

AN ECONOMETRIC ANALYSIS OF AFRICAN STOCK MARKET: ANNUAL RETURNS ANALYSIS, DAY-OF-THE-WEEK EFFECT AND VOLATILITY OF RETURNS¹.

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ABSTRACT

This paper investigates the presence of day-of-the-week effect, returns volatility and analyzes the annual returns of five African stock markets. A set of parametric and non-parametric tests is used to test equality of mean returns and standard deviations of the returns across the-days-of-the-week. To supplement this analysis, graphical representation of the indexes annual percentage changes was explored and their correlation determined. The results contradict the presence of the-day-of-the-week but indicate insignificant daily returns volatility in most of these Markets. The stock exchanges experienced enormous growth between 1997 and 2004. There was a high positive correlation of market gains and declines among the markets.

Key words: returns, volatility, standard deviation, anomalies, day-of-the-week effect, kurtosis, skewness, homoskedasticity

JEL Classification: C32, E32

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I. INTRODUCTION

This paper analyzes the financial markets' trends and characteristics in selected African financial markets indexes namely: Botswana Domestic Companies Index; Egypt's CCSI; Ghana's All Share Index; Nigeria's LSE All Share Index and South Africa's JSE All Share Index. In the face of global integration of financial markets, recurrent economic problems in Africa and constant and multiple efforts by African governments to restructure the economies and modernize the stock exchanges, there is great need to constantly determine the present return characteristics of the African stock markets. Even though the presence of the-day-of-the-week effect has been documented in finance literature especially in regard to some African stock markets, there is no study yet focusing on the period 1997-2004. We therefore investigate the presence of day-of-the-week effect and return volatility in the five financial markets and we also explore the annual return pattern.

II. LITERATURE REVIEW

The returns of the African and other emerging markets have been extensively written on and tested for anomalous stock market seasonal or cross-sectional behavior of their stock returns using annual returns (Ayadi, 1998). Even though tests of stock market anomaly focus more on seasonal or cross-sectional behavior of stock returns and these tests differ from time series tests which look at the predictability of rates of return over time (Claessens et. al, 1995), the presence of anomalies in stock markets generally indicates predictability of returns. The tests applied on emerging markets' returns to determine the presence of anomalies are similar to those applied on developed markets' stock returns.

The presence of anomalies in returns of common stocks has intrigued researchers since the last century challenging the appropriateness of the Capital Asset Pricing model (CAPM) and the whole theory of market efficiency. Day-of-the-week-effect in stock

returns in the US Market has been documented by a large number of studies. For instance, in the US stock market the mean Monday stock return has been found to be negative or significantly lower than the non-Monday return. Many studies have shown that in addition, mean stock return on Fridays is significantly high relative to other days. See for example Cross (1973), French (1980) and Jaff, Westerfield and Ma (1989), Gibbons and Hess (1981), Lakonishok and Levi (1982), Rogalski (1984), Keim and Stambaugh (1984), Smirlock and Starks (1986), Harris (1986), Lakonishok and Smidt (1988), Mehdiian and Perry (2001), among others document the Monday effect or other daily anomalies in the US stock market. Jaff and Westerfield (1985a, b) found a negative Monday effect in Canada and the UK but a negative Tuesday effect in Japan and Australia. Condoyanni et al. (1987) confirms these findings on the Japanese and Australian markets. Kato (1990) also finds that the Tuesday return is negative and Wednesday and Saturday returns are strongly positive in Japan. Jaff, Westerfield, and Ma (1989) drew attention to this phenomenon when they provided international evidence. Findings relating to the linkage between "bad Fridays" and the Monday effect are robust internationally. Bad Friday refers to a decline of the market on the Friday usually preceding a Monday with increased stock selling pressure. For a detailed global review of the day-of-the week effect, please see Chukwuogor-Ndu, (2005) and Chukwuogor-Ndu and Feridun (2006).

In an anomalous turn-of-the-year study of stock return seasonalities in low-income African emerging markets using monthly market indices for the Ghanaian stock market (1991-1996), Nigerian stock market (1984-1995), and Zimbabwean stock market (1987-1995), Ayadi, (1998) find that the results of both the Kruskal-Wallis and Friedman tests suggest the absence of seasonality in stock returns on the Nigerian and Zimbabwean stock markets while the Friedman test confirms the presence of seasonality in stock returns for Ghana. Furthermore, the Wilcoxon-Mann-Whitney test and the dummy-variable regression analysis show the presence of the "January effect" for Ghana but not for Nigeria and Zimbabwe.

In a more recent study, using weekly index returns adjusted for thin trading as a nonlinear autoregressive process with conditional heteroscedasticity, Appiah-Kusi and Menyah (2003) used the EGARCH-M model to investigate the weak-form pricing efficiency of eleven African stock markets. Their findings reject evidence in prior studies that the Nigerian stock market is weak-form efficient. They confirm *ex ante* results that the markets in Egypt, Kenya, and Zimbabwe are efficient while that of South Africa is not weak-form efficient. Their findings indicate that stock markets in Mauritius and Morocco may be efficient while the stock markets in Mauritius and Morocco, Botswana, Ghana, Ivory Coast, and Swaziland are not consistent with weak-form efficiency. The application of the EGARCH model enabled them to capture how conditional volatility affects the pricing process without imposing undue restrictions on the parameters of the conditional variance equation. It is obvious that the question of efficiency of the African financial markets is still unresolved as conflicting research findings prevail.

III. DATA AND METHODOLOGY

We use the daily closing values of the following indexes: Domestic Companies Index, Botswana; CCSI, Egypt; All Share Index, Ghana; LSE All Share Index, Nigeria; and JSE All Share Index, South Africa for the period 1997-2004 to determine the daily returns, day-of-the-week effect and volatility of stock returns. There is obvious scholarly merit in studying longer periods of data. However long-term data that encapsulate archaic data that relate to periods of long forgotten good or poor performance can distort the overall results giving a misleading picture and interpretation of recent trends. As a result of these deficiencies in using long-term data, we chose to focus on more recent trends in this study.

We further use the closing index values to depict the annual trends in stock market movements and use regression analysis to determine how such movements relate to each other.

The daily stock returns for these selected African stock indices are calculated as follows:

$$\ln (P_t/P_{t-1}) *100 \tag{1}$$

Where P_t is the stock index at date t . Except for the returns on Monday, any returns that are preceded by a holiday were excluded. This exclusion as was done to avoid speculation that observed day-of-the-week-effect could be partially due to these non-trading days. To determine the nature of the volatility of returns, the distributions of daily returns are analyzed using such measures as variance, standard deviations, kurtosis, skewness and coefficient of variation. We use parametric and non-parametric tests to substantiate these results.

Since the result of the normality test indicates that the distributions of the returns are non normal, we use the non-parametric test, the Kruskal-Wallis to check for the results on equality on mean returns. The Kruskal-Wallis statistic is as follows:

$$\frac{12}{N(N+1)} \sum_{j=1}^k \frac{R_j^2}{n_j} - 3(n+1) \tag{2}$$

where: k = number of samples; n_j = number of values in j^{th} sample; $N = \sum n_j$ = total number of values; R_j = sum of ranks in the sample when N values are ranked together (the statistic is approximately Chi-square distributed degrees of freedom equal to $k-1$).

To test for the equality of variance across the days of the week, we employ the Bartlett's homogeneity test. The test criterion is as follows (Snedecor and Cochran, 1970).

$$M = v \left(a \ln s^2 - \sum \ln s_i^2 \right) \tag{3}$$

Where a = the number of samples, v = degree of freedom, $s^2 = \sum s_i^2 / a$, s_j^2 = estimate of the σ^2 from sample I , then, the quantity M/C

is distributed approximately as a Chi-square distribution with degrees of freedom equal to (a-1).

The above test is for the case when all groups have the same degrees of freedom. When the degrees of freedom differ, as with samples of unequal sizes, the test criterion is as follows as follows:

$$M = \left(\sum V_i \right) \ln s^{-2} - \sum (v_i \ln s_i^2) \quad (4)$$

$$C = 1 + \left\{ \frac{1}{[3(a-1)]} \right\} \left(\sum \frac{1}{v_i} - \frac{1}{\sum v_i} \right) \quad (5)$$

where $s^{-2} = \sum (v_i s_i^2) / \sum v_i$, s_i^2 is an estimate of the σ^2 from sample I, a = the number of samples, v_i = the degree of freedom of samples i
The quantity M/C is distributed approximately as a Chi-square with degrees of freedom equal to (a-1). In our case, as we have five weekdays in a week, degrees of freedom are four.

However, as Bartlett's test of homogeneity of variance is sensitive to non normality in stock return distribution, the Levene's (1960) test is also employed to check the results on equality of variance. In measuring the variation within a class, Levene's test uses the average of the absolute deviations instead of the mean square of deviations. This avoidance of squaring makes the test criterion much less sensitive to non-normal distributions (Snedecor and Cochran, 1976). The Levene's statistic is as follows:

$$F = \left[\sum_{j=1}^J n_j (D_{.j} - D_{..})^2 / \sum_{j=1}^J \sum_{i=1}^{n_j} (D_{ij} - D_{.j})^2 \right] x \left[\frac{(N - J)}{(J - 1)} \right] \quad (6)$$

where $D_{ij} = |R_{ij} - M_{.j}|$, R_{ij} is the return for week I and weekday j for j =1, 2, ..., J and J =5 if the last trading day of the week is a Friday.

IV. EMPIRICAL RESULTS

A. Daily Returns Analysis

Table 3 contains the basic statistics of returns for the Botswana Domestic Composite Index, Ghana (GSE All Share), Nigerian (LSE),

Egypt's (CCSI) and the South African JSE Securities Exchange. The Ghana (GSE All Share) and the Nigerian (LSE) have no negative returns during the trading days of the week. The Botswana Domestic Composite Index and Egypt's (CCSI) have negative returns on Tuesday while the South African JSE Securities Exchange has a negative return on Wednesday.

Table 1 Basic Statistics of Daily Returns of the 1997-2004

<i>Name of Country/Index</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>
Mean					
BDCI	0.00905	-0.00589	0.1042	0.0416	0.0466
GGSE	0.0840	-	0.1047	-	0.0908
NLSE	0.0131	0.0374	0.0401	0.0029	0.0393
ECCSI	0.0476	-0.00345	0.0273	0.0428	0.00634
SJSE	0.0418	0.0224	-0.00532	0.00275	0.0183
Median					
BDCI	0.0000	0.0000	0.0000	0.0000	0.0000
GGSE	0.0306	-	0.0365	-	0.0327
NLSE	-0.00866	0.0105	0.00366	0.0000	0.0000
ECCSI	0.0188	0.0087	0.0040	0.0364	0.0000
SJSE	0.0390	.00617	0.0000	0.0000	0.0000
Maximum mean					
BDCI	2.3305	8.9822	18.4598	2.6093	1.5990
GGSE	3.8607	-	4.8360	-	5.2642
NLSE	1.7610	1.4576	12.1034	1.2348	12.6334
ECCSI	2.6845	1.0293	1.1594	1.5622	0.4953

SJSE	1.4580	2.5578	3.1554	1.8665	5.0876
Minimum mean					
BDCI	-8.7587	-20.1986	-3.2234	-1.0112	-0.7045
GGSE	-3.0478	-	-2.4935	-	-6.8309
NLSE	-5.2600	-1.3555	-2.1486	-11.3426	-11.6354
ECCSI	-1.2553	-1.1353	-0.6553	-0.7948	-0.2435
SJSE	-3.4519	-5.4844	-2.8646	-2.4149	-2.4132
Standard Deviation					
BDCI	0.6319	1.4178	1.1978	0.3193	0.2518
GGSE	0.3823	-	0.4905	-	0.6703
NLSE	0.4270	0.3483	0.6969	0.6614	0.9380
ECCSI	0.4083	0.2652	0.2545	0.2344	0.1633
SJSE	0.5234	0.5700	0.5440	0.5115	0.5448
Skewness					
BDCI	-10.69	-10.43	13.90	2.83	1.53
GGSE	0.82	-	2.18	-	-1.36
NLSE	-4.61	0.39	13.11	-13.10	1.32
ECCSI	1.01	-0.21	0.76	0.99	1.47
SJSE	-1.55	-1.82	0.04	-0.43	1.72
Kurtosis					
BDCI	151.71	169.39	214.35	20.06	7.53
GGSE	38.35	-	25.09	-	47.59
NLSE	62.10	3.07	229.45	224.58	147.73

ECCSI	6.37	2.92	2.04	6.57	3.96
SJSE	9.09	20.63	5.64	2.61	18.94
Variance					
BDCI	0.3993	2.0100	1.4347	0.1019	0.0634
GGSE	0.1461	-	0.2406	-	0.4493
NLSE	0.1823	0.1213	0.4857	0.4375	0.8798
ECCSI	0.1667	0.0703	0.0648	0.0550	0.0267
SJSE	0.2739	0.3249	0.2959	0.2617	0.2968
Coefficient of variation					
BDCI	6981.81	-24079.23	1149.91	766.66	540.12
GGSE	454.80	-	468.31	-	738.25
NLSE	3265.14	930.09	1736.04	22584.67	2389.19
ECCSI	857.78	-7680.22	932.50	548.01	2576.34
SJSE	1252.74	2539.66	-10244	18578	2971.79
Observations					
BDCI	348	355	361	346	354
GGSE	413	-	415	-	403
NLSE	381	396	394	388	382
ECCSI	300	314	323	321	321
SJSE	445	444	444	445	445

BDCI, Botswana Domestic Composite Index.

GGSE, Ghana (GSE All Share). [Check no of observations]

NLSE, Nigerian (LSE).

ECCSI, Egypt's (CCSI).

SJSE, South African JSE Securities Exchange.

* The Ghana Stock Exchange trades on Monday, Wednesday and Friday.

There is general high volatility in returns. The Botswana Domestic Composite Index and the Nigerian (LSE) recorded the highest and minimum returns. Consistent with expectation, the results of the other indicators of returns volatility such as skewness, standard deviation, kurtosis, variance and coefficient of variation were highest for these two indexes. However the coefficient of variation was also very high for Egypt's (CCSI) on Tuesday and for the South African JSE Securities Exchange on Wednesday, the same days they recorded negative returns. This reflects the paucity of the returns relative to their respective standard deviations. It is important to note that the daily returns for all the indexes are mainly skewed to the right except for those of South African JSE Securities Exchange that seem to be more skewed to the left.

Botswana, Ghana and Nigeria experienced their highest return on Wednesday while Egypt and South Africa experienced their highest return on Monday. Botswana and Egypt recorded the lowest return on Tuesday, Ghana on Monday, Nigeria on Thursday and South Africa on Wednesday. The highest Standard deviation occurred mostly on Friday for Ghana and Nigeria. The lowest standard deviation also occurred on Friday for Botswana and Egypt. The summary of maximum/minimum returns and standard deviations for the five indexes for the period 1997 to 2004 is contained on Table 4.

Table 2
Summary of Maximum/Minimum Returns/Standard Deviations of the AFM for the Period January 2nd 1997- December 31st, 2004.

<i>Name of Country/Index</i>	<i>Maximum return/Std. Dev.</i>	<i>Day of Occurrence</i>	<i>Minimum Return/ Std. Dev.</i>	<i>Day of Occurrence</i>
Botswana, DCI	0.1042*	Wednesday	-0.0059*	Tuesday
	1.4178**	Tuesday	0.2518**	Friday

Egypt's CCSI	0.0476*	Monday	-0.00345*	Tuesday
	0.4083**	Monday	0.1633**	Friday
Ghana's All Share Index	0.1047*	Wednesday	0.0840*	Monday
	0.6703**	Friday	0.3823**	Monday
Nigeria's LSE All Share Index	0.0401*	Wednesday	0.00293*	Thursday
	0.938**	Friday	0.3483**	Tuesday
South Africa's JSE All Share Index	0.0418*	Monday	-.00530*	Wednesday
	0.57**	Tuesday	.5115**	Thursday

* = Mean returns

** = Standard deviation of return

B. The day-of-the-week effect

To test the day of the week effect using the *Kruskal-Wallis* test, the following null and alternate hypotheses are tested for each market.
 Ho: There is no difference in the returns across the days of the week;
 H1: There is a difference in the returns across the days of the week.

If the null hypotheses is rejected, this means that there is presence a day-of-the-week effect in the stock returns pattern. As shown on Table 5, the values of Chi-square statistics are not significant at the 5 percent level for all the markets. These results do not support the existence of the day-of-the-week effect on stock returns in the Botswana, Egypt, Ghana, Nigeria and South Africa stock markets as observed from the analysis of the daily returns of the following stock markets: Botswana Domestic Companies Index; Egypt's CCSI; Ghana's All Share Index, Nigeria's LSE All Share Index and South Africa's JSE All Share Index for the period 1997-2004. This finding confirms and contradicts some earlier findings. For example, they are consistent in the case of Nigeria and at variance in the case of Ghana with earlier documented evidence of day-of-the-week effect on stock returns in Africa. Ayadi, (1998) find that the results of both the *Kruskal-Wallis* and *Friedman* tests suggest the absence of seasonality in stock returns on the Nigerian and Zimbabwean stock markets while the *Friedman* test confirms the presence of seasonality in stock returns for Ghana. The findings of Appiah-Kusi and Menyah, (2003) reject evidence in prior studies that the Nigerian

stock market is weak-form efficient. Our results confirm that the Nigerian LSE is indeed weak form efficient. They confirm results that the markets in Egypt, Kenya, and Zimbabwe are efficient. Our result confirms this finding as it relates to Egypt. The finding of Appiah-Kusi and Menyah, (2003) further indicate that the stock markets of South Africa, Botswana, and Ghana are not weak-form efficient. Our findings indicate that they are.

C. Annual Returns Analysis

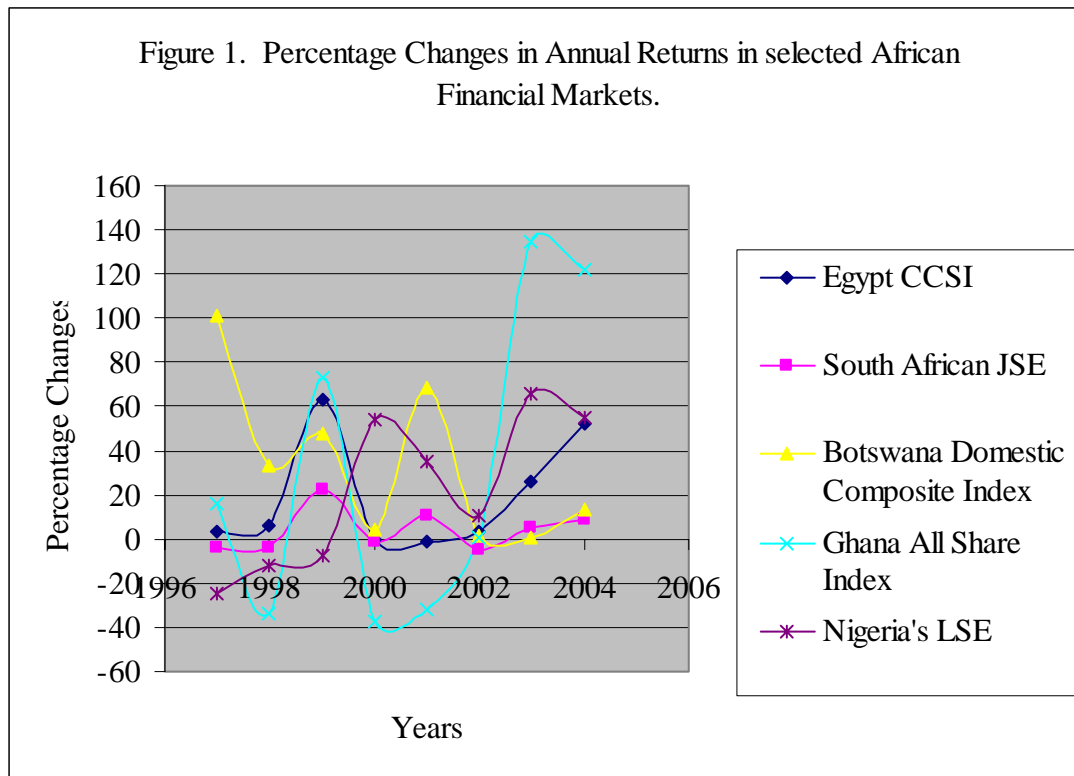
In the period 1997 to 2004, the five indexes have grown enormously: Botswana Domestic Composite Index by 298 percent; Egypt's (CCSI) by 239 percent; the Ghana GSE All Share by 198 percent; the Nigerian (LSE) by 264 percent; and the South African JSE Securities Exchange by 114 percent. The annual closing values of the indexes are shown on Table 3. Figure 1 contains the annual percentage changes in index values. Among the indexes that experienced significant gains during the period are Ghana, Botswana, Nigeria and Egypt.

Table 3 Annual Closing Index Values

End of Year	BDCI	ECCSI	GGSE	NLSE	SJSE
1996	352.18	349.36	861.33	8561.36	5578.62
1997	708.49	359.85	999.68	6440.51	5974.29
1998	946.91	382.77	660.1	5,672.76	5482.17
1999	1399.3	624.51	1139.82	5,266.43	5010.87
2000	1453.45	622.15	715.74	8,111.01	8360.4
2001	2445.38	613	490.05	10,963.11	8140.01

2002	2493.03	635.29	492.85	12,137.72	10425.3
2003	2498.712	803.18	1155.51	20,128.94	9277.22
2004	2820.847	1221.17	2567.99	31,156.69	10387.22

BDCI, Botswana Domestic Composite Index.
 GGSE, Ghana (GSE All Share).
 NLSE, Nigerian (LSE).
 ECCSI, Egypt's (CCSI).
 SJSE, South African JSE Securities Exchange.



In 2003 and 2004, Ghana GSE All Share Index experienced 134.5 percent and 122.2 percent respectively increases in its index values. The Botswana Domestic Composite Index in 1997 and 2001 experienced 101.2 percent and 68.2 percent respectively increases in its index values. In the case of Nigeria, the greatest percentage increases of 54 percent, 65.8 percent and 54.78 percent occurred in 2000, 2003 and 2004. For Egypt's (CCSI), the greatest percentage

increases of 63.16 percent and 52.04 percent occurred in 1999 and 2004 respectively. The Botswana Domestic Composite Index continuously increased during the period and it experienced no negative changes in value.

In general the markets seem to gain and lose momentum simultaneously. For example, the markets generally declined in 1998, 2000 and 2002. The markets gained momentum in 1999, 2001 and have been surging since 2003. Only the Ghana GSE All Share Index did not follow this pattern. It declined in 2001 when the other markets were gaining momentum. The five closing index values for the period 1997-2004 were subjected to a regression analysis. The correlation coefficients indicate that a high correlation exists among most of the indexes. However there was a low correlation of 0.314 between the Ghana (GSE All Share) and Botswana Domestic Composite Index and of 0.293 between Ghana (GSE All Share) and the South African JSE Securities Exchange. The highest correlation

0.932 was between the Egypt (CCSI) and the South African JSE Securities Exchange.

Table 4 Correlation coefficient, Regression Results.

Index	BDCI	ECCSI	GGSE	NLSE	SJSE
BDCI	1	0.795857	0.351308	0.784595	0.862274
ECCSI	0.795857	1	0.814038	0.932506	0.70072
GGSE	0.351308	0.814038	1	0.798612	0.293398
NLSE	0.784595	0.932506	0.798612	1	0.757116
SJSE	0.862274	0.70072	0.293398	0.757116	1

BDCI, Botswana Domestic Composite Index.
GGSE, Ghana (GSE All Share).
NLSE, Nigerian (LSE).

ECCSI, Egypt's (CCSI).
SJSE, South African JSE Securities Exchange.

D. Homoskedasticity

The result of the Levene's test employed to test the equality of the standard deviations across the day-of-the-week is contained in Table 4. Egypt's CCSI has a highly significant Levene statistic (at the 5 percent level). Ghana's All Share Index has a marginally significant Levene's statistic. It can be concluded that in the other markets namely: Botswana Domestic Companies Index, Nigeria's LSE All Share Index and South Africa's JSE All Share Index, the daily return seasonalities are not accompanied by any volatility seasonality and investing on low (high) return weekday does not necessarily mean that risk is also low or high. It is interesting to note that for Egypt's CCSI that has a highly significant Levene statistic, the highest return occurs on Monday, the same day that the markets experiences the highest standard deviation. Even Ghana's All Share Index that has a marginally significant Levene's statistic, the lowest return occurs on Monday when the market experiences the lowest standard deviation. This observation seems compatible with the normal risk return trade-off of higher return and higher risk relationships and vice versa.

Table 5 Results of Test of Normality, Equality of Means/Variance across Day-of-the-Week Effect for the Period January 2nd, 1997-December 31st, 2004.

<i>Countries/Index</i>	<i>Kruskal-Wallis</i>		<i>W Test for Normality</i>		<i>Levene's Test</i>		<i>Bartlett's Test</i>	
	<u>Chi-square</u>	<u>P Value</u>	<u>Statistics</u>	<u>R</u>	<u>Statistics</u>	P Value	<u>Statistics</u>	P Value

Botswana Domestic Companies Index	0.86**	0.931	0.9009	0.440	0.87	0.483	950.18	0.000
Egypt's CCSI	4.84**	0.308	0.958	0.2954	14.32*	0.000	135.39	0.000
Ghana's All Share Index	1.50**	0.827	.765	0.5248	2.36	0.051	147.22	0.000
Nigeria's LSE All Share Index	2.40**	0.662	0.6474	0.523	0.40	0.812	451.34	0.000
South Africa's JSE All Share Index	6.67**	0.154	.952	0.5389	0.35	0.843	6.15	0.188

* Reject the homoskedasticity hypothesis, not significant at 5 percent level

** Reject the Null hypothesis, not significant at 5 percent level

V. CONCLUSION

This paper examined the daily and annuals patterns, characteristics and the volatility of daily returns of five African stock indexes. Even though there were observed daily negative returns for three of the indexes, the results of the *Kruskal-Wallis test* do not support the existence of the day-of-the-week effect on stock returns in the five stock indexes of Botswana, Egypt, Ghana, Nigeria and South Africa. While this finding corroborates some past studies, it contradicts others.

For the most part, we uncovered a tendency of high volatility in the daily returns of African stock markets. The Botswana Domestic Composite Index and the Nigerian (LSE) recorded the highest and minimum returns and are consistent with expectation. The results of the other indicators of returns volatility such as skewness, standard

deviation, kurtosis, variance, coefficient of variation were also highest for these two indexes.

Egypt's CCSI has a highly significant Levene statistic at the 5 percent level. Ghana's All Share Index has a marginally significant Levene's statistic. It can therefore be concluded that in the other markets: Botswana Domestic Companies Index; Nigeria's LSE All Share Index and South Africa's JSE All Share Index. The daily return seasonalities are not accompanied by any volatility seasonality, and investing on low/ high return week day does not necessarily mean that risk is also low or high.

The stock exchanges experienced enormous growth between 1997 and 2004. The changes in annual closing values of the indexes indicate that, in general, the markets seem to gain and lose momentum simultaneously. In 2003 and 2004, Ghana GSE All Share Index experienced the greatest percentage increase of 134.5 percent and 122.2 percent respectively. The regression results indicate a high correlation among most of the markets.

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