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African equity markets' exposure to oil and other commodities - implications for global portfolio diversification

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Abstract

This paper examined the risk-return relationship and the correlation dynamics of African stocks relative to global factors. By applying both the static and augmented capital asset pricing model, as well as dynamic conditional correlation methodology to daily returns series from January 3, 2003 to December 29, 2014, we find evidence of conditional correlation between African stocks and global factors influenced by the global financial crisis. From the risk-return point of view, Egypt and South Africa, although dominant, show relatively weak risk mitigating opportunities. Their information ratios are highly anemic to internationally accepted thresholds. Despite this, international investors seeking to diversify via uncorrelated markets may consider Africa, albeit on account of volatility persistence, present and past market conditions, market stability, as well as size and liquidity considerations.

Keywords African stocks · Diversification · CAPM · Volatility persistence · Commodity financialization

JEL Classification F21 · F36 · G1 · G11 · G15

1 Introduction

Most developing economies depend on primary commodities for export revenues and foreign exchange for development (Deaton 1999). This dependency became

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pronounced between 2000 and 2010 with the broad-based surge in commodity prices, particularly precious metals. Gold prices for instance, quadrupled between 2001 and 2010 (Narayan et al. 2013). To this end, investment inflows attributed to most commodities' future markets surged from US$15 billion to US$200 billion between 2000 and 2008 (CFTC 2008) and subsequently increased to US$210 billion in 2012 (Boako and Alagidede 2016). Baur and McDermott (2010) have explicitly shown that precious commodities exhibit low and positive best response function to negative economic disturbances. This is counterintuitive to the prevailing logic of equity price behavior. As a result, commodities attracted such huge investments in contrast to sharp deteriorations in the performance of global equity markets. The existence of low and negative correlation between unrelated asset classes have been ascribed to the different macroeconomic variables which influence their performance (Gorton and Rouwenhorst 2006). This relationship is very relevant for the transfer of price risk of commodities for diversification and portfolio allocation.

Diversification into commodities has become more significant in the last two decades because of the high volatility and contagion risk emanating from high integration and interdependence among world financial markets. In addition, the increasing financialization of commodity markets expedites the distribution of same in huge multi-asset portfolios to achieve hedging demands and possible substitution (Bekiros et al. 2016). Embracing a diversified portfolio might raise total earnings, decrease risk and enhance sharp ratio (Batten et al. 2010). However, Africa and other emerging equity and commodity markets appear to be losing out of the advantages of this exposure to diversified portfolios which are likely to generate huge portfolio investment. Boako and Alagidede (2016) attributed this to post-crisis era poor performance of equity markets, as well as the uncertainty of the prospects of investing in Africa. They further argue that the prevailing state of knowledge on Africa is very limited, and this often leads to half-baked conclusions on the continents markets. That notwithstanding, the continuing turmoil in the advanced capitalist economies presents Africa and other emerging regions opportunities that can enable investors diversify their portfolio risk and reap superior returns. More importantly, Africa is a haven of safety. The continent has robust natural and human resources that can support literally any kind of investment contemplated by the human mind.

For Africa and emerging markets to appropriately offer international investors a profitable alternative for investment portfolio diversification, there is the need to understand the joint movement between their equity markets and world prices of commodities. This is important because the risk of inadequate knowledge by investors on specific-market drivers of commodities might make them ascribe their performance to demand-side shocks. Given that the performance of financial markets in recent times has been affected by shocks attributed to business cycles, investors are most likely to believe that correlation between prices of commodities and equities will be high.

The primary objectives of this study are two-fold. First, we address the issue of dynamic linkage between commodities and stock markets for Africa amid economic cycles. Second, we explore the relative potentials of African stock markets as vehicles for enhancing international portfolio diversification.

We focus on African and emerging markets as the most favourable alternative to protect international investors from the frequent turmoil across advanced economies due to their likely decorrelation with global shocks (Boako and Alagidede 2016). In

addition, African and emerging markets together constitute the largest producers of most precious metals in the world. For instance, in 2015 African and emerging markets of Asia, South and Central America produced about 59% of the global precious metals (U.S Geological Survey 2016). Cote d'Ivoire, Ghana, Nigeria and Cameroon account for more than 70% of global cocoa output. South Africa is among the top five gold producers, and it is number one for platinum, among a host other precious gems. Four African countries (namely, Algeria, Angola, Libya, and Nigeria) are part of the twelve-member OPEC group. With this in mind, there is no doubt that changes in the prices of these commodities can affect economic, social and financial fortunes of the African continent. Happenings in the commodities markets could therefore reflect the choices and selection of alternative asset classes by both local and international investors. Additionally, African countries depend on raw material and commodities in their production and exports. The net exposure and changing correlations among the asset classes are interesting to examine.

The paper is particularly useful for Africa because at the center of Africa's development agenda is the quest to attract high private capital flows (PCFs).[1] Although the absolute risk borne by international investors in their asset allocation and portfolio selection decisions may be irrelevant (as opined by Bekaert and Harvey 2014), it is important to note that investors may fail to include a particular asset class in their diversified portfolios if the ultimate risk exceeds the expected pay-off. Generally, emerging/frontier markets' equity returns are characterized by higher risk and volatilities (see Moss and Thuotte 2013). At the same time, uncertainty, risk perceptions (such as extreme political strife), institutional underdevelopment and poor corporate governance structures which are common in developed markets have been exported to Africa and they remain critical hindrances to international investors seeking to diversify into the continent's rather nascent markets – see also Alagidede (2008). Additionally, the uncertainty about earning higher expected pay-offs has been a major contributing factor to why the continent (Africa) appears not to be receiving large portfolio investment flows.[2] Meanwhile, recent crashes in the global economy and the increasing significance of developing economies in the globalization process have attracted the attention of fund managers to diversify across those economies. The ability of the African markets to identify and benefit from such potential international cross-border portfolio investment flows and diversification opportunities requires an understanding of the cross-market linkages between its financial markets and the global economy, as well as the risk-return trade-offs.

Section 2 reviews the related literature. Section 3 outlines the methodologies. Detailed discussion of the results is executed in Section 4. Section 5 concludes the paper with some recommendations.

2 Related studies

The literature is replete with studies examining the integration of emerging markets' stocks with global financial markets, and among developed markets (see for example,

[1] Our definition of private capital flows includes foreign direct investments (FDIs), portfolio capital flows and debt flows.

[2] The share of global portfolio flows to Africa in 2010 was just about 1%.

Bekaert 1995; Voronkova 2004; Demian 2011; Garham et al. 2012; Aloui and Hkiri 2014). Dalkir (2009) examines the co-movement in stock market indices during volatile periods and confirms the belief that interdependence between markets are higher during volatile periods. He emphasizes that this interdependence is due to correlated actions of traders in different markets, thus avoiding correlation to fall to its previous level. In explaining the transmission of price and volatility spillovers across the US and European stock markets, Savva (2009) opines that the magnitude of this correlation is higher not only for negative shocks, but also when a combination of shocks of opposite signs occurs.

In Africa, considerable sections of the literature examined Africa's stocks co-movement and level of integration with global stock markets despite the differences in results (see for example, Alagidede 2010; Agyei-Amponsah 2011; Moss and Thuotte 2013). Alagidede (2010) showed that African stock markets are not well connected with each other, raising important questions about the quest for a pan-African exchange. Moreover, he found weak stochastic trends between African markets and the rest of the world, indicating that Africa's markets tend to respond to local, rather than global information. This conclusion helps illuminate the discussion on the integration of African markets to the global economy which are often one sided. The authors on the subject intuit that volatilities in markets around the 2008–2009 financial crisis suggests that no country is after all an island, with the liquid markets feeling the direct brunt of the subprime melt down. By examining trends over two decades Moss and Thuotte (2013) conclude that regional indices have become increasingly correlated with the S&P 500 index with Sub-Saharan Africa being a notable laggard. They conclude that Africa's integration lag may present opportunities for investors seeking regional diversification. Policymakers seeking to attract greater portfolio investment to the continent are urged to take note of this advice.

Theoretically, both commodity "financialization" (Olson et al. 2014; Buyuksahin and Robe 2014) and herd behaviour (Demirer et al. 2015) are identified as drivers of the commodity-equity correlations. In case a price change in commodities is driven by commodity financialization, it can be argued that equity market shocks may lead to herding in the commodity market. The herding behavior could usher asset prices not to show substantial deviation from the overall market (Chang et al. 2000). As market participants subdue their own beliefs and make investment choices that are driven by market sentiments, the correlated behaviour of traders may cause portfolio returns to show higher co-movements resulting in lower deviations within the commodity portfolio (Demirer et al. 2015).

Theoretical justification for the commodity financialization hypothesis can be put under three strands. The first observes that because commodities are generally segmented from other financial markets (Bessembinder 1992) and less constrained than others (Teo 2009), financialization strengthens cross-market linkages if the increases in financialization reflect new entrants or traders not previously in these markets (Buyuksahin and Robe 2014). Second, financialization can lead to cross-market shock contagion (Broner et al. 2006; Buyuksahin and Robe 2014) and risk-sharing (Cheng and Xiong 2013) between commodities and equities. Thus, "financialization" can be seen as "affecting risk sharing in commodities through the double role of financial investors as providers of liquidity and as consumers of liquidity from hedges when trading for their own needs" (Cheng and Xiong 2013; pp. 2). Thirdly, financialization

may affect informational discovery in commodity markets. Heterogeneous expectations among financial investors under information asymmetry can lead to drift in commodity futures prices (Singleton 2012). According to Sockin and Xiong (2015), trading noise of financial investors in futures markets can lead to feed-back effect to the commodity demand of final goods. It thus makes it difficult for producers of goods to decipher whether changes in futures prices occur based on investor trading or developments in global economic environments. This reduces opportunities for arbitrage profits and consequently results in the decoupling of markets that had earlier been linked up.

The above indicates that although financial markets may affect each other's performances, they are not influenced only by their own unique fundamental environment, but also by the behaviour of other markets. For example, the fundamental mechanism of free market economies makes it possible for commodities markets to influence interest rate trend, which affects bond markets. This in turn has an impact on stock prices. Additionally, theory suggests that commodities and stocks move in opposite direction, particularly during periods of economic turmoil. This is because investors typically prefer to slide from riskier investments like company shares to hard assets like gold or other commodities (see Nicolau 2010). Although it may not happen instantly, central banks usually react to increases in commodity prices by raising interest rates. This is observed in the positive correlation between interest rates and commodity prices. The rise in interest rates will then induce a decrease in borrowing activity. This feeds into reduced economic activity. The reduction of demand for products and services has a consequential decline in both consumption and production, therefore a contraction in business activities that leads to changes in the value of company shares. A decrease of the value in this case.

Theoretically, the equity price models suggest that oil price changes can impact stock prices through two channels: the expected discount rate and expected cash flow. Since oil price constitutes significant portion of a firm's input cost, a company's marginal cost of production can be driven by higher oil prices. In fact, oil price volatility may raise uncertainties about the prospects of future energy market conditions which can affect investment behaviour leading to declines in investments (Xu 2015). The price of a stock is a function of the discounted present worth of expected future cash flows. As investors cut in stocks the reduced cash flow can adversely affect stock prices. The reverse is true if rising oil prices causes investors to increase their investments in stocks.[3]

The US Energy Information Administration (EIA) estimates based on the OECD model shows that an increase in the price of a barrel of crude oil by US$25 to US$35 causes a two-year drop in the gross domestic product (GDP) of 0.3, 0.4, and 0.5 percentage points in the US, Japan, and the Eurozone respectively. We argue that if crude oil price constitutes such a decisive factor in economic growth then upturns will meaningfully enhance firms' future cash flows and ultimately their equity prices. In anticipation of higher inflation resulting from increasing oil prices, monetary policy makers may increase interest rates (Bernanke 1983; Pindyck 1981). The corollary effect

[3] This may be depending on whether the firm produces or consumes oil. Park and Ratti (2008) contend that an increase in the price of oil is not always a bad news for the equity market. "Shocks emanating from oil prices may be bad news for the stock market only when high oil prices arise from oil market-specific demand shocks related to shifts in the precautionary demand for crude oil in response to concerns about shortfall in future production" (Xu 2015, pp. 2610)

of this can be a decrease in stock prices through the discount rate channel. This is true since the discounted dividend model (DDM) posits that equity prices are inversely related to interest rates (and a rise in interest rates imply higher required rate of return). Empirical literature examining the oil-stock nexus can be put under two main categories depending on the level of aggregation (Xu 2015): aggregate level (e.g. Frimpong 2009; Adu et al. 2013; Boako et al. 2015) and disaggregate level (e.g. Lee and Ni 2002; Arouri and Nguyen 2010; Nayaran and Sharma 2011; Xu 2015).

The studies by Bodie and Rosansky (1980) and You and Daigler (2013) support the view that the inclusion of commodities in portfolios helps to mitigate risk. The part of the literature examining the interconnectivity between commodities and equity markets produce different results. Buyuksahin and Robe (2014) establish that the correlation between returns on commodity and equity indices increases with the participation of speculators in hedge funds that hold positions in both equity and commodity futures markets (see also Silvennoinen and Thorp 2013). On the otherhand, Buyuksahin et al. (2008) find no evidence of co-movement between equity and commodity index returns for the 1991–2007 period. Olson et al. (2014) uses volatility impulse response functions from a multivariate BEKK model to investigate the relationship between energy and equity markets and shows that low S&P 500 returns cause substantial increase in the volatility of the energy index. Most of these studies have largely focused on developed and emerging markets in Europe, Asia and North America leaving a substantial vacuum in the African context.

3 Data and methodology

Data for the study consist of indices of eleven (11) African stock markets. These markets represent the largest stock markets in Africa, accounting for the bulk of total market capitalization. They could therefore proxy for stock markets in the rest of the continent. Their inclusion in the sample is based on market size, trading volume and regional representation. All the eleven (11) markets are open to international investors despite disparities in the level of openness (Kodongo and Ojah 2011). We include in the sample spot prices of five (5) global commodities (gold, oil, silver, platinum, and cocoa)[4] and an aggregate commodity price index (i.e. the Bloomberg Commodities Index – BCOM)[5]. These indicators are complemented with two global equity indices - the Standard and Poor 500 (S&P 500) index of the U.S and the Morgan Stanley Capital International World index (MSCI-W). We use the main U.S market (i.e. S&P 500) because the U.S remains the main origination point for the 2008–2009 financial crises. The MSCI-W is also included because of the diversity in its composition (i.e. it is made up of both developed and emerging markets).

[4] Alternatively, we could have relied on futures prices. However, as indicated by Vivian and Wohar (2012), spot prices constitute the underlying securities upon which derivatives are based. Relying on spot prices is also noted to avoid issues related to rollover of futures contracts (Creti et al. 2013).

[5] The index with a base value of 100 as of 31 December, 1990 and computed every 15 s is made up of 22 exchange-traded futures on physical commodities. The represented commodities are weighted to account for economic significance and market liquidity. Commodity weights are based on production and liquidity subject to weighting restrictions applied annually such that no related group of commodities constitute more than 33% of the index and no single commodity constitutes more than 15%.

Commodities in the sample have significance in international trade and African economic development. The continent is open to foreign participation even if some individual countries have restrictions to non-resident foreign investors' holdings on local bourses. This high tolerance of openness to non-resident foreign investor's is a fundamental African attribute, and when not abused, opens doors for equal co-creation in the financial markets. For instance, between 2010 and 2012 fiscal years, net private capital flows to Sub-Saharan African (SSA) countries doubled, compared with the 2000–2007 periods. In 2013, portfolio and cross-border bank flows into SSA markets outstripped the US$17 billion mark in 2012. Dominant beneficiaries were Nigeria, Zambia and Ghana. An estimated portfolio flows recorded by these countries stood, respectively, around 2.7, 1.6 and 1.9% of gross domestic product (GDP).[6]At the same time, outflows from Africa has been over 150 times the investments that were made. It is this obvious imbalance that need urgent attention. And it is specifically matters of this nature that escape the attention of academics and policy makers.

The data is obtained from Bloomberg. It is the daily close-to-close stock prices from 3 January 2003 to 29 December 2014 (a total of 3056 observations), [7] expressed in a common currency (using the US dollar (US$)) to ease comparison (see Pukthuanthong and Roll 2009). We therefore assume that hedging and/or diversification opportunities are viewed from the perspective of international investors. The use of the close-to-close (see also Brooks and Persand 2001) method is to mitigate any problems arising from non-synchronous trading (since trading days for the different markets differ in the week). The method is executed by eliminating observations for all markets if the price index for a given market is not available for a given date. We limit our sample to only days for which we have observations for all markets. Empirical analyses are conducted with continuously compounded returns computed as:

$$r_t = \ln\left(\frac{p_t}{p_{t-1}}\right) * 100 \tag{1}$$

where r_t = returns at time t; p_t and p_{t-1} are respectively current price/index and one-period lagged price/index.

Two methods are adopted to capture the effects of the GFC in our models. One is the use of a dummy, and the other is data disaggregation. The latter puts the data into full sample and sub-sample (global financial crisis) periods. Akin to Lean and Nguyen (2014), the global financial crisis (GFC) is considered to have commenced on 15 September 2008 and eased on 30th May, 2009. Our disaggregated data then is the full sample period from 3rd January, 2003 to 29th December, 2014, and a sub-sample (crisis) period covering 16th September 2008 to 1st June, 2009.

3.1 The extended market model

To examine risk-return trade-off of portfolio investments in the African markets, we specify an extended capital asset pricing model (CAPM) – see also Anghelache (2012)

[6] Figures are gleaned from various statistical bulletins of the IMF and World Bank.
[7] The choice of the sample period is influenced by data availability for all variables.

and Keith and Nitzsche (2005). The estimation of the CAPM model in this study is done for the full sample period. However, in order to capture the effects of the GFC, a dummy variable (D_t) taking the value one (1) during the GFC period and zero (0) otherwise is chosen. We estimate this model to determine the global index that exerts the highest influence on Africa's unexpected average excess returns on risk-adjusted basis in the full-sample and GFC period. The extended excess return market model (static approach) is specified with D_t as:

$$\left(r_{it}-r_f\right) = \beta_0 + \beta_1\left(r_{mit}-r_f\right) + \beta_2 D_t + \varepsilon_t \tag{2}$$

where r_{it} = returns on African stocks; r_{mit} = returns on global indices (BCOM, S&P 500, and MSCI-W) which serve as benchmark market portfolios; ε_t is the error; r_f = risk-free interest rate (in this case, considered as the U.S 1-month Treasury bill rate)[8] since returns are measured in US$.

To be able to capture the impact of the global commodities (GC) on the African stocks, the following augmented market model is specified, similar to Lean and Nguyen (2014).

$$\left(r_{it}-r_f\right) = \alpha_0 + \beta^*{}_0\left(r_{mit}-r_f\right) + \sum_{j=1}^{n}\alpha_j \Delta\ln(GC)_{jt} + D_t\left[\delta_0 + \beta_1^*\left(r_{mit}-r_f\right) + \sum_{j=1}^{n}\delta_j \Delta\ln(GC)_{jt}\right] + \varepsilon_t \tag{3}$$

where $\beta^*{}_0$ and $\beta^*{}_1$ are measures of market-wide risk (computed as the covariance of the return of an asset with the return of the benchmark divided by the variance of the return of the benchmark over the sample period) in the full sample and GFC periods respectively; n is the total number of commodities (which is 5); $\alpha_j\,(j = 1, 2, \ldots, 5)$ and $\delta_j\,(j = 1, 2, \ldots, 5)$ denote the marginal effects of the commodities on equities in Africa for the full sample and GFC periods respectively. All other notations are as previously defined in Eq. (2).

3.2 Modeling dynamic conditional correlation (DCC)

We adopt the Engle (2002) DCC model to estimate the correlation between African stocks and global economic factors (i.e. global commodities and indices). The Engle (2002) DCC model can be estimated in two phases: first by estimating univariate GARCH (1,1) parameters and second estimating the coefficient of the conditional correlations. For an $m \times 1$ vector of asset returns, $r_t = (r_{it}, \ldots, r_{mt})'$with conditional mean and variance, we may express the m x m conditional covariance matrix as:

$$H_{t-1} = D_{t-1}R_{t-1}D_{t-1} \tag{4}$$

[8] The 1-month Treasury bill rate is sourced from the website of the Federal Reserve Bank of St. Louis https://research.stlouisfed.org/fred2/categories/116

$$D_{t-1} = \begin{bmatrix} \sigma_{1,t-1} & 0 & \cdots & 0 \\ 0 & \sigma_{2,t-1} & & \vdots \\ \vdots & & \ddots & 0 \\ 0 & 0 & \ldots & \sigma_{m,t-1} \end{bmatrix} \tag{5}$$

$$R_{t-1} = \begin{bmatrix} 1 & \rho_{12,t-1} & \rho_{13,t-1} & \cdots & \rho_{1m,t-1} \\ \rho_{21,t-1} & 1 & \rho_{23,t-1} & \cdots & \rho_{2m,t-1} \\ \vdots & & \ddots & & \vdots \\ \vdots & & & & \rho_{m-1,m,t-1} \\ \rho_{m1,t-1} & \cdots & \cdots & \rho_{m,m-1,t-1} & 1 \end{bmatrix} \tag{6}$$

where D_{t-1} is an *m x m* diagonal matrix with elements $\sigma_{i,t-1}, i = 1, 2, \ldots, m$ representing the conditional volatilities of asset returns, and R_{t-1} denotes the symmetric *m x m* matrix of conditional correlations. We specify the conditional volatility of the *ith* asset returns as given below:

$$\sigma^2_{i,t-1} = Var\left(r_{it} \,|\Omega_{t-1}\right) \tag{7}$$

in which case Ω_{t-1} is the information available at time *t-1* and *Var* is the variance of the asset returns.

The GARCH (1,1) model of $\sigma^2_{i,t-1}$ is then estimated as:

$$\sigma^2_{i,t-1} = \overline{\sigma}_i^2 \left(1-\lambda_{1i}-\lambda_{2i}\right) + \lambda_{1i}\sigma^2_{i,t-2} + \lambda_{2i} r^2_{i,t-1} \tag{8}$$

where $\overline{\sigma}_i^2$ is the unconditional variance of the *ith* asset return (*r)* and λ_{1i}, λ_{2i} are unknown parameters.

The conditional correlations between assets *i* and *j* can be estimated as:

$$\widetilde{\rho}_{ij,t-1}\left(\phi\right) = \widetilde{\rho}_{ji,t-1}\left(\phi\right) = \frac{q_{ij,t-1}}{\sqrt{q_{ii,t-1} q_{jj,t-1}}}, \tag{9}$$

for $-1 \le \rho_{ij,\,t-1} \le 1$, and $\rho_{ij,\,t-1} = 1$, for $i = j$ and $q_{ij,t-1} = \widetilde{\rho}\left(1-\phi_1-\phi_2\right) + \phi_1 q_{ij,t-2} + \varphi_2 \widetilde{r}_{i,t-1}\, \widetilde{r}_{j,t-1}$.

In the above equation, $\overline{\rho}_{ij}$ denote the unconditional correlation, $\widetilde{r}_{i,t-1}$ is standardized asset returns, and ϕ_1 *and* ϕ_2 are non-negative scalar parameters with a sum less than unity i.e. $\phi_1 + \phi_2 < 1$.[9]

4 Results and discussion

Table 1 shows results of unit root test and summary features of all returns series. Panels A and B respectively refer to the full sample and sub-sample (GFC) periods. From the Augmented Dickey-Fuller (ADF) unit roots results shown in the last column, it is

[9] Returns are standardized to achieve normality (see also, Pesaran and Pesaran, 2009).

observed that all series are stationary at the first difference. The distributional properties of the series show extreme behavior. The returns series are characterized by excess kurtosis for all variables and in both sample periods. All series are positively skewed except Namibia, Mauritius, Ghana, Cote D'Ivoire, Botswana, and Oil (in the full sample period); and Kenya, Cote D'Ivoire, Oil, Gold, and Cocoa (in the crisis period). The assumption of normality for the series is also rejected by the Jacque Bera statistic (JB) statistic at the 1% significance level. The daily average mean returns and standard deviations (SDs) show relatively similar magnitudes in both the full and GFC period differentiated by the higher numbers of negative mean returns in the GFC period. Generally, the mean returns and SDs are respectively low and high for the commodities relative to the African stocks in both periods. Of this, gold and oil possess the highest SDs in both periods. Buyuksahin and Robe (2014) and Creti et al. (2013) similarly observe that the rate of return on equities is generally less volatile than that on commodities. This may be partly due to the fact that prices of commodities (especially gold and oil) reflect the real-time equilibrium between demand and supply, with contingencies that change on daily basis.

The standard postulate in finance theory is that expectations for greater returns from an investment should be accompanied by the willingness to bear correspondingly higher risk. The reverse is also true. However, the risk/reward trade-off strikes the balance between the anticipation for the lowest possible risk and the highest possible return. We use the daily reward-to-variability ratio, also called the Sharpe ratio (SR), and computed as the ratio of mean return to standard deviation. We observe from Table 1 that the SRs are positive for all series in the full sample period except gold and BCOM. However, the advent of the GFC (crisis period) renders the SRs of about ten assets (6 African stocks and 4 commodities) negative. Assets with negative/lower SRs show underperformance or higher risk bearing. The highest SRs are recorded for equities in Africa: Tunisia (5.6%), Mauritius (5.9%), and Cote D'Ivoire – (5.0%) - all in the full sample period.

Though not reported for brevity of exposition (*but available upon request*), results of autoregressive conditional hetereoschedasticity (ARCH) test rejects the null of "no ARCH" effects for all returns series except for Botswana, Cote D'Ivoire and Ghana. The presence of the ARCH effects makes the estimation of a GARCH-type model more appropriate in modeling the conditional correlation among the variables.

Figure 1 displays a visual depiction of the series from January 2003 to end of December 2014. Except for Ghana, Cote D'Ivoire, Botswana and Namibia in which volatility clustering intensifies after 2009, all other markets show clustering across the entire sample period. Though the series are seen to be characterized by periodic breaks and variance concentrations, one can easily notice similar noticeable features between 2008 and 2009. This can be attributed to the GFC that sparked fluctuations in the prices/indices of most asset classes across the globe. Since the volatility patterns of the series are seen to vary over time, we will conduct the Engle (2002) dynamic condition correlation (DCC) to empirically determine the level of correlations among the variables.

4.1 The excess market model analysis

The estimated CAPM model in Eq. 2 provides a standard approach for assessing the risk associated with investing in the African stock markets with respect to the global

Table 1 Summary statistics of daily returns

	Mean (%)	SD (%)	Skewness	Kurtosis	JB @ 1% Sign. level	Sharpe Ratio (%)	ADF @ 1% Sig.
Panel A: *Full sample period* (03/01/2003–29/12/2014)							
TUNISIA	0.0389	0.6973	−0.1931	8.7326	4196.634	0.0558	Y
SOUTH AFRICA	0.0463	1.8240	−0.2636	8.6211	4052.103	0.0254	Y
NIGERIA	0.0254	1.3229	−0.2992	8.4972	3887.203	0.0192	Y
NAMIBIA	0.0549	1.2676	1.2366	50.4353	287,198.4	0.0433	Y
MOROCCO	0.0155	1.3147	−0.0691	7.4497	2522.765	0.0118	Y
MAURITIUS	0.0511	0.8613	0.0168	15.7450	20,676.83	0.0593	Y
KENYA	0.0377	1.1784	−0.0298	24.2293	57,368.81	0.0320	Y
GHANA	0.0226	1.0095	0.8322	39.8584	173,283.2	0.0224	Y
EGYPT	0.0804	1.8002	−0.6109	10.2633	6905.414	0.0447	Y
COTE D'IVOIRE	0.0681	1.3606	4.0323	58.6650	402,704.7	0.0501	Y
BOTSWANA	0.0282	1.0004	1.7613	62.2022	447,723.9	0.0282	Y
SILVER	0.0409	2.1162	−0.8063	9.0775	5026.128	0.0193	Y
PLATINUM	0.0239	1.4197	−0.7734	8.6216	4321.624	0.0168	Y
OIL	0.0186	2.3819	0.0391	13.5518	14,231.71	0.0078	Y
GOLD	−0.0028	2.1457	−0.0824	9.8936	6052.505	−0.0013	Y
COCOA	0.0123	1.9338	−0.3544	18.8676	32,113.48	0.0064	Y
S&P 500	0.0269	1.2166	−0.3313	14.7161	17,505.98	0.0221	Y
BCOM	−0.0037	1.1164	−0.2570	5.5069	833.58	-0.0033	Y
MSCI-W	0.0245	1.0442	−0.4695	12.6210	11,894.69	0.0235	Y
Panel B: *Crisis-period* (16/09/2008–01/06/2009)							
TUNISIA	0.0011	0.7798	−0.3042	9.3248	2693.23	0.0014	Y
SOUTH AFRICA	0.0181	2.0176	−0.2045	9.1625	2544.48	0.0089	Y
NIGERIA	−0.0581	1.4302	−0.3637	6.6739	935.71	−0.0406	Y
NAMIBIA	0.0395	1.1479	−0.3661	8.8703	2334.60	0.0344	Y
MOROCCO	−0.0825	1.4715	−0.0826	6.7579	943.88	−0.0561	Y
MAURITIUS	0.0094	0.9255	−0.3085	16.5319	12,240.42	0.0102	Y
KENYA	−0.0055	0.9865	0.6173	13.7736	7844.57	−0.0056	Y
GHANA	−0.0029	1.0439	−0.3906	11.1584	4480.73	−0.0028	Y
EGYPT	−0.0113	1.8501	−0.9584	12.0904	5757.57	−0.0061	Y
COTE D'IVOIRE	0.0190	1.1912	0.1816	9.6950	2998.90	0.0160	Y
BOTSWANA	−0.0004	0.8624	−0.5772	7.5719	1483.23	−0.0055	Y
SILVER	0.0182	2.2568	−0.5526	8.9463	2440.23	0.0081	Y
PLATINUM	−0.0070	1.4855	−0.8493	8.5663	2259.34	−0.0047	Y
OIL	−0.0390	2.5492	0.7987	17.4152	14,032.03	−0.0153	Y
GOLD	−0.0373	2.3803	0.0147	10.9640	4231.03	−0.0157	Y
COCOA	0.0097	1.7067	0.0043	6.1948	680.90	0.0057	Y
S&P 500	0.0280	1.4566	−0.3441	13.0513	6771.00	0.0192	Y
BCOM	−0.0151	1.1049	−0.0857	5.8708	551.72	−0.0137	Y
MSCI-W	0.0153	1.2623	−0.4575	10.8002	4114.59	0.0121	Y

Notes. *JB is the χ^2 statistic for testing normality. SD denotes standard deviation, and ADF is the augmented Dickey-Full test for unit root.* ***Y = "yes"*** *indicating that the series is first-differenced stationary at the 0.01 significance level.*

market indices (i.e. S&P 500, BCOM, and MSCI-W). Eq. 2 is estimated for all eleven African stock markets in a static framework. The country by country estimation results together with two measures of risk-adjusted performance are shown in Table 2.

Although the Shape-Lintner version of the CAPM suggests that the Jensen's alpha (the intercept or constant term) should be zero, it can be observed from Table 2 that the country-by-country constants are negative (less than zero) and significant at the 1% level. The results suggest that during the 12-year period, investments in African stocks underperformed those in the global markets, making African stocks generally less attractive to foreign investors at normal periods.

Results from the estimated beta (β_1) in Table 2 indicating the sensitivity of the African stocks to the market-wide source of risk (systematic risk) possibly arising from global markets volatility confirms the signs and magnitude of the Jensen alphas. The dummy (D_t) represents the effect of the GFC (β_2). As shown in the results all the markets were negatively affected by the GFC at varying significance levels with S&P 500 as the benchmarked global market. This corroborates the view by Giovannetti and Velucchi (2013) that shocks from the collapse of Lehman Brothers (around September 2008) had more relevant impact on African stock markets. South Africa and Nigeria received immediate impacts, with shocks persistent even after the period of the Lehman Brothers debacle. More closely related to our findings is the observation by Beck et al. (2009) that propagation of shocks from the GFC had a second round effect in Africa. Thus, the impact of the GFC to African economies was not through the credit crunch and liquidity freeze in the pre-2008 periods (i.e. Phase 1), but rather through the global recession that followed into the second phase (i.e. between 2008 and 2009).

With the Bloomberg Commodity Index as the global market, significant positive effects are noticed except for Botswana, Egypt, Ghana, Kenya and Nigeria. Similarly, in the case of the MSCI-W, only Nigeria and Ghana are seen to have escaped the

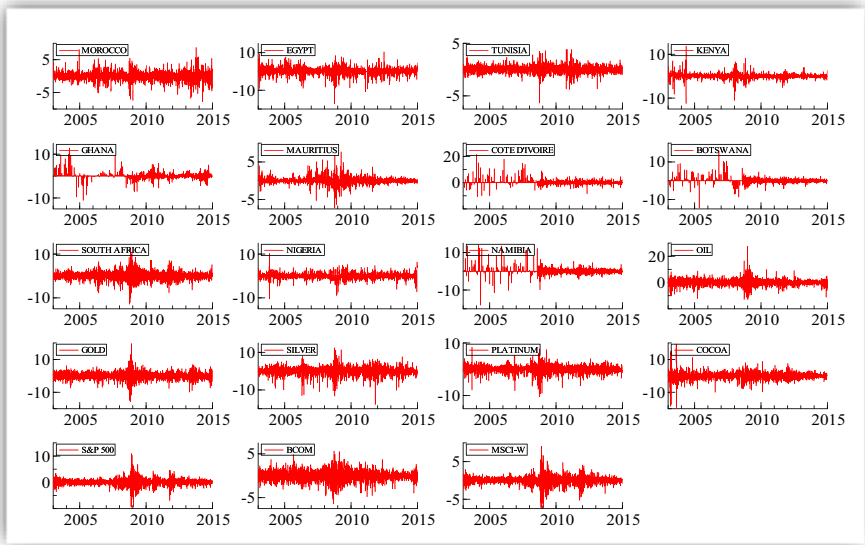

Fig. 1 Time plots of all returns series

Table 2 Estimation results of the static market model and risk-adjusted performance measures

	Static Market Model Results (*full sample period with D_t*) – Eq. 2				Risk-Adjusted Performance Measures			
					Full Sample Period		***Crisis Period***	
Market	β_0	β_1	β_2	DW	Tracking Error	Information Ratio	Tracking Error	Information Ratio
Panel A: S&P 500 as the benchmark global market								
BOTSWANA	−0.418[−13.212]***	0.686[49.539]***	−0.656[−20.451]***	2.03	0.974	0.002	0.834	−0.039
COTE D'IVOIRE	−0.327[−9.158]***	0.727[47.243]***	−0.730[−19.039]***	2.01	1.334	0.032	1.163	−0.008
EGYPT	−0.370[−7.659]***	0.682[33.225]***	−0.590[−12.243]***	2.01	1.774	0.031	1.822	−0.022
GHANA	−0.44[−12.707]***	0.671[−44.105]***	−0.671[−20.897]***	2.08	0.983	−0.003	1.016	−0.030
KENYA	−0.345[−7.975]***	0.425[26.076]***	−0.267[−8.506]***	2.02	1.152	0.010	0.958	−0.035
MAURITIUS	−0.299[−9.588]***	0.459[33.898]***	−0.372[−13.997]***	2.02	0.835	0.030	0.897	−0.021
MOROCCO	−0.452[−12.074]***	0.669[41.745]***	−0.616[−16.530]***	2.03	1.289	−0.008	1.443	−0.077
NAMIBIA	−0.331[−9.417]***	0.734[48.266]***	−0.747[−20.141]***	2.01	1.242	0.023	1.120	0.010
NIGERIA	−0.487[−9.098]***	0.352[19.882]***	−0.216[−6.761]***	2.02	1.296	−0.001	1.402	−0.061
SOUTH AFRICA	−0.342[−7.551]***	0.734[37.806]***	−0.799[−16.238]***	2.00	1.797	0.011	1.989	−0.005
TUNISIA	−0.310[−10.212]***	0.373[31.203]***	−0.375[−16.472]***	2.03	0.671	0.020	0.752	−0.036
Panel B: Bloomberg Commodity Index as the benchmark global market								
BOTSWANA	−0.308[−8.705]***	0.393[26.636]***	0.165[1.381]	2.03	1.004	0.032	0.877	0.012
COTE D'IVOIRE	−0.435[−10.642]***	0.629[37.941]***	0.243[1.715]*	2.02	1.364	0.053	1.206	0.028
EGYPT	−0.451[−8.547]***	0.606[29.181]***	0.218[1.180]	2.02	1.804	0.047	1.865	0.002
GHANA	−0.266[−7.083]***	0.389[26.588]***	−0.151[−1.185]	2.04	1.013	0.026	1.059	0.012
KENYA	−0.365[−7.796]***	0.373[24.282]***	0.103[0.641]	2.02	1.182	0.035	1.001	0.010
MAURITIUS	−0.367[−9.645]***	0.372[28.684]***	0.221[1.710]*	2.04	0.865	0.063	0.940	0.021
MOROCCO	−0.585[−13.540]***	0.565[33.173]***	0.455[3.014]***	2.06	1.318	0.015	1.486	−0.045

Table 2 (continued)

	Static Market Model Results (*full sample period with D_t*) – Eq. 2				Risk-Adjusted Performance Measures			
					Full Sample Period		***Crisis Period***	
Market	β_0	β_1	β_2	DW	Tracking Error	Information Ratio	Tracking Error	Information Ratio
NAMIBIA	−0.516[−11.926]***	0.591[34.298]***	0.549[3.642]***	2.05	1.271	0.046	1.163	0.047
NIGERIA	−0.613[−9.540]***	0.264[15.464]***	0.174[0.783]	2.04	1.326	0.021	1.445	−0.030
SOUTH AFRICA	−0.421[−8.532]***	0.662[33.359]***	0.355[2.077]**	2.01	1.827	0.027	2.032	0.016
TUNISIA	−1.171[−11.050]***	0.065[5.172]***	0.677[1.870]*	2.69	0.701	0.061	0.795	0.020
Panel C: Morgan Stanley Capital International World Index as the benchmark global market								
BOTSWANA	−0.322[−9.383]***	0.378[23.227]***	0.322[2.749]***	2.02	0.976	0.008	0.847	−0.023
COTE D'IVOIRE	−0.431[−10.570]***	0.649[38.977]***	0.369[2.596]***	2.01	1.336	0.033	1.176	0.003
EGYPT	−0.446[−8.535]***	0.625[29.717]***	0.339[1.851]*	2.01	1.775	0.032	1.834	−0.015
GHANA	−0.290[−7.932]***	0.417[25.293]***	0.017[0.139]	2.03	0.985	−0.002	1.028	−0.018
KENYA	−0.419[−8.866]***	0.361[20.711]***	0.276[1.703]*	2.01	1.154	0.012	0.971	−0.021
MAURITIUS	−0.348[−9.797]***	0.376[26.994]***	0.339[2.786]***	2.03	0.837	0.032	0.910	−0.006
MOROCCO	−0.538[−12.980]***	0.616[36.703]***	0.540[3.733]***	2.03	1.290	−0.007	1.456	−0.067
NAMIBIA	−0.464[−11.305]***	0.646[38.693]***	0.635[4.432]***	2.03	1.243	0.024	1.132	0.021
NIGERIA	−0.588[−9.647]***	0.290[15.749]***	0.261[1.231]	2.02	1.298	3.03e-05	1.414	−0.052
SOUTH AFRICA	−0.410[−8.364]***	0.688[34.431]***	0.482[2.821]***	2.00	1.799	0.012	2.002	0.001
TUNISIA	−1.103[−11.518]***	0.087[6.347]***	0.722[2.167]**	2.65	0.673	0.022	0.764	−0.019

***, **, * *denote statistical significance at the 0.01, 0.05, and 0.1 levels respectively. Figures in parenthesis [] represent test statistics. DW is the Durbin-Watson statistic indicating the absence of any remaining autocorrelation in the series*

effects of the financial crisis. Although the dynamics appear a bit intricate to explain, the susceptibility of markets to adverse effects from the MSCI-W index during the GFC may rest on the market's liquidity levels and the real sector of their economies. South Africa and Egypt remain the largest and most liquid markets in Africa, and therefore are likely to be the most integrated with global capital flows. It would then be expected that these markets would be the most susceptible to contagion. Some studies have argued that the extent of market integration in Africa is not high as compared to their developed counterparts. Channels such as the share of foreign-owned banks in a country, drop in international capital flows, and changes the overall international regulatory architecture and the real economy (see also, Beck et al. 2009; Ncube et al. 2014; Simatele 2014) may account for this.

The above results suggest that depending on which global asset is under consideration, the effect of the crisis is uneven. The differences in the effects from the global assets may be due to the differences in their compositions. For instance, although the S&P 500 and MSCI-W indexes are value-weighted and computed with dividends re-invested, the MSCI-W index reflects assets of both developed and emerging markets. It is similar to the widely quoted country index returns (Harvey 1991 as cited in Kodongo and Ojah 2011). This posits that the African country index returns are more comparable to the MSCI-W returns, as opposed to the S&P 500 returns. This is obvious because the S&P 500 reflects only U.S-based assets. We observe that the effects of the GFC on Africa were non-homogenous for individual countries. Commodity driven economies such as Nigeria, South Africa, Botswana and Kenya suffered from drops in export prices and volumes, as well as demand for commodities, among other factors. In Botswana lower diamond sales to financially depressed European markets during the crisis made the domestic economy highly vulnerable to shifts in global economies that consume the country's diamond (see also Abdullahi and Mmolainyane 2014). Since the Botswana market has higher weightings towards the diamond industry the consequential effects on the local bourse was noticeable.

Further to the static model is the examination of some risk adjusted performance of the African equities relative to the benchmark global markets (i.e. S&P 500, BCOM, and MSCI-W) presented in columns 6–9 of Table 2. The market cycle comparisons are done on the basis of tracking errors (TRs) and information ratios (IRs) of the African stocks. First, the tracking error or active risk computed as the variance of the standard deviation of Africa's equities and the benchmark's returns aids in addressing the question of how much returns on African stocks, on average deviated from that of the benchmark during the full-sample and GFC periods. A lower TR indicates the proximity of the two returns and less risk.

It is clear from Table 2 that across all benchmarks and the two sample periods, Tunisia and South Africa recorded the lowest and highest TRs respectively. South Africa's highest TR means that diversifying across the FTSE/JSE (Johannesburg Stock Exchange) in the 12 year period was riskier than across other African markets. Since TRs fail to establish outperformance and underperformance, it is unclear at this point whether the additional risk was worth it for international investors who decided to include South African stocks in a diversified portfolio. The IR rather helps in addressing this puzzle. The IR

is defined as the quotient of the asset's (African stock) average mean excess returns relative to the benchmark's average mean return and the variability of that excess return. It helps to ascertain how much excess returns are generated for a unit of risk taken with the inclusion of an African stock in a diversified portfolio relative to the benchmark.

A critical observation from the results suggest that any additional risk tolerated for investing in the South African equity market in both the full-sample and GFC periods was not worth it since the IRs are highly anemic compared to other markets and international standards.[10] It thus appear that the Egyptian market offers a better alternative with slightly similar TRs in the full sample period as that of South Africa, and higher IRs than South Africa. However, during the GFC, the Egyptian market records negative IRs with the BCOM and MSCI-W benchmarks. The African equities record relatively large numbers of negative IRs with the S&P 500 and MSCI-W as benchmark portfolios. This supports the findings of Goodwin (2009) that managers who benchmark against the S&P 500 index obtain lower IRs.

Next, we present results of the augmented market model in Table 3 where the impact of the global factors and the crisis on the African markets are estimated. The findings are discussed as follows. Analogous to the static market model results, the constant terms (α_0) are all negative and significant. Again, the African stocks underperform the average returns on related global investments. It is informative to note that only Morocco, Ghana, Namibia, and Tunisia are dependent on changes in the market-wide returns (as measured by δ_0), during the GFC period. For all stocks, the betas are positive during full-sample period $\left(\beta_0^*\right)$ and negative during crisis era $\left(\beta_1^*\right)$. The inference is that the ability of African stocks to shield international portfolio investors from adverse shocks, during the crisis was minimal. Simatele (2014) reports that the most immediate effect of the GFC on Africa's equity markets was the flight of portfolio investments, mainly on account of increased risk aversion, tighter global credit conditions, and developments in the bond markets. Baur and McDermott (2010) have observed that relative to developed markets, emerging markets fail to provide protection for traditional assets (such as stocks and bonds) during global market turmoil. The plausible reason may be that increased global market uncertainties during extreme periods casts a shadow of doubt on the potentials of emerging markets to offer higher expected rewards. Fueled by market uncertainty, investor sentiments and risk-aversion, international portfolio investors may pull out their holdings in African equities during crisis periods leading to greater impact. Instead, on the balance of probability of success, they may prefer to shift their portfolios towards the relative safety of developed world markets (Baur and McDermott 2010).

While the above constitute a somewhat simplistic intuitive approach to explain the dynamics, its plausibility is intact. The negative effects of the GFC on African markets could also be attributed to the effects on trade balances arising from export demand shocks and price movements of key commodities. In most of the African economies,

[10] The widely accepted IRs for performance superiority within the investment profession are 0.2 and 0.3 (Kidd 2011). See also Grinold and Kahn (1995)

Table 3 Augmented market model results (full sample period). The regressors GOLD, OIL, COCOA, SILVER, PLATINUM, respectively relate to the coefficients$\alpha_1,\delta_1;\alpha_2,\delta_2;\alpha_3,\delta_3;\alpha_4,\delta_4$; and$\alpha_5,\delta_5$. α_0 is the intercept, andβ_0^*, β_1^* are the coefficients for the excess global markets in the full-sample and sub-sample periods respectively

Market	α_0	β_0^*	α_1	α_2	α_3	α_4	α_5	δ_0	β_1^*	δ_1	δ_2	δ_3	δ_4	δ_5	*DW*
Panel A: S&P 500 as the global market															
BOTSWANA	−0.41***	0.70***	0.04***	0.03***	0.01	0.00	−0.00	0.12	−0.66***	0.05*	−0.00	0.06	0.00	−0.01	2.02
COTE D'IVOIRE	−0.32***	0.73***	0.05***	0.02	0.01	0.02	−0.00	−0.03	−0.73***	0.07**	−0.04	−0.01	0.02	−0.00	2.00
EGYPT	−0.37***	0.68***	0.01	0.03	−0.00	0.02	−0.00	0.03	−0.59***	0.11***	−0.02	0.10	0.03	0.02	2.01
GHANA	−0.42***	0.69***	0.01	−0.01	0.00	0.02	0.00	−0.17	−0.69***	0.01	−0.22	−0.01	−0.03	−0.01	2.07
KENYA	−0.36***	0.42***	0.01	0.01	0.00	−0.00	0.01	0.09	−0.27***	0.00	−0.02	0.14***	−0.05**	−0.06*	2.02
MAURITIUS	−0.32***	0.45***	0.01	−0.00	−0.00	0.01	0.02*	0.12	−0.36***	0.10***	−0.06***	0.17***	0.12***	0.02	2.02
MOROCCO	−0.46***	0.68***	0.07***	0.03**	−0.01	0.01	0.04*	0.22*	−0.62***	0.06*	−0.03	−0.00	0.02	−0.07	2.02
NAMIBIA	−0.34***	0.74***	0.07***	0.05***	0.02	0.00	0.00	0.26**	−0.74***	0.06**	0.04	0.01	0.02	0.00	2.01
NIGERIA	−0.49***	0.35***	−0.02	0.01	−0.00	0.01	−0.02	0.10	−0.21***	−0.01	−0.03	0.08**	−0.01	0.05	2.02
SOUTH AFRICA	−0.28***	0.78***	0.35***	0.10***	0.02	0.01	0.00	0.05	−0.83***	0.01	0.10***	0.12**	−0.00	0.06	1.99
TUNISIA	−0.33***	0.37***	0.05***	0.03***	−0.01	0.00	−0.01	0.17	−0.37***	−0.01	0.02	0.01	−0.00	0.01	2.05
Panel B: Bloomberg Commodity Index as the global market															
BOTSWANA	−0.28***	0.43***	0.03**	0.04***	0.01	0.00	−0.01	0.07	−0.29***	0.05**	−0.03	0.05	0.00	0.01	2.03
COTE D'IVOIRE	−0.36***	0.68***	0.03**	0.03*	0.01	0.01	−0.02	0.03	−0.60***	0.08**	−0.05*	−0.02	0.02	0.02	2.01
EGYPT	−0.36***	0.67***	0.00	0.03*	0.00	0.01	−0.02	−0.00	−0.63***	0.11***	−0.03	0.09	0.03	0.03	2.01
GHANA	−0.23***	0.44***	0.00	−0.00	0.01	0.01	−0.00	−0.28**	−0.39***	0.02	−0.05**	−0.01	−0.01	0.01	2.03
KENYA	−0.35***	0.38***	0.01	0.01	0.01	−0.01	0.01	0.07	−0.06	0.02	−0.01	0.12***	−0.07***	−0.04	2.00
MAURITIUS	−0.33***	0.41***	0.01	−0.00	0.01	0.01	0.02	0.08	−0.33***	0.12***	−0.05***	0.15***	0.12***	0.04	2.04
MOROCCO	−0.50***	0.63***	0.06***	0.04***	−0.01	0.01	0.03	0.26*	−0.49***	0.06*	−0.03	−0.01	0.01	−0.05	2.04
NAMIBIA	−0.41***	0.66***	0.06***	0.06***	0.02	0.00	−0.02	0.35**	−0.58***	0.07**	0.04	−0.01	0.01	0.02	2.03
NIGERIA	−0.56***	0.30***	−0.02	0.02	0.00	0.01	−0.01	0.08	−0.22***	0.01	−0.02	0.07*	−0.02	0.06*	2.04

Table 3 (continued)

Market	α_0	β_0^*	α_1	α_2	α_3	α_4	α_5	δ_0	β_1^*	δ_1	δ_2	δ_3	δ_4	δ_5	*DW*
SOUTH AFRICA	−0.31***	0.74***	0.33***	0.11***	0.02	0.00	−0.01	0.13	−0.63***	0.02	0.10***	0.10*	0.00	0.08	2.00
TUNISIA	−0.04***	0.16***	0.06***	0.03***	−0.01	−0.00	0.00	0.01	−0.20***	0.01	0.01	−0.03	−0.01	−0.02	2.19
Panel C: Morgan Stanley Capital International World Index as the global market															
BOTSWANA	−0.33***	0.75***	0.04***	0.03**	0.01	−0.00	−0.02	0.01	−0.78***	0.05*	−0.00	0.05	0.01	−0.00	2.02
COTE D'IVOIRE	−0.27***	0.77***	0.05***	0.02	0.01	0.01	−0.02	−0.09	−0.80***	0.07**	−0.04	−0.01	0.02	0.01	2.00
EGYPT	−0.30***	0.73***	0.01	0.03	0.00	0.01	−0.01	−0.06	−0.70***	0.11***	−0.02	0.09	0.03	0.03	2.00
GHANA	−0.31***	0.76***	0.01	−0.02	0.01	0.01	−0.01	−0.27**	−0.74***	0.01	−0.02	−0.01	−0.02	0.00	2.04
KENYA	−0.32***	0.47***	0.02	0.00	0.01	−0.02*	−0.00	0.03	−0.41***	0.02	0.01	0.14***	−0.07**	−0.05	1.99
MAURITIUS	−0.27***	0.47***	0.01	−0.01	0.01	0.00	0.02	0.09	−0.39***	0.11***	−0.02	0.17***	0.10***	0.03	2.02
MOROCCO	−0.39***	0.73***	0.07***	0.03**	−0.01	0.01	0.03	0.16	−0.64***	0.05*	−0.03	−0.01	0.02	−0.06	2.02
NAMIBIA	−0.28***	0.78***	0.07***	0.05***	0.02	−0.00	−0.01	0.19	−0.80***	0.06**	0.04*	−0.00	0.02	0.02	2.01
NIGERIA	−0.45***	0.40***	−0.01	0.01	0.00	−0.00	−0.02	0.03	−0.36***	0.00	0.01	0.08**	−0.02	0.06	2.00
SOUTH AFRICA	−0.23***	0.82***	0.35***	0.10***	0.02	0.00	−0.01	0.02	−0.81***	0.01	0.10***	0.11*	0.01	0.08	1.99
TUNISIA	−0.35***	0.44***	0.06***	0.02***	−0.00	−0.01	−0.02	0.33***	−0.39***	−0.01	0.03**	0.01	−0.00	0.01	2.09

*Note: ***, **, * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively; and DW is the Durbin-Watson statistics indicating the absence of any remaining autocorrelation in the series. δ_0 is the parameter capturing the effect of the GFC*

example South Africa, the spill-over effects was felt through a deterioration in the overall economy (Simatele 2014). The slump in the economic aggregates registered heightened pressure on individual country's balance of payment with consequential effects on domestic exchange rates, overall gross domestic product (GDP) and financial sectors, without corresponding increases in portfolio investments flows. For instance, at the peak of the crisis in 2008, no African country issued bonds and already existing ones were either cancelled or postponed (Kasekende et al. 2009; Brambila-Macias and Massa 2010).

Results for the commodities in both the full and GFC periods vary from market to market. A dollar increase in the price of gold is seen to exert significant positive effects on the average returns of six African stock markets in the two regimes. The effects of oil price increases are positive for the affected markets in the full-sample period. However, some negative effects are recorded in the crisis period for Mauritius, Cote D'Ivoire, and Ghana. Rising cocoa prices have significant positive effect on the average daily returns of Kenya, Mauritius, Nigeria and South Africa in the post-crisis era. The effect of silver on the markets is noticeable in the GFC periods; it is negative for Kenya and positive for Mauritius.

4.2 African markets correlations with commodities and world markets

Although return distribution of African markets appear highly volatile (Moss and Thuotte 2013), adding securities from Africa into a diversified global portfolio can reduce overall portfolio risk (Alagidede 2008). Intuitively, as the number of equity securities in a portfolio increases, the return variance of the entire portfolio (irrespective of individual securities variances) should decrease in as much as the correlations between securities are low-positive or negative. With the DCC-GARCH model, we seek to examine hedging and diversification opportunities across the eleven African markets. To address this, we calculate return correlations between individual African stock markets and each of the commodities and global indices in our sample for both the full sample and the crisis period. Due to space limitation, we report only stage two results of the DCC-GARCH model estimation (results of stage one are available upon request). We show the stage two results for both samples in *Appendices 1A and 1B*.

The coefficients associated with the ARCH (φ_1) and GARCH (φ_2) parameters sum up to less than one in all cases. The ARCH coefficients are generally very small suggesting slow changing conditional volatilities under the effects of return innovations. They however evolve with time on the effects of past volatility, as indicated by the close to unity GARCH coefficients in many instances of significant correlations. International diversification across markets with the above volatility characteristics may have to focus on active investment strategies informed by volatility persistence and present market conditions. Advisedly, the African component of portfolio investments may have to be increased (decreased) in bullish (bearish) markets. Additionally, such strategies must take into account the stability and performance of the markets in successive periods.

A close observation of the full sample results in Appendix Table 4 shows similar patterns of correlation between the African stocks and global economic

factors. All significant correlations are low and non-negative. During the crisis, however, although correlations still remain low, the following pairs have negative associations: Tunisia/Platinum, Kenya/Silver, Ghana/Oil, Namibia/Platinum, and Cote D'Ivoire/Platinum (see Appendix Table 5). Significantly low correlations imply the possibility of diversification opportunities across the African markets. The average significant correlations in the full sample and crisis periods are 0.095 and 0.170 respectively, while the number of recorded significant correlations is 19 (full sample) and 25 (crisis) period. Thus, correlations did not only intensify during the crisis, but also spread.[11] The phenomenon may imply that opposing to the 'decoupling' view that Africa's stock markets were insulated from contagion during the GFC, the crisis may have led to some spill-overs to the continents stock markets. This supports Forbes and Rigobon's (2002) 'shift-contagion' theory – of increases in cross-market correlations during a crisis. Intuitively, the effects of the spill-over may be higher in liquid markets compared to thinner ones.

Although the low correlations present compelling reasons for the inclusion of African stocks in international portfolio diversification, several factors remain as critical hindrances to this opportunity. First, the relatively nascent markets in Africa usually have small sizes, are illiquid and not diversified. For instance, the total market capitalization of Sub-Saharan Africa's (SSA) equity markets increased from US$605,113 million in 2005 to US$732,438 million in 2012. Of this, South Africa alone constituted US$565,408 million and US$612,308 million in 2005 and 2012 respectively. Even with this, the number of tradable shares (free floats) is usually small compared to the market capitalization. In SSA, total number of listed companies on all exchanges moved marginally from 911 (2005) to 923 (2012) compared to other emerging economies such as East Asia Pacific with 3931 (5311); South Asia with 6050 (6496); Latin America and Caribbean with 1092 (1066) for years 2005 (2012) respectively. In a similar fashion, by 2012, turn-over ratios (values of traded shares as a percentage of market capitalization) in SSA markets increased slightly from 37.3% in 2005 to 47.2% in 2012, anemic to that of East Asia Pacific of 68.4% (2005) and 127.7% (2012).[12] Because the minimum trade requirements of many international institutional investors are $1–5 million per block (Moss et al. 2005), transactions in Africa markets thus become too small to be considered for diversification.

Second is the problem of exchange rate risk. A highly unstable local currency can have adverse consequential effects on the returns of investors in the domestic bourse. For instance, in the first two regimes of constitutional rule in Ghana from 1993 to 2000, returns on the Ghana stock market in local currency units averaged 43% relative to 5% for dollar-denominated returns following a highly depreciating local currency. Recently, Boako et al. (2016) report of high

[11] Moss and Thuotte (2013) observes increases in correlation and report that excluding South Africa and Mauritius, the correlation between Sub-Saharan African stocks and the S&P 500 were 0.343 in 2000–2007, 0.702 in 2007–2009, and 0.749 in 2009–2011.

[12] Figures are gleaned from World Development Indicators Database (2015) - http://wdi.worldbank.org/table/5.4, and the website of African Securities Exchanges Association (ASEA, 2015) - http://www.african-exchanges.org/yearly_statistic/comparative/

dependence of the Ghana equity market on the foreign exchange market. The authors argue that the link between the two markets follows the international trade-oriented model. Aside the above challenges, constraints relating to poor governance structures, political unrest, high inflation, lack of proper securities regulation and supervision, macro-economic unsteadiness, and returns volatility are apparent. These add substantial risk premiums to equity returns and create the illusion that African markets are not worthy of inclusion in global portfolios. As argued earlier, the fact of the outflows exceeding inflows by a factor of 150 is enough to cause us to move beyond these empirical results and consider other nuanced factors that are at the heart of the commodity-stock debate, and the risk-return trade-off. Such an exercise is beyond the scope of this study and we leave this for future researchers to probe.

5 Conclusion

The increasing vulnerability of global markets to the effects of world economic meltdowns, has forced investors to look-out for alternative means to diversify their portfolios. On account of the "decoupling" proposition that emerging markets' stock returns are not jointly normal with that of developed markets during crisis, it is anticipated that crashes in the world markets may not instantaneously affect returns from emerging markets. This makes them sustainable as hubs for diversification. This paper examined the dynamic relationship between equity returns in Africa and returns on global markets with emphasis on the opportunities for diversification and risk reduction around the 2008–2009 global financial crisis. We explored the co-movement and risk-return trade-off across Africa and global markets.

Our findings provide evidence of correlations between African stocks and global markets influenced by the global financial crisis. Within the risk-return framework, though Egypt and South Africa show some minuscule signs of risk mitigating opportunities relative to the benchmark markets, their information ratios are highly anemic to internationally accepted thresholds. We further report evidence of slow changing conditional volatilities under the effects of return innovations for most African markets. It is recommended that international portfolio investors seeking to diversify across Africa should take into account volatility persistence. More importantly, they should be mindful of present and past market conditions, as well as their stability. We confirm the Forbes and Rigobon (2002) "shift-contagion" theory as against the decoupling phenomenon. It is recommended that on account of the significant volatility cross-effects, future studies may look at estimating the optimal prime weights, hedge ratios and effectiveness of specific African stock-global assets hedged portfolios in order to ascertain the suitability of diversification strategy. The key questions surrounding risk premiums and barriers to investment vis-à-vis the huge outflows should also be of concern to future researchers. We believe such exercise has utility in providing useful evidence to augment efforts of policy makers at promoting Africa as a hub for certain kinds of international investments.

Appendix

Table 4 Dynamic conditional correlation results *(full sample)*

OIL		GOLD	SILVER	PLATINUM	COCOA	S&P 500	BCOM	MSCI-W
MOROCCO								
ρ	0.120***	0.171***	0.014	0.042**	0.014	0.007	0.028	0.015
ϕ_1	0.009	0.013**	0.000	0.012	0.000	0.000	0.018	0.004
ϕ_2	0.981***	0.979***	0.832	0.799**	0.844	0.846	0.720	0.985***
EGYPT								
ρ	0.057***	0.043*	0.006	0.006	0.020	−0.004	0.029	−0.013
ϕ_1	0.017*	0.007	0.011	0.000	0.000	0.000	0.000	0.005
ϕ_2	0.813***	0.960***	0.949***	0.840	0.858***	0.838	0.823***	0.678
TUNISIA								
ρ	0.156***	0.297	0.023	0.002	0.032	−0.033	0.016	0.018
ϕ_1	0.007**	0.009**	0.010	0.017	0.014*	0.004	0.000	0.030
ϕ_2	0.983***	0.991***	0.728***	0.573***	0.961***	0.988***	0.822***	0.593
KENYA								
ρ	0.014	0.046**	−0.023	0.004	0.036	0.029	−0.002	0.025
ϕ_1	0.000	0.055**	0.000	0.018*	0.004	0.000	0.014**	0.006
β	0.834**	0.842	0.840	0.000	0.989***	0.827	0.950***	0.875***
GHANA								
ρ	−0.011	0.023	0.025	0.015	0.025*	0.010	0.001	0.022
α	0.000	0.006*	0.000	0.000	0.000	0.007	0.000	0.023
ϕ_2	0.874**	0.982***	0.844	0.851*	0.863***	0.822***	0.872	0.732***
MAURITIUS								
ρ	0.007	0.055***	0.035*	0.032	0.043**	0.008	0.055***	0.045***

Table 4 (continued)

	OIL	GOLD	SILVER	PLATINUM	COCOA	S&P 500	BCOM		MSCI-W	
α	0.018	0.015	0.000	0.001	0.000	0.022	0.016		0.009	
ϕ_2	0.778***	0.000	0.830	0.833	0.840**	0.676***	0.545**		0.625	
SOUTH AFRICA										
ρ				0.291***	0.452***	0.027	0.010	0.063***	−0.004	0.002	0.031*
α				0.027*	0.021***	0.008	0.003	0.000	0.015	0.004*	0.020
ϕ_2				0.964***	0.975***	0.964***	0.993***	0.863***	0.864***	0.988***	0.555**
NIGERIA										
ρ				0.019	−0.007	0.027	0.001	0.009	0.011	−0.013	0.014
α				0.011	0.082***	0.000	0.049**	0.000***	0.000	0.000	0.052**
ϕ_2				0.505	0.086	0.825***	0.000	0.859***	0.829***	0.836***	0.000
NAMIBIA										
ρ				0.108	0.163	0.004	−0.008	0.042*	0.012	0.017	0.032*
α				0.014***	0.012***	0.007	0.000	0.020*	0.011	0.000	0.000
ϕ_2				0.985***	0.988***	0.968***	0.856	0.942***	0.774***	0.868	0.866***
COTE D'IVOIRE										
ρ				0.000	0.000	0.000	−0.000	0.000	0.000	−0.000	−0.000
α				0.000	0.000	0.000	0.004	0.059	0.000	0.000	0.014
ϕ_2				0.997***	0.999***	0.995***	0.979***	0.904***	0.981***	0.961***	0.979***
BOTSWANA										
ρ				0.000	0.000	−0.000	0.000	0.000	−0.009	−0.000	−0.000
α				0.000	0.000	0.069	0.002	0.000	0.050	0.050	0.061
ϕ_2				0.999***	0.963***	0.912***	0.982***	0.999***	0.900***	0.900***	0.906

Notes: *The table shows results of DCC-GARCH (1,1) estimations for Eq. (4). The model is estimated using the student t distribution.* ϕ_1 *and* ϕ_2 *are respectively the ARCH and GARCH parameters under the restrictive assumptions of non-negativity and* $\phi_1 + \phi_2 < 1$. ρ*is a measure of correlation. ***, **, * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively.*

Table 5 Dynamic conditional correlation results *(Crisis Period)*

	OIL	GOLD	SILVER	PLATINUM	COCOA	S&P 500	BCOM	MSCI-W
MOROCCO								
ρ	0.247**	0.227	−0.002	−0.085	0.002	0.112	0.094	0.125
α	0.041*	0.149	0.029	0.034	0.000***	0.000	0.000	0.001
ϕ_2	0.914***	0.649	0.261	0.528	0.011	0.315	0.785	0.834
EGYPT								
ρ	0.137*	0.112	0.021	−0.089	0.091	−0.018	0.035	0.086
α	0.136	0.096	0.026	0.000	0.069	0.027	0.012	0.000
ϕ_2	0.721	0.656***	0.493	0.828***	0.243	0.878***	0.243	0.815***
TUNISIA								
ρ	0.302***	0.296***	−0.020	−0.147**	0.095	−0.018	0.057	−0.003
α	0.009	0.060	0.000	0.000	0.026	0.011	0.017	0.000
ϕ_2	0.948***	0.805***	0.810	0.952	0.095	0.925***	0.956***	0.815
KENYA								
ρ	0.067	0.188***	−0.113*	−0.113	0.258***	0.047	0.207***	0.033
α	0.000	0.018	0.000	0.000	0.000	0.000	0.000	0.000
ϕ_2	0.009	0.812	0.277	0.000	0.187	0.239	0.126	0.181
GHANA								
ρ	−0.164***	−0.012	0.013	0.021	−0.069	−0.006	−0.028	0.003
α	0.000	0.013	0.000	0.000	0.000	0.000	0.000	0.000
ϕ_2	0.807	0.963***	0.260	0.180	0.270	0.163	0.442	0.095
MAURITIUS								
ρ	0.029	0.204*	0.127*	−0.066	0.259***	−0.028	−0.026	0.120
α	0.111	0.146**	0.000	0.037	0.000	0.000	0.074	0.014

Table 5 (continued)

				OIL	GOLD	SILVER	PLATINUM	COCOA	S&P 500	BCOM	MSCI-W
ϕ_2				0.720	0.569***	0.568	0.339	0.798	0.862	0.698***	0.925***
SOUTH AFRICA											
ρ	0.475***	0.388***	−0.061	−0.090	0.104*	−0.088		0.067		−0.029	
α	0.053	0.031	0.024	0.018	0.000	0.000		0.000		0.086	
ϕ_2	0.893***	0.931***	0.354**	0.451	0.847***	0.884***		0.783***		0.462	
NIGERIA											
ρ	0.043	−0.001	0.102	0.070	0.023	0.089		0.012		−0.032	
α	0.000	0.000	0.000	0.030	0.000	0.000		0.018		0.000	
ϕ_2	0.781***	0.802**	0.157	0.735**	0.805***	0.838***		0.922***		0.230	
NAMIBIA											
ρ	0.411***	0.313***	0.008	−0.135*	0.077	−0.061		0.090		−0.078	
α	0.000	0.012	0.000	0.066	0.000	0.022		0.000		0.000	
ϕ_2	0.939	0.956***	0.835***	0.859**	0.847**	0.937***		0.804***		0.209**	
COTE D'IVOIRE											
ρ	0.177*	0.239**	0.029	−0.158**	0.122	−0.012		0.097		−0.010	
α	0.142	0.099	0.051	0.000	0.007	0.055		0.000		0.000	
ϕ_2	0.802	0.742***	0.744***	0.026	0.965***	0.368		0.539		0.684	
BOTSWANA											
ρ	0.278***	0.247*	−0.056	−0.096	0.117*	0.033		0.037		−0.055	
α	0.000	0.230	0.070	0.000	0.000	0.000		0.000		0.047	
ϕ_2	0.861	0.528	0.379**	0.011	0.999***	0.017		0.023		0.582***	

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