



Contents lists available at ScienceDirect

Research in International Business and Finance

journal homepage: www.elsevier.com/locate/ribaf

Full Length Article

Modelling long memory in volatility in sub-Saharan African equity markets

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ARTICLE INFO

JEL classifications:

C22
G15

Keywords:

Long memory
Thin-trading
FIGARCH
Sub-Saharan African equity markets
Structural breaks

ABSTRACT

This study examines the long memory properties in the second moments of the return series in the equity markets of Ghana, Kenya, Nigeria and South Africa. Using 5219 daily observations of thin-trading adjusted total equity market return data, we find the presence of long-range dependency in the second moments of the return innovations in all the four countries' equity markets in the full sample. To isolate spurious long memory, we perform structural breaks analysis to guide us in splitting the data for further examination. We find that all the four countries exhibited two structural breaks each during the sample period, and long memory identified in these two markets were not influenced by the structural breaks. This finding may have an influence on portfolio diversification and risk management. The long memory characteristics in the conditional volatility may also provide useful information to market participants in pricing long-term derivative contracts.

1. Introduction

International portfolio diversification would continue to engage the attention of investors, particularly in emerging and frontier markets. The increasing globalisation has encouraged international investors to look at equity markets in Africa for portfolio diversification.

However, African equity markets are relatively small compared to equity markets in the developed world. The small size and the attendant low liquidity bring to the fore the efficiency and the price evolution on these markets. This raises the question of long memory in stock market data, and this has important implication for the efficiency of the market in the determination of security prices. Long memory is present when the statistical dependence in stock prices, that is, the autocorrelation functions of the various volatility measures, decays very slowly at a mean-reverting hyperbolic rate. Therefore, the validity of weak-form market efficiency would be challenged if long memory is present.

Considerable attention has been given to the analysis of long memory in asset returns after the findings of [Bekaert and Harvey \(1995\)](#) suggested that persistence is more pronounced in emerging markets than developed markets. For instance, [Barkoulas et al. \(2000\)](#) found evidence of long memory in the Greek equity markets; [Mckenzie \(2001\)](#) found evidence of long memory in the Australian equity market; [Lee et al. \(2001\)](#) could not reject evidence of long memory in the Chinese equity market; [Wright \(2001\)](#) modelled long memory process in 17 emerging equity market and found that only seven exhibited long memory; [Sadique and Silvapulle \(2001\)](#) documented the presence of long memory in seven Asian countries stock markets; [Nagayasu \(2003\)](#) found evidence of long memory in the Japanese equity market. [Assaf and Cavalcante \(2005\)](#) found evidence of long memory in the volatility of the Brazilian stock market; [Saleem \(2014\)](#) found evidence of long memory in all sectors of the Russian equity market. However, [Resende and Teixeira \(2002\)](#) did not find long memory in the Brazilian stock market for periods before and after the Real Stabilisation Plan.

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<http://dx.doi.org/10.1016/j.ribaf.2017.07.073>

Received 15 December 2016; Accepted 3 July 2017

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The lack of consistency in empirical results warrants a further study of long memory, particularly, in African equity markets.

The empirical literature on long memory has been focused on developed and some prominent emerging markets, however, little is known about the statistical dependence in sub-Sahara African equity markets. Generally, equity markets in Africa are comparatively small and are characterised by low liquidity, and higher volatility (Domowitz et al., 1998). Mlambo and Biekpe (2005) argue that African equity markets are characterised by illiquidity, weak investor base, low market capitalisation, poor regulatory framework, and poor accounting and reporting standards. Also, Assaf and Cavalcante (2005) argue that the industrial structure found in small markets, like those in Africa, is quite often different from those found in advanced markets. Clearly, these unique characteristics underlying African equity markets may contribute to different dynamics driving the returns and volatility process.

Empirical research on long memory in sub-Sahara African equity markets is very few. Keith and Thupayagale (2008) found evidence of long memory in the equity market of Botswana, and the volatility of South Africa after they applied FIGARCH of Baillie et al. (1996) model to data with varied commencement dates ranging from 4th January 1994, with all ending on 31st January 2007. Similarly, McMillan and Thupayagale (2009) applied FIGARCH to African equity markets data with varied commencement dates ranging from 9th August 1990, with all ending on January 31, 2007. They found long memory in the returns of all the equity markets examined, but evidence of long memory in volatility was mixed. Similarly, Alagidede (2011) found evidence of long memory in the equity markets of Egypt, Kenya, Morocco, Nigeria, Tunisia and South Africa after applying FIGARCH to data with varied commencement and ending dates ranging from 10th January 1995 to 16th November 2006. Similarly, Anoruo and Gil-Alana (2011) documented the presence of long memory in the equity markets of Egypt, Kenya, Morocco, Nigeria, and Tunisia.

From the foregoing, we argue that the use of symmetric nonlinear heteroskedastic models may not capture the asymmetry in volatility that characterises African equity markets (see Kuttu, 2014 and Appiah-Kusi and Menyah, 2003 for evidence of volatility asymmetry in African equity markets). Moreover, to guarantee that the FIGARCH model is stationary and the conditional variance is always positive requires the imposition of non-negativity and invertibility constraints.

The specific objective of this research is to examine the long memory features in the volatility of the equity markets in Ghana, Kenya, Nigeria and South Africa. These markets are the biggest and the best performers in sub-Saharan Africa in recent years. For instance, in the year 2010, the equity markets of Ghana, Kenya, Nigeria and South Africa posted year on year return of 32%, 37%, 31% and 11%, respectively. This performance increased to 49%, 48.6%, 37% and 22%, respectively, in year 2013.¹

The presence of long memory in the volatility in these markets will contradict the weak form markets efficiency hypothesis. The study uses total return equity indices data spanning the period 2nd January 1996, to 31st December 2015, yielding 5219 observations. Unlike previous research on sub-Saharan equity markets, this study adjusts for thin-trading. Appiah-Kusi and Menyah (2003) and Mlambo and Biekpe (2005) have documented pervasive thin-trading in sub-Sahara African equity markets, and Lo and MacKinlay (1990) have argued that thin-trading introduces serious bias in empirical work. Hence, we adjust for thin-trading.

The paper differs from the existing studies on sub-Sahara African equity markets in four respects. First, prior studies that examined long memory in African equity markets did not adjust for thin-trading. This paper adjusts for thin-trading to eliminate potential bias in empirical work. Second, previous studies employed FIGARCH model to study long memory in sub-Sahara African equity markets. To guarantee that the FIGARCH model is stationary and the conditional variance is always positive requires the imposition of complicated and intractable restriction. However, this study employs the FIGARCH model of Bollerslev and Mikkelsen (1996). The FIGARCH model does not require the non-negativity and inevitability constraints. In addition, it further allows the conditional variance to oscillate, and it accommodates asymmetries between positive and negative shock of equal magnitude emanating from the same source, the so-called leverage effects. Third, to isolate spurious long memory, we perform structural breaks to investigate seasonal long memory component of returns, owing to non-stationarity with statistical properties that are deterministic functions of time. Fourth, our data sample is long and includes more recent observations than previous studies on sub-Saharan African equity markets. Specifically, the data starts from 2 January 1996–31 December 2015.

The findings suggest that, across all samples, there is significant first order autocorrelation and volatility asymmetry. We find the presence of long memory in the equity markets of all four countries. Furthermore, we did not find evidence of spurious long memory due to structural breaks in all the equity markets.

Given that volatility is a very important consideration in the calculation of Value-at-Risk measures, hedge ratios, pricing of derivatives, and hedging and trading strategies, the determination of possible long memory in stock return volatility may provide useful information to market participants. In particular, extreme persistence in volatility may provide investors with useful information in pricing long-term derivative contracts (Bollerslev and Mikkelsen, 1996), given that volatility is useful in pricing and hedging derivative strategies. Also, the strong first-order autocorrelation in the returns and the presence of long memory in the conditional volatility on these markets contradict the efficient market hypothesis. Hence, first and second moments dynamics on these markets might be predictable.

The rest of the paper is organised as follows: The methodology is presented in Section 2; description of the data is presented in Section 3; the empirical result is analysed and discussed in Section 4 and finally, Section 5 summarises and concludes the paper.

2. Methodology

Daily returns for each series are computed by taking the first difference of the natural logarithm of the current day's close and the

¹ Please see The African Securities Exchanges Association 2011 Year Book at <http://www.african-exchanges.org/library/> and Africa Strictly Business at <http://www.africatrictlybusiness.com/lists/top-performing-african-stock-markets-2013>.

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