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THE KENYAN STOCK MARKET: INEFFICIENCY, LONG MEMORY, PERSISTENCE AND ANOMALIES IN THE NSE-20

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Abstract

This paper examines the statistical properties of the NSE-20 index in the Kenyan stock market over the period 2001-2009. The analysis applies both unit root tests and long-range dependence techniques based on the concept of fractional integration. The results indicate that the order of integration of stock prices is significantly above 1, which implies the presence of long memory. This is also detected in the absolute and squared returns. The lowest degrees of integration (very close to zero) are found for Mondays and Fridays, and therefore a day-of-the-week-effect appears to be present.

Keywords: Market efficiency; Kenyan stock market; Long memory

JEL classification: C22, G14

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1. Introduction

The emergence and expansion of stock markets in African countries in recent decades has been an important step for them towards attracting more private investment and becoming more integrated into the global financial markets. In 1990 there were only five stock markets in Africa, but their number had risen to nineteen by 2007; in the period between 1992 to 2002 the total capitalisation of African stock markets increased from US$113,423m to US$244,672m. In 2004 six of the ten best performing markets in the world were in Africa: Ghana, Uganda, Kenya, Egypt, Mauritius and Nigeria, and in 2005 Egypt, Uganda and Zambia were in the top-5.

Excluding South Africa and Nigeria the stock market capitalisation in the Sub-Saharan Africa was only around 10% of GNP, as opposed to 159% in the case of South Africa. Further, these markets, with the exception of South Africa, have a high degree of illiquidity. The average price to earnings (P/E) ratio at the start of 1996 was 2.7 for Ghana, 6 for Kenya and 7.8 for Zimbabwe; for a comparison, the corresponding figure for the US was about 17. These low

The layout of the paper is as follows. Section 2 provides some information about the NSE-20 index (the main stock market index in Kenya) and its components. Section 3 briefly reviews the relevant literature on the Kenyan and other African stock markets. Section 4 outlines the empirical methodology. Section 5 describes the data and presents the empirical results. Finally, Section 6 offers some concluding remarks.

2. The Kenyan Stock Market

Kenya attained independence from the United Kingdom in December 1963, and finally introduced a democratic system in 1991 after prolonged turbulence and increasing international pressure. At present it is one of the best performing economies in East Africa.

The NSE-20 index was created in 1964, when Kenya was under colonial rule, and it is the main index for the Kenyan stock market. This had an upsurge in activity after 1993 as a result of economic reforms and the relaxation of restrictions on foreign investment and exchange controls. However, political problems remain, leading to market volatility. The components of the NSE-20 index are presented in Table 1. It includes different types of companies: four of them are banks (*Barclays Bank (K) Ltd, Equity Bank, Kenya Commercial Bank, and Standard Chartered Bank (K) Ltd*), and there is also an investment company (*ICDC Investment Company*), therefore five out of the twenty companies in the NSE-20 belong to the financial sector.

[Insert Table 1 about here]

The industrial sector is represented by two electricity companies, namely "*Kenya Electricity Generating Company*" (generation) and " which is an automobile company; "*Bambury Cement Ltd*", which is the largest cement manufacturing company in the region; "*British American Tobacco Ltd*", which manufactures cigarettes under contract; "*East Africa Breweries Ltd*", producing alcoholic drinks and other non-alcoholic drinks for adults (ANDs), and "*Athi River Mining*", which is a leading mineral extraction and processing in Kenya.

There are also some companies from the service sector: "*Express Ltd*", which is a logistic company that has five divisions (sea freight, air freight, packing and removals, transport, and warehousing); "*Nation Media Group*", which is a media company; "*Kenya Airways*", which is the main company for commercial aviation in Kenya, and finally "*Safaricom Ltd*", a mobile phone company that is part of Vodafone.

The primary sector comp

the parameters of the conditional variance equation; they considered eleven African stock markets and found evidence against weak-form efficiency in the majority of cases.

Mlambo and Biekpe (2005) tested the efficient market hypothesis in ten African stock markets using the runs test methodology for serial dependency; they could not reject weak-form efficiency in Kenya and Zimbabwe since a significant number of stocks were found to follow a random walk. Vitali and Mollah (2010) carried out unit root, autocorrelation, runs and variance ratio tests on daily price indices of Kenya and other six countries for the time period 1999 – 2009; their results imply a rejection of the random walk hypothesis for all countries except South Africa. Claessens et al. (1995) investigated return anomalies and predictability in nineteen emerging countries and stressed the importance of time variation in the price of risk in emerging markets. Another paper by Olowe (1999) found weak-form efficiency in the Nigerian stock market using correlation analysis.

All the above-mentioned studies investigate market efficiency in various sub-Saharan countries by applying unit root tests or related techniques to test the random walk hypothesis. However, the unit root case is a rather restrictive one to consider; by contrast, the present paper adopts a more general and flexible framework to examine the NSE-20 index: instead of limiting the analysis to the I(0)/I(1) dichotomy the possibility of fractional integration (allowing the degree of integration d to be fractional) is also entertained.

4. Methodology

We model the NSE-20 index, denoted by [illegible], as follows:

$$z \quad x_t, \quad t = 1, 2, \ldots$$

$$(1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots, \tag{2}$$

where d can be any real number, and u_t is assumed to be I(0), specifically a covariance stationary process with a spectral density function that is positive and bounded at the zero frequency and therefore the origin. Such processes were first analysed in the 1960s, when Granger (1966) and Adelman (1965) pointed out that most aggregate economic time series have a typical shape with the spectral density increasing sharp where ¤ (L) and θ(L) are the AR and MA polynomials of order p and q respectively (assumed to be equal to or smaller than 2 in the empirical analysis).

If the (log of) NSE-20 is non-stationary, the regression has to be run in first differences. The parameters in (4) are estimated using MLE, assuming that the error term is white noise and follows a normal distribution. For model selection diagnostic tests are carried out, specifically the Breusch-Godfrey LM test for serial correlation and the Jarque-Bera test for normality, and likelihood criteria. [4]

4. Empirical Results

We use daily data on the NSE-20 taken from the Nairobi Securities Exchange (NSE) over the period from January 1st, 2001, to December 31st, 2009. For missing observations we calculate the arithmetic mean of the value of the previous and the following day.

4.1 NSE-20 Returns

Figure ilys

0.915098 371.4

$$\pi_t = \beta_0 + \beta_1 t + x_t, \qquad (1 - L)^d x_t = u_t, \quad t = 1, 2, \ldots,$$

Table 3 displays the results based on the Whittle function in the frequency domain (Dahlhaus, 1989) under the assumption that the error term is in turn a white noise, an AR(1) and a more general AR process as in Bloomfield (1973). As in the case of the unit root tests we display the results for the three cases of no regressors, an intercept and a linear time trend, and we also report in Table 3 the 95% confidence band of the non-rejection values of d using Robinson's (1994) parametric approach.

[Insert Table 3 about here]

The t-values of the deterministic terms (not reported) imply that the specification with an intercept is the most appropriate in all cases. When assuming where ε_t is a white noise process and all zeros of $\varphi(L) = (1 - \varphi_1 L - \ldots - \varphi_p L^p)$ lying outside the unit circle and all zeros of $\theta(L) = (1 + \theta_1 L + \ldots + \theta_q L^q)$ lying outside or on the unit circle. The spectral density function of this process is then:

$$f(\lambda; \tau) = \frac{\sigma^2}{2\pi} \left| \frac{1 + \sum_{k=1}^{q} \theta_k e^{i\lambda k}}{1 - \sum_{k=1}^{p} \varphi_k e^{i\lambda k}} \right|^2 , \qquad (6)$$

where τ corresponds to all the AutoRegressive (AR) and Moving Average (MA) coefficients and σ^2 is the variance of ε_t. Bloomfield (1973) showed that the logarithm of an estimated spectral density function is often a fairly well-behaved function and thus can be approximated by a truncated Fourier series, and also that (5) approximates (6) extremely well with a smaller number of parameters. Moreover, this model is stationary for all values of τ, and fits extremely well in the context of Robinson's (1994) tests (see, e.g., Gil-Alana, 2004).

Since the results seem to be very sensitive to the specification of the error term we also apply a semi-parametric method due to Robinson (1995) which is based on a "local" Whittle estimator of d around the zero frequency. This where d_o is the true value of d.[5] This estimator is robust to a certain degree of conditional heteroscedasticity (Robinson and Henry, 1999) and is more efficient than other more recent semi-parametric competitors.

[Figure 2 about here]

Figure 2 displays the estimates of d for the whole range of bandwidth parameters, and also confidence bands for the I(1) case. It is clear that the results are very sensitive to the choice of the bandwidth parameter.[6] For the original series, there are some values which are within the I(1) interval; however, if m is large most of the values are above 1. For the logged data practically all values are significantly above 1, which implies long memory in the returns and therefore some degree of predictability of the return series (inconsistently with market efficiency).

4.2 Absolute and Squared Returns

In this section we use absolute and squared returns as proxies for volatility. The former have been employed among others by Ding et al. (1993), Granger and Ding (1996), Bollerslev and Wright (2000), Gil-Alana (2005), Cavalcante and Assaf (2004), Sibbertsen (2004) and Cotter (2005), whereas the latter have been used in Lobato and Savin (1998), Gil-Alana (2003), Cavalcante and Assaf (2004) and Cotter (2005).

Figure 3 shows both absolute and squared returns. Visual inspection suggests that they are both stationary, which is confirmed by various unit root tests (see Table 4).

[Insert Figure3 and Table 4 about here]

[5] This method has been further examined and refined by Velasco (1999), Velasco and Robinson (2000), Phillips and Shimotsu (2004, 2005), Abadir et al. (2007) and others.
[6] The choice of the bandwidth parameter is crucial for this method given the trade-off between bias and variance: the asymptotic variance of this estimator is decreasing with m while the bias is growing with m.

market themselves (rather than rely on brokers); this typically results in net sales on Mondays, when liquidity is low in the absence of institutional trading (Miller, 1988). It has also been suggested that the Monday effect largely reflects the fact that, when daily returns are calculated, the clustering of dividend payments around Mondays is normally ignored; alternatively, it could be a consequence of positive news typically being released during the week, and negative ones over the weekend (Fortune, 1998). Additional factors which could be relevant are serial correlation, with Monday prices being affected by Friday ones, and a negative stock performance on Fridays being given more weight (Abraham and Ikenberry,1994); measurement errors (Keim and Stambaugh, 1984); size (Fama and French, 1992); volume (Lakonishok and Maberly, 1990).

The observations ordered by day of the week also appear to be stationary on the basis of both visual inspection and unit root tests (see Figure 5 and Table 6).

[Insert Figures 5 and 6 and Tables 6 and 7 about here]

Table 7 displays the fractional integration results from the parametric method of Robinson (1994). They appear to be robust to the specification for the error term (whether white noise, AR(1) and Bloomfield-type). The lowest estimates of d are obtained for Mondays and Fridays in all cases. When u_t is assumed to be a white noise, the I(0) hypothesis

5. Conclusions

In this paper we have examined the statistical properties of the NSE

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Table1. Components of NSE-20

NAME OF THE COMPANY	ACTIVITY OF THE COMPANY
ICDC Investment Company	Investment
Kenya Electricity Generating Company	Generate Electricity
Mumias Sugar Company	Manufacturates
Rea Vipingo Plantations Ltd.	Sisal fiber production

Figure 1: NSE-20 index and its corresponding returns

Table 2: Unit root test results

i) DF tests (Fuller, 1976)			
	No regressors	An intercept	A linear time trend

Table 3: I(d) test results

i) white noise disturbances			
	No regressors	An intercept	A linear time trend
Data	1.16 (1.12, 1.20)	**1.40 (1.36, 1.45)**	1.40 (1.36, 1.45)
Log-data	1.00 (0.97, 1.03)	**1.39 (1.35, 1.44)**	1.39 (1.35, 1.44)
[redacted]			

Figure 3: Absolute and squared returns

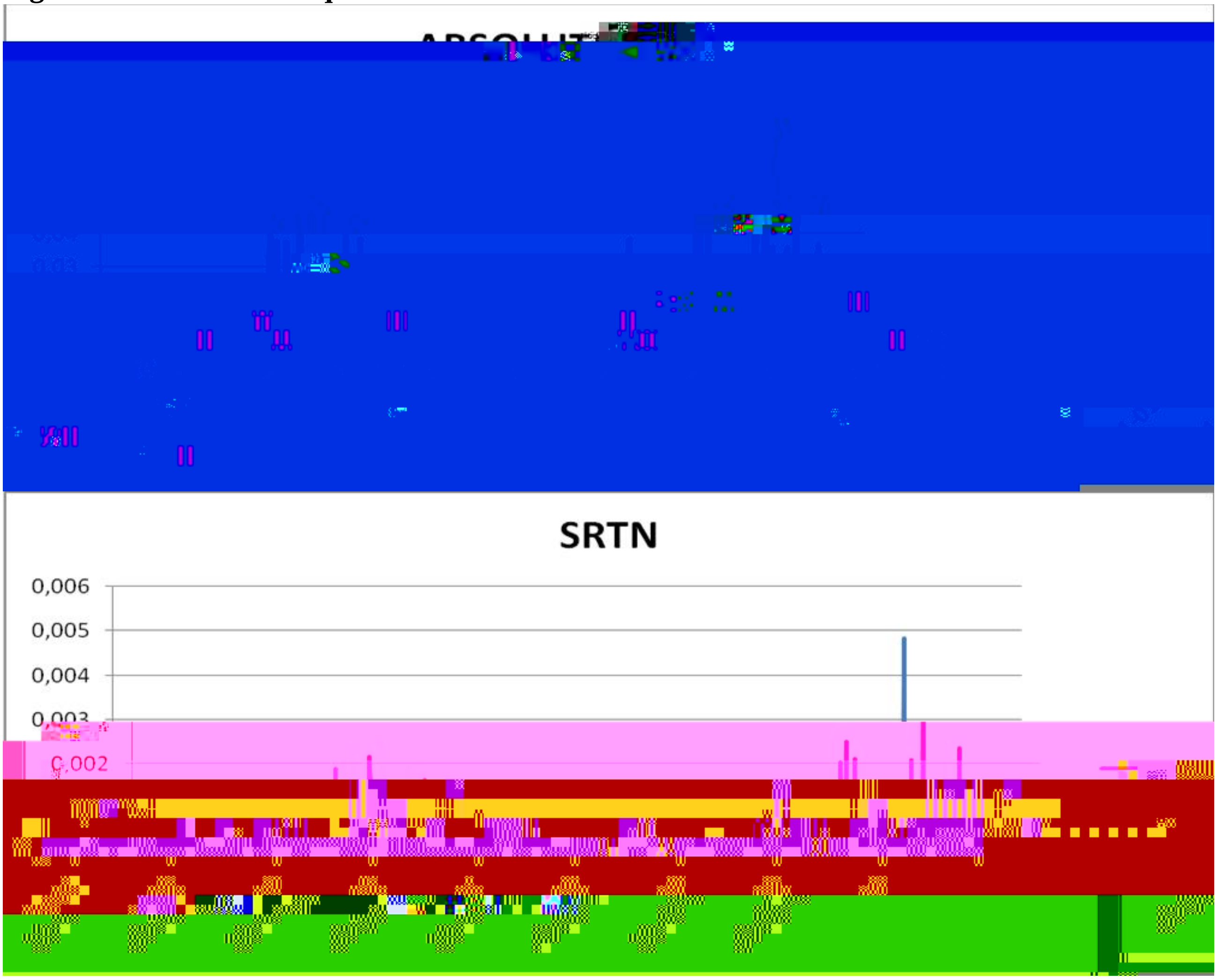

Table 5: I(d) test results on the absolute and squared returns

i) white noise disturbances

Figure 5: NSE-20 index by day of the week

i) Monday

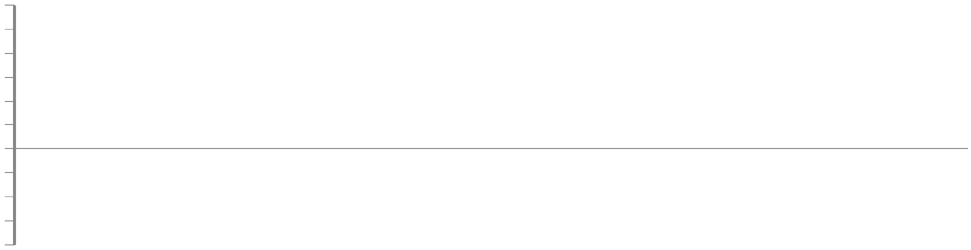

Table 6: Unit root test results on the absolute and square returns

i) DF tests (Fuller, 1976)			
	No regressors	An intercept	A linear time trend
Monday	xxx	-22.65899***	-22.67434***
Tuesday	xxx	-9.075883***	-12.68740***
Wednesday	xxx	-3.303200***	-12.39346***
Thursday	xxx	-21.85909***	-21.84855***
Friday	xxx	-4.964294***	-22.81587***
ii) ADF tests (Dickey and Fuller, 1979)			
	No regressors	An intercept	A linear time trend
Monday	-22.65643***	-22.72762***	-22.70325***

Table 7: I(d) test results for the day of the week returns

i) white noise disturbances			
	No regressors	An intercept	A linear time trend
Monday	-0.03 (-0.08, 0.04)	**-0.03 (-0.08, 0.04)**	-0.03 (-0.08, 0.04)
Tuesday	0.08 (0.04, 0.14)	**0.08 (0.04, 0.14)**	0.07 (0.02, 0.13)
Wednesday	0.04 (0.00, 0.08)	**0.04 (0.00, 0.08)**	0.03 (-0.01, 0.08)
Thursday	0.03 (		