



## STOCK MARKET INTEGRATION IN WEST AFRICAN MONETARY ZONE: A LINEAR AND NONLINEAR COINTEGRATION APPROACH

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### ABSTRACT

*The capital market plays a significant role in the development of an economy and hence an important determinant of regionalisation and single currency area formation. Stock and other capital markets have been found to predict and promote economic activities. The equity markets have been found to predict recession. As the Anglophone countries in West Africa prepare to introduce a second common currency in the region, it is imperative to assess their readiness by analysing the nature of their capital markets. The paper investigated if stock markets in the zone are integrated, since it is being suggested as the basis for common currency. Both linear and nonlinear cointegration methods were employed. The results from the linear cointegration indicated that the only active stock markets (Ghana Stock Exchange and Nigeria Stock Exchange) in the region are not integrated. However, the linear method showed a bleak sign of integration. A fractional integration method showed that whereas the Ghana Stock Exchange has infinite shock duration, the Nigeria Stock Exchange is long-lived. In effect, the markets are more of segmented than integrated, and hence appropriate for risk diversification. It is suggested that the countries work towards harmonising the capital markets through cross listing and adopting common capital market policies.*

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**Keywords:** Stock market, Integration, WAMZ, Linear, Nonlinear cointegration, Fractional integration.

**JEL:** E440,E44,G00

### 1. INTRODUCTION

In integrating economies, significant attention should be paid to joint economic growth and wealth appreciation. Financial markets have been found to predict and promote economic activities (Comincioli, 1995). The traditional valuation model links capital markets and wealth, and posit that the current market value of equity reflects future economic expectation and so it is good predictor of the economy (Comincioli, 1995). Stock markets have been found to be forward looking with current prices that reflect the future earnings, potential or corporate bodies who are key

determinants of economic growth (Pearce, 1983). The equity markets have been found to predict recession (McCracken, 2010). Several other studies have linked the stock market activities to the economy and therefore its importance as a basis for regionalization and single currency adoption.

Chavoushi (2010) examined the development of correlation between country indices during monetary and economic integration in the European Union and found that correlations among country indices increased considerably during the period of closer economic cooperation and integration from 1979 to 1999. However, it was discovered that intra-country correlations decreased substantially after 1999. Consequently, a geographic diversification strategy is optimal for most investors even after the introduction of the euro. Two important deductions can be made from this finding. First, it can be argued that closer correlation of indices among the markets during the period prior to the introduction of the single currency aided the single currency introduction. Therefore it contradicts Chavoushi (2010) view that higher levels of financial market integration are neither a necessary nor sufficient condition for higher cross-country correlation. Second, the difficulty in explaining the phenomena of low correlation may be due to methodological deficiencies. It is also possible that the situation is caused by the recent economic and financial crises. Although there are some evidence of positive correlation in stock markets, identifying the causal links is much more difficult (Ehrmann and Fratzcher, 2006). As put forth by King and Wadhvani (1990), correlation between markets occurs as participants use available information to make price comparison between markets. Sentana and Wadhvani (1994) investigating into volatility spillovers between stock markets, found that changes in correlations between markets are driven mainly by changes in unobservable variables. However, these markets were not in a common regional bloc as the markets under investigation in this paper.

The stocks are listed and traded on stock exchanges which are entities of a corporation or mutual organization specialized in the business of bringing buyers and sellers of the organizations to a listing of stocks and securities together. The creation of regional bodies (monetary unions) in recent times has brought about stock market mergers and integration. In addition, Marashdeh (2006) used the efficient market hypothesis to determine level of stock market integration. An interesting proposition made by Mukhopadhyay (2009) was that financial market integration across countries work at distinct levels. First, financial market integration seems more prominent among markets which are at comparable stage of development. The developed markets are more integrated with each other than less developed markets. Second, financial market integration is mostly led by developed markets. Third, the emerging markets tend to suffer much more than the developed markets during times of distress. The paper investigated if stock markets in the zone are integrated, since it is being suggested as the basis for common currency. The paper employed stock market as measure of the capital market activity on the assumption that it is the most developed market within the zone, compared to the bond markets.

## 2. LITERATURE REVIEW

Stock market integration means that the law of one price is fully consistent throughout all traded assets. In general it is believed that as markets become more integrated, the cost of capital decreases, because the removal of investment barriers allows for imported risk sharing between domestic and foreign agents. Capital market integration means that capital should move freely across the boundaries in a region with minimal friction or transactional costs (Mensah, 2006). But of course, this would have to be preceded by strong economic, social and political ties. In the view of Jain and Bhanumurthy (2005), the developed nature of the respective domestic markets is paramount to integration. Lee and Ho (2009) opined that strong market linkages are induced by strong economic ties among countries through direct investment and trade. There is level of trade relations and trade protocols among member countries within the WAMZ, especially between Ghana and Nigeria, the two countries spear heading the common currency agenda within the zone. Marashdeh (2006) referred to stock market integration as an area of research in financial economics that covers many aspects of interrelationships between stock markets. In stock market integration, all assets with the same level of risk have the potential to attract the same return across all different markets. He opines that there is a popularity of stock market integration due to the competitive auction-model and risk theory. The competitive auction-model asserts that where there are no barriers to capital movement, stock market integration leads to a more efficient allocation of the world's resources, and capital will seek higher returns to investment, moving from stock markets where capital is relatively abundant to another where capital is relatively scarce. The risk theory discusses the market and unique risks. Market risk becomes unique risk to be diversified or eliminated by including the security as part of diversifiable portfolio. Integration of stock markets causes all risk factors to be traded at the same price (Marashdeh, 2006). Jain and Bhanumurthy (2005) opine that domestic securities markets at their developing stage do not easily integrate with the international market. The stock markets within the WAMZ are within this stage and would be interesting exploring these markets to determine their level of integration.

Meanwhile, differences in industry structure have been found as potential explanation for financial market integration; whereby countries with similar industrial characteristics co-move (Roll, 1992). Campbell *et al.* (2001) and Griffin and Stulz (2001) found industry-specific factors as important determinants in understanding international equity market co-movements. However, this position has been contended in other works. According to Heston and Rouwenhorst (1994) and Griffin and Karolyi (1998), industrial structure explains very little of the differences in market volatility across countries.

According to Trichet (2005) there are obstacles to cross border activities within the Euro area equity markets. Nevertheless, a rising degree of integration is signalled by a decreasing cross-country dispersion of equity index returns. Common factors seem to gain: while in the 1980s only 20% of local return variance could be explained by aggregate European (and US) shocks, the proportion increased to 40% after the introduction of the Euro (Baele *et al.*, 2004; European Commission, 2004). Even under the circumstances, Inzinger and Haiss (2006) argue that the level

of integration in the equity market remained below the expectations in the European markets. They found that there are differences among equity ownership, fragmentation in securities settlement and differences in capital gain tax. Such situation impairs on quest of integrating the equity market.

Previous studies have emphasised ways to improve upon the existing path to single currency or challenges countries face in meeting the criteria. On stock markets, the earlier studies have concentrated on the effect on stock market development and the economy at the country level (Yartey and Adjasi, 2007; Ezeoha *et al.*, 2009; Osamwonyi and Kasimu, 2013). Hence, the link between the stock market in the WAMZ countries has not been established in any previous studies.

In addition, extensive discussion has also taken place of the macroeconomic performance of individual member countries in the zone. What is lacking in the earlier studies as far as WAMZ is concern is whether the capital markets are integrated or not. Meanwhile, the behaviour of the capital market is critical for growth and predicting possible future crisis like the recent Euro zone and the sub-prime crisis in the United States of America. For instance, stock markets a catalyst in predicting and promoting economic growth (Comincioli, 1995) as well as predicting recession (McCracken, 2010).

Outside the zone, Aggarwal *et al.* (2003) examined time-varying integration of equity markets, Kim *et al.* (2005); Miller and Pollard (2008); Abas (2009) studied integration among stock markets; Talia (2004), Lovegrove (2007), Battéy *et al.* (2009) studied exchange rate integration. However, none have used their findings as the basis for single currency adoption.

## 2.1. Overview of Stock Markets in West African Monetary Zone

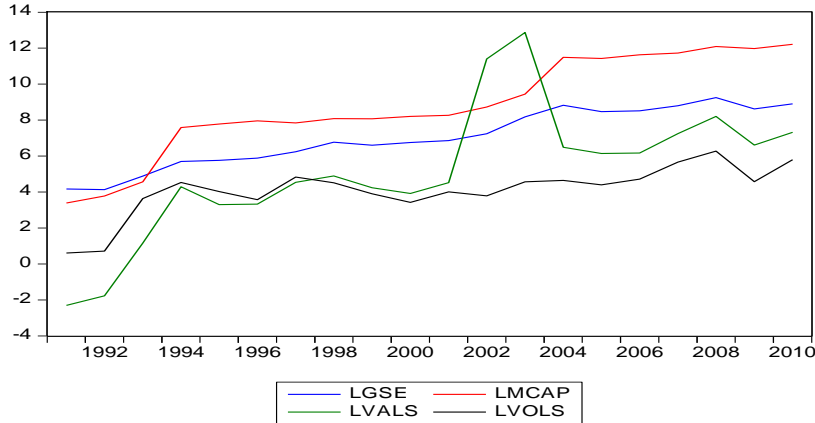
It is estimated that there are 29 stock exchanges representing 38 countries in the 52 countries in Africa (ASEA, 2012). Out of the twenty nine (29), twenty one (21) of them are members of the African Stock Exchanges Association (ASEA, 2012).

There are two notable regional stock exchanges-Bourse des Valeurs Mobilières' Afrique Centrale or BVMAC (for the Central African Republic, Chad, Congo Republic, Congo Republic, Gabon); Bourse Régionale des Valeurs Mobilières, or BRVMC (for the Cote d'Ivoire, Guinea Bissau, Benin, Burkina Faso, Mali, Niger, Senegal and Togo). The Johannesburg stock exchange (JSE) is the largest stock market in Africa. There are currently three stock exchanges in the WAMZ; Ghana Stock Exchange, Nigeria Stock Exchange and Sierra Leone Stock Exchange.

## 2.2. The Ghana Stock Exchange

The Ghana Stock Exchange is one of the emerging markets in the world. According to Moss (2003), the first formal proposal for establishing a stock exchange in Ghana was made some eighteen years before its actual inauguration. As at December 2012, 36 companies were listed. Ghana's stock market has attracted domestic and foreign companies' attention because of its fast development and potential opportunities. The trend on the stock market in Ghana has been erratic exhibiting the bearish and bullish character often associated with such markets. The performance of the exchange since its inception is shown in Figure 1.

Figure- 1.Trend on the Ghana Stock Exchange

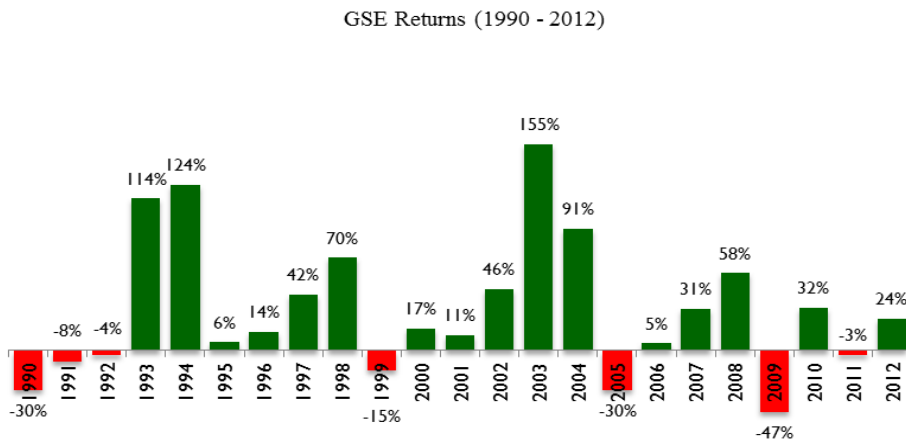


Source: GSE Fact Books

In terms of size and resource mobilization, total market capitalization reached 97,614 billion cedis in 2004 from a previous year’s of 12,616 billion cedis. Trading volume hit 104.4 million shares by 2004 (GSE Fact Book, 2005).

From the Figure 1, it could be seen that the volumes of equity traded on the exchange have been erratic since the 1990s to date. Volume peaked in the 1997 with 125.63 million cedis. Also 104.4 million shares valued at 655.9 billion cedis were recorded in 2003 as against 96.3 million shares valued at 389.3 billion for 2003. Trading volume typically hits 104.4 million shares by 2004. Figure 2 shows a rising share index in the market from an initial creeping index, in the early 1990s, but this tends to rise steadily as it gets to the 2000s. This is indicated on the graph by the rise of the index line between 1995 and 2005. Perhaps, one can say that firms and investors were beginning to understand the important role played by the Exchange in an economy. Hence more companies were being listed and several investors were also participating in the exchange (Adjasi et al., 2008).

Figure-2. Ghana Stock Exchange (GSE Fact Book) Returns



(Ghana Stock Exchange, Fact Books)

The Exchange achieved its most outstanding performance by the end of the year 2003, when the All-Share Index topped performance of several emerging stock markets. This is indicated by a sharp rise in the line between the period of 2000 and 2005. Performance at the end of 2005 was however not impressive as indicated by the GSE All Share Index (Adjasi *et al.*, 2008).

Market capitalization reached 97,614 billion cedis in 2004 from a previous year's of 12,616 billion cedis. However there was a sharp rise in the market capitalization line between the years 2000 and 2005. As was reported in the 2005 edition of the GSE Fact Book, the market capitalization performance has been better especially in 2003 and 2004 seasons. It rose from 12,616 billion cedis in 2003 to 97,614 billion cedis in 2004. This was attributed to the listing of AngloGold Ashanti Limited through a merger.

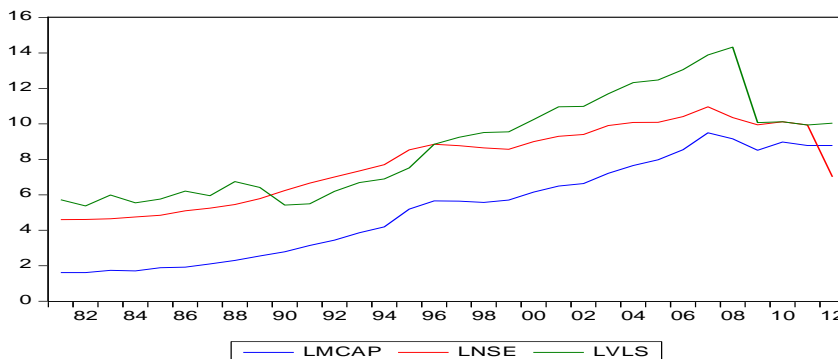
### 2.3. Nigerian Stock Exchange

The Nigerian Stock Exchange Johansen (1991) started operation on 5th June 1961 as the Lagos Stock Exchange (LSE). The LSE was reorganized and renamed the Nigerian Stock Exchange Johansen (1991) in 1977 following the Okigbo Financial Review Committee's recommendation in 1976. The NSE has a head office in Lagos and nine (9) functional trading floors (Emenike, 2008). In recent years, the Nigerian Stock Exchange Johansen (1991) has witnessed growth in market capitalization, membership, value and volume traded. By December 2007, the All Share Index has grown over 57,990.2 from 1113.4 in January 1993 (Gimba, 2012). The NSE is the second largest financial centre in sub-Saharan Africa (ASEA, 2013).

As of December 31, 2012, it had about 198 listed companies with a total market capitalization of about N8.9 trillion (\$57 billion). The capitalization of listed equities grew by 37.31% from N6.54 to N8.98 trillion (\$57.77 billion); the NSE All Share Index (ASI) gained 35.45%; and average daily turnover for equities was N2.65 billion (\$17.05 million), up 2.71%.

By convention, the size of a country's stock market is assessed by its capitalization relative to GDP (Nnanna *et al.*, 2004). The size of NSE increased from 6.9% in 1993 to 28.1 in 2006; liquidity also increased from 0.7% to 7.8% in the same period.

Figure- 3. Trends on the Nigerian Stock Exchange



Source: Nigeria Stock Exchange, 2013

## 2.4. Sierra Leone Stock Exchange

After many years of planning, the Sierra Leone Interim Stock Exchange was inaugurated in 2007. On 17 July 2008, Sierra Leone Stock Exchange was launched. Initially, an interim stock trading facility with the mandate to provide a world class regulatory framework for share transactions, trading proper started on 21 November 2011, when Rokel Commercial Bank was listed. There are three brokerage firms acting as agents for trading in securities. Data on the SSE was difficult to obtain. The rest of the countries in the WAMZ did not operate a stock exchange in their respective countries. The Guinea is part of the BRVMC. The rest are not part of any regional stock market.

## 3. RESEARCH METHODOLOGY

Three cointegration methods, ARDL, Johanssen, and Bruitungcointegration were employed in establishing the relationship between the variables. The multiple methods of analysis have been employed to deal with the weaknesses often associated with the different methods.

### *Empirical ARDL Model Specification and Estimation*

The ARDL empirical specification for the analysis was specified as in equations 1 and 8. The test for lag length using the SchartzBaysian information criteria yielded an ARDL (1, 5):

$$\Delta GSE = \Delta NSE + \Delta GSE_{t-1} + \sum_{i=1}^5 \Delta NSE_{t-i} + NSE_{t-1} + GSE_{t-1} + C \quad (1)$$

ARDL (5, 1):

$$\Delta NSE = \Delta GSE + \Delta GSE_{t-1} + \sum_{i=1}^5 \Delta NSE_{t-i} + NSE_{t-1} + GSE_{t-1} + C \quad (2)$$

Where:

NSE = Nigeria market index

GSE = Ghanaian market index

To further explore the relationship among variables, a granger causality test was carried out to determine the direction of causality if any, between GSE and NSE. The equation for the pairwise Granger (1969) causality tests are as follow:

$$y_t = \beta_0 + \beta_1 x_t \quad (3)$$

### *Johansson Cointegration Test*

In addition, Johanssen's multivariate cointegration test based on the vector autoregression equation, with all variables assumed to be endogenous, was also employed. The multivariate case

in VAR forms (VAR, n variables); between n variables, there may be n-1 separate cointegration relations:

VAR.

$$y_t = A(L)y_{t-1} + \varepsilon_t \quad (4)$$

This is a series of coefficient matrices for the entire lagged variable variables t-1 to t-k.

$$A(L) = A_1 + A_2L + \dots + A_kL^{k-1} \quad (5)$$

Re-written in VECM

$$\Delta y_t = \Gamma(L)\Delta y_{t-1} + \prod y_{t-1} + \varepsilon_t \quad (6)$$

This can alternatively be stated as

$$\Delta y_t = \Psi(L)\Delta y_{t-1} + \prod y_{t-1} + \varepsilon_t \quad (7)$$

With same  $\Pi$  but different  $\Psi$

$$\Gamma_i = -(1 - A_1 - \dots - A_i), i = 1, \dots, k - 1 \quad (8)$$

$$\Pi = -(1 - A_1 - \dots - A_k) \quad (9)$$

Or  $\Pi = \alpha\beta'$  where

$\alpha$ =speed of adjustment, and

$\beta$ =matrix of long run coefficients such that

$\beta'y_{t-k}$  is the multiple cointegration relationships

The cointegration depended on the rank of matrix  $\Pi$  which provides several options:  $\Pi y_{t-k}$  must be  $I(0)$ :

- $r=n$  – all variables in  $y$  are  $I(0)$ , not interesting case to start with.
- $r=0$  – there are no linear combinations of  $y$  that are  $I(0)$ , no cointegration exists, and  $\Pi$  is full of zeros.
- $r \leq (n-1)$  – up to  $(n-1)$  cointegration relationships  $\beta'y_{t-k}$ . i.e.  $r \leq (n-1)$  rows of  $\Pi$  form  $r$  linearly independent combinations of variables in  $y$ , each of which is  $I(0)$ ; alternatively  $(n-r)$  nonstationary vector forming  $I(1)$  stochastic trends.



The number of significant characteristic roots (eigen values) of a matrix determines its rank. The numbers of roots are obtained from trace statistic and the maximum eigen values statistics shown in Table 1.

**Table-1.** Johanssen Rank

<b>H<sub>0</sub></b>	<b>H<sub>1</sub></b>	<b>Test statistic</b>	<b>Critical value 5% level</b>
<b>λ<sub>trace</sub> test</b>			
r=0	r>0	λ <sub>trace</sub> (0)	...
r≤1	r>1	λ <sub>trace</sub> (1)	...
...			
<b>λ<sub>trace</sub> test</b>			
r=0	r≥1	λ <sub>trace</sub> (0)	...
r=1	r≥2	λ <sub>trace</sub> (1)	...
<b>Johansen and Juselius (1990), Osterwald-Lenum (1992)</b>			

*Fractional Integration*

The stationary stochastic process,  $\chi_t$  is fractionally integrated (FI) if there exist a real number  $\check{R}$  and a finite constant  $K$  such that the autocorrelation function  $\alpha(\rho)$  decays at the rate.

$$K\rho^{2(R-1)} \text{ as } \rho \rightarrow \infty. \tag{10}$$

The fractional degree of integration  $d$  (measure of order of integration) is related to the parameter  $R$  by the equality  $d = R - 0.5$  (Box-Steffensmeier and Tomlinson, 2000; Alagidede *et al.*, 2010; Syczewska, 2010; Agyapong and Adam, 2012). The  $d$  classification in FI includes (Tkacz, 2001; Alagidede *et al.*, 2010; Agyapong and Adam, 2012):

<b>Class</b>	<b>Variance</b>	<b>Shock duration</b>	<b>Stationarity</b>
$d=0$	Finite	Short-lived	Stationary
$0 < d < 0.5$	Finite	Long-lived	Stationary
$0.5 \leq d < 1$	Infinite	Long-lived	Nonstationary
$d=1$	Infinite	Infinite	Nonstationary
$d > 1$	Infinite	Infinite	Nonstationary

**Hurst Exponent Method**

The Hurst ( $H$ ) value was expressed as the gradient of regression line of natural logarithms R/S on logarithms of subsamples number of observations,  $t$  (in computations either all divisors of whole sample size,  $T$ , is used, or consecutive powers of two less or equal to  $T$ ). For a time series,  $\chi = \chi_1, \chi_2, \dots, \chi_n$ , R/S analysis method is as follows (Agyapong and Adam, 2012):

1. Calculate mean value  $M = \frac{1}{n} \sum_{t=1}^n X_t$
2. Calculate mean adjusted series Y,  $Y_t = X_t - m, \quad t = 1, 2, \dots, n$
3. Calculate cumulative deviate series Z,  $Z_t = \sum_{i=1}^t Y_i, \quad t = 1, 2, \dots, n$

4. Calculate range series R,  $R_t = \max (Z_1, Z_2, \dots, Z_t) - \min(Z_1, Z_2, \dots, Z_t)$
5. Calculate standard deviation series S,  $S_t = \sqrt{\frac{1}{t} \sum_{i=1}^t (X_t - u)^2}$   $t = 1, 2, \dots, n$   
Here u is the mean value from  $X_1$  to  $X_t$ . Calculate rescaled range series (R/S)
6.  $(R/S)_t = R_t/S_t$   $t = 1, 2, \dots, n$

Hence the Hurst exponent equation was specified as (Peters and Edgar, 1997; Czekaj *et al.*, 2001; Agyapong and Adam, 2012):

$$\ln \left( \frac{R}{S} \right)_i = \ln(t_i) + \ln a \tag{11}$$

In cases where the number of observations is undersized, one can obtain H from:

$$H = \frac{\ln \left( \frac{R}{S} \right)}{\ln(0.5T)} \tag{12}$$

where:

$T$  = number of observations in whole sample,

$t_i$  = divisors of  $T$  (or powers of two not greater than  $T$ ).

$S$  = standard deviation of the series

$R$  = range of the series

The resultant value of series using the Hurst Exponent is interpreted as:

$H = 0.5$  – it implies random walk process;

$0 \leq H < 0.5$  – it implies antipersistent process, diverging from the mean; and

$0.5 < H < 1$  – it implies persistent process, mean-reverting.

#### *Breitung Rank Test for Nonlinear Cointegration*

The test of using fractional integration has been found to overcome the weaknesses in ARDL, Johansen and E-G approach to cointegration. However, this approach does not take into consideration the nonlinearity characteristic of time series of data. The rank and score tests (Breitung, 2001), is used for testing nonlinear cointegration. In order to test for cointegration between two time series  $y_t$  and  $x_t$ . Consider  $y_t$  as a function of  $x_t$  which may be represented by:

$$y_t = f(x_t) + u_t \tag{13}$$

Where  $y_t$  and  $f(x_t)$  are both integrated or order one, that is

$y_t \sim I(1)$  and  $f(x_t) \sim I(1)$ , and  $u_t$  stands for the stochastic disturbances. The cointegration tests in the past have been developed on the assumption that  $f(x_t)$  is a linear function of  $x_t$

As cited in Hsueh and Tsao (2011), (Breitung, 2001) showed that residual-based linear cointegration tests are inconsistent for some class of nonlinear functions (Sargan and Bhargava, 1983; Phillips and Ouliaris, 1990). In order to deal with this limitation, Breitung (2001) suggested cointegration test based on rank transformation of the time series. This test exploits the property that a sequence of ranks is invariant to monotonic transformation of the data (Hsueh and Tsao, 2011). In other words, if  $x_t$  is a random walk then the ranked series of  $x_t$  behaves like a random walk as well. In the same way, if two series are cointegrated, possibly nonlinearly, then the ranked series are cointegrated as well.

According to Hsueh and Tsao (2011), the rank transformation therefore permits getting away from specific functional forms of the cointegrating relation. The power of rank tests is that one does not have to be explicit about the exact functional form of the nonlinear cointegrating relationship (Breitung, 2001; Hsueh and Tsao, 2011).

The rank test is based on a measure of the squared distance between the ranked series. When the test statistic takes on a value smaller than the appropriate critical value, this is evidence against the null hypothesis of no cointegration in favour of the alternative hypothesis of cointegration because in this case the variables move closely together over time and do not drift too far apart. Such a test checks whether the ranked series move together over time towards a long-run cointegrating equilibrium that may be linear or nonlinear c.

Following the Breitung (2001), Hsueh and Tsao (2011) the ranked series was defined as

$R(w_t) = \text{Rank of } w_t \text{ among } (w_1, w_2, \dots, w_T)$ , where  $w = \{y, x\}$ . Two consistent rank-test statistics based on the difference between the sequences of ranks are as follows:

$$B_1 = T^{-1} \sup_{1 < t < T} |d_t|, \text{ and } B_2 = T^{-3} \sum_{t=1}^T d_t^2 \tag{14}$$

Where  $d_t = R(y_t) - R(x_t)$  with  $R(y_t)$  and  $R(x_t)$  are both monotonically changing. The basic idea of these rank tests is that the sequences of ranks tend to evolve similarly if there is cointegration between the two series  $y_t$  and  $x_t$ , otherwise the sequences of ranks tend to diverge. The null hypothesis of no (nonlinear) cointegration between  $y_t$  and  $x_t$  is rejected if these tests statistics are smaller than their respective critical values. The assumption here is that the two time series  $y_t$  and  $x_t$  are mutually serially uncorrelated random walks. To relax this somewhat unrealistic assumption, Breitung (2001) as cited in Hsueh and Tsao (2011), suggests that monotonic functions of  $y_t$  and  $x_t$  are converged with correlation coefficient  $\rho$ . If the value of  $|\rho|$  is small, the test statistics following corrections will be:

$$B_1^* = \frac{\sup_{1 < t < T} |d_t|}{T\sigma_{\Delta d}^2}, \text{ and } B_2^* = \frac{\sum_{t=1}^T d_t^2}{T^3\sigma_{\Delta d}^2} \tag{15}$$

Where  $\hat{\sigma}_{\Delta d}^2 = T^{-2} \sum_{t=1}^T (d_t - d_{t-1})^2$  are used to adjust for possible correlation between the two series of interest. If  $|\rho|$  is close to 1, the test statistics  $B_1^*$  and  $B_2^*$  should be obtained as:

$$B_1^{**} = \frac{B_1^*}{1-0.174(\rho_T^R)^2}, \text{ and } B_2^{**} = \frac{B_2^*}{1-0.174(\rho_T^R)^2} \tag{16}$$

Where  $\rho_T^R$  is the correlation coefficient for differences of ranks as follows:

$$\rho_T^R = \frac{\sum_{t=2}^T \Delta R_T(x_t) \Delta R_T(y_t)}{\sqrt{(\sum_{t=2}^T \Delta R_T(x_t)^2)(\sum_{t=2}^T \Delta R_T(y_t)^2)}} \tag{17}$$

The asymptotic distribution of the test statistics  $B_1^{**}$  and  $B_2^{**}$  are the same as  $B_1^*$  and  $B_2^*$  respectively. The null hypothesis of no cointegration is rejected if the critical value exceeds the test statistics. As indicated by [Breitung \(2001\)](#), the rank test can also be generalized to test cointegration among  $k+1$  variables  $y_t, x_{1t}, \dots, x_{kt}$ , where it is assumed that  $R(y_t)$  and  $R(x_{jt})$  for  $j=1, \dots, k$  are monotonic functions. As such, one may compute the following multivariate rank statistic ([Hsueh and Tsao, 2011](#)):

$$B_3[k] T^{-3} \sum_{t=1}^T (\tilde{u}_t^R)^2 \tag{18}$$

Where

$$\tilde{u}_t^R = R(y_t) - \sum_{j=1}^k \tilde{b}_j R(x_{jt}) \tag{19}$$

in which  $\tilde{b}_1, \dots, \tilde{b}_k$  are the least squares estimates from a regression of  $R(y_t)$  on  $R(x_{1t}), \dots, R(x_{kt})$ , and  $\tilde{u}_t^R$  are the estimated residuals. In order to deal with the probable correlation between the series, the statistics is modified as:

$$B_3^*[k] = B_3[k] / \tilde{\sigma}_{\Delta u}^2 \tag{20}$$

Where  $\tilde{\sigma}_{\Delta u}^2 = T^{-2} \sum (\tilde{u}_t^R - \tilde{u}_{t-1}^R)^2$

The null hypothesis of no (nonlinear) cointegration between  $y_t$  and  $x_t$  is rejected if these tests statistics are smaller than their respective critical values. Critical values obtained from Monte Carlo simulations of  $B_1^{**}, B_2^{**}, B_1^*, B_2^*, B_1, B_2$  and  $B_3^*[k]$  given in Table 1 of [Breitung \(2001\)](#).

To assess whether the cointegration is linear or nonlinear found by the rank test, [Breitung \(2001\)](#), cited in [Hsueh and Tsao \(2011\)](#) suggests the score test statistic  $T \cdot R^2 T$  be:

$$\tilde{u}_t = c_0 + c_1 x_t + c_2 R(x_t) + e_t \tag{21}$$

where  $T$  is the sample size,  $R^2$  is the coefficient of determination of regression [21], and

$\tilde{u}_t = (\tilde{\alpha}_t + \tilde{\alpha}_1 x_t)$ , where  $\tilde{\alpha}_t$  and  $\tilde{\alpha}_1$  in turn, are the least squares estimates from a regression of  $y_t$  on a constant and  $x_t$ . Under the assumptions that  $\tilde{u}_t$  is a zero-mean white noise and that  $x_t$  is exogenous, the score test statistic  $T \cdot R^2$  is asymptotically Chi-squared ( $\chi^2$ ) distributed with one degree of freedom. The null hypothesis of linear cointegration,  $c_0 = 0$ , may be rejected in favour of nonlinear cointegration when  $T \cdot R^2$  exceeds the  $\chi^2$  critical value. However, [Breitung \(2001\)](#) points out that in many cases,  $x_t$  is endogenous. [Breitung \(2001\)](#) proposes to adopt the cointegration regression, by truncating the infinite sums in the following specification appropriately:

$$y_t = a_0 + \sum_{j=1}^{\infty} a_j y_{t-j} + \beta_1 x_t + \sum_{j=-\infty}^{\infty} \gamma_j \Delta x_{t-j} + \varepsilon_t \quad (22)$$

The least squares estimated residual  $\tilde{\varepsilon}_t$  is then regressed on the regressors of equation [22] and  $R(x_t)$ . Under the null hypothesis of a linear cointegration relationship, the resulting  $T \cdot R^2$ , where  $R^2$  is the coefficient of determination of regression [22], is also asymptotically Chi-squared ( $\chi^2$ ) distributed. The Monte Carlo simulations by Breitung (2001) show that for a wide range of nonlinear models, the rank tests perform better than their parametric competitors (Hsueh and Tsao, 2011).

#### 4. EMPIRICAL RESULTS AND DISCUSSIONS

The data for the study comprised daily market index Ghana (GSE Fact Book) and Nigeria Johansen (1991). These are the only two countries with a vibrant capital market. The data used span from 2002:05 to 2011:02, yielding a sample size of 2264. The variables exhibit large variation (Table 2). The highest dispersion is found in the market index for Nigeria. It indicated that market index for Ghana and Nigeria are non symmetric (positively skewed). The positive values of market index of these countries indicate that the longer tails extends in the direction of large values. Also, market index of both countries does not follow a normal skewness.

The p-values of Jarque-Bera statistics ( $p < .00$  from Table 2) is less than five per cent for all the countries, hence the alternative hypotheses for all countries can be accepted – that the data are not normally distributed. This means the null hypothesis of normal distribution is rejected at the 5% level. The co-efficient of variation value for NSE (1.79) is less than that of the GSE (3.5); indicating a lower variability of stock prices on the NSE than the GSE.

**Table- 2.** Descriptive Statistical Analysis

	GSE	NSE
Mean	42.99	455.14
Median	42.70	372.53
Maximum	69.16	1142.29
Minimum	21.61	156.45
Std. Dev.	12.32	254.18
Skewness	.08	1.19
Kurtosis	2.23	3.32
Jarque-Bera	58.65	547.70
Probability	.00	.00
Sum	97330.11	1030444.
Sum Sq. Dev.	343292.5	1.46E+08
Observations	2264	2264

Source: Author's Computation, 2013

#### Tests for the order of integration, $I(1)$ vs. $I(0)$

The results of the tests for the order of integration of stock index are reported in Tables 3 and 4. With the Dicky-Fuller test, the null hypothesis of a common unit root cannot be rejected at levels  $I(0)$ . This was further confirmed by the  $I(1)$ . As reported in Table 3., the series for the countries are all stationary upon the first difference.

Also, using the ADF test, the null hypothesis of a common unit root could not be rejected for all the countries at levels. However, the series for all the countries attain stationarity upon the first difference. Again the results for the PP test indicated that the null hypothesis of a common unit root could not be rejected for all the countries at levels. However, the series for all the countries attain stationarity upon the first difference. In using the KPSS test, the null hypothesis that market indices of the countries are stationary at levels was not accepted. The series were found not to be stationary. Upon the first difference, the series for the two markets attained stationarity. Also, for the ERS test, the null hypothesis that the two markets indices contain unit root could not be rejected. The unit root hypotheses can be rejected for all the two markets.

**Table- 3.** Tests for the order of integration, I (1) vs. I (0) with Intercept

Country	DF (0)	DF (1)	ADF (0)	ADF (1)	KPSS (0)	KPSS (1)	PP (0)	PP (1)	ERS (0)	ERS (1)
GSE	.30	-45.97	.05	.00	.49	.36	.45	.00	66.97	.02
	-1.94	-1.94			.46	.46			3.26	3.26
NSE	-.43	-29.10	.65	.00	1.78	.37	.65	.00	34.54	.015
	-1.94	-1.94			.46	.46			3.26	3.26

Critical value at 5% (ADF, PP); DF – critical value is -1.94; KPSS is .46; ERS is 3.26

Source: Author's Computation, 2013

Similar trends of differences in results of unit root test were found when the series was tested with only intercept (Table 3) and also with intercept and trends (Table 4). The results from these tests indicate that there are no differences in the order of integration in the series for the two markets. This is an indication of differences in the behaviour of the two stock markets. The findings show that there is no uniformity in the behaviour of the NSE and the GSE. Two possible causes may account for these findings. First, the size of these markets in terms of market capitalisation and the number of listed companies are some of the plausible cause of the segmented nature of these markets. Additionally, although the countries have done some considerable work in trying to harmonise their economies since their first attempt at integration, the concentration has been on working on their macroeconomic indicators with the exception of the capital market. This is reflected in the convergence criteria set by member countries prior to the take off.

**Table- 4.** Tests for the order of integration, I (1) vs. I (0) with trend and Intercept

Country	DF (0)	DF (1)	ADF (0)	ADF (1)	KPSS (0)	KPSS (1)	PP (0)	PP (1)	ERS (0)	ERS (1)
GSE	-.73	-45.93	.81	.00	.49	.27	.79	.00	85.83	.08
	-2.89	-2.89			.15	.15			5.62	5.62
NSE	-.78	-29.21	.96	.00	.81	.19	.96	.00	50.96	.055
	-2.89	-2.89			.15	.15			5.62	6.89

Critical value at 5% (ADF, PP); DF (critical value) is -2.89; KPSS is .15; ERS is 5.62.

Source: Authors' computation, 2013

### Results from ADRL Cointegration Test

In Table 5, with GSE being the dependent variable, the computed F-Statistic is 1.41 (see Appendix 1) which is lower than the lower bounds critical value (4.94) and upper bound critical value (5.73). This means that the null hypothesis of no co-integration cannot be rejected. Based on this, it is inferred that no long run relationship exists between the stock markets of the two countries. It is therefore difficult to integrate these two stock markets that appear more segmented. As indicated earlier, the two markets are more segmented rather than integrated.

In order to probe further the relationship between the two markets, further test was carried out, this time, with the NSE as the dependent market. However, with NSE being the dependent, the results indicated that there is cointegration from NSE to GSE. From Table 5 the computed F-statistic is 50.16 which are higher than both the lower bounds critical value (4.94) and upper bound critical value (5.73).

**Table- 5.** F-Statistic for Testing the Existence of Long run Relationship

<b>Computed F-Statistic</b>	<b>1.4078</b>
Bound Testing Critical Value at 5%	4.94(Lower)
	5.73 (upper)

The critical values are taken from Pesaran *et al.* (2001), unrestricted intercept and no trend with a single regressor denote rejecting the null at 5% level. The range of the critical value at 10%, 5%, 2.5% and 1% are 4.04-4.78, 4.94-5.73, 5.77-6.68; and 6.84-7.84 respectively.

This means that the null hypothesis of no co-integration is rejected. Based on this, it is inferred that there is long run relationship between the stock markets of the two countries. To explain this inconsistent behaviour, other cointegration methods were used to confirm this finding. But in all, there was no indication of cointegration between the markets. So the issue of cross listing effect was seen to be the probable cause. There are some multinational companies that are listed on the stock markets in Ghana and in Nigeria. Due to its size, the NSE is likely to take a lead for investors on the GSE. So there is the tendency for investors on the GSE to move their stake in equities that are not performing well and invest in similar stocks on the NSE.

Although the behaviour of these markets poses a challenge for any capital market integration immediately, the later evidence (Table 6), is an indication that some form of integration is possible in the long run. Meanwhile, the behaviour of prices on the two markets is a subject of enduring fascination to investors. Since the markets are not moving together, and with the ECOWAS protocol of free movement of capital, these markets may be source of risk diversification by investors since the markets do not move together.

As indicated earlier, the segmented nature of the market could be as a result of differences in size, age and volume of transaction. As of December 2012, there were thirty-six companies listed on the GSE as against 198 companies listed on the NSE. Market cap was about USD57 billion or 21.5% of GDP for NSE as against a market cap of about USD26.42 billion or 8.5% of GDP for the

GSE (World Bank, 2012). In terms of age, the NSE is three decades older than the GSE. These differences are likely to also cause the segmented nature of these markets.

Another possible reason is information asymmetry on these two markets. The findings could represent a widespread assumption of less informed domestic and foreign investors about the investment potential of these emerging markets as the countries move towards integration. Again, if firms from these countries raise cross border capital from the stock markets in other countries in the region, then it could spur market integration as investors would be monitoring the activities on these different markets to making decisions on which market to invest and where to disinvest. The information flow theory and asymmetry theory explain the contagion or spillover effects in regional markets; and hence the need to monitor, collect and analyze relevant information.

**Table- 6.** F-Statistic for Testing the Existence of Long run Relationship

<b>Computed F-Statistic</b>	<b>50.16</b>
Bound Testing Critical Value at 5%	4.94(Lower)
	5.73 (upper)

The critical values are taken from Pesaran *et al.* (2001), unrestricted intercept and no trend with a single regressor denote rejecting the null at 5% level. The range of the critical value at 10%, 5%, 2.5% and 1% are 4.04-4.78, 4.94-5.73, 5.77-6.68; and 6.84-7.84 respectively.

### Results from Granger Causality Test

The result, shown in Table 7, indicated that none of the variables granger causes the other. This also indicates that there is no short run relationship between the variables.

**Table-7.**Granger Causality Test

<b>Null Hypothesis:</b>	<b>Obs</b>	<b>F-Statistic</b>	<b>Probability</b>
NSE does not Granger Cause GSE	2262	1.64102	0.19401
GSE does not Granger Cause NSE		0.63212	0.53156

**Source:** Authors' computation, 2013

The relative smallness of the GSE to NSE may result in a lack of causality between them since a small stock market implies smaller stock price movements compared with a bigger one with higher price movement. The Market capitalization of listed companies (% of GDP) in Ghana was 7.90 in 2011 and that of Nigeria is 16.1% (World Bank, 2012). It was expected that due to geographical proximity, regional economic ties, common historical experiences could have resulted in some co-movement between the countries. The results may be suggesting that the two countries are not reaping any significant benefit from their relationship. Another possible reason is that the countries may not be involved in that much investment and capital market activities and as a result, there is relatively lesser cross market activities between the two countries. Despite the relationship between the two countries, there is currently no Nigerian company or companies listed on the GSE and a Ghanaian company is yet to be listed on the NSE. The current cross listing is only by multinational firms operating in the two countries and listed on the two exchanges. More so, the



capital market has largely been less exploited by companies in Ghana to raise capital. This is reflected in fewer numbers of companies listed on the exchange. The situation is not so much different in Nigeria, although better in terms of size by way of market capitalisation and percentage to gross domestic product. So that these exchanges still remain largely underdeveloped.

### Results from Johansson Cointegration Test

According to the results in Table 8, the trace test finds no cointegrating relationship among the stock markets in the zone. The maximum eigenvalue test did not also provide any support for cointegration among the variables. The analysis was rotated using various data trend, i.e. intercept and trend, no intercept and no trend, intercept with no trend (see Table 8). In effect, both the trace and maximum eigenvalue tests agree. The  $H_0: r \geq 1$  is rejected,  $H_1$  is accepted.

**Table- 8.**JohanssonCointegration Test

<b>Selected (0.05 level*) Number of Cointegrating Relations by Model</b>					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	0	0	0	0	0
Max-Eig	0	0	0	0	0
*Critical values based on <a href="#">MacKinnon et al. (1999)</a>					
Information Criteria by Rank and Model					
Data Trend:	None	None	Linear	Linear	Quadratic
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend
Log Likelihood by Rank (rows) and Model (columns)					
0	-7429.784	-7429.784	-7429.674	-7429.674	-7429.176
1	-7429.753	-7428.760	-7428.760	-7428.638	-7428.638
Akaike Information Criteria by Rank (rows) and Model (columns)					
0	6.573891*	6.573891*	6.574679	6.574679	6.575123
1	6.575633	6.575639	6.575639	6.576416	6.576416
Schwarz Criteria by Rank (rows) and Model (columns)					
0	6.578954*	6.578954*	6.582273	6.582273	6.585249
1	6.585759	6.588296	6.588296	6.591605	6.591605

**Source:** Authors' computation, 2013

The results show no cointegration and largely confirm the findings in some of the earlier tests, which indicate that the markets are more segmented than integrated. Despite the socio-economic and political ties between the two countries, the relationship is yet to be fully reflected in their securities trading and cross listing and other capital market activities. Another possible reason for the results is that there is less interaction in stock market activities between the countries. Again, the issue of no cointegrating relationship between the two markets are supported by the Johanssen methodology.

### Results from the Rank Tests

Table 9 reports the bivariate case of the rank test. As shown in Table 9, the null hypothesis of no cointegration cannot be rejected for the two markets, since the test statistics are smaller than the critical values at the 5% level of significance. As such, one cannot observe cointegrating relationships among the stock markets of the countries. Since rank tests for nonlinearity are meaningful only in cases where cointegration is detected, further nonlinearity test could not be carried out. This is inconsistent with the linear cointegration methods. Meanwhile, the results support the earlier ones, indicating no cointegration between the two markets. It furthermore buttresses the point that there is no nonlinear relationship. In this case, any relationship that exists, as indicated by the ARDL method, is more of a linear relationship.

**Table-9.**Brietung Rank Cointegration Test

		Test with drift			Test with no drift		
		t-statistic	Critical Value		t-statistic	Critical Value	
Ho	H1		5%	10%		5%	10%
r = 0	r > 0	203.90	713.30	596.20	137.47	329.90	261.00
r = 1	r > 1	61.00	281.10	222.40	20.92	95.60	67.89
			r=0	r=0		r=0	r=0

Source: Authors' computation, 2013

### Results from Fractional Integration

Table 10 shows the estimates of stock market parameters using GPH and Whittle (W) methods. The result from the estimation of the d parameter shows infinite variance and nonstationary for both markets. The GSE has infinite shock duration, but that of NSE is long-lived. Again the finding from Table 10 shows the differences in the shock persistence even among the markets. The differences as observed by the FI are sometimes elusive when standard unit root tests are applied (Alagidede *et al.*, 2010).

**Table- 10.**Est. of FI parameters (GPH and Whittle Methods)

Countries	Stock market index				
	d-value		interpretation		
	WM	GPH	VAR	Shock Duration	Stationarity
Ghana	1.09	1.10	infinite	Infinite	nonstationary
Nigeria	1.09	1.06	Infinite	Long-lived	nonstationary

Source: Authors' computation, 2013

The data sample has 2264 observations; hence it has five integral divisors, corresponding to subsamples used for the H computations (see Table 10). For the data results did not indicate any significant difference between the two markets.

**Table- 11.**Hurst Exports for WAMZ Countries

Countries	Stock Market Index	
	H-value	interpretation
Ghana	.77	Persistent
Nigeria	.54	Antipersistent

**Source:** Authors' computation, 2013

The Hurst exponent estimate is equal to slope of this regression. In the case of GSE, H values were greater than .5. According to the aforesaid classification, there are persistent series. The value for the GSE is greater than .6, which suggests stronger persistence (trend maintaining tendency) than for the NSE. In using the different set of data, the H value for NSE was about .5. According to the aforesaid classification, there is antipersistent series.

In effect, both linear and nonlinear methods indicate that the markets do not largely co-move. However, there was a very dim sign of co-movement, using the ARDL. There was an indication that the activities on the GSE can be used to predict that on the NSE. On the whole, there was really no significant evidence that the two markets have attained the level of integration that can be a basis for introducing a common currency.

## 5. CONCLUSIONS AND RECOMMENDATIONS

The paper analysed stock market activities in the zone using both the linear and nonlinear methods. In general, both approaches indicate that the markets do not largely co-move. However, there was a very dim sign of co-movement, using the ARDL. There was an indication that the activities on the GSE can be used to predict that on the NSE. On the whole, there was really no significant evidence that the two markets have attained the level of integration that can be a basis for introducing a common currency.

The results from the analysis also indicated uni-directional causality in the stock market activities in Ghana and Nigeria. This means in the short run, the two markets have some relationship. In other words, the markets are not integrated in the long run. The capital market plays an important role in predicting and promoting growth, predicting recession. So their absence in some of these member countries, cast doubts on their preparedness in the run up to the introduction of the common currency. In terms of trade, Ghana and Nigeria have a number of trade and economic relations within the zone, so strong economic ties alone may not be a sufficient condition to integrate capital markets, but developed nature of the respective domestic markets.

Again, the finding of the study reveals that the use of the capital market to propel growth through the raising of the needed funds for investment has not been exploited in some WAMZ countries. Also, the whole process of forming a single currency union in the region did not take into account factors that can cause disturbance in the stock markets in the region. Earlier studies have concentrated on the effect on stock market development and the economy at the country level.

Hence, the link between the stock market in the two countries has not been established in any previous studies.

On the micro level, however, market segmentation is appropriate for risk diversification as suggested by portfolio theory. Integration of stock markets causes all risk factors to be traded at the same price, which makes trading in equities on different exchanges across the zone unattractive to investors.

The key policy recommendation is for the countries to work towards harmonising the capital markets. Like their counterparts francophone countries, the members of the WAMZ can start with the stock markets in Ghana and Nigeria. In this case, other countries can encourage firms in their respective countries to get listed on the NSE and the GSE, which would eventually become a WAMZ stock exchange. Meanwhile, current segmented nature of the NSE and GSE offer an opportunity for investors to diversify their risks.

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## APPENDIX

## Appendix- 1.ARD with GSE as Dependent

Dependent Variable: D(GSE Fact Book)					
Method: Least Squares					
Date: 12/02/12 Time: 17:43					
Sample (adjusted): 7 2264					
Included observations: 2258 after adjustments					
White Heteroskedasticity-Consistent Standard Errors & Covariance					
Variable	Coefficient	Std. Error	t-Statistic	Prob.	
D(Johansen)	0.000841	0.001465	0.574380	0.5658	
D(GSE(-1))	0.030550	0.021329	1.432278	0.1522	
D(GSE(-2))	0.021138	0.017022	1.241787	0.2144	
D(GSE(-3))	0.044936	0.041063	1.094309	0.2739	
D(GSE(-4))	0.003558	0.014026	0.253646	0.7998	
D(NSE(-1))	-0.000707	0.001224	-0.577797	0.5635	
D(NSE(-2))	-0.000568	0.001304	-0.435552	0.6632	
D(NSE(-3))	-0.000828	0.001113	-0.743866	0.4570	
D(NSE(-4))	0.002254	0.001354	1.665312	0.0960	
D(NSE(-5))	0.000424	0.001267	0.334376	0.7381	
GSE(-1)	-0.002110	0.001207	-1.747395	0.0807	
NSE(-1)	7.66E-05	5.17E-05	1.481673	0.1386	
C	0.067647	0.035391	1.911411	0.0561	
R-squared	0.007469	Mean dependent var		0.013291	
Adjusted R-squared	0.002164	S.D. dependent var		0.484307	
S.E. of regression	0.483783	Akaike info criterion		1.391379	
Sum squared resid	525.4327	Schwarz criterion		1.424324	
Log likelihood	-1557.867	F-statistic		1.407833	
Durbin-Watson stat	1.999948	Prob(F-statistic)		0.154623	

## Appendix-2.

Simulation results:

S = simulated test statistic

Case: No drift  $r = 0$  Prob[S > 137.47] = 0.41740Case: No drift  $r = 1$  Prob[S > 20.92] = 0.46350Case: Drift  $r = 0$  Prob[S > 203.90] = 0.87940Case: Drift  $r = 1$  Prob[S > 61.00] = 0.82100

Actual size at 10% significance level:

Case: No drift  $r = 0$  Prob[S > 261.00] = 0.10230Case: No drift  $r = 1$  Prob[S > 67.89] = 0.10070Case: Drift  $r = 0$  Prob[S > 596.20] = 0.09510Case: Drift  $r = 1$  Prob[S > 222.40] = 0.10030



Actual size at 5% significance level:

Case: No drift	$r = 0$	$\text{Prob}[S > 329.90]$	=	0.05210
Case: No drift	$r = 1$	$\text{Prob}[S > 95.60]$	=	0.05290
Case: Drift	$r = 0$	$\text{Prob}[S > 713.30]$	=	0.04610
Case: Drift	$r = 1$	$\text{Prob}[S > 281.10]$	=	0.05200

Based on 10000 replications of Gaussian random walks with length  $n = 2264$ .

### Appendix-3. ARDL with NSE as Dependent

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Dependent Variable: D(Johansen)				
Method: Least Squares				
Date: 12/02/12 Time: 17:42				
Sample (adjusted): 7 2264				
Included observations: 2258 after adjustments				
White Heteroskedasticity-Consistent Standard Errors & Covariance				
D(GSE Fact Book)	0.149420	0.259281	0.576289	0.5645
D(GSE(-1))	-0.160958	0.211420	-0.761319	0.4465
D(GSE(-2))	0.446263	0.411992	1.083184	0.2788
D(GSE(-3))	-0.007864	0.247700	-0.031747	0.9747
D(GSE(-4))	0.246936	0.220659	1.119084	0.2632
D(NSE(-1))	0.451119	0.045598	9.893346	0.0000
D(NSE(-2))	0.006782	0.043625	0.155462	0.8765
D(NSE(-3))	-0.052067	0.035692	-1.458812	0.1448
D(NSE(-4))	-0.056994	0.034311	-1.661090	0.0968
D(NSE(-5))	-0.012962	0.027612	-0.469422	0.6388
GSE(-1)	-0.017856	0.010275	-1.737862	0.0824
NSE(-1)	-0.000246	0.000767	-0.321081	0.7482
C	0.944316	0.424210	2.226056	0.0261
R-squared	0.211419	Mean dependent var		0.107233
Adjusted R-squared	0.207204	S.D. dependent var		7.240850
S.E. of regression	6.447186	Akaike info criterion		6.570905
Sum squared resid	93316.14	Schwarz criterion		6.603850
Log likelihood	-7405.552	F-statistic		50.15726
Durbin-Watson stat	1.999293	Prob(F-statistic)		0.000000