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Currency Carry Trades and Stock Market Returns in Africa

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Abstract: Research Question: Is there a causal link between African currency targeted carry trades and the returns of their stock market indices? What is the nature of return volatility in carry trades and stock markets, and does volatility spillover exist between the two series in Africa? **Motivation:** The interactive and dynamic relationship between currency carry trade returns and stock market returns has not been communicated in exactitude, especially in emerging and frontier markets of Africa. This study explores the causal link between African currency carry trades and stock market returns. It also explores the dynamic relationship and volatility spillover between the currency carry trades and stock market returns. **Idea:** The primary idea is that there is conclusive evidence on the empirical failure of the uncovered interest rate parity (UIP) condition, and currency carry trades, which are investment/trading strategies, seek to exploit this failure. **Data:** Data on prices of stock market indices, interbank interest rates, and exchange rates between the target currencies and funding currencies of weekly periodicity sourced from DataStream, Quantic EasyData, and the central banks of the sampled countries are used. **Method/Tools:** The vector autoregressive (VAR) - Granger causality framework and the dynamic conditional correlation-generalised autoregressive conditional heteroskedasticity (DCC-GARCH) estimation technique were employed in this study. **Findings:** The study finds evidence of causality running from carry trades to stock markets in 22 out of the 28 currency pairs studied, but not causality from stock markets to carry trades. Traces of volatility spillover could only be observed from carry trades to stock markets in 10 out of the 28 currency pairs studied. We conclude that the African currency carry trades drive their stock markets, that the conditional correlations between currency carry trades and stock market returns are dynamic and time-varying, and that there is high degree of persistence in African return volatility. **Contributions:** This study has made significant contribution to our knowledge on currency carry trades in Africa's emerging and frontier markets. It has shown the interactive and dynamic relationships that exist between currency carry trade returns and the returns of stock market indices.

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1. Introduction

Carry trades are currency investment strategies that are funded by borrowing in low-interest-rate currencies and investing in high-interest-rate currencies. A carry trading strategy is motivated by and exploits the failure of the theory of uncovered interest rate parity (UIP). The UIP condition predicts that a high-interest-rate currency will depreciate relative to a low-interest-rate currency. The assumption is that the interest rate differential between any two countries is offset fully by an expected depreciation of the high-interest-rate currency or, equivalently, by an expected appreciation of the low-interest-rate currency (Cho *et al*., 2018). However, empirical evidence indicates an apparent violation of the UIP condition, where the interest rate differentials between the two countries are not completely offset by the exchange rate differentials in these countries. This evident violation of the UIP condition by the speculative activities of carry traders is a major issue in international finance and has accordingly received and continues to receive high research support.

Carry trade activities have relevance for international financial markets and their participants as well as the economies of various countries. There is conclusive evidence on the empirical failure of the UIP (Hansen and Hodrick, 1980; Fama, 1984; Froot and Thaler, 1990; Engel, 1996; Obstfeld and Rogoff, 2000; Sarno *et al*., 2006; Burnside, 2015) and the profitability of currency carry trades (Brunnermeier *et al*., 2008; Burnside *et al*., 2007; Ackermann *et al*., 2012; Ames *et al*., 2013; Menkhoff *et al*., 2012; Nkansah and Kaseeram, 2018a). Korhonen and Kunz (2009) for instance showed that currency crary trade could be categorised as a prudent investment, and that, on risk-adjusted basis, the currency carry trades outperform equity indices regardless of the risk measure. Similarly, Das *et al*. (2013) affirmed the viability of currency carry trade as an asset class. The inclusion of currency carry trade in an existing portfolio enhances the portfolio performance as well as the risk-return profile of that portfolio (Das *et al*., 2013). Thus currency carry trades provide the alternative investment and portfolio diversification opportunities that investors, portfolio managers, hedge funds and other stock market partakers search for (see e.g. Galati and Melvin, 2004; Galati *et al*., 2007; Popova *et al*., 2007; Ferri, 2010; Marston, 2011). Nkansah and Kaseeram (2018b) confirmed the viability of African carry trade as an asset class and demonstrated its significance for asset allocation decisions. This is largely consistent with previous studies on currency carry trades of developed countries.

In fact, the last two decades have seen the introduction of a variety of new instruments designed exclusively for the purpose of currency carry trading (see e.g. Lynch, 2007; Galati *et al*., 2007; Korhonen and Kunz, 2009). The Deutsche Bank's G10 Carry Spot index, the CSFB index, the Barclays Intelligent Currency Carry Trade Index, and other forms of structured currency carry trade instruments which take the form of collateralised foreign exchange obligations (CFXOs) now exist. Also, investment in the currency carry trades which ignites capital flows into the target currency countries and the unwinding of the carry trade which reverses the flow of capital tend to move the stock markets in these target countries. For instance, Hattori *et al*. (2007) contended that the decision of the central bank of Japan to reduce interest rate to near zero percent not only influenced the liquidity position of the Japanese economy, but rather the liquidity of the entire world economy. When this happens, investors will borrow cheaply from Japan and invest the proceeds in high-yielding financial assets, such as stocks abroad, thereby exerting pressure on both the foreign exchange rates and stock markets of the recipient countries, especially during periods of carry trade unwinding.

Elder (2012) suggested that the performance of currency carry trades and stock markets is linked. Undoubtedly, carry trade profits usually attract more investment funds from investors and could also find their way into the stock markets as well as strengthen the target currencies. Given this interconnectedness between carry trades and stock market returns, their associated volatilities can therefore be transmitted across countries. For instance, Minh (2016) reported, among other things, a significant positive association between carry trade and stock market performance in target currency countries. Similarly, Cheung *et al*. (2012) studied the implications of carry trade on returns of stock markets in Australia, Canada, Britain, Mexico and New Zealand, and found that currency carry trade has a significant influence on the stock market returns of the target currency countries. Tse and Zhao (2012) found significant proportions of volatility spillovers between the US stock market and carry trade; and Fung *et al*. (2013) documented significant causality and volatility spillover between the currency carry trade and the Asian stock market returns.

Whilst carry trades have been studied since the 1980s, very little is known about its interactive and dynamic relationship with the stock market, especially in Africa's emerging and frontier markets. For instance, Tse and Zhao (2012) examined the link between the daily carry trades and the U.S stock market returns, whereas, Fung *et al*. (2013) analysed the information transmission mechanism between currency carry trade and four equity markets, namely, the Japanese stock market, Australian stock market, Indian stock market, and Korean stock market. Also, Cheung *et al*. (2012) assessed the effect of the Yen carry trades on stock markets domiciled in the target currency countries including Australia, Britain, Canada, New Zealand and Mexico. The aforementioned studies mainly focused on the G10 currencies and other emerging markets outside the African region. Yet most African countries could be fertile grounds and a major target for currency carry trading activities due to the high interest rate regimes that most of these countries experience in the region. Studies on African carry trades have focused on the profitability of the trade and its asset class viability (Hassan and Smith, 2011; Nkansah and Kaseeram, 2018a, 2018b). The dynamic relationship between carry trade and stock markets remains a major research gap that necessitates this enquiry.

This study builds on prior carry trades studies and addresses two major research issues. First, it examines the causal relationship between the currency carry trades and stock market returns in the African emerging and frontier markets. Second, it explores the time-varying relationship and volatility spillover between carry trade returns and the stock market returns in these markets. We use four developed currencies (USD, EUR, JPY and GBP) as funding currencies and seven African currencies (BWP, EGP, ZAR, GHS, TND, MAD and NGN) as the target markets as well as the returns of stock indices of their respective countries (i.e. Botswana, Egypt, South Africa, Ghana, Tunisia, Morocco and Nigeria). For each of the seven countries, four carry trade strategies are conducted and all these four compared successively to the returns of the respective stock index. Thus the approach enables us to examine the intra-country causality and volatility spillover between stock markets and carry trades for the selected countries.

The study provides evidence of significant causal relationship running from currency carry trades to the stock markets of their respective African countries. Evidence is also provided that the stock market returns generally do not cause currency carry trades in Africa, except for very limited currency pairs. The study further reports evidence of volatility spillover emanating from the currency carry trades to the stock markets for a significant number of currency pairs. Ten out of twenty eight currency pairs have evidence of volatility spillover from carry trade to their respective stock markets.

The remainder of the paper is organised as follows. Section 2 presents the related literature, whilst Section 3 deals with the methodology and data of the study. The empirical results are presented in Section 4 with Section 5 presenting the conclusion of the study.

2. Related Literature Review

The currency carry trade strategy is anticipated to generate zero returns, and can generate positive returns only when the UIP fails to hold. Factors such as consumption risk, liquidity risk, peso effect, market frictions and untimely revisions of portfolio decisions are said to explain the excess return of carry trade (Bacchetta and Wincoop, 2010; Brunnermeier *et al*., 2008; Burnside *et al*., 2007; Lustig and Verdelhan, 2007; Melvin and Taylor, 2009). Investors all over the world take advantage of this strategy by borrowing from the countries with low interest rates (of which the Japanese currency has been the most popular). The yen was the most sought after funding currency until after the 2008 financial crisis, when the dollar carry trade and the recently emerging euro carry trade came into the picture (Fung *et al*., 2013). The Australian dollar and the New Zealand dollar, on the other hand, have been the most sought after high-yielding target currencies for carry traders. It is therefore not surprising that most studies on currency carry trade focus on these currencies and the G10 currencies in general.

Carry trade activities involving intensive borrowing of Japanese yen during 2006–2007 and US dollars during 2008–2009 are evidenced in the literature (Curcuru *et al*., 2010). Carry trade activities of investing markets intensified worldwide post global financial crisis in 2008 (Shah, 2010; Szalay, 2012). There appears to be a consensus that the currency carry trade is profitable (Brunnermeier *et al*., 2008; Burnside *et al*., 2008; Darvas, 2009; Olmo and Pilbeam, 2009; Xanthopoulos, 2011; Moosa and Halteh, 2012; Potì *et al.*, 2014; Al-Ali, 2015; Burnside, 2015). However, unwinding activities of carry traders can put selling pressure on the stock market of the target currency country (Cheung *et al*., 2012). In consequence, the Yen carry trades moved the stock markets of target currency countries but subsequently aggravated the global financial market slide in 2007 (Hayashi, 2007). The unwinding of the Yen carry trades partially led to the sharp decline of the global financial markets (Fackler, 2008; Parkinson, 2008). Zhang *et al*. (2010) documented that during financial crisis or extreme market conditions, exchange risk intensifies and for that matter carry trade investors are forced to reverse their positions by buying back their funding currencies.

Empirically, Fung *et al*. (2013), Cheung *et al*. (2012), Tse and Zhao (2012), and Lee and Chang (2013) are relevant studies that investigated the relationship between the currency carry trade and the stock markets as well as their volatility spillovers. They predominantly focus on the cross-market predictive power of whether variations in currency carry trade (or stock market) are able to predict the performance of stock markets (or carry trades), and their associated volatility spillover effects. For instance, Tse and Zhao (2012) examined the link between the daily carry trade and U.S stock market returns using vector autoregression and the exponential generalised autoregressive conditional heteroskedasticity methods. Their study found that the returns of the currency carry trade (or stock markets) had no predictive power over the future returns of stock markets (or carry trade). The study further concluded that there was significant volatility spillover from the US stock market to carry trade market but the reverse was not the case.

Also, Fung *et al*. (2013) intimated that the flow of capital from low yielding currency countries to invest in high yielding assets like stocks in target currency countries will lead to the appreciation of the target currency, and that the performance of the stock markets and carry trade are closely related. They studied the information transmission mechanism between currency carry trade and four equity markets in Asia, namely, the Japanese stock

market, Australian stock market, Indian stock market, and Korean stock market, using similar approach to Tse and Zhao (2012). They found evidence of significant Granger causality from the carry trade returns to Indian, Japanese and Australian stock markets. Also, Fung *et al*. (2013) additionally documented that the causality of currency carry trade to Asian stocks could not be observed during the period prior to the 2008 financial crisis, which is an indication that the uncovered interest parity hypothesis may not hold in a systematic way. Their findings on volatility spillover indicated that volatility flow from carry trade to stock markets and vice versa (i.e. bi-directional) and that the spillover effects were more intense during the financial crisis and post-crisis periods.

Cheung *et al*. (2012) also assessed the effect of yen carry trade on stock markets domiciled in the target currency countries with an aim to empirically evaluate the implications of the yen carry trades on the target currency countries' stock market returns. Their study used three different proxies; currency specific profit measure, a currency-specific futures position variable and the Deutsche Harvest Index as proxies for carry trade activity and scope. Focusing on five target countries including Australia, Britain, Canada, New Zealand and Mexico they found evidence which supports the perception that the currency carry trade affects the activities of stock markets domiciled in the target currency countries. Thus, the investment in the currency carry trade which ignites flow of capital into these target currency countries and the unwinding of the carry trade which reverses the flow of capital tend to move the stock markets in these target countries. The prior study above however did not consider the dynamic relationship and the volatility spillover between carry trade and the stock markets.

Currency carry trade investors worldwide, after the 2007-2009 global financial crisis, found solace in the economies with growth prospects where monies are invested in high-yielding financial assets such as stocks, bonds, and other securities with growth potentials. The influx of capital into the recipient countries has the potential of strengthening their currencies, and for that matter, could influence the performance of the stock markets. These high-yielding financial assets were mostly in the emerging markets and, as such, most of these carry trade funds found their way into the emerging markets (Shah, 2010; Szalay, 2012). Indeed, Elder (2012) concluded that there appears to be close correlation between differing assets classes in the financial markets post financial crisis, and Tse and Zhao (2012) corroborated this, examining the relationship between the currency carry trade and the US stock markets.

The interest rates in Japan have been extremely and continue to be low relative to other developed countries. This makes it a potential funding currency alongside other currencies such as the USD, EUR and the GBP which have also maintained a relatively low interest rate for some years now. African currencies, which are largely characterised by high interest rates, also offer some arbitrage opportunities and present an avenue for them to be targets for the currency carry trades. Indeed, studies on African carry trades have confirmed the profitability of the trade and its viability as an asset class (Hassan and Smith, 2011; Nkansah and Kaseeram, 2018a, 2018b). Plantin and Shin (2011) suggested that the success of currency carry trade could rather result in the failure of the uncovered interest parity but not the UIP as a pre-condition of carry trade. Thus, the currency carry trade has the potential of disrupting the international financial markets and in particular the target currency countries through the building up and unwinding of carry trades which are a concern to policymakers. In their study, Hattori *et al*. (2007) contended that the domestic monetary policy of Japan to reduce policy rate or interest rate to near zero percent not only influences the liquidity position of the Japanese economy but indirectly influences the liquidity of the entire world economy. This near zero interest rate of Japan stimulates currency carry trades over the globe, as investors borrow cheaply from Japan and invest the proceeds in high-yielding

financial assets, such as stocks, abroad, thereby exerting pressure on not only the foreign exchange rates but also the stock markets of the recipient countries.

Indeed, the players in the financial markets have in the recent past attributed the movements in stock market returns to the activities of carry trade. Yen carry trade is believed to have spurred on stock markets of target currency countries and its unwinding was responsible for the global stock market crash during the 2007 financial crisis (Hayashi, 2007). Likewise, the sudden fall of the global stock market in the global market crash in October 2008 is believed to have been partially caused by the unwinding of the yen currency carry trade (Fackler, 2008; Parkinson, 2008). Thus, the unwinding of the yen currency carry trade usually destabilises the stock markets of the target currency country. Moreover, the perception or the knowledge of unwinding of the carry trade in itself, even if there is no unwinding, puts selling pressure on the stock markets and consequently destabilises the market (Cheung *et al*., 2012).

The relationship between carry trade and stock markets has also been situated within the context of global liquidity and asset prices which is concerned with global money supply and asset price inflation at the same time (Kramer and Baks, 1999; Rüffer and Stracca, 2006; Giese and Tuxen, 2007; Belke *et al*., 2010). Lee and Chang (2013) studied the link between spillovers of currency carry trade returns and U.S stock market returns using the generalised vector-autogression method of Diebold and Yilmaz (2012). The study hypothesised "that the magnitude of spillovers of currency carry trade returns is positively correlated with market risk sentiments and, therefore, has an impact on market returns". Using the G10 currencies and the S&P 500 index futures, they found a significant positive relationship between spillovers of currency carry trade returns and stock market returns. They further concluded that this relationship intensifies during bear markets rather than in bull markets.

Studies on carry trade and stock market nexus in the extant literature completely ignores the African markets. Additionally, the dynamic interaction and information linkages between carry trade and stock markets have not been adequately explored in the existing studies. Funding currencies to implement the trade have always been limited to one currency (mostly Japanese Yen). Thus, the scope of carry trade and stock market relationship will therefore be limited to one funding currency. The current study uses a broad-based funding currencies of four low-interest currencies to implement the trade on seven African markets. Each African market's dynamic relationship with carry trade is examined for all the four funding currencies.

3. Methodology and Data

3.1 Estimating Causal Relationship Between Carry Trade Returns and Stock Market Returns

We specify an unrestricted vector autoregressive (VAR)-Granger model, in the spirit of Fung *et al*. (2013), and adopt equation (1) to estimate the causality relationship between carry trade returns and stock market returns. We adopt Eqs. (1) and (2), respectively, to estimate the sum of cross-asset which describes the total causality from the stock market to the carry trade market ($\sum c_{1i}$) and from the carry trade transaction to the stock market ($\sum b_{2i}$). The choice of the VAR becomes appropriate as both carry trade and the stock market returns follow an I(0) process. The estimation is done for a pair of carry trade return and stock return, estimating in all twenty eight (28) currency pairs.

$$\mathrm{CT_t} = \mathrm{a_1} + \sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{b_{1i}}\,\mathrm{CT_{t-i}} + \sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{c_{1i}}\,\mathrm{STOCK_{t-i}} + \mathrm{d_1 CRISIS_t} + \varepsilon_{1,t} \qquad (1)$$

$$\mathrm{STOCK_t} = \mathrm{a_2} + \sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{b_{2i}}\,\mathrm{CT_{t-i}} + \sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{c_{2i}}\,\mathrm{STOCK_{t-i}} + \mathrm{d_2 CRISIS_t} + \varepsilon_{2,\mathrm{t}} \quad (2)$$

where CT_t = weekly returns of currency carry trades; $STOCK_t$ = weekly returns of the stock markets; $\sum c_{1i}$ = total causality from stock market to carry trade market with $\varepsilon_{1,t}$ as error term; $\sum b_{2i}$ = total causality from carry trade market to stock market with $\varepsilon_{2,t}$ as error term; and $CRISIS_t$ = a dummy variable equals 1 for the crisis period and 0 otherwise.

3.2 Estimating the Time-Varying Relationship Between Carry Trade Returns and Stock Returns

The dynamic conditional correlations–generalised autoregressive conditional heteroskedasticity (DCC-GARCH) model proposed by Engle (2002) is used to estimate the conditional correlations between any pair of carry trade returns and stock market returns. The approach enables us to examine the volatility spillover and information linkages between carry trade returns and returns of African stock market indices. We specify the conditional covariance matrix ($\mathrm{H_t}$) as in Eq. (3) and the conditional correlation matrix (Q_t) as in Eq. (4). The variance terms ($\mathrm{H_{ii,t}}$), the covariance terms ($\mathrm{H_{ij,t}}$), and the standard residual terms (ε_t) are specified as in Eq. (5), Eq. (6) and Eq. (7), respectively. Admittedly, the strength of the DCC-GARCH model is sturdily upheld in the extant literature (see for instance Kearney and Lucey, 2004; Chelley-Steeley, 2005; Chiang *et al*., 2007; Padhi and Lagesh, 2012; Fung *et al*., 2013; Hwang *et al.*, 2013).

$$\mathrm{H_t} = \mathrm{D_t R_t D_t} \quad (3)$$

$$\mathrm{Q_t} = (1 - \delta - \theta)\mathrm{Q_0} + \delta\varepsilon_{\mathrm{i,t-1}}\varepsilon_{\mathrm{i,t-1}} + \theta\mathrm{Q_{t-1}} \quad (4)$$

$$\mathrm{H_{ii,t}} = \alpha_{\mathrm{ii}} + \sum_{\mathrm{j=1}}^{2} \beta_{\mathrm{ij}}\varepsilon^2_{\mathrm{j,t-1}} + \gamma_{\mathrm{i}}\mathrm{H_{ii,t-1}} + \lambda_{\mathrm{i}}\varepsilon^2_{\mathrm{i.t-1}}\mathrm{I}_{\varepsilon_{\mathrm{i}}<0}\left(\varepsilon_{\mathrm{i,t-1}}\right) \quad (5)$$

$$\mathrm{H_{ij,t}} = \mathrm{Q_{ij,t}}\frac{\sqrt{\mathrm{H_{ii,t}H_{jj,t}}}}{\sqrt{\mathrm{Q_{ii,t}Q_{jj,t}}}} \quad (6)$$

$$\varepsilon_{\mathrm{t}} = \begin{pmatrix}\varepsilon_{1,\mathrm{t}} \\ \varepsilon_{2,\mathrm{t}}\end{pmatrix} | \psi_{\mathrm{t-1}} \sim \mathrm{Student - t}(0, \mathrm{H}, \nu) \quad (7)$$

where H_t = conditional covariance matrix; Q_t = conditional correlation matrix; $H_{ii,t}$ = variance terms; $H_{ij,t}$ = covariance terms; R_t = a time-varying correlation matrix; D_t = *a k x k* diagonal matrix of time-varying standard deviations; Q_0 = the unconditional correlation matrix; β_{ij} = a measure of volatility spillover from asset *j* to asset *i*; γ_i = a coefficient of GARCH effect; λ_i = a coefficient of asymmetric volatility; and δ and θ = are conditional correlation coefficients of time-varying volatility. The standardized residuals or errors, with a process that follows student-t distribution, are formulated as $\varepsilon_t = \begin{pmatrix}\varepsilon_{1,t} \\ \varepsilon_{2,t}\end{pmatrix} | \psi_{t-1} \sim Student - t(0, H, \nu)$.

3.3 Data and Data Sources

The weekly price indices of seven emerging and frontier markets in Africa, namely, South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia were sourced from

DataStream. Also, the weekly interbank interest rate with one month investment horizon of the target countries (i.e. South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia) and the funding countries (i.e. United States of America, United Kingdom, Japan, and the Euro Area) as well as the exchange rates between the target currencies and the funding currencies were obtained from the Central Banks of the respective countries and BFA INET. The data covers the period between January 2001 and December 2014. We used the formulation $Z_{t+1} = ln\big(1 + (i_t^* - i_t)\big) - \Delta S_{t+1}$ with its log return of the interest rate differential $ln\big(1 + (i_t^* - i_t)\big)$, *and* $\Delta S_{t+1} = S_{t+1} - S_t$ to compute the weekly African carry trade returns for all the 28 currency pairs. In the formulation above, i_t^* is the interest rate of the target countries at time *t*, and i_t is the interest rate of the funding countries. Also, we used the formulation $R_t = [\ln(P_t) - \ln(P_{t-1})] \times 100$ to transform the weekly price indices into their continuously compounded weekly log returns. In the above formulation, R_t is the weekly stock returns, P_t is the current stock price, and P_{t-1} is the previous week's stock returns.

4. Empirical Results

4.1 Descriptive Statistics of The Stock Market Returns

Table 1 and Table 2 present the descriptive statistics of the weekly returns of the market indices in the sample and of the currency carry trades executed in this study, respectively.

Table 1: Descriptive statistics of returns to stock market indices

Market	Obs.	Mean	Std Dev.	Skew	Kurtosis	Min	Max	Jarque-Bera
Botswana	729	4.5177	17.31	0.590	9.646	-0.119	0.167	1384.006***
Egypt	729	4.9324	28.84	-1.008	8.024	-0.248	0.129	889.974***
Ghana	729	3.6014	27.40	-0.388	5.711	-0.166	0.135	241.504***
Morocco	677	4.2213	17.31	-0.667	6.279	-0.124	0.086	353.431***
Nigeria	729	4.3206	27.40	-0.388	5.711	-0.166	0.135	241.504***
South Africa	729	3.6534	28.12	-0.275	8.308	-0.201	0.242	865.185***
Tunisia	729	4.6058	12.98	-0.728	8.966	-0.119	0.072	1145.469***

Notes: The sample covers the period January 12, 2001 to December 26, 2014, except Morocco which covers the period January 11, 2002 to December 26, 2014. The obs. is the total number of weekly observations per market. Mean statistics and standard deviations are annualized by multiplying them by $\sqrt{52}$ and expressing same in percentages. *** is statistical significance at the 1% level.

In Table 1, positive mean annualised returns are observed for all the stock indices in the sample markets. The annualised returns range from 3.60% for the Ghanaian stock market index to 4.93% for the Egyptian stock market index. Also, the annualised standard deviations are relatively large and range from 12.98% (Tunisia) to 28.84% (Egypt). Moreover, all the market returns, excepting the Botswana stock market, are negatively skewed and characterised by large excess kurtosis. Thus the results corroborate the prior evidence that African markets are largely volatile (see for instance, Alagidede, 2009; Alagidede and Panagiotidis, 2009).

In Table 2, twenty-eight currency pairs are executed with four currency pairs from each of the seven countries in the sample. All the currency pairs produced positive excess returns, excepting the GBPTND and EURTND pairs. The annualized mean excess returns range from ±0.0721% (for the EURMAD, USDTND, and GBPTND pairs) to 1.947% (for the USDBWP pair). Also, volatility of the excess returns is quite high for most of the pairs as the annualized standard deviations range from 1.4422% (EURMAD pair) to 132.827% (JPYNGN pair). The annualized excess returns are predominantly negatively skewed with large excess Kurtosis, an indication that the African carry trade returns are largely leptokurtic. The results thus point to the fact that the African carry trade exhibits crash risk

or the peso effect. The results further reveal non-normality of currency carry trade returns on the basis of the Jarque-Bera statistics. These results are upheld by the extant literature on the stylized features of returns in African financial markets (see for example, Alagidede, 2009; Alagidede and Panagiotidis, 2009).

Table 2: Descriptive statistics of African currency carry trade weekly returns

Carry Trade	Obs.	Mean	Std. Dev.	Skew	Kurtosis	Min.	Max.	Jacque-Bera
EURBWP	729	0.6489	12.1866	-0.6934	7951	-0.1007	0.0603	543.2287***
EUREGP	729	0.2163	9.4464	-1.2442	12.6963	-0.1122	0.0508	3043.902***
EURGHS	729	0.6489	10.3838	0.0730	5.6936	-0.0647	0.0803	221.0241***
EURMAD	677	0.0721	1.4422	0.0115	3.9288	-0.0109	0.0085	24.34903***
EURNGN	729	0.8653	8.3648	-0.1444	24.1172	-0.0790	0.1120	13547.79***
EURZAR	729	0.2163	13.1240	-0.6363	5.6688	-0.0954	0.0735	265.5368***
EURTND	729	-0.1442	3.1007	0.0344	3.8690	-0.0178	0.0157	23.0807***
USDBWP	729	1.9470	12.4029	1.2432	9.9351	-0.0621	0.1324	1648.699***
USDEGP	729	0.3606	4.8314	-9.1473	130.1805	-0.1106	0.0231	501478.1***
USDGHS	729	0.8653	10.8165	-0.4357	146981	-0.2297	0.2244	628987.9***
USDMAD	677	0.3606	6.5620	-0.0233	5.3252	-0.0365	0.0548	152.567***
USDNGN	729	0.8653	8.3648	-0.1444	24.1172	-0.0790	0.1120	13547.79***
USDZAR	729	0.3606	14.0615	-0.8165	5.7654	-0.1062	0.0647	313.2929***
USDTND	729	0.0721	5.9130	-0.0170	4.8622	-0.0335	0.0479	105.3641***
JPYBWP	729	1.1538	127.346	-0.1375	353.8054	-3.3505	3.3374	3738085***
JPYEGP	729	0.6490	9.3022	-1.0945	10.3114	-0.1009	0.0495	1769.273***
JPYGHS	729	1.1538	10.7444	0.1398	5.5071	-0.0682	0.0790	193.2904***
JPYMAD	677	0.5048	9.0138	-0.5982	7823	-0.0739	0.0603	487.7322***
JPYNGN	682	1.0817	132.827	0.1630	321.2499	-3.3371	3.3609	2878128***
JPYZAR	729	0.6490	16.0805	-0.9468	7.1588	-0.1353	0.0758	634.2845***
JPYTND	729	0.3606	8.4369	-0.6653	4565	-0.0669	0.0523	459.8904***
GBPBWP	729	0.7211	12.2587	-0.8607	8.5166	-0.1234	0.0571	1014.427***
GBPEGP	729	0.2884	8.9416	-0.9969	14.4993	-0.1086	0.0591	4137.378***
GBPGHS	729	0.7932	10.0233	0.0762	5.4711	-0.0658	0.0676	18839***
GBPMAD	677	0.2163	5.6967	-0.0141	9.6737	-0.0597	0.0417	1256.387***
GBPNGN	729	0.7932	12.4750	-0.1262	9.2097	-0.0935	0.1123	1173.212***
GBPZAR	729	0.2163	13.1240	-0.5481	6.0115	-0.0971	0.0789	742.879***
GBPTND	729	-0.0721	5.7688	-0.0539	7.9442	-0.0566	0.0414	311.9719***

Notes: The sample covers the period January 12, 2001 to December 26, 2014, except Morocco which covers the period January 11, 2002 to December 26, 2014. The obs. is the total number of weekly observations per market. Mean statistics and standard deviations are annualized by multiplying them by $\sqrt{52}$ and expressing same in percentages. *** is statistical significance at the 1% level. The carry trade column shows the currency pairs such as EURBWP being the Euro-Botswana currency pair; USDGHS being the Dollar-Ghanaian Cedi currency pair, etc.

4.2 Causality Between African Carry Trades and Stock Market Returns

Table 3 presents the results of estimating Eqs. (1) and (2) which sought to investigate the causal relationship between currency carry trade returns and stock market returns. To this end, two hypotheses were tested: (1) that the returns of stock market indices in the sample do not Granger-cause the variations in the returns of carry trades; and (2) that the carry trade returns of the sample markets do not Granger-cause the movements or changes observed in the returns of stock market indices. From the results in Table 3, the hypothesis that stock markets do not drive currency carry trades was sustained for all sampled countries and for all funding currency pairs. The results show significant evidence that stock market returns do not drive currency carry trades in Africa. Thus there is broad lack of sufficient evidence to reject the hypothesis regardless of the funding currency (USD, EUR, GBP or JPY) used. Specifically, all four strategies for each of the funding currency in relation to the Botswana

Pula (BWP), the Nigerian Naira (NGN), and the South African Rand (ZAR) support the hypothesis no causal relationship running from the stock market to the currency carry trades in Africa. Three out of the four strategies for the remaining four African currencies (the Ghanaian Cedi, GHS; the Egyptian Pound, EGP; the Moroccan Dirham, MAD; and the Tunisian Dinar, TND) in relation to each of the funding currencies also sustain the hypothesis.

The results in Table 3 however reject the second proposition that currency carry trades do not cause/drive stock market movements in Africa. The results show largely significant evidence of causal relationship running from returns of currency carry trades to the stock market returns. Thus, for all investment strategies implemented (i.e. targeting each local currency for four carry trades in USD, EUR, GBP or JPY by longing the local currencies and shorting the funding currencies), currency carry trade is found to drive stock market movements in Africa. Specifically, carry trades that target the Moroccan Dirham, the South African Rand, and the Tunisian Dinar using USD, EUR, GBP and JPY as funding currencies cause movements in stock market of that particular country. Also, the results show that stock market movements in Botswana, Egypt and Nigeria can be caused by carry trades that target the currencies of these countries and are funded by EUR, GBP and USD (for Botswana and Nigeria) and GBP, USD and JPY (for Egypt). The results further indicate that the Ghanaian stock market responds to carry trades that target the Cedi and are funded by EUR and GBP.

The findings are consistent with prior studies on carry trades such as Fung *et al*. (2013). The evidence is indicative of a violation of the uncovered interest rate parity condition. In this case the target currencies appreciate rather, and the target currency appreciation strengthens the profits that accrue to carry trade strategy and that certainly will attract more investors. Moreover, as more investors are attracted by these carry trade profits, the demand for these target currencies and for that matter currency carry trade investment will rise. The rise in demand for currency carry trade means an increase in capital inflows into the targeted African countries which ultimately will strengthen the cash flows of the financial markets in the target countries. The rise in cash inflows will ultimately move stock market returns in the target countries. As suggested by Fung *et al*. (2013), this finding reinforces the argument that high carry trade returns ultimately lead to high stock returns and vice versa.

Table 3: Causality between African currency carry trade returns and their stock market returns

	EUR FUNDED			GBP FUNDED			USD FUNDED			JPY FUNDED		
Market	Lags	F-stat	Prob	Lags	F-stat	Prob	Lags	F-stat	Prob	Lags	F-stat	Prob
Botswana												
Stock⇏Carry trade	4	0.910	0.458	4	0.820	0.512	6	0.438	0.854	7	0.501	0.834
Carry trade⇏Stock		29.875	**0.000**		34.152	**0.000**		39.954	**0.000**		0.846	0.550
Egypt												
Stock⇏Carry trade	4	2.631	**0.033**	4	0.577	0.679	3	1.923	0.124	2	0.676	0.509
Carry trade⇏Stock		1.078	0.367		2.031	**0.088**		6.227	**0.000**		6.449	**0.002**
Ghana												
Stock⇏Carry trade	3	0.560	0.642	3	2.156	0.092	5	2.212	**0.051**	8	1.809	0.072
Carry trade⇏Stock		3.230	**0.022**		3.761	**0.011**		1.055	0.384		1.258	0.263
Nigeria												
Stock⇏Carry trade	3	1.821	0.142	2	1.650	0.193	3	1.821	0.142	8	0.526	0.837
Carry trade⇏Stock		19.475	**0.000**		10.880	**0.000**		19.475	**0.000**		0.289	0.970
Morocco												
Stock⇏Carry trade	3	0.677	0.566	2	5.358	**0.005**	2	2.325	0.099	2	1.698	0.184
Carry trade⇏Stock		39.042	**0.000**		413	**0.001**		79.786	**0.000**		17.295	**0.000**
South Africa												
Stock⇏Carry trade	3	0.247	0.863	1	0.124	0.725	4	1.050	0.381	3	1.086	0.354
Carry trade⇏Stock		24.828	**0.000**		170.590	**0.000**		47.739	**0.000**		103.210	**0.000**
Tunisia												
Stock⇏Carry trade	2	4.309	**0.014**	3	1.561	0.198	2	0.806	0.447	4	1.587	0.176
Carry trade⇏Stock		28.728	**0.000**		2.410	**0.066**		74.489	**0.000**		12.984	**0.000**

Notes: The Table shows the results of VAR Granger causality test between currency carry trade targeting African currencies and their respective stock market indices. Thus Stock⇏Carry trade test the hypothesis that the stock market index of the country under study does not Granger cause currency carry trade in that country and vice versa. Selection of lag length was based on the Akaike information criterion (AIC). A total of 729 weekly observations (12/01/2001-26/12/2014) for each market were used for the estimations.

4.3 Volatility Spillover Effects of African Carry Trades and Stock Market Returns

Table 4 (with EUR, GBP, USD and JPY as funding currencies as funding currencies) presents the results of estimating Eq. (2), a DCC-AR (1)-GARCH (1, 1)-*t* framework. Prior to the estimation, we tested and confirmed the stationarity of the series as well as the presence of ARCH effect and volatility clustering in the carry trade returns and stock market returns. Tables 4 show that the estimates of carry trade and stock market return volatilities for all the countries have all satisfied the non-negativity constraint ($\alpha + \beta < 1$). The hint is that the model is adequate in measuring the time-varying conditional correlations, as this suggests that mean reversion exists along a constant level, and controls for high degree of persistence in conditional volatility of carry trade and stock market returns.

The results in Tables 4 indicate largely very small coefficients of the ARCH parameter α, in most cases not significantly different from zero, but nevertheless with a few statistically significant coefficients such as the Nigerian and Moroccan currencies both paired against the Great British Pound. The coefficients of the GARCH parameter β are predominantly large and statistically significant for a number of markets and currency pairs. These results reveal that the conditional volatility of the stock market returns is influenced more by the previous volatility of carry trade than their lagged returns. Thus, there is more of a GARCH effect than there is for an ARCH effect. The large GARCH coefficients are also a demonstration of a significant amount of fluctuation in the return volatility over time. This further signifies that there is a high degree of persistence in the return volatility and evidence of mean reversion. An increase in volatility is established in the literature as a condition for increased volatility spillover between the two assets (King and Wadhwani, 1990; Padhi and Lagesh, 2012). There is evidence of modest volatility spillover from carry trade market to the stock market returns dotted across the sampled countries. Specifically, we report evidence of volatility spillover from EUREGP, GBPGHS, EURNGN, GBPNGN, GBPMAD, EURZAR, GBPTND, JPYEGP, JPYGHS and USDMAD carry trade to the stock markets of Egypt, Ghana, Nigeria, Morocco and South Africa.

An indication is that the conditional correlations between the African carry trades and stock market returns are dynamic and time-varying. Besides, the conditional correlation coefficient across the pairs of carry trades and the stock markets are largely low, with the lowest being the GBP-NGN pair (0.0012) and the highest being the EUR-MAD pair (0.1525). The evidence thus seems to suggest that carry trade can be an important asset class to consider for portfolio diversification across African markets. The evidence presented in Tables 4 is consistent with the position established in the literature (Cheung *et al.*, 2012; Tse and Zhao, 2012; Fung *et al*., 2013; Minh, 2016). Nevertherless, this study documents only a few cases of volatility spillover considering the number of currency pairs executed. This seemingly low level of volatility spillover cases reported could be attributed to the fact that the currency carry trade as a trading strategy may not be popular and formalised amongst the players of African financial markets. Once it is not popular or practised, the volume and value of carry trades expected to take place to influence this volatility transmission may be very few or even non-existent.

Table 4: Volatility spillover effects of African carry trade returns and stock market returns

Market	EUR FUNDED				GBP FUNDED			USD FUNDED			JPY FUNDED		
	Parameter	Estimate	Std Errors	t-statistic	Estimate	Std Errors	t-statistic	Estimate	Std Errors	t-statistic	Estimate	Std Errors	t-statistic
Botswana	ρ	-0.0368	0.0379	-0.9711	0.0012	0.0345	0.0353	0.0126	0.0344	0.3670	-	-	-
	α	0.0333	0.0330	1.0100	0.0000	0.0000	0.0552	0.0000	0.0000	0.0000	-	-	-
	β	0.0781	0.5527	0.1413	0.5814	0.4370	1.3300	0.8274	0.6405	1.2920	-	-	-
	ν	5.2441***	0.5106	10.2700	4.9494***	0.4272	11.5900	5.3695***	0.5289	0.0000	-	-	-
	L-L	3523040			3761.6280			3760.1200			-	-	-
Egypt	ρ	-0.0575	0.0394	-1.4610	-0.0051	0.0389	-0.1319	0.0350	0.0311	1.1230	-0.0328	0.0435	-0.7545
	α	0.0000	0.0000	0.0000	0.0221	0.0305	0.7227	0.0488	0.0390	1.2520	0.0127	0.0212	0.6001
	β	0.8129**	0.4047	2.0090	0.0000	0.5477	0.0000	0.0000	0.3783	0.0000	0.9108***	0.1025	8.8850
	ν	4429***	0.8994	7.3860	5.8304***	0.6384	9.1330	3.1644***	0.1205	26.2700	6.0197	0.6920	8.6990
	L-L	3404.1620			3680.5860			4629.4570			3605.6140		
Ghana	ρ	-0.0151	0.0368	-0.4103	-0.0261	0.0358	-0.7294	0.0118	0.0358	0.3291	-0.0185	0.0419	-0.4414
	α	0.0000	0.0000	0.0090	0.0000	0.0000	0.0000	0.0000	0.0000	0.0012	0.0040	0.0103	0.3849
	β	0.2962	23.2750	0.0127	0.7684**	0.3859	1.9910	0.3623	0.7232	0.5009	0.9698***	0.0407	23.8100
	ν	8.7238***	1.6672	5.2330	8.5258***	1.5687	5.4350	3.8557***	0.2682	14.3700	8.4808***	1.4728	5.7580
	L-L	3335.4260			3612.9580			4014.9870			3564.7310		
Nigeria	ρ	0.0654*	0.0352	1.8580	0.0404	0.0855	0.4718	0.0118	0.0358	0.3291	-0.0014	0.0292	-0.0462
	α	0.0083	0.0202	0.4121	0.0152**	0.0079	1.9290	0.0000	0.0000	0.0012	0.0000	0.0000	0.0017
	β	0.8736***	0.0848	10.3100	0.9727***	0.0170	57.2500	0.3623	0.7232	0.5009	0.0385	6.0930	0.0063
	ν	4.5670***	0.4027	11.3400	10.7135***	2.3859	4.4900	3.8557***	0.2682	14.3700	2.8936***	0.1026	28.2000
	L-L	3800.6810			3491.7340			4014.9870			2550.0290		
Morocco	ρ	0.1525***	0.0383	-3.9850	0.0251	0.0542	0.4640	0.1263***	0.0417	3.0300	0.0812**	0.0378	2.1490
	α	0.0000	0.0000	0.4590	0.0530**	0.0262	2.0220	0.0046	0.0165	0.2819	0.0000	0.0000	0.0164
	β	0.3124	1.7622	0.1773	0.8242***	0.0644	12.8100	0.9004***	0.0819	10.9900	0.7801	0.8652	0.9017
	ν	9.1333***	1.6686	5.4740	8.4141***	1.5808	5.3230	9.2940***	1.7267	5.3830	8.4450	1.3601	6.2090
	L-L	4838.1000			4046.4230			3938.8760			3729.8280		
S. Africa	ρ	0.0030	0.0595	0.0510	0.1148***	0.0378	3.0400	0.0128	0.0394	0.3257	0.0782*	0.0417	-1.8780
	α	0.0073	0.0066	1.0950	0.0078	0.0250	0.3139	0.0000	0.0000	0.0047	0.0862	0.0543	1.5870
	β	0.9829***	0.0095	103.7000	0.0000	0.6030	0.0000	0.0030	1.6096	0.0018	0.0825	0.1941	0.4249
	ν	10.1838***	1.9364	5.2590	10.0016***	1.9717	5.0730	10.2950***	2.0678	4.9790	8.7684***	1.5213	5.7640
	L-L	3180.6970			3185.9470			3118.9290			3031.0870		
Tunisia	ρ	-0.0513	0.0372	-1.3780	-0.0286	0.0499	-0.5731	0.1429***	0.0348	4.1040	0.05279	0.040299	1.31
	α	0.0000	0.0000	0.0161	0.0207	0.0228	0.9072	0.0000	0.0000	0.0103	0.0000	0.0000	0.3108
	β	0.2694	1.3861	0.1943	0.9026***	0.0756	11.9400	0.1262	1.1181	0.1129	0.6619	0.8257	0.8017
	ν	9.3473***	1.8678	5.0050	7.5620***	1.1748	6.4370	9.1611***	1.8522	4.9460	7.4433	1.1817	6.2990
	L-L	4580.902			4210.0540			4195.2590			3954.0290		

Notes: This Table presents the volatility spillover effects between carry trade returns and stock market returns in Africa with EUR and GBP as funding currencies. The Table shows the results of the Engle (2002) DCC-AR (1)-GARCH (1, 1) with student t distribution. ρ measures correlation, while α and β are respectively the ARCH and GARCH parameters under the restrictive condition of non-negativity satisfying $\alpha+\beta<1$ in all cases. L-L is log-likelihood, SE is standard error, t-stat is t-statistics and ν is the degrees of freedom of the distribution of innovation. ***, **, and * are statistical significance at 1%, 5% and 10%, respectively. A total of 729 observations (12/01/2001-26/12/2014) for each country were used for the estimation.

Furthermore, Figures 1 and 2 present the conditional correlation plots between the carry trade returns of African currencies and their respective stock market returns. Figure 1 relates to carry trades funded by the Euro and British Pound, whilst Figure 2 relates to those funded by the United States Dollar and Japanese Yen. The plots confirm the presence of conditional correlations between African currency carry trades and stock market returns, excepting carry trades that target the Tunisian Dinar and funded by the Yen, that target the Botswana Pula and the South Africa Rand and funded by the US Dollar, and those that target the Moroccan Dirham and Tunisian Dinar and financed by the Euro. In addition, the plots largely show that the conditional correlations between the African currency targeted carry trades and their stock market returns are dynamic and time-varying.

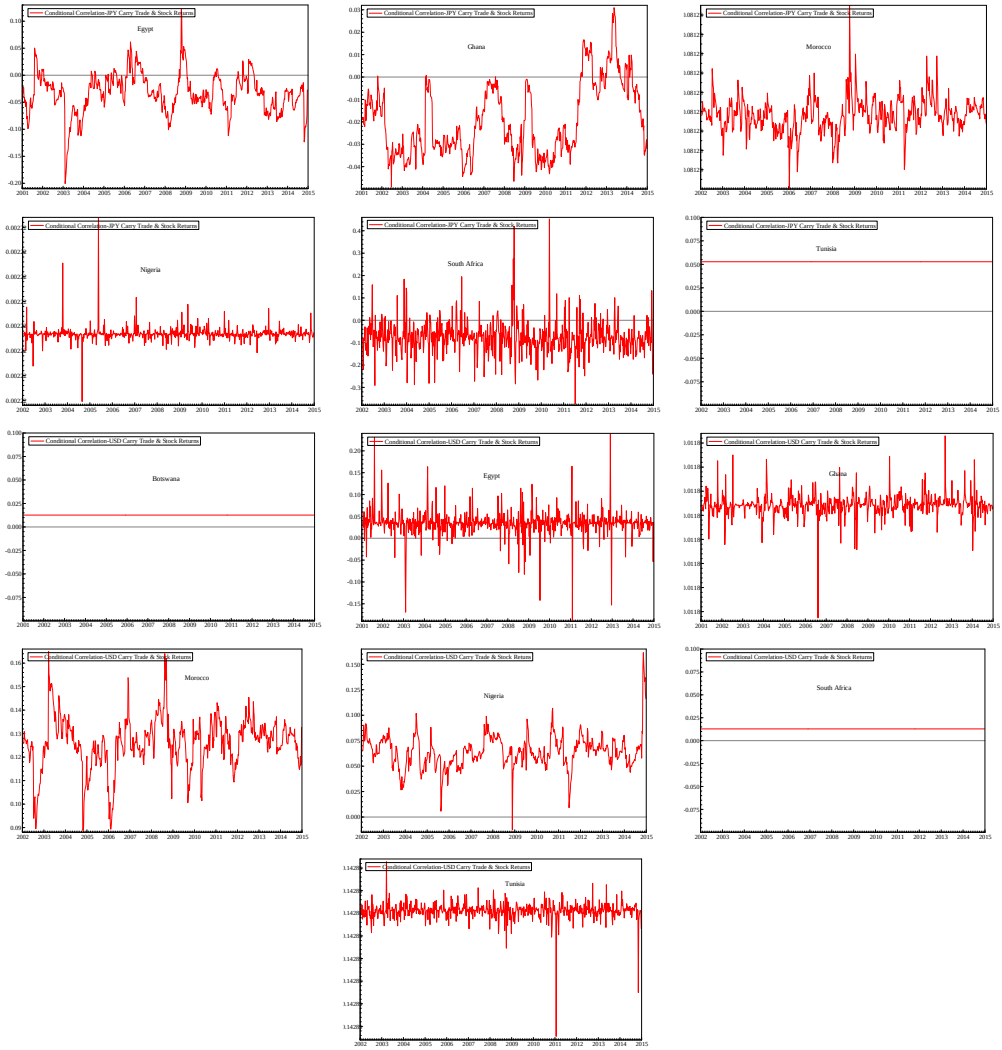

Figure 1: Conditional correlations of JPY and USD carry trades and stock markets

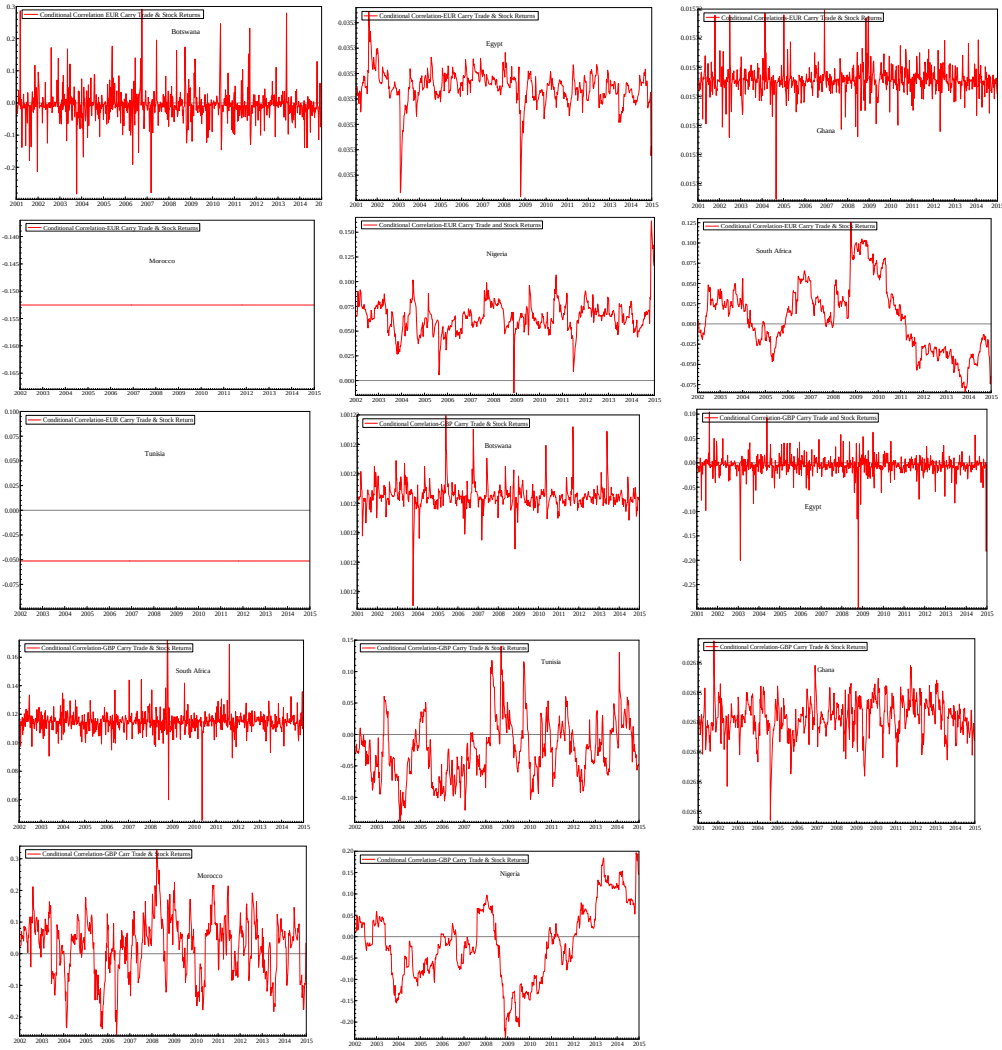

Figure 2: Conditional correlations of EUR and GBP carry trades and stock markets

5. Conclusions

We explore the implications of carry trades targeting African currencies for the returns of stock market indices in Africa. To this end, we examine the causal relationship between African currency targeted carry trades and stock market returns using vector autoregressive-Granger causality (VAR-Granger). We additionally investigate the dynamic relationship and volatility spillover between currency carry trade returns and stock market returns using the dynamic conditional correlation-generalised autoregressive conditional heteroskedasticity (DCC- GARCH). We use four developed currencies as funding currencies and seven African currencies as the target markets as well as the returns of stock indices of their respective countries.

The paper provides evidence of significant causal relationship running from African currency targeted carry trades to the stock markets of their respective countries, but not vice versa. The paper also finds that stock market returns generally do not drive currency carry trades in Africa. The paper further documents evidence of moderate volatility spillover

emanating from the currency carry trades to the stock markets for a significant number of currency pairs, but not from stock markets to carry trade markets. In addition, evidence is provided that the conditional correlations between the African currency targeted carry trades and stock market returns are dynamic and time-varying, and that there is evidence of high degree of persistence in return volatility and mean reversion. An overarching implication of the findings is that there is high information transmission mechanism from the currency carry trade market to the stock markets much more than it is from the stock markets to currency carry trades.

The findings of this study have far-reaching implications for the stability of foreign exchange markets, the efficiency and growth of international financial markets and, to some extent, the global economy as a whole. First, from a theoretical standpoint, the findings confirm the assertion that the UIP does not hold in most financial markets, which further suggests that most financial markets, especially in developing economies, are inefficient. Impliedly, while it is plausible for investors and fund managers to make systematic gains by shorting low-yielding currencies and taking long positions in high-yielding currencies, such activities or trading strategies have the potential to disrupt foreign exchange markets, deepen financial market inefficiency and financial system failure, and, given the degree of economic and financial integration, disrupt the global economy. Given that carry trade has the ability to cause systematic mispricing and asset bubbles in the foreign exchange markets, and the fact that it is a major source of shock and volatility spillover in financial markets, we recommend that policy makers and financial markets regulators in Africa, in particular, need to formulate policies and tighten regulations to control the practice. The range of policies and regulations could comprise stepping up efforts to improve informational efficiency and flows in African financial markets, improve market regulation, and promote greater market integration with the developed financial markets for market efficiency, among others.

Second, an empirical implication of the findings is that, given that the African targeted currency carry trades are closely linked with their stock markets, activities of carry traders could influence the stock markets in two main ways: (1) carry-trade-related capital flows could find their way into the stock markets, spurring improved performance, and (2) the transient nature of the currency carry trade strategy could cause unexpected unwinding of carry trade investments by investors. The abrupt unwinding of carry trade investments is often due to large anticipated future losses caused by adverse economic and market conditions. This sudden withdrawal from the market can have devastating consequences for the performance of stock markets and economies, especially when sound regulatory and institutional framework to deal with the situation is lacking. The findings thus show that it is important for policy makers in developing and emerging economies, in particular, to maintain sound macroeconomic environment to keep traders in the financial market. Additionally, it is imperative for regulators in these economies to take the necessary, innovative and bold steps to improve their regulatory and institutional frameworks to track carry trade funds in order to be able to deal with the risks associated with the downside risk of the strategy.

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