two structural changes
ur3: Perron Break Test that allows the test of null of unit root against trend level stationarity with one structural change
ur4: Perron Break Test that allows the test of null of unit root against trend level stationarity with two structural changes

The report of results in Table 3.3 gave supporting evidence at 1% level of significant to reject the null of unit root process for Nigeria as against regime wise level stationarity with a single structural change suspected at 2006 and the null of unit root process may also be rejected for Botswana as against the trend level stationarity in the presence of a single structural change. Nonetheless, the results of the same table reveal that for other African Stock Markets, there is no evidence to reject null of unit root as against either regime wise or trend level stationarity in the presence of a single structural change.On the other hand the results in Table 3.4 reveal at 5% level of significance the evidence to reject the null hypothesis of unit root process in Nigeria as against the regime wise level stationary with two structural changes suspected at 2006 and 2009. In similar vein, the results gave evidence to support the rejection of the null of unit root as against trend stationary with two structural changes for Nigeria at 1%,, Botswana at 1%, Egypt at 1% and Ghana at 1% level of significances. This research work interprets this phenomenon as aftermath of global financial crisis. However, all the markets investigated are not badly affected though their trends are slightly destructed.

CONCLUSION

The research work was set out to investigate the specific panel of seven African stock markets between the period of 1988 to 2014 with a view to determining their weak form efficiency and more importantly examining the structural breaks within this period. The existing methods on Seemingly Unrelated Regression Augmented Dickey Fuller Test, Variance Ratio Tests, and Perron Break. The results of the specific panel unit root suggested that the null of unit root cannot be rejected for all the countries.
In the context of the institutional characteristics of the various stock exchanges and the economies in which they operate, this indicates that absolute size (in terms of capitalization and turnover) and the rate of growth of market liquidity seem to be moving towards weak form efficiency. This confirms the work of Keith and Graham (2005), their study of random walk behavior of some African stock markets using GARCH models and this indicates that the South Africa, Egypt, Morocco and Nigeria stock markets are weak form efficient, nevertheless the stock market of Kenya is found inefficient in their result and. Since market efficiency evolves with time, and then the two results tend to be commendable for two different time domains. There were all evidences to accept the null that all the markets follow a random walk behavior from the Variance Tests. The Perron Break test with Single structural change gave supporting evidence at 1% level of significant to reject the null of unit root process for Nigeria as against regime wise level stationarity with a single structural change suspected at 2006 and the null of unit root process may also be rejected for Botswana as against the trend level stationarity in the presence of a single structural change.
Nonetheless, the results of the same table reveal that for other African Stock Markets, there is no evidence to reject null of unit root as against either regime wise or trend level stationarity in the presence of a single structural change.On the other hand the Perron Break Test with two structural changes revealed at 5% level of significance the evidence to reject the null hypothesis of unit root process in Nigeria as against the regime wise level stationary with two structural changes suspected at 2006 and 2009. In similar vein, the results gave evidence to support the rejection of the null of unit root as against trend stationary with two structural changes for Nigeria at 1%, Botswana at 1%, Egypt at 1% and Ghana at 1% level of significances. This research work interprets this phenomenon as aftermath of global financial crisis.

However, all the markets investigated are not badly affected though their trends are slightly destructed.

REFERENCES

[1] Adusei, M. (2013). Financial Development and Economic Growth: Evidence from Ghana. *The International Journal of Business and Finance Research*, **Vol**. 7(5), p. 61-76.

[2] Apergis, N., Filippidis, I., and Economidou, C., (2007). Financial Deepening and Economic Growth Linkages: A Panel Data Analysis. *Review of World Economics*,**Vol.** 143, No. 1, p. 179-198.

[3] Babayemi A. W., and Asare B. K., (2010). Volatility Modeling of Asset Returns, *International Journal of Natural and Applied Sciences*,**Vol**. 6, No. 1, p. 1-9.

[4] Babayemi A. W. and Asare B.K. (2014). African Stock Markets, Banks and the Long-run Economic Growth. *Equity Journal of Science and Technology*, **Vol.** 2, No. 1 p.1-15.

[5] Bokpin G. A. (2008). Ownership Concentration and Corporate Performance on the Ghana Stock Exchange: A Panel Data Analysis, *International Academy of African Business and Development(IAABD) Proceedings*, **Vo**l. 9, p. 9-16

[6] Breuer, J. B., McNown, R. and Wallace, M. S. 2001. Misleading Inferences from Panel Unit Root Tests with an Illustration from Purchasing Power Parity. *Review of International Economics* 9: 482-493.

[7] Breuer, J. B., McNown, R. and Wallace, M. S. 2002. Series-specific Unit Root Tests with Panel Data. *Oxford Bulletin of Economics and Statistics* 64: 527-546.

[8] Capital Market Authority (CMA), (2010). A Comparative Analysis of the Performance of African Stock Markets for the Period 2008-2009 Volume II, Research, Policy Analysis and Planning Department, June 2010.Accessed on 17/04/2011, Time: 7am.

[9] Christopoulos, D. K., Tsionas, E. G., (2004). Financial Development and Economic Growth: Evidence from Panel Unit Root and Cointegration Tests. *Journal of Development Economics*, **Vol**.73, No. 1, p.55- 74.

[10] Engle, R. F. (2001). Financial Econometrics - A new discipline with new methods, *Journal of Econometric***Vol.** 100, p. 53- 56.

[11] Keith, J. and Graham, S. (2005) The Changing Efficiency of African Stock Markets. *South African Journal of Economics***Vol. 73,** p. 54-66

[12] Kim J.H. (2006). Wild bootstrapping variance ratio tests. Economics Letters, **Vol**. 92, p.38-43.

[13] Kim, D. and Perron (2009). Unit root tests allowing for a break in the trend function at an unknown time under both the null and alternative hypotheses. Journal of Econometrices, Elsevier, Vol. 148(1). 1-13.

[14] Laurent C., Christian G., Franz P., (2011). Stock Markets, Banks and Long- run Economic Growth: A Panel Cointegration-Based Analysis. *Preprint submitted to Elsevier*. Retrieved: 02/04/12, Time: 3pm

[15] Lo, A. and Mackinlay, A. C. (1988). "Stock Market Prices Do Not Follow Random Walks. Evidence from a Simple Specification Test", *Review of Financial Studies*, Vol. 1, No. 1, p. 41-66

[16] Macias, J.B. and Massa,I. (2009). The global financial crisis and sub-Saharan Africa: The effects of slowing private capital inflows on growth, Overseas Development Institute, 111 Westminster Bridge Road, London SE1 7JD. Retrieved: 02/02/11, Time: 11:11pm.

[17] Ndako U.B. (2010). Financial Development and Economic Growth: Evidence from Nigeria. *Journal of Financial Economics*, **Vol.** 8, No. 4., p. 14, 23-24.

[18] Nile Capital Management, LLC, (2011). Nile Pan Africa Fund (Nafax) – 2010 Performance Update. http://www.nilefunds.com. Retrieved 20/09/2011, Time: 2pm

[19] Ogboi C. and Oladipo S.O. (2012). Stock Market and Economic Growth: The Nigerian Experience, *Journal of Finance and Accounting*, **Vol.** 3, No. 4, p. 103.

[20] Olugbenga A.A. (2011). The Impact of Macroeconomic Indicators on Stock Prices in Nigeria, Developing Countries Studies, **Vol**. 1, No. 2, p. 1-14.

[21] Papell, D. H. and R. Prodan (2012). The statistical behavior of GDP after Finnancial crises and severe recessions. The B.E. Journal of Macroeconomics **Vol.** 12, No 3, p. 31.

[22] Perron, P. (2006) "Dealing with Structural Breaks". In Palgrave Handbook of Econometrics, Econometric Theory, K. Patterson and T.C. Mills (eds.), PalgraveMacmillan, Vol.1, p.278-352.

[23] West, K.D. (1988) Asymptotic Normality when Regressors have a Unit Root, *Econometrica***Vol.** 56, p. 1397-1418

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