UNIVERSITY OF ZULULAND

Essays on Currency Carry Trade in Africa's Emerging and Frontier Markets

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DECLARATION

I, **Eric Nkansah** declare that:

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Name of student: **Eric Nkansah**

Signature:………………………

DEDICATION

To my parents Mr. Matthew Akwei Nkansah and Mrs. Rose Nkansah whose guidance and support have brought me this far; and to my lovely wife (Akua Pokuaa Nkansah) and son (Nana Kwame Nkansah) whose love, unceasing prayers, support and encouragement energised me to attain this height.

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CURRENCY SYMBOLS

Code	Name
BWP	Botswana Pula
EGP	Egyptian Pound
EUR	Euros
GBP	Great British Pounds
GHS	Ghana Cedis
JPY	Japanese Yen
KES	Kenyan Shillings
MAD	Moroccan Dirham
MUR	Mauritius Rupees
NGN	Nigerian Naira
TND	Tunisian Dinar
USD	United States Dollars
ZAR	South African Rand
ZMW	Zambian Kwacha

LIST OF ACRONYMS

ACF	Autocorrelation Function
ADF	Augmented Dickey Fuller
AIC	Akaike Information Criterion
APT	Arbitrage Pricing Theory
AR	Autoregressive
ARCH	Autoregressive Conditional Heteroskedasticity
ARDL	Autoregressive Distribution Lag
ASEA	African Securities Exchange Association
BEKK-GARCH	Baba-Engle-Kraft-Kroner GARCH Model
BIC	Bayesian information criterion
BRICS	Brazil, Russia, India, China and South Africa
CAPM	Capital Asset Pricing Model
CCC	Constant Conditional Correlation
CFXO	Collateralised Foreign Exchange Obligation
CIP	Covered Interest Parity
CSFB	Credit Suisse Fear Barometer
CTA	Commodity Trading Advisors
DCC	Dynamic Conditional Correlation
DCC-GARCH	DCC-Generalised Autoregressive Conditional Heteroskedasticity
ETF	Exchange Traded Funds
G7	Group of Seven Countries
G10	World’s Ten Most Traded Currencies
GARCH	Generalised Autoregressive Conditional Heteroskedasticity
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
GDPPC	Gross Domestic Product Per Capita
GEINDEX	Global Equity Index
IFC	International Finance Corporation
IMF	International Monetary Fund
IPS	Im-Pesaran-Shin
LLC	Levin-Lin-Chu
LLF	Log Likelihood Function

LM	Lagrange Multiplier
M-GARCH	Multivariate Generalised Autoregressive Condition Heteroskedasticity
MSCI	Morgan Stanley Capital International
NYSE	New York Stock Exchange
OLS	Ordinary Least Squares
PACF	Partial Autocorrelation Function
RIP	Real Interest Parity
S&P 500	The Standard and Poor’s first 500 stocks in the United States
SBIC	Schwartz Bayesian Information Criterion
SMD	Stock Market Development
SSA	Sub-Saharan Africa
UIP	Uncovered Interest Rate Parity
VAR	Vector Autoregression
VECH-GARCH	Vector Autoregressive Conditional Heteroskedasticity-GARCH
VECM	Vector Error Correction Model
WBG	World Bank Group
WDI	World Development Indicators

ABSTRACT

The currency carry trade, an investment strategy where investors borrow funds from low-interest currency countries and invest the funds in financial assets domiciled in high-interest currency countries, has become very popular in the academic literature over the last two decades. The strategy exploits the failure of the uncovered interest rate parity (UIP) hypothesis which states that the interest rate differential between two countries is exactly offset by the depreciation of high interest rate currency over the investment time horizon. Thus this investment strategy is expected to yield zero returns if the uncovered interest rate parity condition holds. Its failure is well documented in literature, though these studies mostly concentrate on currencies of the developed world. This study implements the trade by targeting ten currencies of Africa's emerging and frontier markets, and fund the trade with four developed market currencies. The researcher first evaluates the profitability of the trade across all the forty currency pairs from 1998 to 2015. This is then followed by a rigorous analysis of returns using advanced risk-adjusted performance measures to test their viability as an alternative asset class or prudent investment. The study further examines a value-at-risk (VaR) analysis of the currency carry trade returns using generalised autoregressive conditional heteroskedasticity (GARCH) models. Finally, the study investigates the relationship or the information transmission mechanism between returns of the African currency carry trade and the returns of its respective Stock Markets. Different methodologies were employed to achieve the various objectives of this study. Notable among them are the Huber's robust regression, advanced portfolio performance evaluation measures, univariate generalised autoregressive conditional heteroskedasticity (GARCH) with value-at-risk and expected shortfall estimations, vector autoregressive Granger causality, panel vector autoregression (xtvar) and multivariate dynamic conditional correlation GARCH analysis. The study concludes that only a handful of the currency pairs studied were statistically profitable during and after the financial crisis of 2007. Naïve estimation of carry trade however produced some modest profits for a good number of the currency pairs. The study also concludes that some of the currency pair studied exhibit features of a viable investment and may be classified as an asset class. Furthermore, the researcher shows that the most appropriate approach to estimating the risk or value-at-risk of African currency carry trade returns is through the GARCH (1, 1) with skewed t distribution of the innovation. Finally, the implications of the African currency carry trade for the stock markets in Africa were found to be mixed. Thus African currency carry trade returns of twenty two currency pairs were found to significantly Granger cause the stock markets of the target currency countries, whilst evidence of causality could not be established for six

currency pairs. A large number of currency pairs show one-way causality from the currency carry trade to the stock markets, with minimal amount of volatility spillover sparsely distributed across the selected African countries. For all the currency pairs together and the stock markets of Africa together, the study found that the stock markets respond greatly to shocks in carry trade whilst there appears to be very minimal response by carry trade to shocks in the stock markets.

CHAPTER 1
Introduction

1.0 Background and Problem Statment

The currency carry trade has in recent times received increasing coverage in the financial media. The currency carry trade is a transaction where an investor borrows at a low interest rate and invests in an asset that yields a higher interest rate, making money on the spread (Burnside and Eichenbaum, 2011). Theoretically, this transaction should generate zero excess return if the Uncovered Interest rate Parity (UIP) holds. "The UIP refers to the parity condition in which exposure to foreign exchange risk, with unanticipated changes in exchange rates, is uninhibited and therefore if one assumes rational risk-neutral investors, then changes in the exchange rates should offset the potential profit from the interest rate differentials between high interest rate (investment) currencies and low interest rate (funding) currencies" (Ames et al., 2013). Stated differently, the UIP predicts that exchange rates will move to close up any possibility of profit. Although UIP seems to draw on sound theoretical foundations, empirical work produces enough evidence for its systematic failure (Ackermann et al., 2012; Ames et al., 2013; Brunnermeier et al., 2008; Burnside et al., 2010, 2006a; Menkhoff et al., 2012b). Deviation from UIP is well established in currency carry trade literature. This is commonly known as the "UIP puzzle" or the "forward rate anomaly". Evidence suggests that incorporating a carry trade component in a conventional portfolio improves portfolio performance[1](Das et al., 2013). The currency carry trade has been categorised in academic literature as prudent investment which can be selected by investors as an alternative to other risky assets (Das et al., 2013; Korhonen and Kunz, 2009).

From the foregoing discussions of the academic literature it is evident that the failure of UIP and its resultant profits in currency carry trade is well documented. But these studies have mostly concentrated on the G10[2]currencies which are regarded as the most liquid and traded currencies in the world. Thus their findings thereof may not be applicable to the African continent where both interest rate and exchange rate are perceived to be volatile. As consequence from the failure of UIP, there has been a proliferation of financial instruments or

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[1]Measured in terms of its Sharpe ratio, Sortino ratio, value at risk, and adjusted Sharpe ratio.

[2]G10 currencies comprise US Dollar (USD), Euro (EUR), Japanese Yen (JPY), Great British Pound (GBP), Swiss Franc (CHF), Australian Dollar (AUD), New Zealand Dollar (NZD), Canadian Dollar (CAD), Swedish Krona (SEK) and Norwegian Krone (NOK).

index funds of currency carry trade on the international financial markets such as the Deutsche Bank G10 Carry Index which tracks the daily carry trade returns of G10 currencies. Increasingly this popular trade is gaining grounds with major currencies such as the Japanese Yen, US dollars and the Euro leading the way. Investors, hedge fund managers, portfolio managers, investment bankers and individuals are actively trading in this strategy especially in countries where the interest rate is low such as Japan where interest rate has been maintained at near zero for well over decade now. These funds from the low interest countries will usually find its way to countries where interest rates are high to invest. African countries generally have high interest rates and so might attract some of these capital flows from low interest countries of the world. But in the academic literature, studies on the profitability of the African is almost non-existent (to the best of the researcher's knowledge), possibly because the African currencies are perceived to be illiquid. Recent studies on African financial markets show rapid improvement in the liquidity of African currencies, especially among Africa's emerging and frontier markets. It for this reason that this study seeks to embark on what appears to be a continent-wide (in respect of emerging and frontier markets) to examine issues such as profitability of the trade, whether it could be classified as an asset class, value-at-risk analysis and implications for the stock markets.

This work thus focuses on the African continent, specifically the emerging and frontier markets, as the target market for currency carry trade to evaluate those findings in that particular strand of the literature. The study primarily concentrates on the emerging and frontier markets of Africa as per the S&P Dow Jones Indices country classification 2014. This classification took into consideration the fact that those African countries categorised under emerging and frontier markets are politically and economically stable as well as achieving high growth rates and most importantly are open to foreign investor participation in their economies (S&P Dow Jones Indices, 2015). Thus a significant proportion of carry trade funds are likely to find its way to those African markets because many portfolio managers are attracted by the huge interest rate differential between African countries and the first world countries (Sy and Rakotondrazaka, 2015).

The study empirically explores the currency carry trade strategy in Africa financed by the four most traded currencies in the world with very low interest rates (i.e. US Dollar, Euro, Japanese Yen, and Great British Pound). Then the strategy is analysed using financial econometric analysis in relation to the profitability of the strategy, its viability as a prudent investment or alternative asset class, value at risk (VaR) of returns and the implications of currency carry trade returns for stock market returns of countries involved in the trade.

The study will hopefully be a useful guide for policy makers who constantly make policies to promote investment and economic growth, and investors (or portfolio managers) who are constantly making investment decisions or constructing optimal portfolios. The study may also stimulate the interest of international investors in the African financial market. The study is divided into four separate essays: the first essay evaluates the profitability of the currency carry trade in African currencies paired with the low-interest first world currencies selected for the study; the second essay explores the viability of this African currency carry trade as a prudent investment or as an alternative asset class which investors can consider; the third essay analyses the value at risk (VaR) for this African currency carry trade; the fourth and final essay investigates the implications that currency carry trade may have for the stock returns of the African Stock Markets.

1.1 Motivation

In financial economics, the difference between the interest rate on an asset denominated in any one country's currency unit and the interest rate on a similar asset denominated in another country's currency is assumed to be compensated for by the expected rate of change in the spot exchange rate between the two currencies. This is referred to as uncovered interest rate parity (UIP) and it is the very reason why currency carry trades should not work in theory. Thus if the UIP holds, the expected excess return on the currency carry trade will be zero. However, there appears to be substantial evidence in the academic literature that the UIP condition does not hold (Brunnermeier et al., 2008; Burnside et al., 2010; Cheung et al., 2012; Darvas, 2009). Currency carry trade is a strategy of shorting a low-yield currency and longing a high-yield currency with the aim of earning profit from the spread. The extent to which this carry trade strategy generates profit, which could be categorised as an alternative asset class, and where the worst possible losses could be measured, and the implications of carry trade for the stock markets remain centre stage issues of continuing interest. These issues are of great interest to stakeholders such as governments, central banks, policy makers, investors, hedge funds or mutual funds managers, and firms. Answers to these questions are likely to widen the scope of the African financial markets for international investors, hedge funds, central banks, policy makers and other stakeholders, which may ultimately affect their economies. On the other hand, currency carry trade can hurt international economies as it can lead to currency market crashes.

As might be expected, these issues have been the subject of an enormous amount of research the world over. In the extant literature, studies on these issues are focused on the developed countries, specifically the G10 currency countries and emerging Asian, European and Latin American economies (Ackermann et al., 2012; Brunnermeier et al., 2008; Cheung et al., 2012; Das et al., 2013; Fong, 2010; Fung et al., 2013; Jurek, 2014; Korhonen and Kunz, 2009; Wang et al., 2013). Research in Africa on these issues of continuing relevance is largely limited. Even the few studies on Africa which do exist are mostly on South Africa which is usually included in the emerging economies and have mostly produced mixed findings (Ames et al., 2013; Burnside et al., 2010; Cenedese et al., 2014; Hassan and Smith, 2011; Huang and Macdonald, 2013; Menkhoff et al., 2012a; NBIM and Staff, 2014). Furthermore, academic research on the evidence of currency carry trade activity in Africa is rare, except for South Africa which has seen some studies on currency carry trade activity and profitability (Doskov and Swinkels, 2015; Galati et al., 2007; Hassan and Smith, 2011). However, Standard Bank's 'African Markets Revealed' May 2015 edition of their quarterly journal reports some positive and some negative returns of currency carry trade for fifteen (15) African countries against the US dollars and Euro for the first quarter of 2015. The countries are Angola, Botswana, Democratic Republic of Congo, Egypt, Ghana, Kenya, Malawi, Mauritius, Mozambique, Nigeria, Rwanda, South Africa, Tanzania, Uganda and Zambia (Bailey-Smith et al., 2015, pp. 11–14). This makes it imperative for continent-wide academic research to be conducted on the currency carry trade (Fung et al., 2013). As a developing continent that is largely characterised by an inadequate regulatory framework, poor financial intermediation, an underdeveloped currency market and lack of innovative financial instruments, issues such as profitability, value at risk, asset viability of currency carry trade and its implications for stock markets remain absolutely relevant for policy and investment decision making purposes.

As currency carry trade becomes increasingly relevant in international financial economics, and for that matter the African continent, accurate and reliable evidence as to whether or not the strategy is profitable in Africa, appropriate measurement of worst possible losses or value at risk, and whether this strategy can be a viable alternative asset class remain very relevant. Again, the implications of the African currency carry trade for the returns of stock markets in Africa are of continuing interest. The extent of African currency markets' exposure and the fact that financial crises can have dire consequences for developing markets makes the need for reliable evidence on continent-wide currency carry trade very important. This study makes significant contributions to the aforementioned issues.

1.2 Research Questions

A number of research questions emerged following the background review of the relevant literature, including the following:

1. To what extent is the strategy of currency carry trade profitable in Africa?
2. What is the appropriate value at risk (VaR) model to capture the risk associated with the returns of African currency carry trade financed by borrowing low-interest-rate currencies in the developed countries?
3. To what extent can the African currency carry trade constitute a prudent investment or be classified as an alternative asset class?
4. What implications does African currency carry trade may have for the returns of African Stock Markets?

1.3 Objectives of the Study

The main objective of this study was to empirically investigate the viability or otherwise of a currency carry trade strategy which targets African currencies as a financial asset and to establish how this strategy relates to, or affects, the African stock markets. The specific objectives were as follows;

1. To evaluate the profitability of the currency carry trade, targeting African currencies funded by some selected first world currencies with lower interest rates.
2. To explore how the African currencies targeted carry trade (in its simple form) could represent a prudent investment, or viable alternative asset class, using risk-adjusted performance measures.
3. To examine a value-at-risk (VaR) analysis of African currency carry trade returns, using generalised autoregressive conditional heteroskedasticity (GARCH) models.
4. To investigate the relationship, or the information transmission mechanism, between returns of African currency carry trade and the returns of their respective Stock Markets.
5. To recommend policy prescriptions based on the empirical findings of the study

1.4 Scope of the Study

The study mainly investigates the African financial markets to establish the potential and viability of the very popular investment strategy currency carry trade. The study is limited to a total of fourteen currencies in all, with ten currencies from selected African countries as the ***target currencies*** and four (4) currencies from first world countries as the ***funding currencies.*** The criterion for the selection of these currencies was based on the S&P Dow Jones Index Country Classification, 2014. The S&P Dow Jones Index is a part of McGraw Hill Financial, and is the world's largest global resource for index-based concepts, data and research. The index classified African countries into Emerging Markets and Frontier Markets. There are however other African countries that S&P Dow Jones considers as "stand-alone" and are not included in its categories. This study does not include the "stand-alone" either. Specifically, the Emerging Market countries in Africa are South Africa, Egypt and Morocco, all of which are included in this study, whilst the Frontier Markets in Africa included in our study are Kenya, Nigeria, Ghana, Botswana, Mauritius, Tunisia and Zambia. The funding currencies selected for the study are US Dollars (USD), Japanese Yen (JPY), British Pounds Sterling (GBP), and the Euro (EUR) for the Euro zone countries, which are all classified under the S&P Dow Jones Country Classification as Developed Markets. Stock market indices from all the emerging market countries (South Africa, Morocco and Egypt) as well as four of the frontier markets (Ghana, Nigeria, Tunisia and Botswana) are used to test their relationship with African currency carry trade returns. Table 1.1 summarises the selected countries and their currencies with their respective ISO – 4217 currency codes.

Table 1.1: Summary of Countries and their Currencies

Target Currencies: African Emerging Market Countries		
Country	**Currency**	**Currency Code**
Egypt	Egyptian Pound	EGP
Morocco	Moroccan Dirham	MAD
South Africa	Rand	ZAR
Target Currencies: African Frontier Market Countries		
Botswana	Pula	BWP
Cote d'Ivoire	CFA Franc	XOF
Ghana	Cedi	GHS
Kenya	Shilling	KES
Mauritius	Rupee	MUR
Namibia	Namibian Dollar	NAD
Nigeria	Naira	NGN
Tunisia	Tunisian Dinar	TND
Zambian	Kwacha	ZMW
Funding Currencies: Developed Market Countries		
Country	**Currency**	**Currency Code**
Euro Area	Euro	EUR
Japan	Yen	JPY
United Kingdom	Pounds Sterling	GBP
United States of America	Dollar	USD

Source: Author's Survey 2015 on National Currencies

1.5 Contributions of Study

This current study of currency carry trade targeting African currencies financed by borrowing low-interest rate currencies (i.e. USD, EUR, GBP and JPY) will hopefully contribute significantly to the academic literature and also contributes to the body of information available on the market for investors to exploit. The contributions of the study are drawn from the four separate essays which look at the profitability of the currency carry trade using African currencies as target currencies, its viability as an asset class, the value-at-risk analysis of the returns generated by the African currency carry trade, and, finally, its implications for the performance of stock markets or the information transmission mechanism between the stock market and the carry trade.

Firstly, the research examines the profitability or otherwise of currency carry trade among African currencies financed by borrowing low-interest currencies (EUR, USD, JPY and GBP) in what appears to be a continent-wide study (in respect of emerging and frontier markets). Beyond the profitability of the individual African currencies as target currencies, a number of these currencies are put together to construct a portfolio of African currencies and its profitability or otherwise examined. Though the results are mixed the African currency carry trade strategies are largely found to be profitable. This study, targeting only African currencies, is to the best of the researcher's knowledge the first of its kind in the academic literature. The results of this work will also be very useful for practitioners and investors. It should be noted that the researcher employed Huber's robust regression model in estimating the parameters of the uncovered interest rate parity condition in order to account for the outlying data points.

Secondly, measuring the worst expected loss or value-at-risk of the African currency carry trade weekly returns for individual African currencies over the period of 2001-2015 at a wide range of confidence intervals (i.e. 0.25% to 5%) with GARCH-type models is a significant contribution to the academic literature. The study further estimates Conditional Value-at-Risk (CVaR) or expected shortfall (which is a more coherent measure of risk) of the returns of African currency carry trade. To the best of the researcher's knowledge this is the first study to consider the expected shortfall or conditional VaR for currrency carry trade returns and, for that matter, will enrich the academic literature and also augment the existing knowledge of practitioners in the estimation of risk of currency carry trade.

Thirdly, the study assesses the viability of African currency carry trade returns in order to confirm whether it constitutes a prudent investment and whether it could also be classified as an asset class. Though testing the viability of currency carry trade as a prudent investment or alternative asset class may not be new to the academic literature, to the best of the researcher's knowledge, currency carry trade targeted at African currencies is yet to be looked at. Furthermore, this study presents the actual contribution or impact the currency carry trade has on an existing portfolio either as a complement to the portfolio or replacing an asset in the portfolio. This is to the best of the researcher's knowledge a novel contribution to the academic literature on behavioural finance and at the same time a very useful contribution to the investing community which has the potential to improve the asset allocation decisions of portfolio managers.

Finally, this study on the implication of currency carry trade for stock returns or the information transmission mechanism between the African currency carry trade and the stock markets in Africa brings a couple of innovations to the existing literature. The first innovation is that the volatility spillover or information transmission mechanism and the Granger causality, are tested for intra-country markets. Thus four currency carry trade strategies are conducted within each African country selected for the study and all these four carry trades are pegged against the stock market index of each country successively to assess their stochastic relationships. This intra-country analysis with four different funding currencies brings out what appears to be the true relationship between the returns of currency carry trade and stock market returns of respective countries regardless of the funding currency used for the trade. The second innovation is the fact that the study considered only African currencies as target currencies, the historical returns of the currency carry trade estimated from the interest rate differential, and the change in exchange rate over the investment horizon.

Generally, the results contained in this study provide potentially very useful information to the investing community, the Central Banks, Governments, hedge funds managers, firms, finance researchers, and banks (within the African continent and beyond) for the execution of their various objectives. It also contributes greatly to the existing academic literature in the area of behavioural finance and financial economics.

1.6 An Outline of the Study

The study is organised in seven chapters. Chapter one covers the introductory part of the study while chapter two provides a brief overview of the African currency and stock markets and takes a tour of the interest parity conditions and their violations which form the basis for the currency carry trade strategy. Chapter three contains the first essay, a study of the profitability of the currency carry trade in Africa's emerging and frontier markets. Chapter four presents the the second essay, which assesses the viability of the African currency carry trade as an alternative asset class. In chapter five the study presents the value at risk analysis of the African currency carry trade returns, while chapter six examines the implications of African currency carry trade returns for the their respective African stock markets returns. Finally, in chapter seven, the study presents summaries of the findings and conclusions for the four essays. Chapter seven also discusses the implications of the findings for investors, policy makers and central bankers as well as the limitations and direction for future research.

CHAPTER 2

Overview of African Markets and Some Macroeconomic Theories

2.0 Introduction

This section presents a brief account of the African countries selected for the study and, in a few cases, discusses some African countries not included in the study where necessary. The study focuses on the Emerging and Frontier markets of Africa as per S&P Dow Jones Indices Country Classifications, 2014. This chapter is divided into five main sections. Section one presents an overview of the foreign exchange market in Africa, while section two proceeds to highlight the characteristics of the stock markets within the emerging and frontier markets of Africa. In chapter three the researcher presents detailed discussions of the interest rate parity conditions which form the basis for the currency carry trade ; the covered and uncovered interest parity conditions are explained, with an extensive review of existing literature on the empirical testing of these theories. In section four the study relates the failure of uncovered interest parity to currency carry trade which invests in assets of high interest currency financed by borrowing funds from a low- interest currency. Section five, which is the last section of the chapter, summarises and concludes the chapter.

2.1 Foreign Exchange Markets in Africa

The foreign exchange market is the largest financial market (and perhaps most liquid) in the world with estimated average daily trading of over five trillion US dollars (BIS, 2013). The outlook of the African foreign exchange market is an emerging one with relatively thin liquidity and small volumes of trade. Apart from the South African rand, the African currencies have been lightly traded. A complex mix of domestic politics as well as international market conditions has been part of the illiquidity of most African currencies.

However, over the last decade some steps have been made by various managers of the economy within the region to improve the foreign exchange market situation. Countries like Botswana, Egypt, Morocco, Ghana, and South Africa have been actively embarking on policies to strengthen their respective currencies and also have opened up their economies to attract international capital flows. Ghana in particular over the last ten years has been embarking on an industrialization drive mainly for export to improve their balance of trade position and ultimately strengthen their currency against major trading partners and at the same time creating the enabling environment for their financial market development. In the last ten years, the Ghanaian government has issued a number of Eurobonds to attract foreign currency into their country and this has been replicated by some other African countries. Such inflows may have the potential to strengthen and improve the liquidity of their respective currencies.

Theoretically, the liquidity of currencies is quite closely correlated with the size of the respective countries' economy. According to the International Monetary Fund, the *"economic growth in sub-Saharan Africa remains robust and is expected to pick up in 2014. After expanding by 4.9 percent in 2013, output looks set to expand by about 5½ percent this year. The region's recent strong period of economic performance thus looks set to be sustained, supported by stronger global economic activity spurred by the improved outlook for the advanced economies"*(International Monetary Fund, 2014: p 1). It is therefore envisaged that the currency market in Africa can only get better. Some banks in Africa now offer continuous prices in currencies like the Kenyan Shilling, Zambian Kwacha and Botswana Pula in addition to traditionally traded currencies such as the South African Rand, Nigerian Naira, Egyptian Pound, Moroccan Dirham, and CFA. These current developments on the currency landscape of Africa coupled with some African countries' recent participation in the international capital markets have increased the focus on African currencies. For example, Zambia, Ghana, Rwanda and Mozambique issued Eurobonds between 2012 and 2013 which were largely oversubscribed. As a result of all these developments it is established that, over the last two years, there has been a 92 percent increase in foreign exchange volume across Africa (Al-Ali, 2015).

2.2 Stock Markets in Africa

There are twenty nine (29) stock markets in Africa, with two (2) regional stock exchanges located in Cote d'Ivoire and Gabon. Twenty four (24) of these stock exchanges are members of the African Securities Exchanges Association (ASEA). Generally, African stock markets, except for South Africa, are very small in terms of number of listed companies and market value when they are compared to other emerging market countries in other parts of the world. That notwithstanding, South Africa, Egypt, and Morocco have been classified as part of the global emerging markets. Furthermore, nine other African countries also made it to the Frontier Markets as per the S&P Dow Jones Indices Country Classification, 2014 (see Table 1.1).

Table 2.1: Characteristics of African Stock Markets (2015)

Country	IFC/S&P Category	Date Est. (Age)	No. of Listed Firms	Market Cap (US$M)	Value Traded (US$M)	Turnover Ratio (%)
East Africa:						
Uganda	None	1997(18)	16	7294	11	**0.15**
Tanzania	None	1998(17)	18	1803	26	**1.60**
Kenya	Frontier	1954(61)	61	14790	1008	**8.07**
West Africa:						
Cote D'Ivoire	Frontier	1998(17)	37	7828	163	**2.31**
Ghana	Frontier	1990(25)	34	3464	53	**1.64**
Nigeria	Emerging	1960(55)	190	56389	4204	**8.79**
North Africa:						
Morocco	Emerging	1929(86)	76	52633	3501	**6.21**
Tunisia	Frontier	1969(46)	71	8886	1251	**13.49**
Egypt	Emerging	1883(132)	212	58008	20160	**37.79**
Southern Africa						
Botswana	Frontier	1989(26)	35	4587	113	**2.60**
Malawi	None	1995(20)	14	753	16	**1.51**
Mauritius	Frontier	1988(27)	91	7092	295	**4.01**
Mozambique	None	1999(16)	04	0.55	n/a	**n/a**
Namibia	Frontier	1992(23)	34	1305	21	**1.71**
Zambia	Frontier	1994(21)	21	3003	195	**5.58**
Zimbabwe	Emerging	1946(69)	67	11816	1609	**14.17**
Swaziland	None	1990(25)	06	n/a	n/a	**n/a**
S. Africa	Emerging	1887(128)	386	612308	311777	**54.93**
Total			1373	851959.5	344403	**164.56**
Excluding SA			987	239651.55	32626	**109.63**
SA as % of Total			28	71.87	90.53	**33.38**
Average Africa			72	28.13	9.47	**66.67**
Brazil	Emerging	1890(125)	359	1229849	834534	**67.88**
China	Emerging	1990(25)	1070	3697376	5826505	**164.44**
India	Emerging	1875(140)	5689	1263335	622478	**54.63**
Malaysia	Emerging	1960(55)	904	476340	124497	**28.57**
UK	Developed	1801(214)	2406	3019467	2488566	**84.04**
US	Developed	1792(223)	2464	18668333	2137528	**124.60**

Source: Adopted from Aawaar (2017).

Table 2.1 was adopted from the work of Aawaar (2017) and presents summary characteristics of stock markets in Africa compared with some developed some developed and emerging markets around the globe. Second column shows the IFC/S&P classification of markets followed by the date of establishment of the exchange with the actual age as of 2015 in brackets. The fourth column presents the total number of listed firms on the exchange and their associated market capitalisation (in million US dollars) in column five. The total value traded (in million US dollars) for each exchange appears in the sixth column with the turnover ratio recorded in the last column. Market capitalisation, value traded, and turnover ratio are all end-of-year values in 2012.

2.2.1 Emerging Markets of Africa

The Johannesburg Stock Exchange (JSE) in South Africa is the largest stock market in Africa and the second oldest stock market in Africa, as it was set up in 1887. There are a total of 386 companies listed on the JSE and it accounts for 72 percent of the total capitalisation of all Stock Exchanges in Africa put together, with a turnover ratio of 54.93 percent (S&P, 2015, IMF, 2015).The JSE has a wide market coverage which spans the equity market, debt market and derivative market. More specifically, the JSE trades in bonds, emerging market debt, equities, exchange traded products, warrants as well as agricultural, currency, energy, interest rates, and metal derivatives. The market runs five different market indices, namely; Fixed Income Index series, FTSE[3]/JSE Africa Index Series, Rand Index (RAIN), Socially Responsible Investment (SRI) Index, and Volatility Indices.

The Egyptian Stock Exchange established in 1883 is the oldest stock market in the whole of Africa with 212 listed companies. The Egyptian Stock Exchange is the next largest stock market in Africa after South Africa. It accounts for 6.81 percent of the total capitalisation of all the capitalisation of stock markets in Africa, with the turnover ratio of 37.79 percent. Just like the JSE, the Egyptian Stock Exchange trades stocks, bonds, exchange traded funds, and other structured products. The other stock market for the emerging market countries is the Casablanca Stock Exchange in Morocco. This stock market, established in 1929, accounts for 6.18 percent of total market capitalisation of the entire stock market in Africa and has a market turnover ratio of 6.21 percent. Like the Egyptian and South African stock markets the Casablanca Stock Exchange also trades in bonds, stocks and other structured products (S&P Dow Jones Indices, 2015).

[3]Financial Times Stock Exchange in the United Kingdom

2.2.2 Frontier Markets of Africa

The frontier markets of Africa according to the S&P Dow Jones Country Classification are: Kenya, Nigeria, Ghana, Cote d'Ivoire, Namibia, Zambia, Botswana, Tunisia and Mauritius Stock Exchanges. The Nigerian Stock Exchange is the largest among the frontier markets in Africa. In fact, according S&P classifications, Nigeria meets all the quantitative requirements to be part of the emerging market group but their markets are not as easily accessible as expected of emerging market countries (S&P Dow Jones Indices, 2015). The Nigerian stock market was established in 1960 with a significant amount of market capitalisation of 6.62 percent of the total capitalisation of all stocks markets in Africa. Currently, 190 companies are listed on the Nigerian Stock Exchange, with a market turnover ratio of 8.79 percent. The Nairobi Securities Exchange (NSE) is the next largest stock market within the frontier markets. The Exchange was established in 1954 as a stock exchange with voluntary association of stockbrokers and charged with the responsibility of developing the securities market and regulating trading activities. Its market capitalisation is currently 1.74 percent of the total African market capitalisation, with sixty one (61) companies listed. The NSE trades in the derivative market, equity and debt markets. The NSE in all runs six (6) stock market indices, as follows: NSE All Share Index, NSE 20 Share Index, FTE NSE Kenya 15 Index, FTE NSE Kenya 25 Index, FTE NSE Kenya Government Bond Index, and FTE ASEA Pan African Index.

The rest of the stock markets in the frontier markets are Cote D'Ivoire, Mauritius, Botswana, Ghana, Zambia, Namibia and Tunisia stock exchanges which constitute a small fraction of the total capitalisation of entire stock markets in Africa and are dominated by a handful of listed companies. These stock markets were established between the years of 1969 to 1998 with the Tunisian one being the first to be established in 1969. Mauritius was established in 1988, Botswana was established in 1989, Ghana and Swaziland in 1990, Namibia in 1992, Zambia in 1994 and Cote D'Ivoire 1998. In spite of the small nature of the stock markets in Africa, the World Bank reckons that some of the highest investment returns in the world are recorded in Africa. For example, over the last few years Kenya, Mauritius, Namibia, Uganda and Zambia had three-year returns of at least 27 per cent in dollar terms (International Monetary Fund, 2014; S&P Dow Jones Indices, 2015).

2.3 Interest Rate Parity Conditions

Whether the currency carry trade strategy will be profitable or otherwise largely depends on the failure of the interest rate parity conditions i.e. the covered interest parity (CIP) and uncovered interest parity (UIP). These two parity conditions and their empirical deviations had long been recognized in the early works of Maynard Keynes in the 1920's, as noted by Isard (2006). The collapse of the Bretton Woods and the Smithsonian Agreements on floating exchange rate during 1971 and 1973 respectively stimulated massive academic research on the covered and uncovered interest rate parity conditions. Although the CIP and the UIP imply that the forward exchange rate represent an unbiased forecaster of future spot rate (Burnside et al., 2010) their systematic failures or deviations have been widely documented in the extant academic literature (Bilson, 1981; Cumby and Obstfeld, 1984; Fama, 1984; Mishkin, 1984). Indeed, in the works of Shafer et al. (1983) they noted that empirical evidence of the failure of these two concepts could be traced to late 1976. Perhaps the empirical evidence rejecting the UIP hypothesis far exceeds evidence found in favour of most economics theories (Frankel, 2007). Nonetheless, the interest rate parity condition is usually used as a measure of integration between financial markets in the world and also represents a building block for exchange rate models (Wu and Chen, 1998). Again, some studies have suggested some evidence in support of the uncovered interest rate holding under certain circumstances. The works of Frankel (1979) and Bansal and Dahlquist (2000) are the most relevant in this regard. Frankel (1979) suggested that the UIP holds in the long run when the exchange rate reaches its long-run equilibrium, whiles Bansal and Dahlquist (2000) argued that the forward premium puzzle or the UIP deviation is actually a phenomenon of the developed world, particularly United States of America, and does not appear to be present in the emerging economies. The next two subsections present a brief overview of the covered and uncovered interest rate parity conditions.

2.3.1 Covered Interest Parity

In economics the covered interest rate parity is usually defined as a no-arbitrage condition mostly used in the foreign exchange markets to determine the forward exchange rate. The covered interest parity suggests that foreign exchange risk could be hedged or covered by investors with forward contracts. More formally, the CIP is defined as a theoretical condition in which the relationship between interest rates and the spot and forward currency values of two countries are in equilibrium (Al-Ali, 2015; Moosa, 2004). Research on this condition has been widely reported in the academic literature, with varying results. Akram et al. (2008)

concluded that there are arbitrage opportunities in the covered interest parity but can only be detected with very high frequency data.

Since it is expected under the covered interest parity condition that there would not be any arbitrage opportunities for arbitrageurs, high-interest currencies are expected to be traded at discount and low-interest currencies traded at a premium in the forward exchange market. This premium or discount would therefore be the spread between the spot rate and the forward, expressed algebraically as follows;

$$Discount\ or\ Premium = \frac{f - s}{f} = \left(\frac{f}{s}\right) - 1 \qquad (2.1)$$

where f represents forward rate and s is also the spot rate. Al-Ali (2015) recounted four main reasons why covered interest parity has generated interest among researchers. Firstly, the covered interest parity could be used as a measure of international capital mobility. Secondly, the CIP serves as a bridge connecting interest rates and the structure of the forward rates. Thirdly, since the CIP usually implies that financial resources are allocated around the world in an optimal manner it becomes very important for policy makers in policy formulation. Finally, the CIP also has an implication for the financing, investment and hedging or risk management decisions of firms and, for that matter, becomes an important consideration in the business arena.

Figure 2.1 summarises the most important features of the covered interest parity condition. The Figure is adopted from Al-Ali (2015) with some slight modifications. It follows that the investor is faced with two options with his/her investment decision when he/she has an amount of money (M) to invest. First, the investor can invest his/her money domestically and earn domestic interest (i) which will translate to M (1+i) at the end of the investment horizon. The second option would be to convert his/her local currency into foreign currency (i.e. to obtain $\frac{M}{s}$ units of the foreign currency) and invest same in foreign assets and earn foreign interest (i^*) at the end of the investment horizon. Thus the actual earning to this investor will be $\frac{M}{s}(1 + i^*)$, which is already covered by a forward contract to receive $\frac{Mf}{s}(1 + i^*)$.

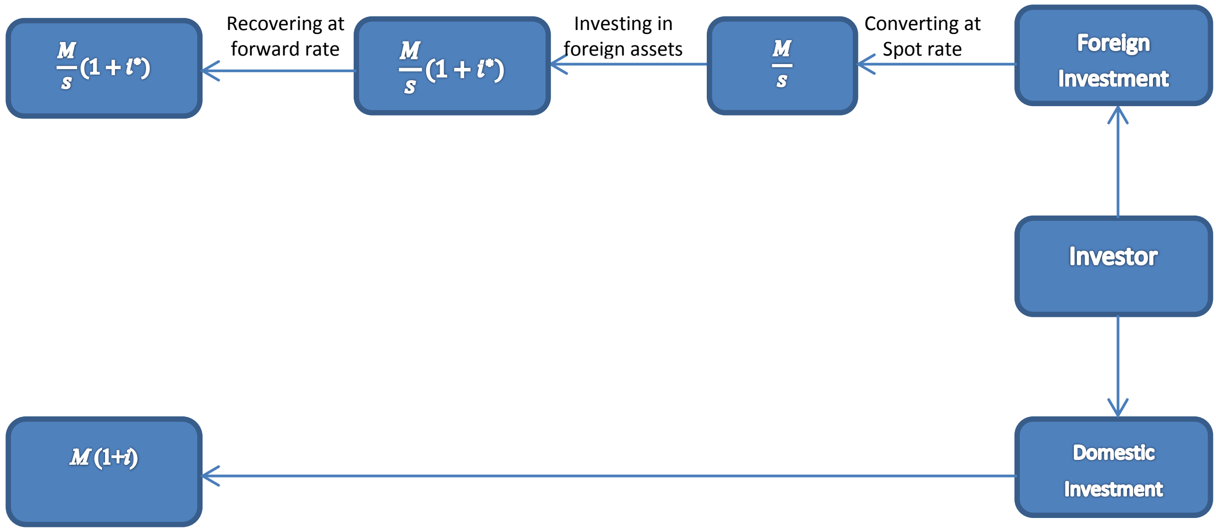


Figure 2.1: Covered Interest Parity

Thus the CIP will be expressed as follows:

$$\frac{Mf}{s}(1+i^*) = M(1+i) \tag{2.2}$$

The researcher further expresses equation 2.2 in terms of one unit of domestic currency as follows:

$$(1+i) = \frac{f}{s}(1+i^*) \tag{2.3}$$

The researcher then tests the covered interest parity with the following regression equation;

$$(s_{t+1} - s_t)/s_t = \alpha + \beta(f_t - s_t)/s_t + \varepsilon_{t+1} \tag{2.4}$$

Equation 2.4 has been used in the extant literature to test the covered interest parity condition, the failure of which results in the currency carry trade. Thus carry traders evaluate the profitability or otherwise between currencies by collecting data on spot and forward exchange rate to the regression coefficient α and β. If the CIP holds, α will be equal to zero and the β will be equal to one or unity.

Researchers over the years have tested the validity or otherwise of this parity condition and a reasonable amount of evidence has been found in favour of the covered interest parity condition, though volumes of evidence against the condition abound as well. Taylor (1987) tested the efficient market hypothesis in an attempt to test the validity of the covered interest parity and found strong evidence in favour of efficient market hypothesis and for that matter the CIP. Taylor and Branson (2004) used the term structure of interest to test the no-arbitrage which varies along the maturity of investment horizon. Thus as the gap to maturity widens, then the strength of the arbitrage opportunities fall, which naturally makes it unattractive for arbitrageurs to commit funds to it. Another group of researchers studied the CIP with data from 1983 to 2005 and found that the deviation of CIP is time- varying (Batten and Szilagyi, 2007; Szilagyi and Batten, 2006). Again they noted that the strength of the deviation actually reduces significantly as the data approaches the year 2000 and almost non-existent beyond the year 2000. This behaviour, they argued, could be attributed to the use of computers for trading (i.e. electronic trading) which became so pervasive during the year 2000 and beyond and which had the potential to improve the efficiency of the market. Bhatti and Moosa (1995) also studied the integration of international financial markets in a bid to test the validity of the covered interest parity, and document that the financial markets are highly integrated - which supports the position of the covered interest parity condition. Another group of researchers also found that there was an absence of CIP violation before the global financial crisis and apparent existence or presence during the financial crisis (Baba and Packer, 2009; Levich, 2011; NBIM and Staff, 2014).

2.3.2 Covered Interest Parity Deviation

On the deviation of CIP, Mancini-Griffoli and Ranaldo (2011) used high frequency data on market interest rate rather than the traditional Libor rate used for this testing and found significant arbitrage opportunities during the Lehman crisis. They attributed these arbitrage opportunities during the crisis to lack of funding liquidity but not increased risk. Also, Flood and Rose (2002) and Moore and Roche (2009), using developed countries' currencies, argue that deviations from the covered interest parity may not provide profitable arbitrage opportunities, but deviations start to grow when emerging countries' currencies are involved. Thornton (1989) refers to deviation of the estimated forward rate (calculated from interest rate differentials) from the actual forward rate that exists simultaneously in the market. The empirical investigations into covered interest parity can be done in two ways. The first involves testing the deviation between actual premiums and what is implied by CIP, and the second by finding out whether CIP holds on average, i.e. whether domestic and foreign interest rates and spot and forward exchange rates respond in a way that is consistent with CIP (Thornton, 1989).

A number of factors have been adduced in the extant literature which is believed can explain the deviation of the covered interest parity. These factors include, but are not limited to liquidity risk, transaction costs, capital mobility, measurement errors, tax difference considerations, political risk, legal restrictions, and regulations.

Liquidity is the ease with which assets can be converted into cash (Moosa, 2003). The higher the uncertainty, the higher the liquidity risk and the higher the premium required, which leads to a higher deviation. Mancini-Griffoli and Ranaldo (2011) find that funding liquidity constraints are strongly related to CIP deviations, particularly after the collapse of Lehman Brothers.

Transaction cost plays a major role in explaining the deviations of the CIP (Balke and Wohar, 1998; Cody, 1990; Moosa, 1996) in the sense that arbitrageurs always incur some cost for the various transactions they generate to take advantage of the condition. To account for this cost, a "transaction band" is usually introduced into the CIP equation, which means that arbitrage opportunities should be greater than the upper bound of the transaction band in order to generate profit. Thus as long as the departure from CIP stays within a specific band's borders, arbitrage is not profitable. Frenkel and Levich (1977), Fratianni and Wakeman (1982), Clinton (1988), Balke and Wohar (1998) document that taking into account transaction costs strengthens the efficiency to money markets because the deviation from CIP rarely leaves the band. And as soon it leaves the band, smart arbitrageurs will quickly exploit it in order to restore the market back to equilibrium. Some suggestions of reasonable bands for transaction costs have been made in the extant literature. Keynes (1922) suggested that a minimum amount of approximately half a percentage point needs to be exceeded before arbitrage becomes profitable. Einzig (1937) also argues that the minimum arbitrage opportunity should be of the order of 50 basis points on an annualised basis.

Capital mobility is the next factor to be considered, which is also believed could account for the deviation of the covered interest parity. Ordinarily, arbitrage opportunities should not exist in an efficient market. Thus Frankel (1992) believes in using deviation from CIP as a gauge for international capital mobility. Ma et al. (2004) find in their studies large differentials between Chinese onshore and Chinese offshore interest rates that are calculated from non-deliverable forwards on the Chinese currency and are traded outside of China. If capital were free to move, such spreads would disappear by force of arbitrage. China, however, maintains a battery of capital flow restrictions, which prevents exploitation of riskless profit opportunities. On the other hand, Moosa (2004) contradicts that and argues that the CIP holds regardless of market efficiency, and for that reason cannot be used as a measure of capital mobility.

Fourthly, some minor deviations from CIP might occur due to inaccurate data or measurement error. Agmon and Bronfeld (1975) intimate the difficulties with working with bid-ask spreads, whereas Taylor (1987) points to the complexities related to contemporaneous sampling and suggests that the published rates may not necessarily represent the actual tradable rates all the time. Moosa (2002) uses quarterly data for three currencies for the period January 1978 to April 2000, and concludes that the deviation from UIP was due to measurement errors.

Furthermore, differences in tax rates charged on interest income and foreign exchange losses/gains in different countries could also account for the failure of covered interest parity. Different countries may charge differently. In some cases tax holidays or fringe benefits are given in some countries which may not present in other markets and, for that matter, these fringe benefits could also actually swell the profits or lead to the deviation of the covered interest parity in those markets. Levi (1977) and Kupferman and Levi (1978) find in their studies that if market participants are faced with different tax rates based on residency criteria, simultaneous two-way covered interest arbitrage could occur.

The covered interest parity deviation may also occur due to political risk which involves freeze, inconvertibility, default, political unrest, or even confiscation (Aliber, 1973). He argues that the money market assets used to test CIP should be identical in terms of political risk. He indicates that while Eurocurrency assets satisfy the comparability criterion, domestic assets do not, because they are issued under different political jurisdictions. Moosa (1996) attributes the deviation in CIP between Australia and New Zealand in the mid-1980s (after the abolition of capital control) to the political risk that either country would reimpose capital control. In their study on the Russian ruble and U.S. dollar, Taylor and Branson (2004) show that arbitrageurs would need 70-300 basis points on an annualised basis to compensate for political risk and trigger arbitrage. Dooley and Isard (1980) state that deposits from different countries are not comparable if investors expect the introduction of capital control measures or if a country is expected to default. If investors do not account for differences when comparing deposits deviation from CIP will be observed.

Finally, legal restrictions and regulations are to a very reasonable extent a contributing factor to the deviation of covered interest parity condition. Frankel and MacArthur, (1988) found evidence of minor deviations of CIP using some selected countries where cross-border capital flows are restricted by law. Gultekin et al. (1989) examine return differentials between Euro/yen investments traded in London and interest rates on comparable yen deposits traded in Tokyo. Since the deposits were identical except for their trading location, differentials provide evidence for deviation from CIP. They report large interest rate differentials between 1977 and 1980, a period during which Japan imposed restrictions on capital flows. These differentials disappeared quickly following the removal of restrictions in 1981. Similar results were documented by Thornton (1989).

2.3.3 Uncovered Interest Parity

The uncovered interest rate parity (UIP) is a parity condition which states that the interest rate differential between two countries is equal to the expected movement or change in the exchange rate between the two countries' currencies. The expectation is that there should not be any arbitrage opportunities between the two countries' interest rate differential because even where the difference between the two countries' interest rate is very large, the exchange rate is expected to move to offset any gains or profits that could have been accrued. Hence if this parity does not exist, there will be an opportunity to make profit. The difference between UIP and CIP is based on the assumption that the forward market is used to cover foreign exchange risk for the CIP, while the UIP is left uncovered. The change in spot exchange rate is estimated based on its expected value. Under the Fisher hypothesis (Fisher, 1930), nominal interest rate differentials between assets that are identical in all respects except for the currency of denomination can be explained by the expected change in the spot exchange rate between those currencies over the holding period (Fisher, 1930).

What makes UIP so widely researched is that the condition links the exchange rates and interest rates of different countries. It is a basic assumption in many economic models, such that the validity of these models relies on UIP's validity. In addition, UIP implies the equality of returns on investment in different countries, and this equality means the exclusion of arbitrage opportunities. Therefore, the failure of UIP may indicate arbitrage opportunities in international financial markets, which means a great deal for international investors. Deviations from UIP equilibrium imply a lack of integration among capital markets. According to Flood and Rose (2002), "deviations from UIP are the basis for interest rate defense of fixed exchange rate". Since the interest rate defence of fixed exchange rates is similar to the use of interest rate policy to stabilise an exchange rate, the failure of UIP also ensures the effectiveness of interest rate policy to stabilise the exchange rate. Flood and Rose (1994) conclude that a large part of the forward discount puzzle vanishes for regimes of fixed exchange rates, and that the deviation seems to vary based on the exchange rate regime.

The concept of UIP is illustrated in Figure 2.2, where the investor who has an initial amount of money (M) to invest is faced with two alternatives. The first is to invest in domestic assets and earn domestic interest (i) and at the end of the investment horizon receive $M\ (1+i)$. The second is to convert the initial investment from the domestic currency to a foreign currency, obtaining M/s units of the foreign currency and investing them in foreign assets to earn the foreign interest rate(i^{*}). At the end of the period the investor receives$(M/s)(1+i)$. In this case, the investor faces foreign exchange risk since he/she will wait until the end of the investment horizon to cover the position at the spot rate. He/she will be converting the foreign currency back to the domestic currency at the expected spot rate to obtain $\frac{Ms^{e}}{s}(1+i^{*})$. The equilibrium condition is obtained where all arbitrage opportunities are eliminated when:

$$\frac{Ms^{e}}{s}(1+i^{*})=M(1+i) \qquad (2.5)$$

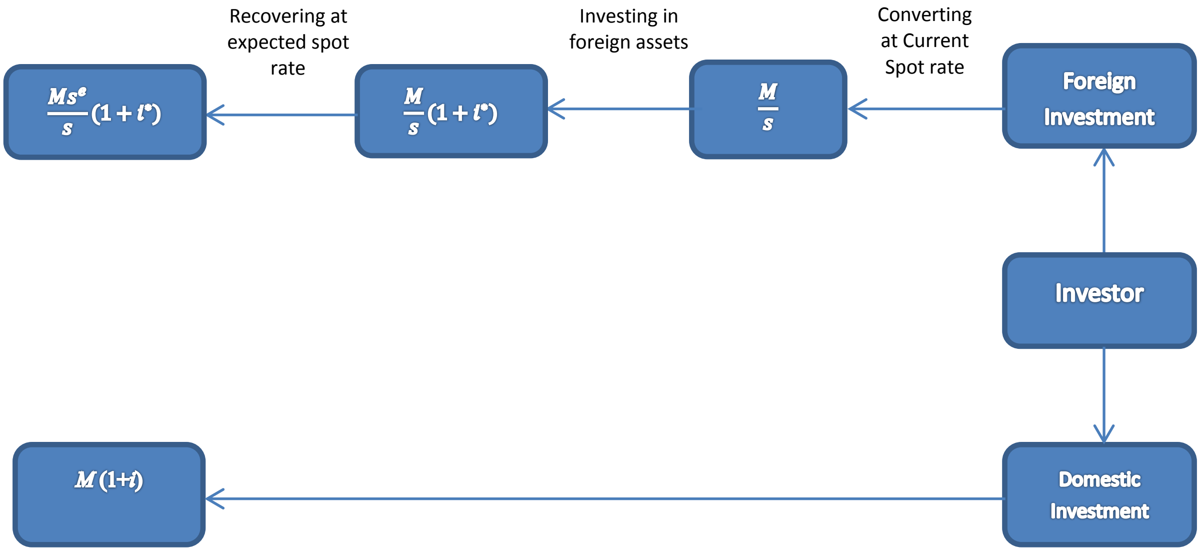


Figure 2.2: Uncovered Interest Parity

Following the works of Kohler (2008) and Al-Ali (2015) the uncovered interest parity condition could be defined as follows:

$$E_t\left(\Delta UIP_{t,t+1}\right) = i^f_{t,t+1} - i_{t,t+1} + E_t(S_{t+1}) - S_t \tag{2.6}$$

where $E_t\left(\Delta UIP_{t,t+1}\right)$ represents the expected deviation from UIP between *t*, *t+1*, if i^f_t, i^f_{t+1} is the foreign nominal interest rate, and i_t, i_{t+1} is the domestic interest rate.

S_t also represents the log of the current spot exchange rate, and $E_t(S_{t+1})$ is the log of the expected spot rate for time t+1. The UIP would always be zero if this condition holds, i.e. the interest rate differential is exactly offset by the expected exchange rate changes or fluctuations. It is expected that if UIP will hold then the following condition must be satisfied:

$$S_{t+1} = S_t\left(\frac{1+i}{1+i^*}\right) \tag{2.7}$$

where S_t denotes the spot rate, S_{t+1} is the future rate, while i and i^*represent the domestic and foreign interest rate respectively. The uncovered interest parity condition or hypothesis is believed to hold over short time investment horizons (Batten and Szilagyi, 2007; Chaboud and Wright, 2005).

2.3.4 Failure of Uncovered Interest Parity

The failure of the uncovered interest parity hypothesis, which is usually linked to the "forward rate puzzle" identified by Fama (1984), has attracted volumes of research in the literature. There is a general consensus in the academic literature that the uncovered interest parity hypothesis does not hold most of the time (Chinn and Meredith, 2004; Flood and Rose, 2002). Indeed, Chinn and Meredith (2004) describe the uncovered interest parity conditions as useless at best and at worst perverse. There is a consensus in the extant literature that the failure of the uncovered interest parity hypothesis is very common with a time horizon of less than 5 years (Chinn and Meredith, 2004; Engel, 1996; Flood and Rose, 2002; Gyntelberg and Remolona, 2007), meaning that the uncovered interest parity works poorly with a short- term investment horizon as opposed to long- term horizons. Indeed, Froot and Thaler (1990) and Chinn and Meredith (2004) find evidence to suggest that the UIP may work better over longer horizons. Berk and Knot (2001) and Razzak (2002) suggest that the validity of the UIP increases with the time horizon of the investment, thus supporting the fact the longer the time horizon the better the performance of the UIP. In spite of this, there appears to be low R-square in almost all regressions testing the UIP, which may suggest that the UIP may have weak explanatory power in explaining the variations in exchange rates. Brunnermeier et al. (2008) confirm this by stating that investment currency appreciates a little on average but with a low predictive *R*-square. McCallum (1994) examined the relationship between the UIP condition and forward exchange rate using a variety of economic models, and found sufficient evidence to reject the hypothesis of forward rate unbiasedness—however, there was insufficient evidence to support the hypothesis of UIP failure. Perhaps the failure of the UIP is the most common finding amongst the researchers in behavioural finance. There is strong evidence in the literature that suggest that contrary to the UIP hypothesis, the currency with high interest rate usually appreciates rather than depreciates and, for that matter, the UIP is consistently rejected in the extant literature (Chaboud and Wright, 2005). Furthermore, Gagnon and Chaboud (2007) emphasise this phenomenon of high-interest currencies appreciating against low-interest-rate currencies over short and medium horizons, but conclude that the predictive power of this effect is quite small. Bui (2010) find strong evidence to suggest that there is a negative relationship between interest rate differentials and exchange rate depreciation in the short run. Plantin and Shin (2006) state that not only does UIP fail but also that a currency with high interest rates will exhibit the classic price pattern of "going up by the stairs, and coming down in the elevator." Jylhä and Suominen (2011) find that the uncovered interest parity hypothesis does not hold in equilibrium, as real interest rates differ across countries due to variations in inflation risks and money supply. In fact, a good number of empirical studies show that exchange rate changes do not compensate for the interest rate differential, as suggested by the uncovered interest rate parity condition (Brunnermeier et al., 2008; Burnside, 2015; Burnside et al., 2011; Menkhoff et al., 2012b; Olmo and Pilbeam, 2009).

Some researchers have documented the fact that the uncovered interest parity hypothesis holds well under harsh market conditions. Baillie and Chang (2011) and Flood and Rose (2002) are the most relevant studies in this regard. Baillie and Chang (2011) argue that UIP is more likely to hold in countries or markets where volatility is unusually high, whereas Flood and Rose (2002) also suggest that UIP works for countries in crisis, where the volatility of exchange rates and interest rates are pronounced. And when UIP holds, it holds over a very short window of usually overnight period data different from the traditional data frequencies (Chaboud and Wright, 2005).

In the extant literaturetwo separate groups can be distinguished in the studies of uncovered interest rate parity and discussed herein as follows.

The first group of researchers attempt to explain UIP's empirical failure by considering violations to the basic assumptions of the condition or hypothesis. The irrational expectations of Frankel and Froot (1990), and time-varying risk premiums, as argued by Fama (1984) and Malliaropulos (1997) are examples of these studies.

The second group of researchers base their works on the intuition that UIP is actually a long-run relationship obscured by short-run exogenous shocks and have accordingly employed models that could capture this long-run relationship. Econometric tools used include cointegration analysis (Bhatti and Moosa, 1995) and the use of long-run average data (Lothian, 1998). Most of these studies on the failure of the UIP recorded favourable results for long-run UIP relationship.

Even though there appears to be general consensus in the literature about the failure of the uncovered interest parity, there seems not to be agreement yet as to what accounts for the deviation. Froot and Thaler (1990), in an attempt to explain the UIP, surveyed 75 published estimates, and reported few cases where the sign of the coefficient on interest rate differential was consistent with UIP. Fama (1984), Hodrick (1989), and Dumas and Solnik (1995) explain foreign exchange movements in terms of compensation for risk. The most popular explanations for the failure of UIP in the literature include, but are not limited to, risk premium, irrational speculation, the peso problem[4], and nonlinearities in the exchange rate (Chinn, 2007; Menkhoff et al., 2012b; Olmo and Pilbeam, 2009). Wagner's (2012) empirical results show that UIP holds in a speculative sense and that exchange rate dynamics include a time-varying risk premium, the omission of which causes the forward bias in the Fama regression.

2.4 UIP and Carry Trade

The currency carry trade strategy can only be profitable or successful when the uncovered interest parity condition fails. Thus, the world over, the failure of the UIP is always an important factor in currency carry trading. This leads to the popular belief in the academic literature that the currency carry trade is merely a speculation against the uncovered interest parity condition (Baillie and Chang, 2011; Gyntelberg and Remolona, 2007). According to the UIP condition, the currency carry trade cannot be profitable if the uncovered interest parity condition holds, because if the UIP holds then the high interest currency is expected to depreciate against the low- interest currency to offset the arbitrage gains of the interest rate differentials between the two currencies (Gyntelberg and Remolona, 2007). There appears to be a general consensus in the academic literature that the uncovered interest parity systematically fails most of the time. Thus the hypothesis that the high- interest rate currency should depreciate against the low -interest rate currency to erode the arbitrage gains of the interest rate differential between the two currencies is mostly rejected, and market participants actually take advantage of this failure (Brunnermeier et al., 2008). Moreover, Baillie and Chang (2011) conclude that the currency carry trade is merely a speculation against the uncovered interest rate parity condition. The failure of UIP means that the interest rate differential between two currencies is not equal to the percentage change in the exchange rate of the currency pair. Nonetheless, Meredith and Chinn (1998) and Fujii and Chinn (2001), studying the G-7 currencies, conclude that the uncovered interest parity condition actually holds better with long horizon investment (three years or longer). The link between the failure of the uncovered interest rate parity condition and the profitability of the currency carry trade is therefore implied in the extant academic literature. It is however established in

[4] The Peso problem refers to the fact that the observed market prices may be shaped by a small probability of a major event

the literature that the failure of the uncovered interest rate parity condition may not necessarily lead to significant profitable currency carry trade all the time (Darvas, 2009). Again, while the failure of uncovered interest rate parity is a necessary condition for the profitability of currency carry trade, it is not a sufficient condition (Moosa and Halteh, 2012). This means that if the target currency depreciates against the funding currency more than the interest rate differential between target and funding currencies, then the uncovered interest parity condition would have been violated but will not result in any profit. Rather, there would be losses to the trader despite the failure of the uncovered interest rate parity condition. In order to make a profit, the percentage change in the exchange rate between the two currencies should not be large enough to offset the interest rate differential between the two currencies over the horizon of the investment. This is what Baillie and Chang (2011) intimate, as the currency carry trade is merely a speculation against uncovered interest rate parity. Further, Kitchen and Denbaly (1987) argue that the only thing that differentiates between speculation and arbitrage is the absence risk in the latter.

2.5 Chapter Summary and Concluding Remarks

The objective of this chapter was to give a brief overview of the foreign currency market and stock markets in Africa with particular emphasis on Africa's emerging and frontier markets. The chapter also gave a brief account of the theories underpinning the currency carry trade in order to serve as the theoretical basis for the study. Section one of the chapter dealt with the general foreign exchange environment in the international financial market and located the African situation in the scheme of global foreign exchange markets. The liquidity of currencies, particularly African currencies, was briefly discussed. The next section gave a brief account of the stock markets in Africa and discussed the stock markets under their classification (emerging and frontier) as per the S&P 2014 country classifications. African stock markets are mainly classified under 'frontier', with the exception of South Africa, Morocco and Egypt, which form the emerging markets of Africa. Section three of this chapter examined the interest rate parity conditions which underpin the popular trading strategy the currency carry trade. There was detailed discussion of the covered and uncovered interest rate parity conditions and existing literature on these theories was reviewed. Last but not least, section four looked at the theory of uncovered interest parity and how its failure leads to the occurrence of currency carry trade profits. These thus form the theoretical basis of the entire study of currrency carry trade, targeting the currencies of Africa's emerging and frontier markets. The next chapter investigates the profitability or otherwise of the currencies of Africa, specifically the emerging and frontier markets.

CHAPTER 3
Currency Carry Trade Profitability in Africa

3.0 Introduction

In this chapter, the researcher empirically examines the interest rate and exchange rate data of Africa's emerging and frontier markets to ascertain whether the currency carry trade is profitable or not. The chapter is subdivided into six main sections with a number of subsections. Section one presents the background of the study. The review of existing literature is captured in section two. Section three discusses the methodology and basic description of the data. This is where the hypothesis test and the econometric model employed (robust regression) are duly specified. Section four presents the data and preliminary analysis which is followed by the presentation of empirical results and discussions in section five. The analysis is done for four economic regimes; full sample, pre-crisis sample, crisis period and post crisis period samples. African currency carry trade portfolio is constructed and tested for profitability as well. The sixth and final section summarises and concludes the chapter.

3.1 Background on Carry Profitability

The currency carry trade is a strategy where an investor borrows at a low interest rate and invests in an asset that yields a higher interest rate, making money on the spread (Burnside et al., 2010). In financial economics, the difference between the interest rate on an asset denominated in any one country's currency unit and the interest rate on a similar asset denominated in another country's currency is assumed to be compensated for by the expected rate of change in the spot exchange rate between the two currencies. This is referred to as uncovered interest rate parity (UIP) and it is the very reason why currency carry trades should not work in theory. Thus if the UIP holds, the expected excess return on the currency carry trade will be zero. The UIP predicts that exchange rates will move to close up any possibility of profit emanating from the interest rate differential between two countries (Ames et al., 2013). Although UIP seems to draw on sound theoretical foundations, empirical work produces enough evidence for its systematic failure (Ames et al., 2013; Barroso and Santa-Clara, 2015; Brunnermeier et al., 2008; Burnside et al., 2007; Fong, 2010; Olmo and Pilbeam, 2009; Razzak et al., 2002; Xanthopoulos, 2011). This deviation is commonly referred to as the "UIP puzzle" or the "forward rate anomaly" in the body of international finance literature. Evidence suggests that incorporating a carry trade component in a conventional portfolio improves portfolio performance[5] (Das et al., 2013). As might be expected, the profitability of currency carry trade has been the subject of enormous research work the world over. In the extant literature, studies on this subject are focused on the developed countries, specifically the G10 currency countries and emerging Asian, European and Latin American economies (Brunnermeier et al., 2009, Das et al., 2013, Fong, 2010, Fung et al., 2013, Jurek, 2014, Wang et al., 2013). Whilst it is admitted that this present study is not the first to test the UIP hypothesis and its consequent carry trade profitability, the study brings a number of innovations and contribution to the academic literature on this subject. Firstly, the researcher used Huber weighting robust regression (see section 3.2) to estimate Fama's regression equation (Fama, 1984). This becomes necessary because of the significant amount of influential data points in the financial data of Africa's emerging and frontier markets (Chatterjee and Mächler, 1997; Heiberger and Becker, 1992; Huber, 2011; Street et al., 1988). Ordinary least squares could only fit the data after winsorising and trimming, which does not reflect the unique characteristics and behaviour of the African financial data. To the best my knowledge this is new to the study of currency carry trade. Secondly, the study shows that currency carry trade returns in the emerging and frontier markets (Africa in particular) intensify during periods of financial crisis. Thus there seems to be some negative correlation between the international financial markets and carry trade returns in Africa. Thirdly, the study compares the performance of currency carry trade in Africa with realised carry trade returns of Deutsche Bank G10 FX Carry Trade Index and shows that the African FX carry trade portfolio generates more attractive returns than the Carry trade Index. Finally, the study covers almost all the emerging and frontier markets in Africa as per the S&P Dow Jones Indices country classification 2014, which to the best of the researchers' knowledge is the first study to have considered the entire African continent in respect of the emerging and frontier economies. The researcher explores empirically the profitability of currency carry trade strategy in African currencies funded by the four major currencies in the world with very low interest rate, namely, United States Dollar (USD), Euro (EUR), Japanese Yen (JPY) and British Pound Sterling (GBP). The study examines the stability and behaviour of the β parameter of the UIP hypothesis through time, in particular *before*, *during* and *after* the global financial crisis in 2007. Policy makers and the managers of the monetary economies of the target countries may find these results useful since currency carry trade can undermine the

[5]Measured in terms of its Sharpe ratio, Sortino ratio, value at risk, and adjusted Sharpe ratio.

stability of the financial markets. The study may also stimulate the interest of international investors on the African financial market.

3.2 Related Literature

Despite differentials in interest rates of countries, carry trade are not expected to be profitable if the theory of Uncovered Interest rate Parity (UIP) should hold (Papadopoulos and Koutsougeras, 2011). According to UIP, if investors are risk- neutral and form expectations rationally, exchange rates will move to eliminate any gain arising from the differential in interest rates across countries (Brunnermeier et al., 2008; Burnside et al., 2011; Menkhoff et al., 2012a). However, there are volumes of empirical evidence in the literature that show that the currency carry trade has been profitable among the world's most traded currencies violating the UIP (Burnside et al., 2007, 2006b; Darvas, 2009; Das et al., 2013; Jordà, 2013). Indeed, Burnside (2015) conludes that the mere fact that the naïve estimation of currency carry trade shows excess positive returns or profits in itself is enough evidence against the UIP. He termed that as 'economic' evidence against the uncovered interest parity whilst the regression-based testing of the UIP failure remains the 'statistical' evidence against evidence against UIP. Not much has been done, however, in relation to the profitability of currency carry trade in Africa. In this strand of the literature, the yen-funded currency carry trade targeting the South African Rand is historically profitable, using either the naïve strategy or the regression based strategy (Hassan and Smith, 2011). The profitability of the yen currency carry trade has been well established in literature, especially the last decade (2001-2009) when the Japanese interest rate was very low relative to the other major currencies (Fong, 2010; Gyntelberg and Remolona, 2007; Shin and Hattori, 2009).

Eugene Fama's regression (1984), explains the forward rate relative to the realised future spot rate with the interest rate differential. If the UIP holds, the intercept α will be equal to zero and the regression coefficient β will be equal to one. But in many empirical studies this joint null hypothesis is rejected. In recent times, researchers have been using the returns on actual trading strategies as a way of investigating the validity of the UIP. Thus, if UIP holds, the currency carry trade should produce zero excess returns in the long run (NBIM, 2014). In Fama's (1984) regression, the interest rate differential has nearly zero predictive power for changes in the exchange rates. Hassan and Mano (2015) confirm this in their findings that most of the carry profits are due to the alpha intercept in the Fama (1984) regression.

In the strand of literature, several choices have been made regarding sample selection and the evaluation of trading strategies. Most studies start in the early 1980s and also include the financial crisis (Ackermann et al., 2012; Ames et al., 2013; Brunnermeier et al., 2009; Burnside et al., 2006; Burnside et al., 2011; Menkhoff et al., 2012a). Most of these recent studies find Sharpe ratios of between 0.5 and 1.0 for carry trade, regardless of the methodology and sample size (Menkhoff et al., 2012a). Comparing this to the stock market, which has a Sharpe ratio[6]of close to 0.34, gives an indication that the currency carry trade is profitable (NBIM, 2014). Bansal and Dahlquist (2000) however found, on the contrary, that UIP is a much larger puzzle in developed countries than in emerging markets over the period 1976–1998. From the available literature one-month interest rate is the most common, even though one-month compared to, say, three-months contract, might have a higher transaction cost because of the monthly rolling of the forward contract. Lately, several studies have tried to link the term structure of interest rates and exchange rates and have found that UIP holds much better for long-term interest rates than for short-term interest rates (Chinn and Meredith, 2005; Chinn and Quayyum, 2012). Furthermore, bond term premium within a country has a negative relationship with the carry return that can be earned from exposure to the currency of that country (Lustig et al., 2014). Sarno et al. (2012) in their study also developed a multi-currency term-structure model for interest rates and linked time-varying currency risk premiums and bond risk premiums, which are important for long-horizon international bond investors.

Cavallo (2006), suggests that there could be two ways of making currency carry trade profits, which include interest differential between the two currencies involved in the trade and exchange variation spurred by the demand and supply of foreign currency. In the case of interest rate differential, the author explains that the carry trade profits only represent a proportion of the difference in interest rate between the target and funding currency should the exchange rate between these two countries stabilise. Cavallo (2006) concludes that the other source of carry trade profits also emerges from the favourable exchange rate movements. Thus the carry trader will even increase his/her fortunes when the target currency appreciates against the funding currency and the reverse may erode the gains of the interest

[6]The Sharpe ratio originally propounded by William Sharpe to evaluate the performance of mutual funds has now become a very useful tool for Portfolio Managers and Academic researchers for accessing the performance of portfolios of assets including currencies. It is the ratio of excess return on a portfolio to standard deviation of the returns (Frank Reilly and Keith Brown, 2000: p 1113).

rate differential. Therefore the appreciation or depreciation of the target currency could be a source of profit or loss.

The difference in methodologies has to do with the implementation of the trading signal and the position of the US dollar in the trading strategy. In the extant literature it appears that three main trading approaches are usually employed in practice by the currency carry traders. The first group of researchers use trading signal based on the interest rate differential between the foreign currency and the US dollar. Thus if the interest rate on the dollar is relatively high, the strategy is to long the US dollar and short a basket of foreign currencies and vice versa (Burnside et al., 2011). "Such a definition of the trading strategy takes a non-diversified directional position on the US dollar"(NBIM and Staff, 2014).

The second group of researchers tried to address the sensitivity to the US dollar by sorting currencies on the basis of their interest rates and taking a long position in a group of high-interest countries and funding this position with a short position in a group of low-interest countries (Brunnermeier et al. 2008; Lustig et al. 2011). The disadvantage of the long-short strategy is that it only uses information on the extreme interest rates and ignores the information on the interest rates in the middle, and therefore might be less diversified. In spite of the disadvantage it seems to have become the standard in exchange-traded funds (ETFs) that follow carry trade indices, such as the Deutsche Bank Currency Future Harvest Index.

The third and the last group of researchers use a strategy that takes a position in all currencies, but the magnitude of the position depends on the cross-sectional ranking of the interest rate (Koijen and Moskowitz, 2012). The advantage with this strategy is that it uses information on all the currencies regardless of their ranking in terms of interest rate. Also weights are assigned to the positions taken depending on the ranking of the interest rate which together make this strategy more diversified than the first two strategies.

This current study blends a little of everything and perhaps could be classified as the fourth strategy in the body of knowledge of currency carry trade. The study takes a short position in all the four major currencies, i.e. USD, EUR, JPY and GBP and accordingly takes a long position in all the ten African currencies ZAR, EGP, MAD, TND, MUR, GHS, ZMW, BWP, KES and NGN. The study then assesses the individual performance of carry trade returns for all the forty currency pairs generated with their regression-based analysis. The currency pairs are then sorted according to the statistical significance of their carry trade returns and subsequently an equally weighted portfolio is constructed with those currency pairs.

3.3 Methodology

This section presents the statistical procedures and econometric modeling employed for achieving the objectives of this chapter. The section also presents the hypothesis of the study, specification of the robust regression model, estimation of currency carry trade returns for individual currency pairs and portfolio construction under four subsections.

3.3.1 Hypothesis Test

Let $\boldsymbol{i_a}$ be the interest rate of African currencies (high interest rate) and $\boldsymbol{i_b}$ be the interest rates of the developed countries currencies (low interest rates), thus $i_a > i_b$. Let also $\mathbf{S_t}$ be the spot exchange rate between 'a' and 'b' measured as 'a' price per unit of 'b'. Thus African currencies are priced per unit of foreign currencies, namely USD, EUR, JPY and GBP. This quotation is known as ***direct quotation***, which is slightly different from the ***indirect quotation*** of the many currency pairs where the foreign currencies are priced per unit of the local currency. The researcher uses the direct quotation since the African countries selected for this study all follow the direct system of quotation. It is important to make this distinction since the direction of appreciation and depreciation of the spot exchange rates are measured differently. A rise in the spot exchange rate will mean depreciation of the 'a' and a fall means appreciation of 'a' against 'b'. The opposite is true for the indirect quotation. The test for currency carry trade profits or returns in Africa's emerging and frontier markets employs the classical Fama's (1984) regression which postulates that the currency carry trade would not be profitable if $\boldsymbol{\alpha}$ is equal to zero and $\boldsymbol{\beta}$ is equal to one as specified in equation one:

$$S_{t+1}^{b/a} - S_t^{b/a} = \alpha + \beta \times \left(r_{t,t+1}^{a} - r_{t,t+1}^{b}\right) + \varepsilon_{t+1} \tag{3.1}$$

with the null hypothesis that the parameters α and β are zero and one respectively (i.e. H_0: $\alpha = 0$, $\beta = 1$); where $S_t^{b/a}$ is the natural log spot exchange rate between the currency 'a' and 'b' at time t; $S_{t+1}^{b/a}$ is the log spot exchange rate between the same currencies at time t+1; $r_{t,t+1}^{a}$ is the high interest rate of currency 'a' for investment at time t and at the maturity of asset at t+1; $r_{t,t+1}^{b}$ is the low interest rate of the developed countries' currency 'b' at the time of investment t and at maturity of investment at t+1; and ε_{t+1} is the error term of the regression model whiles the $\alpha\ and\ \beta$ are the parameters to be estimated.

Equation 3.1 is first estimated with ordinary least squares after checking and ensuring stationarity of the data. The OLS assumptions are therefore tested for compliance where the model failed normality of the residuals in most cases even though assumptions of linearity, heteroskedasticity and serial correlation were not violated. The data exhibit many outliers which influence the fitting of the regression line and have the potential to bias the results. The study thus winsorised the data to minimise the effect of influential data points on the model and repeated OLS regression, but not without problems. Because there were many influential data points, the unique statistical properties associated with African data appeared to have been lost, meaning that the results could be misleading. To deal with these outliers effectively and reduce the standard errors reasonably the study imposes the unwinsorised data on Huber's robust regression to fit the regression line by assigning different weights to the data points in order not to bias the model. The results show that the use of robust regression fits the data better than OLS.

3.3.2 Robust Regression with Huber Weighting

Ordinary least squares assign equal weights to all observations in calculating the regression equation. This means that outliers or influential data points can substantially influence the regression equation and for that matter the regression coefficients. With Huber weighting robust regression, data points with high residuals are not treated equally when calculating the regression equation. Different weights are assigned to these influential data points to neutralise their effect on the regression equation. Thus robust regression is insensitive to small deviations from the assumptions the model imposes on the data, particularly the distributional assumptions. Put another way, robust regression is insensitive to the assumptions of ordinary least squares and so it's the appropriate model to use when residuals do not behave as prescribed by OLS (Fox and Weisberg, 2002; Huber, 2011). Since our data is plagued with many influential data points the natural thing to do is employ this method to estimate our regression model.

A tuning constant (denoted as *k*) is generally picked to give reasonably high efficiency in the normal case, in particular, k=1.345σ (where σ is the standard deviation of the errors) produce 95 percent efficiency when the errors are normal, and still offers protection against outliers.

The researcher specified the Huber weighting (which is used to estimate our regression equation) in equation (3.2) as follows:

$$W(i) = \begin{cases} 1 & for\ |e\ | \leq k \\ \frac{k}{|e|} & for|e\ | > k \end{cases} \qquad (3.2)$$

where ***k*** is a *tuning constant* for the Huber estimator, ***e*** is the residual of the regression model and $W(i)$ is the Huber's weight for the $\boldsymbol{i^{th}}$ observation. It follows that if the absolute value of the residual is less than or equal to the tuning constant *k* then the weight will take the value of 1, but if the absolute value of the residual is greater than the tuning constant *k*, then the weight will take the value of the tuning constant *k* divided by the absolute value of the residual.

3.3.3 Carry Trade Returns

The study computes the returns of the currency carry trade from Fama's regression equation. The researcher denotes currency carry trade as $Z_{t.}$ Since UIP states that the interest rate differential between countries 'a' and 'b' is compensated for by the movement of exchange rate between the two countries, the researcher can express it algebraically as:

$$r_{t,t+1}^{a} - r_{t,t+1}^{b} = S_{t+1}^{b/a} - S_{t}^{b/a} \qquad (3.3)$$

This means that if the uncovered interest parity holds, then the exchange movement will exactly offset the interest rate differential as follows and the net effect will be zero:

$$(r_{t,t+1}^{a} - r_{t,t+1}^{b}) - (S_{t+1}^{b/a} - S_{t}^{b/a}) = 0 \qquad (3.4)$$

The researcher therefore estimate the currency carry trade (Z_t) as follows:

$$Z_t = (r_{t,t+1}^{a} - r_{t,t+1}^{b}) - (S_{t+1}^{b/a} - S_{t}^{b/a}) \qquad (3.5)$$

Here Z_t which measures currency carry trade will be zero if the UIP holds and failure may lead to $Z_t > 0$ thus making profit. This is used to estimate the profitability or otherwise of currrency carry trade of all the forty currency pairs under study. The mean monthly excess returns are then annualised together with their standard deviations (measure of risk). The researcher computes Sharpe ratios for the carry trade returns to adjust for risk to compare with other asset classes. Calculation of the Sharpe ratios follows the formula used by Burnside et al. (2006), Gyntelberg and Remolona (2007) and Moosa (2008) where returns are divided by their respective standard deviations ignoring risk-free. This is quite different from the Sharpe ratios used for portfolio performance evaluation since that includes the risk-free rate. The researcher ignored risk free rate because there are two currencies involved in the trade and the problem would be which of the two rates should be used for the calculation.

3.3.4 Sharpe Ratio

The Sharpe ratio, which is usually used by academic researchers and investors to measure the risk-adjusted performance of a portfolio, is used by the researcher to evaluate the returns of African currency carry trade returns as well as the returns for the other asset classes selected for the study. The Sharpe ratio is defined as the average return of an asset or a portfolio, in excess of the risk-free rate, divided by its standard deviation (Cogneau and Hubner, 2009a). The Sharpe ratio is specified as follows:

$$SR = \frac{R_i - R_f}{\sigma_i} \tag{3.6}$$

where R_i is the return of the portfolio i, R_f is the risk-free rate, and σ_i is the standard deviation of portfolio i. The researcher uses the Sharpe ratio to assess the risk-adjusted performance of African currency carry trades and other asset classes in the study, in particular the stock market returns. This ratio is widely used because it is very simple to interpret. The drawback of this measure however is that it assumes normality, and currency carry trade returns are rarely normally distributed (Mistry and Shah, 2013). To deal with the non-normality problem, the researcher employs the adjusted Sharpe ratio in section 4.3.2.3 to account for the skewness and kurtosis in the data.

3.3.5 Portfolio Management

The researcher generated individual currency carry trade returns for the forty currency pairs and subsequently constructed portfolios with these currency pairs and compared them with Morgan Stanley Capital International Index (MSCI All Country World Index) and the Deutsche Bank G10 FX Carry Trade Index. The strategy is to take a short selling position in all the four developed currencies, namely USD, JPY, EUR and GBP, and a long position in all ten African currencies, ZAR, EGP, MAD, KES, NGN, BWP, TND, GHS, MUR and

ZMW, totalling forty currency pairs. On the basis of their statistical significance as per the UIP test in section 3.1, the researcher included them in the study's portfolio. Four main naïve equally weighted portfolios are constructed within the period of 1998 and 2015. The first portfolio considers all the currency pairs found to be profitable per the UIP test for the full sample period (1998-2015). The remaining three portfolios follow the same criterion for three different subsamples: pre-crisis period, crisis period and post crisis period. The pre-crisis period takes positions in the forty currency pairs as described earlier for the period before the global financial crisis (1998-2006). The crisis period looks at the period of the global financial crisis (2007-2009) whilst the post-crisis considers the period after the financial crisis (2009-2015). In all cases the researcher includes only the currency pairs suggested to be profitable by the UIP test for the various regimes.

It must be noted that the failure of the UIP is a necessary but not sufficient condition for profitability of currency carry trade since it is possible to observe the a failure in the UIP, but there would still not be profits left after accounting for transaction cost (Darvas, 2009, Moosa, 2008). The researcher examined every single currency of Africa's emerging and frontier markets selected for the study with both naïve and regression based strategy. The researcher stuck to the naïve equally weighted portfolio as it has been proven to be better than many sophisticated optimal portfolio selection strategies (DeMiguel et al., 2009).

3.4 Data

The researcher collected one month interbank interest rates[7] and one month exchange rates data on ten African countries and used them as target currencies, and collected the same for four first world countries as funding currencie*s*. Interbank interest rates and in some cases Treasury bill rates have been widely used in the academic literature as an indicative interest rate to test for the uncovered interest parity theory. The interbank rate is the rate at which commercial banks lend to themselves and has become the premier short-term interest rate quoted in most money markets around the world which serves as a reference rate for a wide range of transactions (Bodie et al., 2004, p. 29). The researcher also collected 91- day Treasury bill rates as a proxy for risk-free for the four funding currency countries (USA, Japan, United Kingdom and Euro Area). The beginning sample date for the data varied across the various countries (between 1998 and 2006). This is purely dictated by the availability of data on the countries selected for the study. Samples on South Africa, Egypt, and Zambia

[7] In the case of Ghana, South Africa and Kenya, Treasury bill rates data were available and were used.

were taken from 1998 to 2015, Ghana, Morocco and Tunisia from 1999 to 2015, Botswana and Nigeria from 2001 and 2002 respectively, and Kenya and Mauritius from 2006 to 2015. Funding currencies for this study included the United States Dollars (USD), Japanese (JPY), British Pound (GBP) and Euro for the Euro Area. The researcher also collected monthly prices of the Morgan Stanley Capital International (MSCI) World stock index and the Deutsche Bank G10 FX Carry Trade Index (1998-2015 for MSCI Index and 2000-2015 for G10 FX Carry Trade Index) as benchmark indices. These data are available and can be downloaded from Bloomberg terminal, INET BFA, Datastream and Quantec EasyData.

3.4.1 Test of Stationarity of Data

For time series analysis such as this, it is extremely important to test for the presence or otherwise of unit root in the series before using for any form econometric modeling. This is to avoid spurious results that cannot be trusted. This study employs the use of Augmented Dickey Fuller and Philip-Perron unit root tests to investigate for unit roots in the currency carry trade and the stock market returns series. These models are specified as follows:

For the Augmented Dickey Fuller test:

$$\Delta s_t = \phi S_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta s_{t-1} + u_t \tag{3.7}$$

$$\Delta s_t = \beta_1 + \phi s_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta s_{t-1} + u_t \tag{3.8}$$

$$\Delta s_t = \beta_1 + \beta_2 t + \phi s_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta s_{t-1} + u_t \tag{3.9}$$

where t represents the time or trend variable. Note that test includes the lagged difference terms of the dependent variables as an explanatory variable. This is done to deal with serial correlation in the error terms. Lag selection will be done with help of Schwarz Bayesian Information Criterion (SBIC) and Akaike Information Criterion (AIC).

For the Philip-Perron test:

$$\Delta s_t = \Omega D_t + \delta s_{t-1} + \mu_t \tag{3.10}$$

where D_t is a vector of deterministic terms such as constant, trend, etc., $\Delta s = s_t - s_{t-1}$ and $\mu_t$is I(0) the white noise process which may be heteroskedastic. The Philip-Perron test modifies ADF test statistics and calculates the test statistics $Z_t \, and \, Z_\pi$ (see equations 5.29 and 5.30) to deal with any possible serial correlation and heteroskedasticity in the errors μ_t.

$$Z_t = \left(\frac{\hat{\sigma}^2}{\hat{\sigma}^2}\right)^{\frac{1}{2}} \times t_\pi = 0 - \frac{1}{2}\left(\frac{\hat{\lambda}^2 - \hat{\sigma}^2}{\hat{\lambda}^2}\right) \cdot \left(\frac{\mathrm{T} \times SE(\hat{\pi})}{\hat{\sigma}^2}\right) \tag{3.11}$$

$$Z_\pi = \mathrm{T}_\pi - \frac{1}{2}\frac{\mathrm{T}^2 \times SE(\hat{\pi})}{\hat{\sigma}^2}\left(\hat{\lambda}^2 - \hat{\sigma}^2\right) \tag{3.12}$$

The terms σ^2 and λ^2 in equations *(5.29)* and *(5.30)* respectively are consistent estimates of the variance parameters

$$\sigma^2 = \lim_{n\to\infty} \mathrm{T}^{-1} \sum_{t=1}^{T} E[\mu_t^2] \tag{3.13}$$

$$\lambda^2 = \lim_{n\to\infty} \sum_{t=1}^{T} E[\mathrm{T}^{-1} S_T^2] \tag{3.14}$$

where $S_T = \sum_{t=1}^{T} = \mu_t$ with the sample variance of the least squares residual $\hat{\mu}^2$ being a consistent estimate of σ^2 and the Newey-West long-run variance estimate of μ_t using $\hat{\mu}^2$ is a consistent estimate of λ^2.

3.5 Empirical Results and Discussion

This section presents results of the study under four main subsections. The first subsection presents the results of the unit root test of the currency carry trade series of all forty currency pairs. The second subsection presents results and discussions of the test of the uncovered interest rate parity condition using Fama's regression model to estimate the coefficients. The third subsection shows results of historical currency carry trade returns of African currencies with their associated statistical properties. These returns and their statistical properties are calculated under full sample, period before the sub-prime lending financial crisis, during the crisis, and post crisis periods respectively. The fourth and final subsection looks at African currencies carry trade returns as a portfolio and compared against realised returns of other assets or indices.

3.5.1 Results of Unit Root Test

Tables 3.1 to 3.8 present the results of the unit root tests for both Augmented Dickey Fuller and Philip-Perron for all the series used for this study. The tests are done (in both cases) for the level data and the first-differenced data. Tables 3.1 to 3.4 present the stationary test results of the interest rate differential where the majority of the series were not stationary at level but only became stationary after being first-differenced. Tables 3.5 to 3.8 also present the unit root test of the exchange ration depreciation or appreciation (change in exchange rate) and were found to be stationary at level and at first-differenced.

Table 3.1: Unit Root Tests – USA & Africa Interest Differential

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-1.576*	*-7.386****	*-2.192*	*-7.415****
	Intercept only	*-1.255*	*-7.400****	*-1.345*	*-7.429****
	Intercept & Trend	*-1.385*	*-7.374****	*-2.177*	*-7.404****
Morocco	*None*	*-1.560*	*-16.391****	*-1.391*	*-16.467****
	Intercept only	*-1.436*	*-16.432****	*-1.279*	*-16.510****
	Intercept & Trend	*-1.964*	*-16.388****	*-1.817*	*-16.473****
Egypt	*None*	*-1.217*	*-11.498****	*-1.771*	*-12.101****
	Intercept only	*-0.136*	*-11.525****	*-0.317*	*-12.123****
	Intercept & Trend	*-1.268*	*-11.471****	*-1.816*	*-12.079****
Kenya	*None*	*-1.872*	*-8.795****	*-2.022*	*-8.772****
	Intercept only	*-0.665*	*-8.826****	*-0.733*	*-8.812****
	Intercept & Trend	*-2.642*	*-8.706****	*-2.883*	*-8.682****
Nigeria	*None*	*-2.519*	*-11.313****	*-2.488*	*-11.447****
	Intercept only	*-1.925*	*-11.270****	*-1.795*	*-11.416****
	Intercept & Trend	*-2.110*	*-11.558****	*-2.121*	*-11.629****
Zambia	*None*	*-1.368*	*-12.459****	*-1.763*	*-12.804****
	Intercept only	*-0.598*	*-12.486****	*-0.840*	*-12.828****
	Intercept & Trend	*-1.781*	*-12.431****	*-2.254*	*-12.779****
Tunisia	*None*	*-1.118*	*-11.561****	*-1.499*	*-11.792****
	Intercept only	*-0.411*	*-11.581****	*-0.681*	*-11.813****
	Intercept & Trend	*-1.412*	*-11.523****	*-1.791*	*-11.758****
Botswana	*None*	*0.003*	*-11.807****	*-0.582*	*-12.229****
	Intercept only	*-0.747*	*-11.793****	*-0.689*	*-12.224****
	Intercept & Trend	*-2.574*	*-12.028****	*-2.750*	*-12.432****
Mauritius	*None*	*-2.593*	*-10.225****	*-2.853*	*-10.223****
	Intercept only	*-1.513*	*-10.268****	*-1.618*	*-10.267****
	Intercept & Trend	*-2.896*	*-10.262****	*-3.101*	*-10.266****
Ghana	*None*	*-1.067*	*-7.482****	*-1.690*	*-7.501****
	Intercept only	*-0.461*	*-7.501****	*-0.747*	*-7.519****
	Intercept & Trend	*-0.888*	*-7.476****	*-1.630*	*-7.495****

Table 3.2: Unit Root Tests–Euro & Africa Interest Differential

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-1.858*	*-7.312****	*-2.436*	*-7.359****
	Intercept only	*-1.236*	*-7.327****	*-1.261*	*-7.374****
	Intercept & Trend	*-1.556*	*-7.308****	*-2.406*	*-7.355****
Morocco	*None*	*-2.009*	*-15.280****	*-1.838*	*-15.439****
	Intercept only	*-1.525*	*-15.317****	*-1.384*	*-15.479****
	Intercept & Trend	*-3.091*	*-15.348****	*-2.964*	*-15.550****
Egypt	*None*	*-1.382*	*-11.183****	*-2.043*	*-11.597****
	Intercept only	*0.074*	*-11.208****	*-0.107*	*-11.618****
	Intercept & Trend	*-1.558*	*-11.172****	*-2.186*	*-11.588****
Kenya	*None*	*-1.849*	*-8.743****	*-2.050*	*-8.730****
	Intercept only	*-0.627*	*-8.782****	*-0.700*	*-8.775****
	Intercept & Trend	*-2.796*	*-8.666****	*-3.053*	*-8.652****
Nigeria	*None*	*-2.006*	*-11.537****	*-2.045*	*-11.644****
	Intercept only	*-1.336*	*-11.536****	*-1.277*	*-11.647****
	Intercept & Trend	*-1.701*	*-11.709****	*-1.752*	*-11.770****
Zambia	*None*	*-1.408*	*-12.529****	*-1.807*	*-12.861****
	Intercept only	*-0.567*	*-12.556****	*-0.803*	*-12.886****
	Intercept & Trend	*-1.840*	*-12.500****	*-2.338*	*-12.836****
Tunisia	*None*	*-0.773*	*-10.283****	*-1.239*	*-10.391****
	Intercept only	*0.044*	*-10.294****	*-0.201*	*-10.406****
	Intercept & Trend	*-2.452*	*-10.267****	*-2.697*	*-10.378****
Botswana	*None*	*0.130*	*-13.239****	*-0.271*	*-13.499****
	Intercept only	*-0.821*	*-13.221****	*-0.743*	*-13.488****
	Intercept & Trend	*-2.608*	*-13.607****	*-2.701*	*-13.774****
Mauritius	*None*	*-2.516*	*-10.537****	*-2.800**	*-10.542****
	Intercept only	*-1.406*	*-10.587****	*-1.473**	*-10.592****
	Intercept & Trend	*-3.131**	*-10.519****	*-3.445***	*-10.527****
Ghana	*None*	*-1.126*	*-7.374****	*-1.786*	*-7.394****
	Intercept only	*-0.465*	*-7.393****	*-0.744*	*-7.413****
	Intercept & Trend	*-0.896*	*-7.374****	*-1.704*	*-7.394****

Table 3.3: Unit Root Tests–Japan & Africa Interest Differential

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***1st Difference***	***Levels***	***1st Difference***
South Africa	*None*	*-1.734*	*-7.105****	*-2.076*	*-7.171****
	Intercept only	*-1.797*	*-7.101****	*-1.511*	*-7.166****
	Intercept & Trend	*-1.604*	*-7.096****	*-2.538*	*-7.096****
Morocco	*None*	*-3.742****	*-17.514****	*-3.443****	*-19.327****
	Intercept only	*-1.775****	*-17.493****	*-2.056****	*-19.174****
	Intercept & Trend	*-4.128****	*-17.532****	*-3.665***	*-19.469****
Egypt	*None*	*-1.697*	*-12.710****	*-1.926*	*-12.976****
	Intercept only	*-1.191*	*-12.688****	*-1.044*	*-12.962****
	Intercept & Trend	*-2.274*	*-12.691****	*-2.876*	*-12.959****
Kenya	*None*	*-2.328*	*-8.871****	*-2.556****	*-8.837****
	Intercept only	*-0.745*	*-8.920****	*-0.778****	*-8.889****
	Intercept & Trend	*-2.752*	*-8.796****	*-2.982****	*-8.759****
Nigeria	*None*	*-2.466*	*-12.236****	*-2.449****	*-12.318****
	Intercept only	*-1.941*	*-12.155****	*-1.870****	*-12.254****
	Intercept & Trend	*-1.797*	*-12.449****	*-4.549****	*-12.485****
Zambia	*None*	*-1.290*	*-12.682****	*-1.640*	*-12.994****
	Intercept only	*-0.624*	*-12.711****	*-0.803*	*-13.020****
	Intercept & Trend	*-1.879*	*-12.653****	*-2.347*	*-12.968****
Tunisia	*None*	*-2.338*	*-12.706****	*-2.411*	*-12.666****
	Intercept only	*-1.448*	*-12.699****	*-1.382*	*-12.659****
	Intercept & Trend	*-2.715*	*-12.644****	*-2.981*	*-12.596****
Botswana	*None*	*1.143*	*-13.700****	*0.767*	*-13.942****
	Intercept only	*-2.082*	*-13.262****	*-1.747*	*-13.625****
	Intercept & Trend	*-1.952*	*-14.030****	*-2.066*	*-14.189****
Mauritius	*None*	*-1.338*	*-10.300****	*-1.472*	*-10.300****
	Intercept only	*-1.299*	*-10.340****	*-1.328*	*-10.340****
	Intercept & Trend	*-2.567*	*-10.285****	*-2.809*	*-10.285****
Ghana	*None*	*-1.145*	*-7.506****	*-1.731*	*-7.520****
	Intercept only	*-0.608*	*-7.524****	*-0.791*	*-7.538****
	Intercept & Trend	*-0.912*	*-7.501****	*-1.713*	*-7.515****

Table 3.4: Unit Root Tests–UK & Africa Interest Differential

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-2.187*	*-13.961****	*-2.495*	*-14.068****
	Intercept only	*-1.054*	*-13.993****	*-1.144*	*-14.097****
	Intercept & Trend	*-2.139*	*-13.936****	*-2.471*	*-14.045****
Morocco	*None*	*-2.077*	*-20.455****	*-1.513*	*-21.576****
	Intercept only	*-2.010*	*-20.503****	*-1.439*	*-21.624****
	Intercept & Trend	*-2.985*	*-20.429****	*-2.465*	*-21.590****
Egypt	*None*	*-2.303*	*-19.970****	*-2.092*	*-19.486****
	Intercept only	*-0.140*	*-19.989****	*0.022*	*-19.495****
	Intercept & Trend	*-2.708*	*-19.922****	*-2.509*	*-19.442****
Kenya	*None*	*-1.832*	*-8.827****	*-1.967*	*-8.752****
	Intercept only	*-0.675*	*-8.862****	*-0.723*	*-8.797****
	Intercept & Trend	*-2.783*	*-8.744****	*-3.008*	*-8.666****
Nigeria	*None*	*-2.275*	*-13.132****	*-2.268*	*-13.132****
	Intercept only	*-1.373*	*-13.140****	*-1.385*	*-13.141****
	Intercept & Trend	*-2.225*	*-13.298****	*-2.197*	*-13.303****
Zambia	*None*	*-1.452*	*-12.367****	*-1.858*	*-12.694****
	Intercept only	*-0.552*	*-12.392****	*-0.816*	*-12.716****
	Intercept & Trend	*-1.864*	*-12.341****	*-2.328*	*-12.670****
Tunisia	*None*	*-2.077*	*-21.863****	*-1.573*	*-22.135****
	Intercept only	*-1.052*	*-21.878****	*-0.544*	*-22.101****
	Intercept & Trend	*-3.272**	*-21.810****	*-2.803*	*-22.086****
Botswana	*None*	*-1.492*	*-17.500****	*-1.226*	*-17.207****
	Intercept only	*-0.652*	*-17.523****	*-0.653*	*-17.223****
	Intercept & Trend	*-2.925*	*-17.658****	*-2.728*	*-17.424****
Mauritius	*None*	*-2.593**	*-10.225****	*-2.853***	*-10.223****
	Intercept only	*-1.513*	*-10.268****	*-1.618*	*-10.267****
	Intercept & Trend	*-2.896*	*-10.262****	*-3.101**	*-10.266****
Ghana	*None*	*-1.116*	*-8.510****	*-1.765*	*-8.703****
	Intercept only	*-0.396*	*-8.531****	*-0.720*	*-8.723****
	Intercept & Trend	*-0.977*	*-8.504****	*-1.712*	*-8.697****

Table 3.5: Unit Root Tests –Changes in Exchange Rate [USD]

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-10.281****	*-19.176****	*-10.191****	*-23.590****
	Intercept only	*-10.135****	*-19.221****	*-10.063****	*-23.659****
	Intercept & Trend	*-10.286****	*-19.137****	*-10.191****	*-23.558****
Morocco	*None*	*-10.300****	*-18.853****	*-10.214****	*-23.341****
	Intercept only	*-10.326****	*-18.900****	*-10.240****	*-23.415****
	Intercept & Trend	*-10.310****	*-18.805****	*-10.214****	*-23.270****
Egypt	*None*	*-10.384****	*-20.630****	*-10.423****	*-26.215****
	Intercept only	*-9.958****	*-20.679****	*-10.044****	*-26.293****
	Intercept & Trend	*-10.371****	*-20.582****	*-10.409****	*-26.141****
Kenya	*None*	*-8.573****	*-16.922****	*-8.557****	*-20.478****
	Intercept only	*-8.521****	*16.995****	*-8.520****	*-20.585****
	Intercept & Trend	*-8.590****	*-16.849****	*-8.564****	*20.373****
Nigeria	*None*	*-9.182****	*-16.442****	*-9.113****	*-19.999****
	Intercept only	*-9.017****	*-16.493****	*-8.977****	*-20.078****
	Intercept & Trend	*-9.185****	*-16.392****	*-9.109****	*-19.920****
Zambia	*None*	*-9.421****	*-17.820****	*-9.138****	*-20.351****
	Intercept only	*-9.206****	*-17.859****	*-8.962****	*-20.410****
	Intercept & Trend	*-9.400****	*-17.778****	*-9.118****	*-20.279****
Tunisia	*None*	*-10.452****	*-19.672****	*-10.439****	*-24.450****
	Intercept only	*-10.299****	*-19.721****	*-10.302****	*-24.525****
	Intercept & Trend	*-10.469****	*-19.624****	*-10.445****	*-24.386****
Botswana	*None*	*-13.699****	*-24.943****	*-13.705****	*-34.457****
	Intercept only	*-13.570****	*-25.013****	*-13.592****	*-34.566****
	Intercept & Trend	*-13.804****	*-24.874****	*-13.799****	*-34.352****
Mauritius	*None*	*-11.400****	*-17.502****	*-11.395****	*-25.411****
	Intercept only	*-11.449****	*-17.578****	*-11.443****	*-25.541****
	Intercept & Trend	*-11.373****	*-17.430****	*-11.370****	*-25.271****
Ghana	*None*	*-11.270****	*-25.800****	*-11.719****	*-33.322****
	Intercept only	*-9.914****	*-25.865****	*-10.435****	*-33.416****
	Intercept & Trend	*-11.322****	*-25.736****	*-11.764****	*-33.233****

Table 3.6: Unit Root Tests –Changes in Exchange Rate [EUR]

Variable	*Test Equation*	ADF Unit Root Test		PP Unit Root Test	
		Levels	*1st Difference*	*Levels*	*1st Difference*
South Africa	*None*	*-11.440****	*-20.821****	*-11.442****	*-26.194 ****
	Intercept only	*-11.246****	*-20.869****	*-11.275****	*-26.270****
	Intercept & Trend	*-11.414****	*-20.779****	*-11.415****	*-20.779****
Morocco	*None*	*-11.243****	*-19.125****	*-11.102****	*-26.078****
	Intercept only	*-11.272****	*-19.173****	*-11.133****	*-26.159****
	Intercept & Trend	*-11.228****	*-19.076****	*-11.081****	*-26.016****
Egypt	*None*	*-10.846****	*-20.229****	*-10.882****	*-25.708****
	Intercept only	*-10.723****	*-20.276****	*-10.779****	*-25.785****
	Intercept & Trend	*-10.872****	*-20.181****	*-10.902****	*-25.631****
Kenya	*None*	*-10.646****	*-17.447****	*-10.651****	*-25.137****
	Intercept only	*-10.650****	*-17.524****	*-10.652****	*-25.275****
	Intercept & Trend	*-10.647****	*-17.369****	*-10.653****	*-24.996****
Nigeria	*None*	*-12.727****	*-21.307****	*-12.728****	*-30.882****
	Intercept only	*-12.553****	*-21.372****	*-12.549****	*-30.996****
	Intercept & Trend	*-12.883****	*-21.240****	*-12.898****	*-30.769****
Zambia	*None*	*-10.159****	*-18.273****	*-9.838****	*-21.846****
	Intercept only	*-9.938****	*-18.313****	*-9.659****	*-21.910****
	Intercept & Trend	*-10.154****	*-18.231****	*-9.835****	*-21.768****
Tunisia	*None*	*-10.768****	*-18.514****	*-10.536****	*-22.903****
	Intercept only	*-10.124****	*-18.560****	*-9.990****	*-22.976****
	Intercept & Trend	*-10.745****	*-18.465****	*-10.509****	*-22.825****
Botswana	*None*	*-14.539****	*-25.495****	*-14.494****	*-37.769****
	Intercept only	*-14.437****	*-25.568****	*-14.406****	*-37.894****
	Intercept & Trend	*-14.536****	*-25.426****	*-14.490****	*-37.653****
Mauritius	*None*	*-14.586****	*-22.146****	*-14.503****	*-37.523****
	Intercept only	*-14.640****	*-22.241****	*-14.552****	*-37.701****
	Intercept & Trend	*-14.690****	*-22.044****	*-14.670****	*-37.329****
Ghana	*None*	*-12.146****	*-23.027****	*-12.246****	*-30.394****
	Intercept only	*-11.013****	*-23.085****	*-11.305****	*-30.486****
	Intercept & Trend	*-12.264****	*-22.971****	*-12.337****	*-30.329****

Table 3.7: Unit Root Tests –Changes in Exchange Rate [JPY]

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-10.822****	*-20.416****	*-10.788****	*-24.404****
	Intercept only	*-10.676****	*-20.461****	*-10.668****	*-24.467****
	Intercept & Trend	*-10.794****	*-20.372****	*-10.759****	*-24.355****
Morocco	*None*	*-10.509****	*-19.966****	*-10.503****	*-23.877****
	Intercept only	*-10.535****	*-20.016****	*-10.529****	*-23.949****
	Intercept & Trend	*-10.493****	*-19.916****	*-10.484****	*-23.803****
Egypt	*None*	*-11.309****	*-21.414****	*-11.300****	*-25.350****
	Intercept only	*-11.124****	*-21.464****	*-11.155****	*-25.417****
	Intercept & Trend	*-11.389****	*-21.363****	*-11.352****	*-25.281****
Kenya	*None*	*-8.836****	*-16.568****	*-8.903****	*-20.136****
	Intercept only	*-8.840****	*-16.641****	*-8.912****	*-20.241****
	Intercept & Trend	*-8.837****	*-16.496****	*-8.897****	*-20.033****
Nigeria	*None*	*-10.679****	*-19.606****	*-10.693****	*-24.989****
	Intercept only	*-10.584****	*-19.666****	*-10.614****	*-25.082****
	Intercept & Trend	*-10.724****	*-19.545****	*-10.730****	*-24.902****
Zambia	*None*	*-10.017****	*-19.477****	*-9.868****	*-22.498****
	Intercept only	*-9.841****	*-19.520****	*-9.723****	*-22.564****
	Intercept & Trend	*-10.023****	*-19.430****	*-9.873****	*-22.423****
Tunisia	*None*	*-10.066****	*-19.887****	*-10.095****	*-23.297****
	Intercept only	*-10.006****	*-19.937****	*-10.047****	*-23.367****
	Intercept & Trend	*-10.050****	*-19.837****	*-10.078****	*-23.227****
Botswana	*None*	*-12.991****	*-22.784****	*-12.991****	*-29.895****
	Intercept only	*-12.916****	*-22.849****	*-12.921****	*-29.994****
	Intercept & Trend	*-12.959****	*-22.723****	*-12.959****	*-29.815****
Mauritius	*None*	*-10.693****	*-18.898****	*-10.715****	*-25.301****
	Intercept only	*-10.730****	*-18.980****	*-10.751****	*-25.429****
	Intercept & Trend	*-10.718****	*-18.815****	*-10.734****	*-25.172****
Ghana	*None*	*-10.728****	*-23.470****	*-11.011****	*-28.478****
	Intercept only	*-9.895****	*-23.529****	*-10.260****	*-28.560****
	Intercept & Trend	*-10.846****	*-23.413****	*-11.105****	*-28.407****

Table 3.8: Unit Root Tests –Changes in Exchange Rate [GBP]

Variable	***Test Equation***	**ADF Unit Root Test**		**PP Unit Root Test**	
		Levels	***First Difference***	***Levels***	***First Difference***
South Africa	*None*	*-11.893****	*-20.497****	*-11.845****	*-26.799****
	Intercept only	*-11.741****	*-20.545****	*-11.712****	*-26.880****
	Intercept & Trend	*-11.876****	*-20.451****	*-11.825****	*-26.748****
Morocco	*None*	*-11.728****	*-22.175****	*-11.794****	*-28.054****
	Intercept only	*-11.756****	*-22.230****	*-11.822****	*-28.135****
	Intercept & Trend	*-11.703****	*-22.118****	*-11.768****	*-27.968****
Egypt	*None*	*-11.247****	*-21.602****	*-11.413****	*-27.766****
	Intercept only	*-11.141****	*-21.652****	*-11.326****	*-27.843****
	Intercept & Trend	*-11.260****	*-21.553****	*-11.422****	*-27.703****
Kenya	*None*	*-11.308****	*-17.355****	*-11.378****	*-24.580****
	Intercept only	*-11.334****	*-17.431****	*-11.401****	*-24.711****
	Intercept & Trend	*-11.269****	*-17.283****	*-11.340****	*-24.449****
Nigeria	*None*	*-12.526****	*-21.663****	*-12.539****	*-30.834****
	Intercept only	*-12.400****	*-21.728****	*-12.427****	*-30.935****
	Intercept & Trend	*-12.534****	*-21.597****	*-12.546****	*-30.714****
Zambia	*None*	*-10.182****	*-18.910****	*-9.906****	*-22.327****
	Intercept only	*-9.963****	*-18.950****	*-9.728****	*-22.389****
	Intercept & Trend	*-10.167****	*-18.865****	*-9.894****	*-22.247****
Tunisia	*None*	*-11.936****	*-21.959****	*-11.965****	*-28.118****
	Intercept only	*-11.722****	*-22.013****	*-11.781****	*-28.199****
	Intercept & Trend	*-11.912****	*-21.903****	*-11.939****	*-28.034****
Botswana	*None*	*-14.160****	*-22.865****	*-14.151****	*-35.015****
	Intercept only	*-14.086****	*-22.930****	*-14.074****	*-35.137****
	Intercept & Trend	*-14.218****	*-22.801****	*-14.218****	*-34.902****
Mauritius	*None*	*-11.400****	*-17.502****	*-11.395****	*-25.411****
	Intercept only	*-11.449****	*-17.578****	*-11.443****	*-25.541****
	Intercept & Trend	*-11.373****	*-17.430****	*-11.370****	*-25.271****
Ghana	*None*	*-11.389****	*-23.579****	*-11.623****	*-29.366****
	Intercept only	*-10.370****	*-23.638****	*-10.738****	*-29.451****
	Intercept & Trend	*-11.467****	*-23.522****	*-11.684****	*-29.293****

3.5.2 Uncovered Interest Rate Parity

The study begins the UIP test by estimating Fama's (1984) regression with ordinary least squares for all forty currency pairs used for the study spanning the period 1998 to 2015. This period includes the global financial crisis in 2007 which destabilised financial markets across the globe. Thus after estimating the regression with the full sample, the researcher proceeds to check the stability and behaviour of the β parameter *before*, *during* and *after* the financial crisis and their consequent carry trade returns. After the OLS the researcher imposed the data on the Huber's weighting robust regression to estimate Fama's regression with the null hypothesis that $\beta=1$ and the one-sided alternative hypothesis that $\beta < 1$. The parameter estimates with their respective p-values for the full sample and the other three sub-samples test are shown in Table 3.9 for all the currency pairs used in the study. All forty currency pairs are showing β coefficients which are lower than one, with the majority of them being negative, even though not all of them are statistically significant. The negative sign of the statistically significant coefficients is an indication that currency carry trade may be profitable in those currency pairs. It is instructive to note that out of the forty currency pairs none of them shows a β coefficient of unity as postulated by the uncovered interest rate parity hypothesis though a sizeable number of the currency pairs have positive coefficients. The results also show that the failure of the UIP does not guarantee profitability of the currency carry trade in Africa, which is consistent with studies in other parts of the world (Olmo and Pilbeam, 2009). Thus UIP may fail but the carry trade strategy may deliver negative returns, as shown in Tables 3.10 to 3.13. In the majority of the currency pairs for this study the researcher fails to reject UIP hypothesis, which reinforces the position in the literature that the UIP failure is a problem for the developed economies (Bansal and Dahlquist, 2000; Burnside, 2015).

The UIP test for the full sample generally shows that the UIP hypothesis cannot be rejected for most of the currency pairs. Only six out of the forty currency pairs could be rejected and, for that matter, may generate positive excess carry trade returns. The six currency pairs are ZAREUR, ZARJPY, KESGBP, TNDEUR, MURJPY and MURGBP. The pre-crisis period appears to be the period where the researcher fails to reject the UIP hypothesis for almost all of the forty currency pairs.

The UIP hypothesis is however rejected for three of the currency pairs namely, ZAREUR, ZARJPY and TNDUSD, with two of the parameter estimates showing negative and the TNDUSD parameter being positive though far less than unity as predicted by the UIP. For as many as eleven currency pairs, the UIP hypothesis is rejected during the crisis period between 2007 and 2009. This represents the largest number of cases of UIP deviation in the data set which is an indication that currency trade thrives in Africa during periods of financial crisis in the international financial markets. The eleven currency pairs with β coefficients significantly lower than unity are GBPZAR, USDEGP, GBPEGP, EUREGP, JPYKES, GBPKES, EURTND, GBPBWP, USDMUR, EURMUR and USDGHS. Interestingly, the majority of these currency pairs are showing positive signs but are however far lower than unity, which is not enough to offset the interest rate differential as predicted by the UIP hypothesis, thus generating excess positive carry trade return.

Moreover, four out of the eleven currency pairs have negative estimated β coefficients which further widen the excess returns on carry trade. Finally, the researcher rejects the null hypothesis of the uncovered interest parity for nine currency pairs in the sample for post-crisis period. These currency pairs are USDZAR, EURZAR, JPYZAR, GBPZAR, JPYEGP, USDKES, JPYKES, EURMUR and JPYMUR. All these currency pairs except MURJPY exhibit negative β coefficients.

Table 3.9: β Parameter Estimates of Fama's Regression

Country	Full Sample [1998-2015]				Pre-Crisis [1998-2006]				Crisis Period [2007-2009]				Post-Crisis [2009-2015]			
	USD	**EUR**	**JPY**	**GBP**	**USD**	**EUR**	**JPY**	**GBP**	**USD**	**EUR**	**JPY**	**GBP**	**USD**	**EUR**	**JPY**	**GBP**
ZAR	-0.04	**-0.12**	**-0.15**	-0.02	-0.04	**-0.16**	**-0.21**	-0.02	-0.04	-0.08	0.04	**0.23**	**-0.06**	**-0.05**	**-0.05**	**-0.05**
	(0.23)	**(0.03)**	**(0.06)**	(0.49)	(0.31)	**(0.01)**	**(0.02)**	(0.39)	(0.74)	(0.63)	(0.88)	**(0.04)**	**(0.00)**	**(0.00)**	**(0.02)**	**(0.00)**
MAD	0.00	0.00	-0.02	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	-0.01	-0.02	0.09	0.01	0.08	-0.08
	(0.44)	(0.99)	(0.25)	(0.69)	(0.44)	(0.89)	(0.19)	(0.64)	(0.80)	(0.41)	(0.91)	(0.41)	(0.25)	(0.50)	(0.57)	(0.29)
EGP	0.01	-0.05	-0.04	0.01	-0.01	-0.06	-0.03	-0.03	**0.05**	**-0.15**	-0.02	**0.13**	-0.03	0.10	**-0.09**	0.04
	(0.45)	(0.42)	(0.65)	(0.78)	(0.53)	(0.57)	(0.86)	(0.23)	**(0.00)**	**(0.05)**	(0.90)	**(0.00)**	(0.22)	(0.29)	**(0.01)**	(0.27)
KES	0.00	0.00	-0.03	**-0.02**	-	-	-	-	0.01	0.03	**-0.46**	**-0.06**	**-4.10**	-3.68	**-6.60**	0.18
	(0.46)	(0.82)	(0.26)	**(0.08)**	-	-	-	-	(0.59)	(0.71)	**(0.04)**	**(0.05)**	**(0.04)**	(0.14)	**(0.01)**	(0.93)
NGN	0.01	0.02	0.00	0.03	0.01	0.10	0.06	0.05	0.02	0.00	-0.01	0.03	-0.02	-0.03	0.00	-0.05
	(0.35)	(0.64)	(0.92)	(0.13)	(0.62)	(0.39)	(0.46)	(0.29)	(0.42)	(0.96)	(0.91)	(0.31)	(0.55)	(0.62)	(0.97)	(0.54)
TND	0.00	**0.02**	-0.04	0.00	**0.02**	-0.01	-0.04	0.00	0.00	**0.04**	0.08	0.00	0.06	0.02	-0.05	0.07
	(0.34)	**(0.03)**	(0.53)	(0.57)	**(0.08)**	(0.65)	(0.63)	(0.82)	(0.95)	**(0.00)**	(0.60)	(0.61)	(0.25)	(0.54)	(0.56)	(0.19)
BWP	-0.11	-0.01	-0.22	-0.06	-0.11	0.57	-0.07	-0.03	-0.08	-0.08	-0.29	**-0.22**	-0.17	-0.10	-0.29	0.00
	(0.24)	(0.91)	(0.17)	(0.36)	(0.60)	(0.12)	(0.88)	(0.82)	(0.63)	(0.57)	(0.45)	**(0.04)**	(0.20)	(0.35)	(0.11)	(0.99)
MUR	0.00	0.00	**0.03**	**0.01**	-	-	-	-	**0.11**	**0.08**	0.00	-0.04	0.00	**-0.01**	**0.03**	0.01
	(0.13)	(0.87)	**(0.05)**	**(0.08)**	-	-	-	-	**(0.07)**	**(0.04)**	(0.99)	(0.31)	(0.28)	**(0.07)**	**(0.02)**	(0.53)
GHS	0.01	-0.01	-0.02	-0.01	0.00	0.00	-0.05	0.00	**0.04**	-0.09	0.16	-0.05	-0.01	0.04	-0.06	-0.02
	(0.61)	(0.82)	(0.58)	(0.73)	(0.72)	(0.96)	(0.36)	(0.91)	**(0.07)**	(0.24)	(0.13)	(0.37)	(0.70)	(0.52)	(0.37)	(0.67)
ZMW	-1.56	-0.55	-1.28	-1.52	-0.01	-0.01	-0.02	-0.02	-0.09	0.00	-0.02	-0.05	-0.02	0.00	0.01	-0.01
	(0.32)	(0.77)	(0.56)	(0.40)	(0.51)	(0.73)	(0.71)	(0.43)	(0.16)	(0.96)	(0.89)	(0.41)	(0.37)	(0.99)	(0.88)	(0.80)

Note: Results of Fama's (1984) regression which tests the uncovered interest rate parity. The beginning date of the full sample for the various currrency pairs varies from 1998 to 2006. Full samples of Mauritius and Kenya begin 2006; Nigeria begins 2002; Botswana begins 2001 whilst Ghana, Tunisia and Morocco begin 1999. The remaining countries, Zambia, Egypt and South Africa, all start from 1998 to 2015. The researcher reports the results for ten African currencies against the US dollars, Euro, Japanese Yen, and Great British Pound in succession totaling forty currency pairs. Values in bold are the β coefficients significantly smaller than 1 with their p-values in parenthesis, estimated with the null hypothesis that **β=1** against the one-sided alternative hypothesis that **β < 1** with using Huber's weighting robust regression.

3.5.3 Distribution of Carry Trade Returns

The researcher reports summary statistics of annualised returns of the currency carry trade on African currencies paired with four major currencies in the world. Full sample statistics cover the entire sample from 1998 to 2015 whereas the pre-crisis, crisis period and post-crisis reflect the returns generated by carry trade strategy before, during and after the subprime global financial crisis experienced in 2007. The researcher again reports summary statistics of equally weighted portfolios constructed from the significant individual currency pairs for the full sample, pre-crisis period sample, crisis period and the post-crisis period. The researcher calls this portfolio the 'African FX Carry Trade Portfolio' and compares it to returns of MSCI World Index and G10 FX Carry Trade Index.

3.5.3.1 Full Sample Period

Currency carry trade is generally profitable among the forty currency pairs studied for the entire sample period using the naïve method of calculation. However, the returns for only six out of the forty currency pairs are statistically significant. The statistically significant returns or profits shown in Table 3.10 are not very attractive since two out of the six are negative returns whilst the remaining four currency pairs are ranging between 1.14% and 4.62% with relatively low Sharpe ratios. The carry trades returns exhibit negative skewness and large excess kurtosis which is an indication that they are susceptible to downside or crash risk which is usually associated with currency carry trade all over the world. The large excess kurtosis shows that currency carry trade returns have fatter tails in their distribution and it is evidence that currency carry trades could unwind abruptly and cause large losses. This is consistent with various findings in the carry trade literature (Brunnermeier et al., 2009; Burnside et al., 2011; Burnside et al., 2007) and reinforces the popular saying that "exchange rates go up by the stairs and down by the elevator". The Jarcque-Bera normality test shows that the returns in the study are not normally distributed, which affirms the skewness and large excess kurtosis.

The remaining currencies, which are not significant according our regression model, produced some attractive returns using the naïve approach of estimation. In fact, Egypt, Botswana, Nigeria, Ghana, Zambia, Morocco, Kenya and Mauritius are generating very attractive returns, except that they are not statistically significant. These profits in themselves are however 'economic' evidence against the UIP hypothesis since according to the UIP the carry trade strategy should generate zero returns (Burnside, 2015).

Table 3.10: Full Sample Carry Trade Returns

		Full Sample [1998-2015]					
Currency	**Return**	**Standard Deviation**	**Risk-Free Rate**	**Sharpe Ratio**	**Skewness**	**Kurtosis**	**Jarcque Bera**
USDZAR	-0.83	13.53	0.0017	-0.06	-0.88	6.59	142.66***
USDEGP	2.60	5.36	0.0017	0.48	-5.85	58.58	28899.11***
USDGHS	2.02	11.24	0.0016	0.18	0.21	11.59	625.62***
USDZMW	5.78	15.84	0.0017	0.36	-0.21	8.45	267.59***
USDMAD	0.52	6.68	0.0016	0.08	-0.14	3.55	3.22
USDTND	-1.10	6.42	0.0016	-0.17	-0.10	3.07	0.35
USDBWP	5.11	12.58	0.0012	0.41	0.65	7.35	153.46***
USDNGN	5.81	6.66	0.0011	0.87	-3.24	20.32	2378.75***
USDKES	2.79	9.44	0.0009	0.30	0.33	3.85	5.73***
USDMUR	0.31	9.95	0.0009	0.03	-1.09	6.86	97.14***
EURZAR	-0.28**	12.81	0.0033	-0.02	-0.97	5.66	96.94***
EUREGP	3.17	10.07	0.0033	0.31	-1.29	9.29	414.16***
EURGHS	2.90	13.36	0.0032	0.22	0.60	8.56	273.60***
EURZMW	6.31	16.82	0.0033	0.37	-0.30	8.60	284.32***
EURMAD	1.40	2.43	0.0032	0.58	-0.70	6.45	117.19***
EURTND	-0.22**	3.27	0.0032	-0.07	0.58	4.69	35.60***
EURBWP	6.08	12.77	0.0031	0.48	-0.80	13.72	877.38***
EURNGN	4.62	12.34	0.0030	0.37	-1.49	13.31	801.18***
EURKES	4.44	12.23	0.0029	0.36	0.43	5.58	36.75***
EURMUR	2.08	8.35	0.0029	0.25	-0.55	4.70	20.44***
JPYZAR	1.14**	15.02	0.0001	0.08	-1.21	7.71	251.48***
JPYEGP	4.59	9.80	0.0001	0.47	-1.13	7.38	217.32***
JPYGHS	4.64	14.12	0.0001	0.33	0.09	5.79	66.26***
JPYZMW	7.76	18.44	0.0001	0.42	-0.44	7.37	178.05***
JPYMAD	3.15	8.96	0.0001	0.35	-0.61	6.21	99.47***
JPYTND	1.52	8.67	0.0001	0.18	-0.12	5.75	70.51***
JPYBWP	7.15	14.54	0.0001	0.49	-0.23	6.30	82.79***
JPYNGN	6.88	11.64	0.0001	0.59	-0.81	7.58	164.18***
JPYKES	4.46	13.83	0.0002	0.32	-0.57	5.06	27.50***
JPYMUR	2.11**	12.47	0.0002	0.17	-1.60	11.06	372.81***
GBPZAR	-0.69	12.67	0.0026	-0.05	-0.90	6.04	111.62***
GBPEGP	2.76	8.80	0.0026	0.31	-0.92	10.23	498.17***
GBPGHS	2.10	12.94	0.0024	0.16	0.49	7.22	158.30***
GBPZMW	5.68	16.02	0.0026	0.35	0.07	7.88	213.72***
GBPMAD	0.60	5.24	0.0024	0.11	0.96	6.88	158.49***
GBPTND	-1.02	5.33	0.0024	-0.19	0.45	4.25	20.04***
GBPBWP	5.66	12.39	0.0021	0.46	0.15	6.92	114.99***
GBPNGN	5.08	10.38	0.0020	0.49	0.15	4.46	15.54***
GBPKES	4.62*	12.39	0.0015	0.37	0.33	4.82	18.59***
GBPMUR	2.26**	9.46	0.0015	0.24	0.07	4.97	19.40***

Note: Table 3.10 reports the annualised carry trade returns and standard deviation for forty currency pairs for the full sample period (1998 to 2015). Table 3.10 again reports the skewness and kurtosis of the distribution as well as the Jarcque Bera normality test results. The researcher denotes * as significant at 10%, ** significant at 5% and ***significant at 1%.

Interestingly, the yen carry trade, which enjoys large volumes of trade due to the very low interest rate of Japan and its attendant high interest rate differential with many currencies around the world as noted in the works of Gyntelberg and Remolona (2007) and Shin and Hattori (2009), does not seem to be profitable (using the regression based test) against many of the African currencies, which is a puzzle that needs to be investigated further.

It is however important to note that though not statistically significant the yen carry trade posted some attractive excess positive returns, which appears to be ‘indirect’ evidence that the uncovered interest parity hypothesis does not hold, albeit not statistically supported.

3.5.3.2 Pre-Crisis Period

Table 3.11 presents the summary statistics of carry trade returns for the period before the global financial crisis, specifically from January 1998 to December, 2006 with varying start date for some currency pairs. The naïve computation of carry trade returns generated very attractive returns as shown in Table 3.11, though many of them are not statistically significant using regression based analysis. This suggests that currency trade may not be profitable in these markets. But as discussed in the previous section 3.5.3.1, those currency pairs with excess positive carry trade returns may be inferred to constitute indirect or economic evidence against the uncovered interest rate parity condition which postulates that currency carry trade profits are not possible. The currency pairs which generate statistically insignificant carry trade profits are the USDZAR, USDEGP, USDGHS, USDZMW, USDMAD, USDBWP, USDNGN, EURGHS, EURZMW, EURMAD, EURBWP, EURNGN, JPYEGP, JPYGHS, JPYZMW, JPYMAD, JPYTND, JPYBWP, JPYNGN, GBPGHS, GBPZMW, GBPBWP and GBPNGN. Thus the profits generated by these currency pairs may serve as economic evidence against the holding of the uncovered interest rate parity hypothesis. The currencies carry trade returns for EURZAR, USDTND and JPYZAR are the only currency pairs which are statistically significant using Fama’s regression. Moreover, the USDTND currency pair, which is among the statistically significant carry trade returns, appears to produce negative returns consistent with earlier studies that the failure of the uncovered interest parity in itself does not automatically translate into profitable carry trade (Moosa, 2008; Olmo and Pilbeam, 2009).

The researcher could not examine the pre-crisis period behaviour of USDKES, USDMUR, EURKES, EURMUR, JPYKES, JPYMUR, GBPKES and GBPMUR currency pairs due to unavailability of data.

The currencies carry trade returns are generally characterised by negative skewness and large excess kurtosis. Hence those returns are also characterised by crash risk or the peso effect.

Table 3.11: Pre-Crisis Period Carry Trade Returns

		Pre-Crisis [1998-2006]					
Currency	**Return**	**Standard Deviation**	**Risk-Free Rate**	**Sharpe Ratio**	**Skewness**	**Kurtosis**	**Jarcque Bera**
USDZAR	2.18	14.27	0.0028	0.15	-0.93	5.82	**51.39*** **
USDEGP	1.24	6.77	0.0028	0.18	-5.31	43.89	8032.87***
USDGHS	4.40	10.52	0.0027	0.42	-2.12	8.68	200.82***
USDZMW	11.15	16.30	0.0028	0.68	0.91	6.57	72.09***
USDMAD	1.05	6.39	0.0027	0.16	0.19	3.09	0.58
USDTND	-0.38*	6.31	0.0027	-0.06	0.14	2.72	0.60
USDBWP	9.85	14.33	0.0021	0.69	1.38	7.83	92.78***
USDNGN	10.75	3.88	0.0020	2.77	-1.39	8.89	106.00***
USDKES	-	-	-	-	-	-	-
USDMUR	-	-	-	-	-	-	-
EURZAR	0.85***	13.78	0.0037	0.06	-1.29	6.54	86.32***
EUREGP	-0.10	11.35	0.0037	-0.01	-1.66	9.86	261.46***
EURGHS	3.65	11.63	0.0037	0.31	-1.11	5.99	55.70***
EURZMW	9.88	18.03	0.0037	0.55	0.65	6.61	66.33***
EURMAD	0.30	2.93	0.0037	0.10	-0.77	5.40	32.50***
EURTND	-1.12	2.67	0.0037	-0.42	-0.42	2.56	3.63
EURBWP	8.69	17.05	0.0035	0.51	-0.91	10.65	185.38***
EURNGN	3.16	10.20	0.0034	0.31	-0.38	2.92	1.46
EURKES	-	-	-	-	-	-	-
EURMUR	-	-	-	-	-	-	-
JPYZAR	5.26**	13.32	0.0001	0.40	-0.84	4.28	19.97***
JPYEGP	4.32	10.94	0.0001	0.39	-1.57	8.14	163.42***
JPYGHS	8.64	13.52	0.0001	0.64	-1.25	5.11	42.64***
JPYZMW	13.94	18.13	0.0001	0.77	0.92	5.15	36.16***
JPYMAD	5.29	7.35	0.0001	0.72	-0.26	4.37	8.60**
JPYTND	3.86	7.50	0.0001	0.51	0.21	4.56	10.44***
JPYBWP	13.30	13.34	0.0000	1.00	1.06	6.17	43.66***
JPYNGN	11.92	9.57	0.0000	1.25	0.00	2.76	0.14
JPYKES	-	-	-	-	-	-	-
JPYMUR	-	-	-	-	-	-	-
GBPZAR	-0.89	13.86	0.0040	-0.06	-1.20	6.65	85.77***
GBPEGP	-1.84	9.44	0.0040	-0.19	-1.65	11.86	401.72***
GBPGHS	1.31	11.07	0.0038	0.12	-1.13	4.97	36.06***
GBPZMW	8.05	17.48	0.0040	0.46	0.82	6.57	69.31***
GBPMAD	-2.04	4.19	0.0038	-0.49	-0.24	4.52	10.09***
GBPTND	-3.47	4.15	0.0038	-0.84	0.14	3.53	1.47
GBPBWP	6.25	15.82	0.0036	0.39	-0.12	5.19	14.63***
GBPNGN	3.11	9.99	0.0035	0.31	0.07	2.95	0.05
GBPKES	-	-	-	-	-	-	-
GBPMUR	-	-	-	-	-	-	-

Note: Table 3.11 reports the annualised carry trade returns and standard deviation for forty currency pairs for the pre-crisis period of 1998 to 2006. The Table also reports the skewness and kurtosis of the distribution as well as the Jarcque Bera normality test results. Data was not available for JPYKES, GBPKES and GBPMUR for this period. The researcher denotes * as significance at 10%, ** significance at 5% and ***significance at 1%.

3.5.3.3 The Crisis Period

This covers the period of global financial crisis from January 2007 through to August 2009 when many investors around the world suffered huge losses. The results (see Table 3.12) show that contrary to what was experienced in many parts of the world, carry trade profits intensified in Africa more than any period between 1998 and 2015. Eleven out of the forty currency pairs generated returns that are statistically significant. This is an indication that currencies' carry trade profits may exist in these eleven African markets during the crisis period of 2007 to 2009. These currency pairs are GBPZAR, USDEGP, EUREGP, GBPEGP, JPYKES, GBPKES, EURTND, GBPBWP, USDMUR, EURMUR and USDGHS. Apart from USDGHS and EURTND which generated negative returns over the period, the nine other currency pairs generated very attractive excess positive returns. The GBPEGP currency pair generated as high as 14.68% returns with Sharpe ratio of 1.56 within that period and many other currency pairs generated high positive excess returns, with Sharpe ratios greater than 1.00 (see Table 3.12). In addition to the eleven statistically significant profitable carry trade returns, seventeen more currency pairs, USDZAR, USDZMW, USDMAD, USDTND, EURZMW, USDKES, EURZAR, USDBWP, EURBWP, JPYEGP, JPYZMW, GBPGHS, GBPZMW, GBPMAD, GBPTND and GBPNGN, GBPMUR, posted very attractive positive returns though not statistically significant. As discussed in section 3.5.3.1, this may constitute economic evidence against the uncovered interest rate parity hypothesis which assumes zero profits in the carry trade strategy.

The returns are characterised by negative skewness and large excess kurtosis which is a signal for crash risk or downside risk. The study concludes that currency carry trade in emerging and frontier markets is a financial crisis phenomenon and thrives very well when there is economic downturn around the world. Since the failure of the uncovered interest parity is an anomaly and occurs as a result of market inefficiencies, then the evidence of this study shows that African currency carry trade takes advantage of market inefficiencies. The performance of the African currency carry trade during the financial crisis could be explained by the correlation that exists between the African markets and the world market. Most African markets, like other developing markets, appear to yield negative correlation with the world (Alagidede, 2008). Indeed, the African markets have been said to be a significant separate asset class and a good one for diversification purposes. The continent has been tipped to follow Asia in the next wave of development (Boako and Alagidede, 2016). Again, most African markets are not strongly integrated with the world, except for the few emerging ones, whose degree of integration is far from perfect (Aawaar, 2017). This study documents again that currency carry trade is a short term strategy and profit opportunity closes up when the market reestablishes equilibrium after economic distress or market inefficiencies.

Table 3.12: Crisis Period Carry Trade Returns

		Crisis Period [2007-2009]					
Currency	**Return**	**Standard Deviation**	**Risk-Free Rate**	**Sharpe Ratio**	**Skewness**	**Kurtosis**	**Jarcque Bera**
USDZAR	4.51	17.01	0.0019	0.26	-1.27	7.56	**40.92*** **
USDEGP	7.78***	2.40	0.0019	3.24	-0.93	4.09	6.95***
USDGHS	-1.59*	6.68	0.0019	-0.24	-0.23	3.09	0.34
USDZMW	8.52	16.20	0.0019	0.53	-1.14	5.17	14.80***
USDMAD	3.04	7.85	0.0019	0.39	-0.74	3.97	4.70*
USDTND	1.77	7.44	0.0019	0.24	-0.80	3.45	4.15
USDBWP	7.14	13.18	0.0019	0.54	-0.58	4.28	4.45
USDNGN	-1.14	10.69	0.0019	-0.11	-2.77	11.33	150.18***
USDKES	1.96	10.68	0.0019	0.18	0.36	3.07	0.79
USDMUR	6.42*	10.68	0.0019	0.60	-1.59	7.02	39.49***
EURZAR	3.03	13.96	0.0036	0.22	-0.65	4.17	4.56
EUREGP	6.47**	8.75	0.0036	0.74	0.37	2.93	0.83
EURGHS	-4.73	11.31	0.0036	-0.42	0.09	3.18	0.10
EURZMW	5.38	15.26	0.0036	0.35	-1.78	8.83	70.01***
EURMAD	-0.10	1.73	0.0036	-0.06	0.64	2.96	2.49
EURTND	-1.36***	3.01	0.0036	-0.45	0.49	3.96	2.85
EURBWP	4.84	9.72	0.0036	0.50	0.35	3.58	1.25
EURNGN	-3.42	17.28	0.0036	-0.20	-2.14	13.77	201.19
EURKES	-2.05	12.99	0.0036	-0.16	-0.73	3.54	3.65
EURMUR	4.32**	9.29	0.0036	0.47	-0.70	10.37	10.37***
JPYZAR	-2.91	22.13	0.0004	-0.13	-1.50	7.38	42.42***
JPYEGP	0.53	9.95	0.0004	0.05	-0.59	2.89	2.13
JPYGHS	-8.66	10.67	0.0004	-0.81	-0.36	2.63	1.00
JPYZMW	1.46	21.50	0.0004	0.07	-1.50	6.09	27.87***
JPYMAD	-4.03	11.57	0.0004	-0.35	-1.38	7.04	35.92***
JPYTND	-5.29	11.08	0.0004	-0.48	-1.27	6.21	25.05***
JPYBWP	-0.26	19.21	0.0004	-0.01	-0.98	5.52	15.26***
JPYNGN	-8.61	15.91	0.0004	-0.54	-1.18	6.97	31.96***
JPYKES	6.86**	17.03	0.0004	0.40	-1.00	4.68	10.20***
JPYMUR	-0.76	16.56	0.0004	-0.05	-2.03	10.33	105.38***
GBPZAR	11.25**	13.84	0.0032	0.81	-1.06	4.87	11.93***
GBPEGP	14.68***	9.44	0.0032	1.56	0.55	4.78	6.60***
GBPGHS	4.01	11.55	0.0032	0.35	0.20	2.86	0.26
GBPZMW	14.13	13.33	0.0032	1.06	-0.80	3.20	3.91
GBPMAD	8.64	7.69	0.0032	1.12	0.98	4.88	11.13***
GBPTND	7.38	7.27	0.0032	1.01	0.19	3.72	0.99
GBPBWP	1.36**	11.46	0.0032	0.12	1.33	7.31	38.53***
GBPNGN	4.90	13.61	0.0032	0.36	0.41	4.73	5.53**
GBPKES	7.65**	15.63	0.0032	0.49	-0.50	2.95	1.48
GBPMUR	12.44	11.80	0.0032	1.05	0.03	3.15	1.15

Note: Table 3.12 reports the annualised carry trade returns and standard deviation for forty currency pairs for the global financial crisis period (2007 to 2009). The Table reports the skewness and kurtosis of the distribution as well as the Jarcque Bera normality test results. The researcher denotes * as significance at 10%, ** significance at 5% and ***significance at 1%.

3.5.3.4 The Post Crisis Period

Currency carry trade is predominantly profitable in the post-financial crisis period, as presented by Table 3.13. This is the last sub-sample and it looks at the period just after the global financial crisis in the period September 2009 to December 2015. The results show that nine out of the forty currency pairs are generating statistically significant carry trade profits and all of them except GBPZAR and USDZAR are generating positive excess return, an indication that carry trade profits existed in those currencies during this period.

The instance of the two currency pairs which were statistically significant but produced negative returns is supported in the academic literature, which notes that the failure of the UIP does not always imply currency carry trade profits (Olmo and Pilbeam, 2009). The statistically significant currency pairs are USDZAR, EURZAR, JPYZAR, EGPZAR, JPYEGP, USDKES, JPYKES, EURMUR and JPYMUR. Moreover, there are twenty six more currency pairs which posted excess positive returns but were not statistically significant meaning that the UIP hypothesis could not be rejected. These however, could be considered profitable, as argued by Burnside (2015), i.e. that the profits generated is enough economic evidence against the holding of the UIP. These statistically insignificant but profitable currency pairs are USDEGP, USDGHS, USDZMW, USDMAD, USDMUR, EUREGP, EURZMW, USDBWP, EURGHS, EURMAD, EURTND, EURBWP, EURKES, JPYGHS, JPYZMW, JPYMAD, JPYTND, JPYBWP, JPYNGN, GBPEGP, GBPGHS, GBPZMW, GBPMAD, GBPBWP, GBPKES and GBPMUR.

The high profits level of carry trades within this period is consistent with the researcher’s conclusions in section 3.5.3.3 for two reasons. One, this period marks the regime that was just coming out of the global financial crisis and, for that matter, the market was adjusting to equilibrium. Two, this process of equilibrium adjustment was again disturbed by the recent European debt crisis popularly referred to as the Eurozone crisis which started since the end of 2009. Several Eurozone countries such as Portugal, Ireland, Spain, Greece and Cyprus were caught up in this economic quagmire and needed bailing out to survive. These happened alongside relatively lower interest rates in Europe compared with generally high interest rate in African markets. This, inter alia, caused the British to vote on June 23, 2016 to exit the European Union (popularly referred to as BREXIT). Thus the spillover effect of the Eurozone crisis could account for the attractiveness of currency carry trade in Africa’s emerging and frontier markets. It is however important to note that these seemingly attractive currency carry trade profits are also plagued with high volatility of exchange rates, negative skewness and large excess kurtosis, even though a few of the returns show positive skewness (see Table 3.13). The Jarcque-Bera statistic confirms the position of skewness and excess kurtosis since it is significant for a number of the returns, meaning that the returns are not normally distributed.

Table 3.13: Post-Crisis Period Carry Trade Returns

		Post-Crisis [2009-2015]					
Currency	**Return**	**Standard Deviation**	**Risk-Free Rate**	**Sharpe Ratio**	**Skewness**	**Kurtosis**	**Jarcque Bera**
USDZAR	-2.02***	11.20	0.0001	-0.18	0.41	4.20	7.27***
USDEGP	3.22	3.56	0.0001	0.90	-3.06	16.76	784.18***
USDGHS	2.58	13.09	0.0001	0.20	1.51	11.54	283.61***
USDZMW	0.48	15.01	0.0001	0.03	-1.65	11.78	304.32***
USDMAD	0.03	6.45	0.0001	0.00	-0.20	3.39	1.06
USDTND	-1.96	6.16	0.0001	-0.32	-0.12	3.06	0.21
USDBWP	3.50	10.54	0.0001	0.33	-0.38	4.07	5.91*
USDNGN	-3.11	5.90	0.0001	-0.53	-1.28	6.22	58.64***
USDKES	4.26**	8.96	0.0001	0.48	0.38	4.46	9.36***
USDMUR	0.45	8.13	0.0001	0.06	-0.27	4.79	12.10***
EURZAR	0.78***	11.01	0.0025	0.07	-0.11	3.60	1.43
EUREGP	6.02	8.31	0.0025	0.72	-0.26	3.67	2.46
EURGHS	5.83	15.41	0.0025	0.38	1.42	9.08	155.82***
EURZMW	3.73	15.33	0.0025	0.24	-1.80	11.89	318.25***
EURMAD	3.29	1.77	0.0025	1.86	0.44	4.12	6.97***
EURTND	1.30	3.84	0.0025	0.34	0.80	4.34	15.17***
EURBWP	6.32	8.67	0.0025	0.73	-0.22	4.07	4.64*
EURNGN	-0.87	10.77	0.0025	-0.08	-0.15	3.32	0.68
EURKES	7.15	12.20	0.0025	0.59	0.97	5.77	39.35***
EURMUR	3.27*	7.28	0.0025	0.45	-0.11	3.38	0.69
JPYZAR	1.88**	13.62	0.0001	0.14	-0.12	3.90	3.01
JPYEGP	7.12***	7.64	0.0001	0.93	0.57	3.53	5.53*
JPYGHS	7.32	15.25	0.0001	0.48	1.07	6.58	60.00***
JPYZMW	5.22	16.75	0.0001	0.31	-1.76	10.72	248.71***
JPYMAD	4.78	12.98	0.0001	0.37	0.28	3.55	2.15
JPYTND	2.79	8.60	0.0001	0.32	0.26	3.62	2.28
JPYBWP	8.08	13.42	0.0001	0.60	0.00	3.28	0.27
JPYNGN	1.07	10.77	0.0001	0.10	0.48	3.23	3.41
JPYKES	8.94***	12.54	0.0001	0.71	0.39	2.88	2.20
JPYMUR	5.07**	10.73	0.0001	0.47	-0.21	4.05	4.42
GBPZAR	-1.75***	10.22	0.0003	-0.17	0.28	3.27	1.33
GBPEGP	3.49	7.21	0.0003	0.48	-0.21	2.78	0.78
GBPGHS	2.30	15.34	0.0003	0.15	1.14	7.17	78.21***
GBPZMW	0.20	14.72	0.0003	0.01	-1.37	10.37	213.72***
GBPMAD	0.24	5.27	0.0003	0.05	0.35	3.04	1.71
GBPTND	-2.23	5.83	0.0003	-0.38	0.02	2.55	0.70
GBPBWP	3.19	9.21	0.0003	0.35	0.02	3.74	1.89
GBPNGN	-3.40	9.66	0.0003	-0.35	-0.33	3.25	1.77
GBPKES	4.22	10.40	0.0003	0.41	1.17	8.10	109.16***
GBPMUR	0.37	7.60	0.0003	0.05	-0.16	2.90	0.38

Note: Table 3.13 reports the annualised carry trade returns and standard deviation for forty currency pairs for the post-crisis period of September 2009 to December 2015. The Table reports the skewness and kurtosis of the distribution as well as the Jarcque Bera normality test results. The researcher denote * as significance at 10%, ** significance at 5% and ***significance at 1%.

3.5.4 Currency Carry Trade Portfolio

Table 3.14 presents summary statistics of the selected currency carry trade portfolios using African currencies as target currencies against USD, GBP, EUR and JPY as funding currencies. The researcher constructs four different and independent portfolios of African currency carry trade for the full sample data (1998 to 2015), pre-crisis period (1998-2006), the financial crisis period (2007-2009)[8], and the post-crisis period (2009-2015)[9]. The criterion for the inclusion of individual currency pairs in the African currency carry trade portfolios is the simple deviation of the uncovered interest parity (i.e. the currency pairs with statistical evidence against the UIP). Thus the researcher selects all the currency pairs whose β parameter estimates are significantly less than unity and the UIP hypothesis is rejected, regardless of whether the naïve calculation generates losses or profits. The researcher includes all the statistically significant negative returns in the portfolio in order to avoid bias or overestimation of portfolio returns. The full sample currency pairs are EURZAR, JPYZAR, GBPKES, EURTND, JPYMUR and GBPMUR. Pre-crisis contained only 3 currency pairs (EURZAR, JPYZAR and USDTND) out of the forty pairs, whiles 11 currency pairs (GBPZAR, USDEGP, EUREGP, GBPEGP, JPYKES, GBPKES, EURTND, GBPBWP, USDMUR, EURMUR and USDGHS) were included in the crisis period. The post-crisis included 9 currency pairs (USDZAR, EURZAR, GBPZAR, JPYEGP, USDKES, JPYKES, EURMUR and JPYMUR). For the purposes of this study the researcher calls this portfolio 'African FX Carry Trade Portfolio'. Note that this portfolio assumes different and independent sets of currency pairs for the four different regimes being studied and so should not be misconstrued to mean the performance of the same basket of currencies over time. The researcher constructed equally weighted portfolios for the regimes the researcher is looking at in this study, which is known to give better results in optimal portfolio selection (DeMiguel et al., 2009). The researcher's portfolio is then compared to returns of the Morgan Stanley Capital International Index and Deutsche Bank G10 FX Carry Trade Index as the benchmark investment for the various regimes.

Panel A in Table 3.14 shows full sample summary statistics of the African FX Carry Trade Portfolio, the MSCI World Index, and the Deutsche Bank G10 FX Carry Trade Index. The African currency carry trade portfolio performed poorly against the stock market index, even though it generated positive excess return over the period. The African currency carry trade portfolio nevertheless outperformed the G10 FX Carry Trade Index, generating a return of 1.22% with a Sharpe ratio of 0.11 as against the -0.12% and a Sharpe ratio of -0.01 of G10 FX Carry Trade Index.

[8] The period covers January 2007 through to August 2009.
[9] This period spans from September 2009 to December 2015.

Table 3.14: Carry Trade Portfolio Returns and Benchmark Investment

Portfolio and Benchmark	Retuns	Std Deviation	Risk-Free Rate	Sharpe Ratio	Skewness	Kurtosis	Jarcque-Bera
Panel A: Full Sample [1998-2015]							
African FX Carry Portfolio	1.22	11.59	0.0017	0.11	-1.02	9.34	1827.83***
MSCI World Index	3.02	16.49	0.0017	0.18	-0.93	5.25	76.46***
G10 FX Index	-0.12	8.86	0.0017	-0.01	-1.01	6.19	114.15***
Panel B: Pre-Crisis Period [1998-2006]							
African FX Carry Portfolio	2.00	11.79	0.0028	0.17	-1.06	6.59	226.28***
MSCI World Index	5.19	14.93	0.0028	0.35	-0.81	4.09	17.04***
G10 FX Index*	4.06	5.98	0.0028	0.68	-0.61	3.02	5.23*
Panel C: Crisis Period [2007-2009]							
African FX Carry Portfolio	6.46	11.17	0.0019	0.58	-0.76	7.16	323.50***
MSCI World Index	-8.65	23.43	0.0019	-0.37	-0.94	4.33	8.00**
G10 FX Index	-6.79	12.67	0.0019	-0.54	-1.16	5.14	14.90***
Panel D: Post Crisis Period [2009-2015]							
African FX Carry Portfolio	3.06	10.54	0.0001	0.29	0.12	4.17	44.61***
MSCI World Index	9.43	15.75	0.0001	0.60	-0.27	3.31	1.35
G10 FX Index	1.11	9.34	0.0001	0.12	-0.20	3.25	0.77

Note:*The G10 FX Index sample starts from 2000 and therefore does not include the years 1998 and 1999. Table 3.14 reports the summary statistics of the returns of the African currency carry trade portfolio. The US Treasury bill is used as a proxy for risk-free rate return. Four portfolios are constructed to compare with the benchmark asset classes, namely, the Morgan Stanley Capital All Country World Index (MSCI World Index) and the Deutsche Bank G10 FX Carry Trade Index. Panel A shows Africa's portfolio generated from the full sample test of UIP. This consists of six currency pairs found to be significantly profitable by the Fama regression equation; ZAREUR, ZARJPY, KESGBP, TNDEUR, MURJPY and MURGBP. Panel B shows the African FX Carry Portfolio generated from the period before the financial crisis of 2007 and also compares with the performance of the stock market and the realised carry trade returns within the same period. Panel C, looks at the period of the financial crisis (i.e. January 2007 to August 2009) and Panel D looks at the period after the financial crisis (i.e. September 2009 to December 2015). *** indicates significance at 1%, ** as significance at 5% and * as 10% significance level.

It is important to note that the African FX Carry Trade portfolio has a more negatively skewed and large excess kurtosis distribution, as confirmed by the Jarcque-Bera statistic, than the stock market index and carry trade index. The heavier tailed distribution (excess kurtosis) and the negative skewness is an indication that our African FX portfolio is associated with sudden downside or crash risk. This is consistent with studies in the extant literature (M. Brunnermeier et al., 2008; Burnside, 2011; Burnside et al., 2010, 2006b).

Table 3.14, Panel B presents the returns of the portfolios for the period prior to the global financial crisis. The African FX Carry Trade performed poorly relative to the two benchmark indices. Though the African FX Carry Trade portfolio generated excess positive return of 2% with a Sharpe ratio of 0.17, the MSCI Index generated a return of 5.19% with a Sharpe ratio of 0.35, and the G10 FX Index generated 4.06% with an impressive Sharpe ratio of 0.68. The Sharpe ratio is the measure of the returns of asset adjusted for risk. Thus the ratio represents excess return per unit of risk; the higher the ratio the better in terms of profitability. It therefore follows that the Sharpe ratio of 0.68 for the G10 FX Index and 0.17 for African FX Carry Trade in Table 3.14 represent the most and the least profitable respectively on risk-adjusted basis. In addition to the fact that the African FX Carry Trade performed poorly, it also has a more negatively skewed and larger excess kurtosis in return distribution than the two benchmark indices which implies that the African FX carry portfolio is much more risky (downside risk). This is consistent with the view in the literature that the currency carry trade is not a compensation for taking risk by the market participants, since it is uncorrelated with traditional risk factors (Burnside et al., 2007).

Panel C in Table 3.14 presents the summary statistics of African FX Carry Trade during the period of the global financial crisis. The results show here that currency carry trade in Africa's emerging and frontier markets booms during periods of global economic downturn. Whereas the two benchmark indices were simply on their knees during the period of financial crisis, the African FX Carry Trade portfolio generated a very impressive 6.46% with a Sharpe ratio of 0.58, which is far higher than that of the two benchmark indices (generating negative returns) and the historical S&P average Sharpe ratio of 0.45 in the literature (Moosa, 2008). The returns for all the three asset classes exhibit negative skewness and excess kurtosis. Interestingly, the carry trade portfolio, which is the highest performing asset within the period, has a lower standard deviation and lower negative skewness but slightly larger excess kurtosis. This means that the carry trade portfolio, although exhibiting crash risk (negative skewness), that risk may not be as intense as the stock market index and G10 FX Carry Trade Index, but the fatter tails (kurtosis) is an indication that there could be a sharp or abrupt crash of the returns. According to the extant literature, these characteristics are usually associated with currency carry trade.

Panel D in Table 3.14 considers the returns for the various portfolios for the period just after the global financial crisis. The researcher reports that African FX Carry Trade Portfolio again generated excess positive returns of 3.06% with a Sharpe ratio of 0.29, which was a better performance than the G10 FX Carry Trade Index. The stock market index however generated 9.43% (highest over the period) with a Sharpe ratio of 0.60, which is higher than the African FX Carry Trade Portfolio. This is also consistent with the view in literature that carry trade cannot outperform the stock market all the time (Moosa, 2008). Interestingly, the African FX carry trade portfolio is exhibiting positive skewness and moderately excess kurtosis, whereas the benchmark indices are showing negative skewness, though near zero and normally distributed, as explained by the Jarcque-Bera statistics. This positive skewness distribution (long right tail) of the African FX carry trade means that frequent small negative carry trade returns and downside risk or peso events are less likely to occur, as opposed to the negative skewness. Thus if this trend continues into the future, the implication would be that the African FX carry trade will generate sustainable attractive risk-adjusted profits.

Finally, it should be noted that the researcher only made use of the statistically significant currency pairs for the construction of the African FX carry trade portfolios, which included some negative returns. The study ignores the profitable but statistically insignificant currency pairs in the formulation of the portfolio. Given that these statistically insignificant profitable currency carry trades dominate and record very attractive returns with relatively low standard deviation, if they were included in the African FX carry trade portfolios, it had the potential of enhancing their performance. On the other hand, this study made use of mid-rate of exchange for the currency pairs instead of bid and offer rate. Thus if the bid and offer rate were to be employed instead of the mid-rate used, the returns of the African FX carry trade portfolios were likely to be lower than reported (see subsection 3.5.5). Also, as noted in the works of Burnside et al. (2006) and Moosa (2008), the stock market benchmark indices that were used only reflect the capital gains but not the dividends that may be distributed to investors. Thus if all these factors are considered perhaps the results would be different. In the next section, the researcher analyses the impact of bid and ask may have on Fama's regression results.

3.5.5 What Drives African Carry Trade Returns?

Theoretically, carry trade returns are associated with the failure of the uncovered interest parity condition as established in section 3.1, though the failure does not necessarily culminate in profits all the time. On the account of the foregoing discussion where the naïve carry trade calculation has produced some profits and losses over the period of 1998 to 2015, it would be interesting to examine the key drivers of these returns. This section examines graphically, how interest rate differential and exchange rate movements influenced carry trade returns over the period. Figure 3.1 present line graphs which compare the movements in the carry trade returns with that of the interest rate differentials for all the forty currency pairs in this study whilst Figure 3.2 compares carry returns with exchange rate movements for the same currency pairs.

In Figure 3.1, the vertical axis on the left handside measures the interest rate differentials (blue in colour) between ten African countries and the four developed countries used for the study. The vertical axis on the right handside on the other hand measures the currency carry trade returns (red in colour) generated for the respective currency pairs over the period of 1998-2015. Generally, both interest differentials and the carry trade returns for all the forty currency pairs appear to be volatile over the period under consideration.

Figure 3.1: Interest Rate Differentials vs. Carry Trade Returns

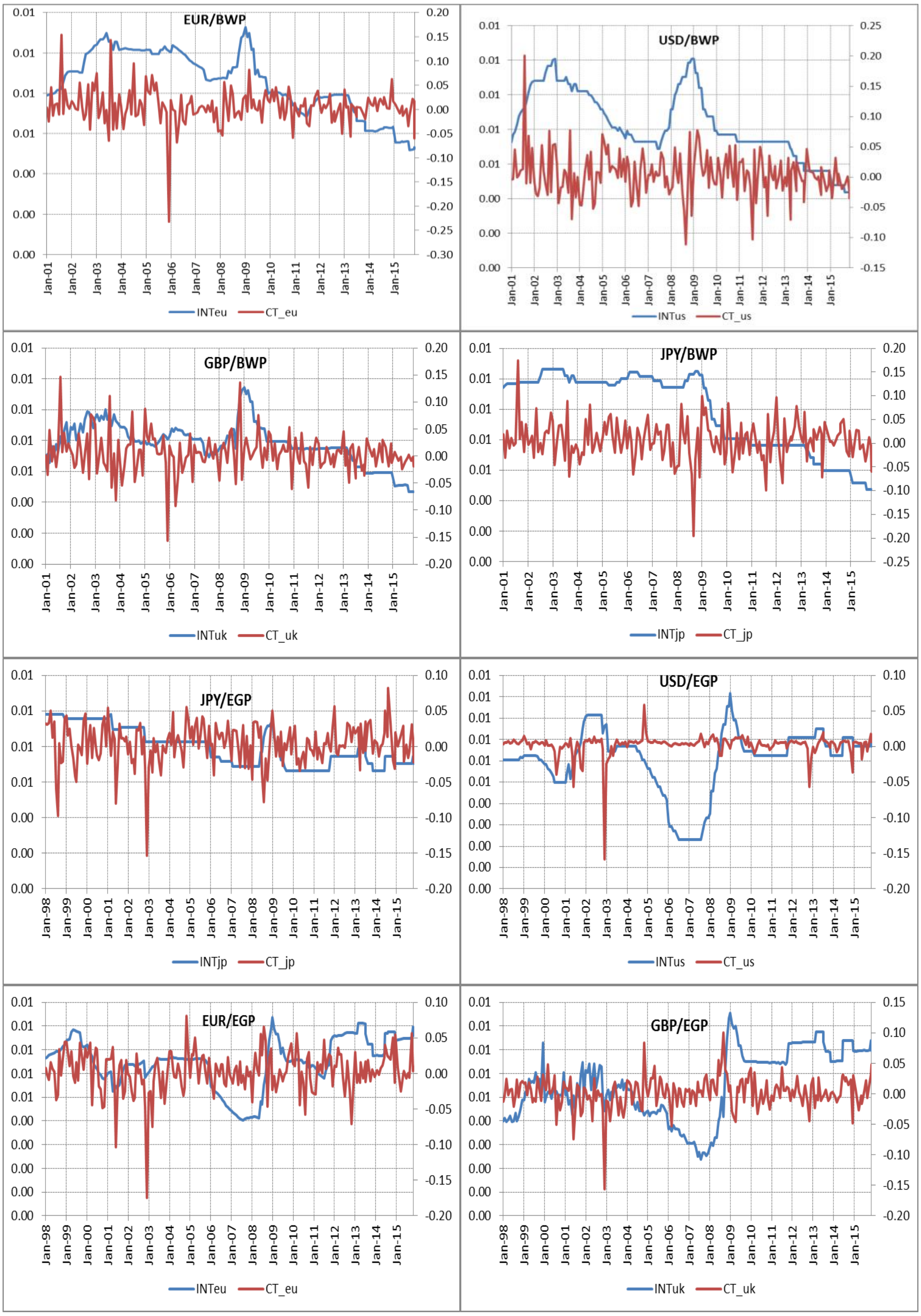


Figure 3.1: Continue

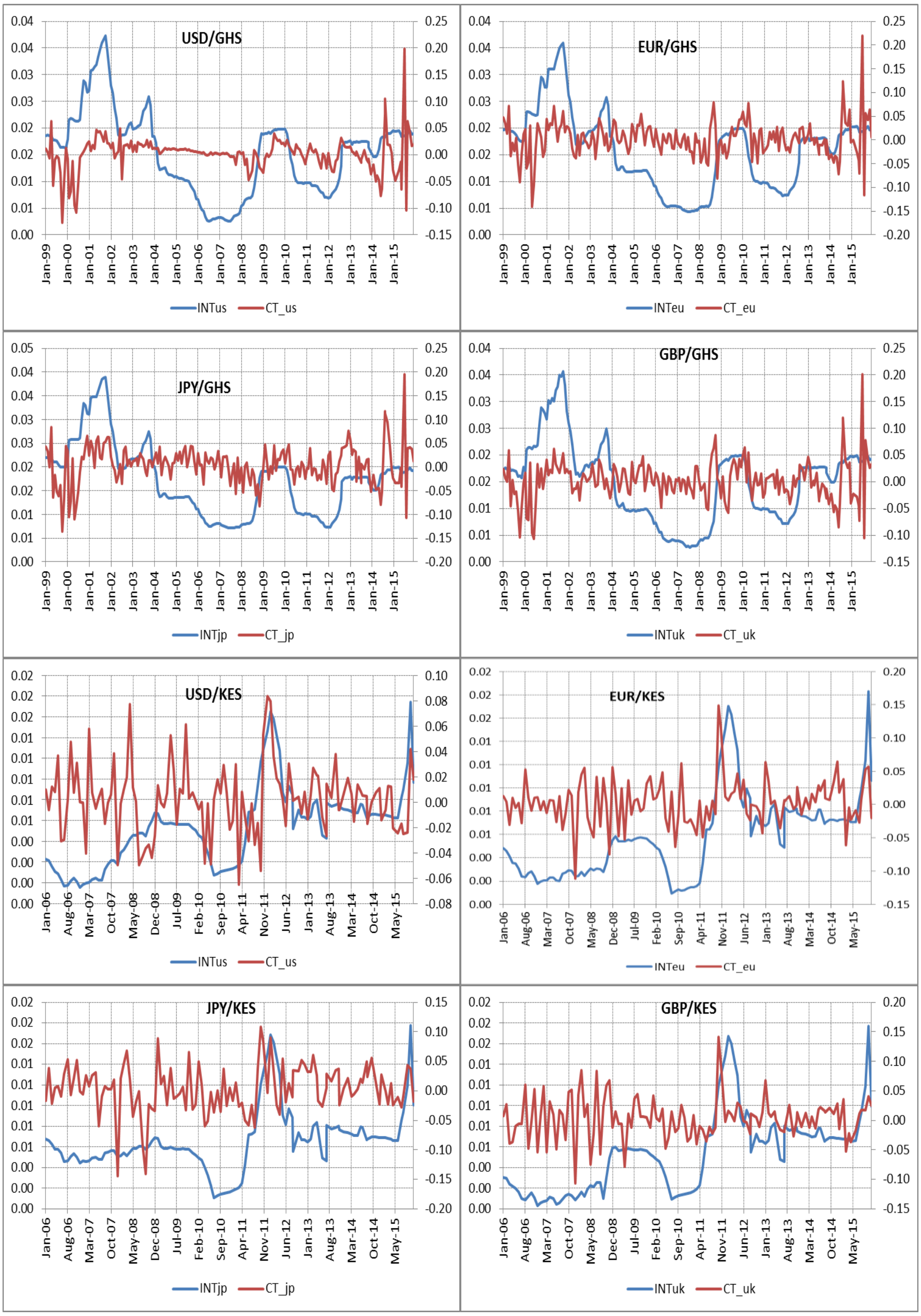


Figure 3.1: Continue

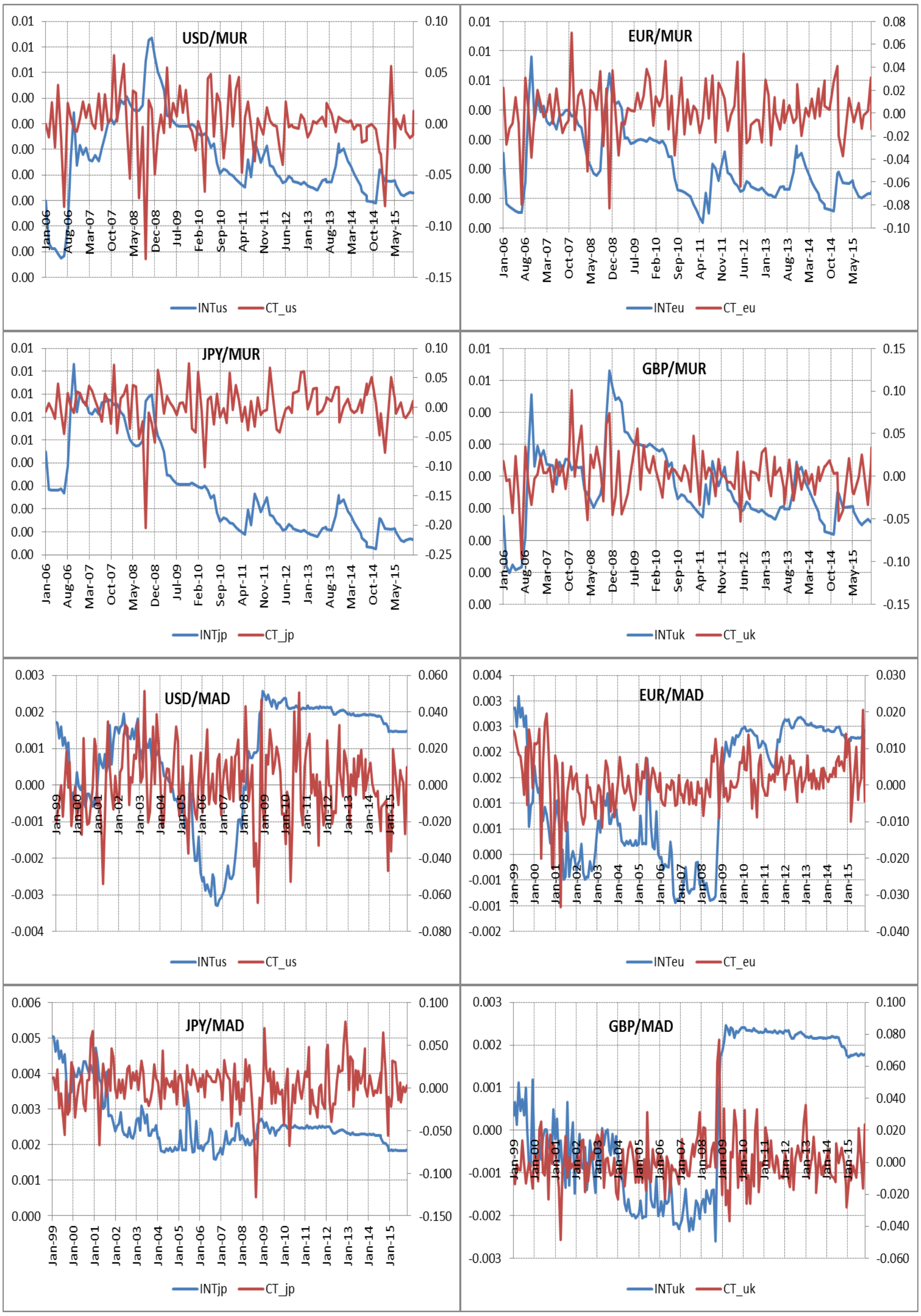


Figure 3.1: Continue

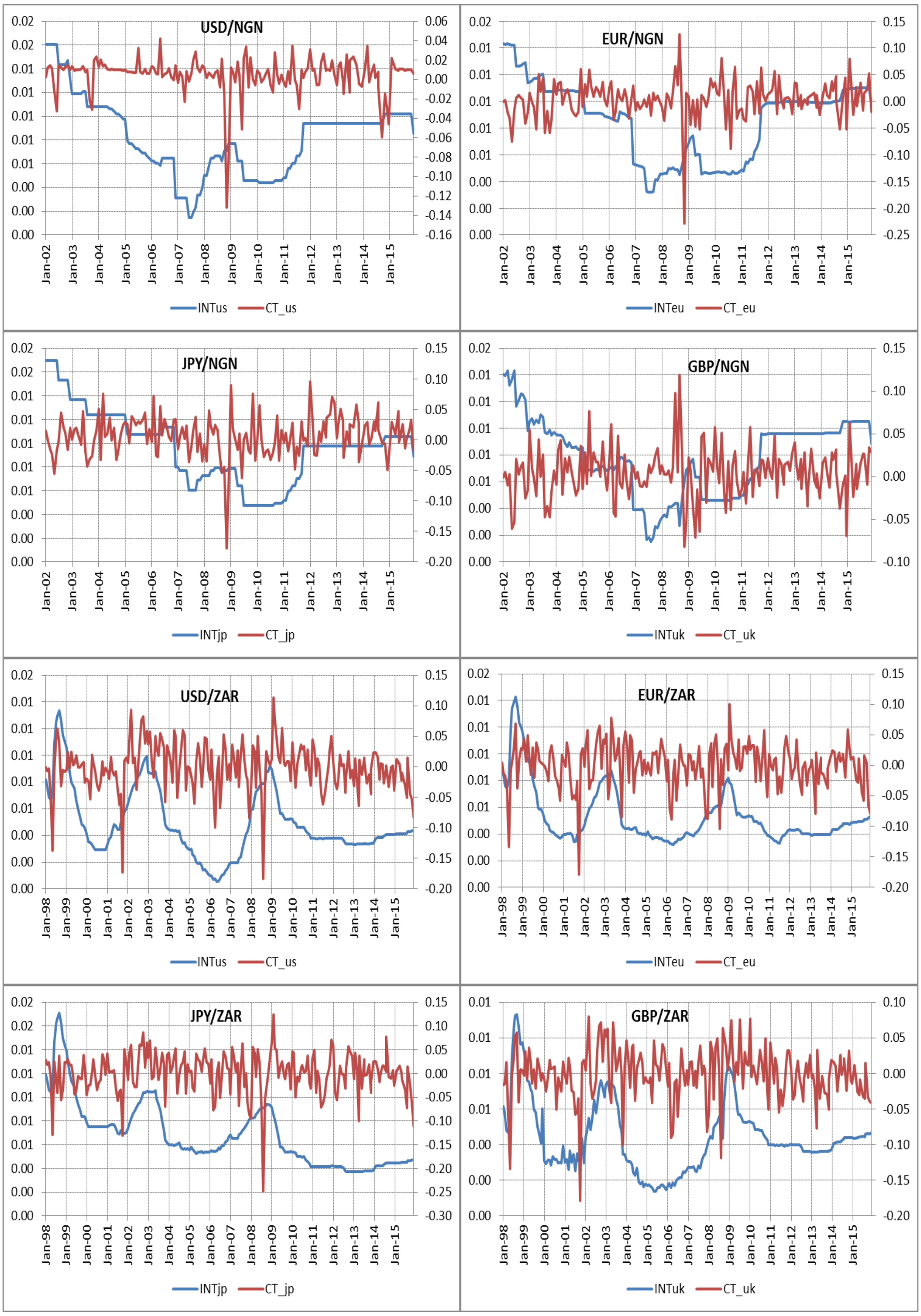
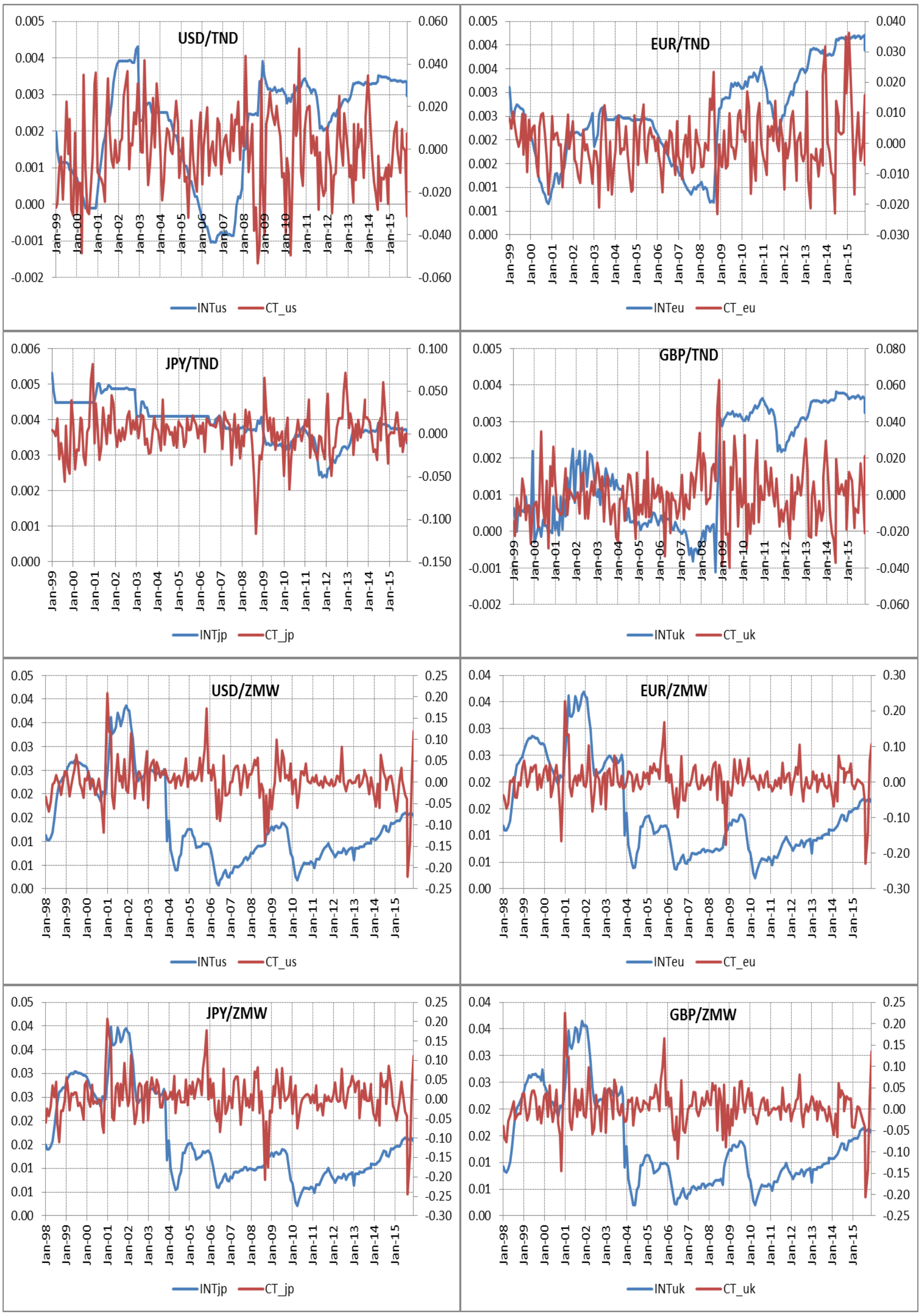


Figure 3.1: Continue



A cursory look at Figure 3.1 reveals that the interest rate differential for virtually all the forty currency pairs reflect a marginal influence on the variabilities in the carry trade returns. The spikes and troughs of the currency carry trade returns do not follow the patterns in the interest rate differentials over the period. A case in point is on January 2006 of EUR/BWP currency pair where the currency carry trade returns decline sharply at a time that interest differential is actually increasing and many of such instances are recorded across the forty currency pairs. Similiarly, most the currency pairs in Figure 3.1 exhit increases in the returns of the currency carry trade at the time when the interest differential is actually declining. However it can also that observed that the interest differentials drive a handful of the currency pairs. For instance in the early months of JPY/ZMW and at the later months of GBP/TND, the influence of the interest differential on the carry trade returns is quite prominent.

In Figure 3.2 the vertical axis to the right measures the carry trade returns (red in colour) whilst the vertical axis to the left measures the exchange rate movements (blue in colour). The exchange rate movements measure the change in exchange rate over the investment horizon. Thus negative change (trough) represents the appreciation of the target currency (i.e. African currencies) and positive change (spike) represents depreciation of the target currency. According to the UIP the target currency must depreciate in order to wipe out the arbitrage benefits inherent in the interest differentials. The target currency appreciation therefore is a further boost to the carry trade profit (i.e. interest differential widens). It could be observed from Figure 3.2 that the carry trade returns move in exact opposite with the foreign exchange movements. Spikes (depreciation) in foreign exchange movements cause deep troughs or decline in carry trade returns. Similarly, sharp decline (troughs) in foreign exchange movements (appreciation) is associated with sharp increases in carry trade returns. This trend is observed across all the forty currency pairs in the study.

On the basis of the foregoing discussion, it is safe to conclude that the carry trade returns of Africa's emerging and frontier markets are influenced more by the exchange rate movements than the interest rate differentials. This is consistent with the uncovered interest parity condition well document in the academic literature.

Figure 3.2: Exchange Rate Movements vs. Carry Trade Returns

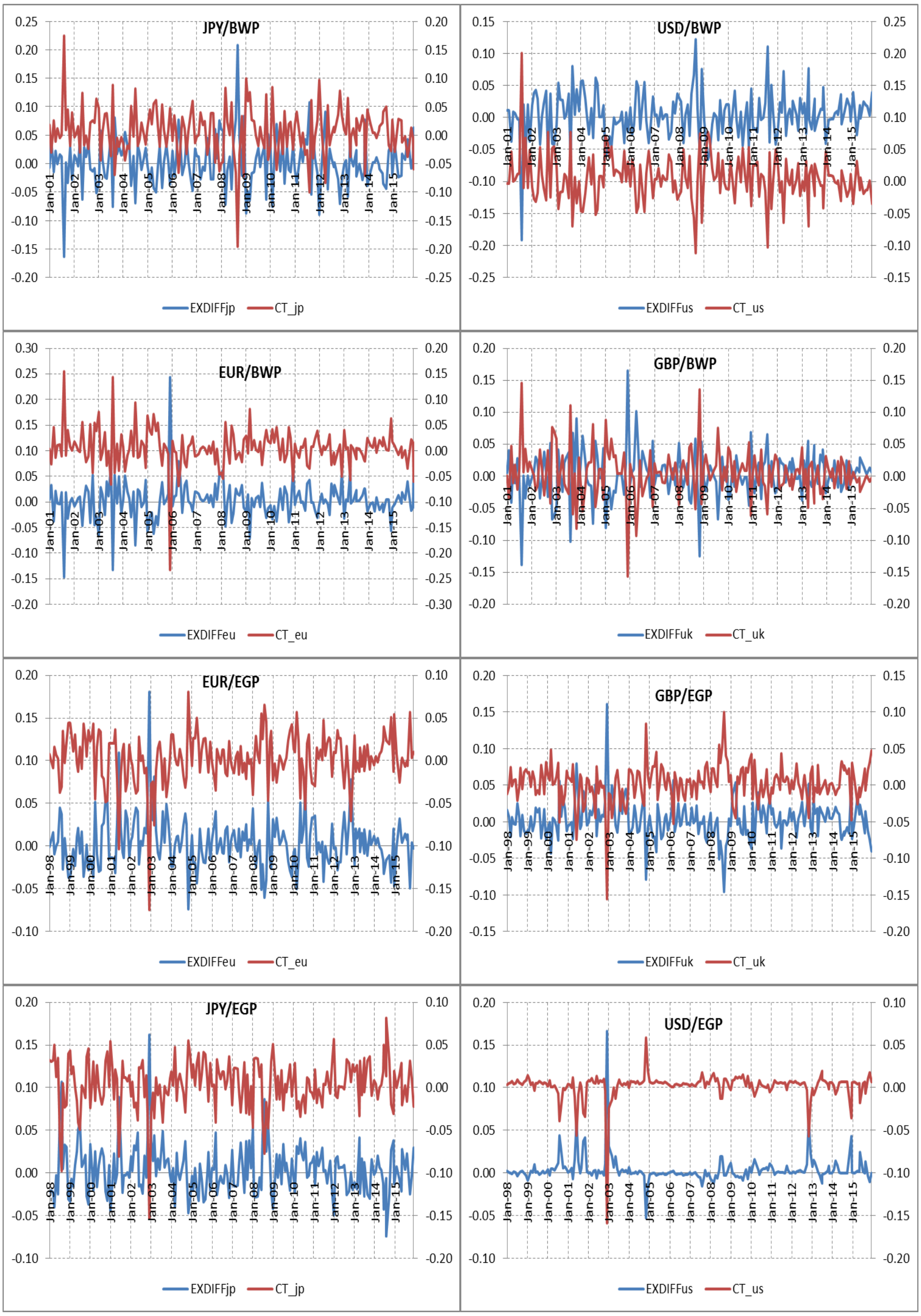


Figure 3.2: Continue

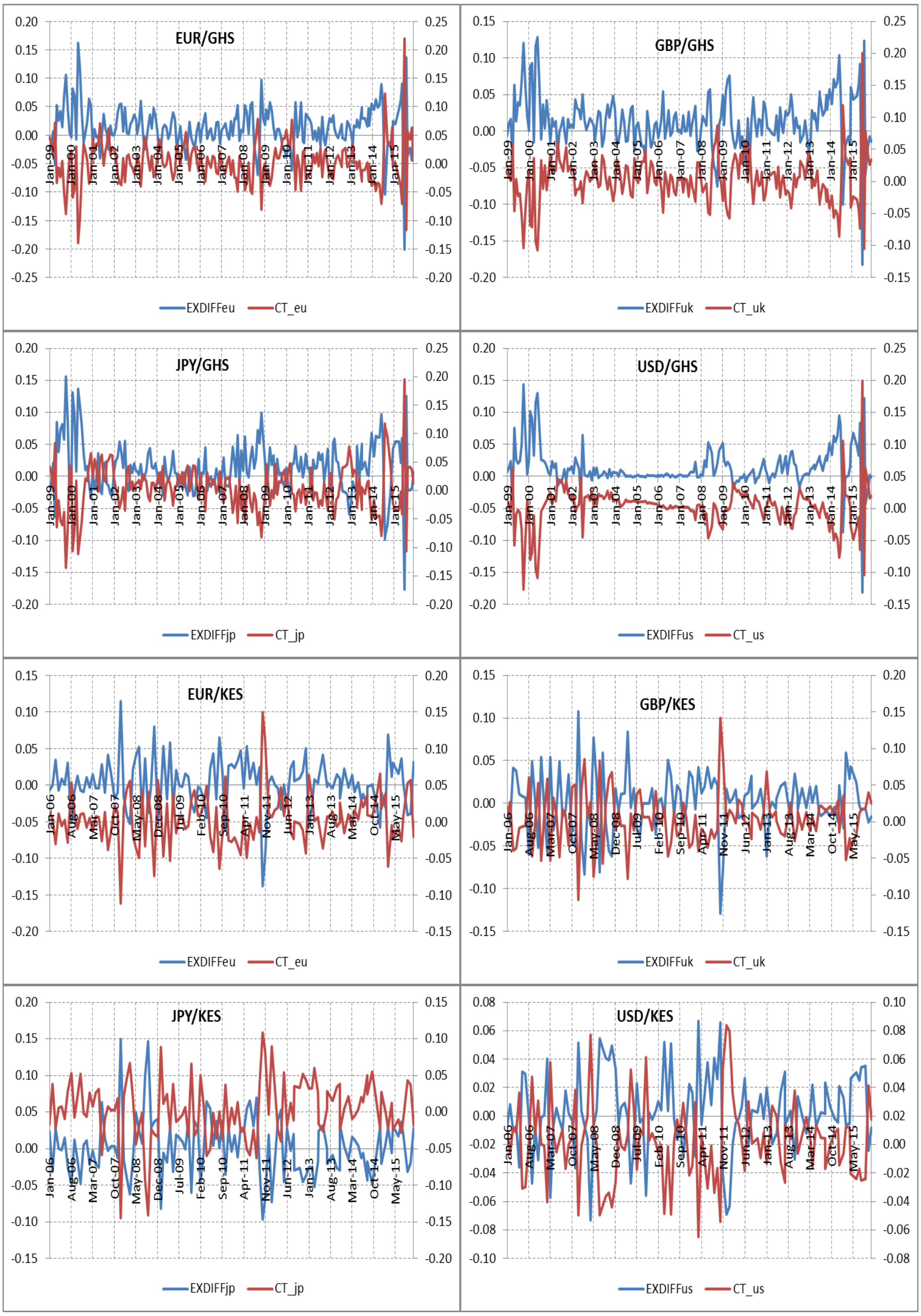
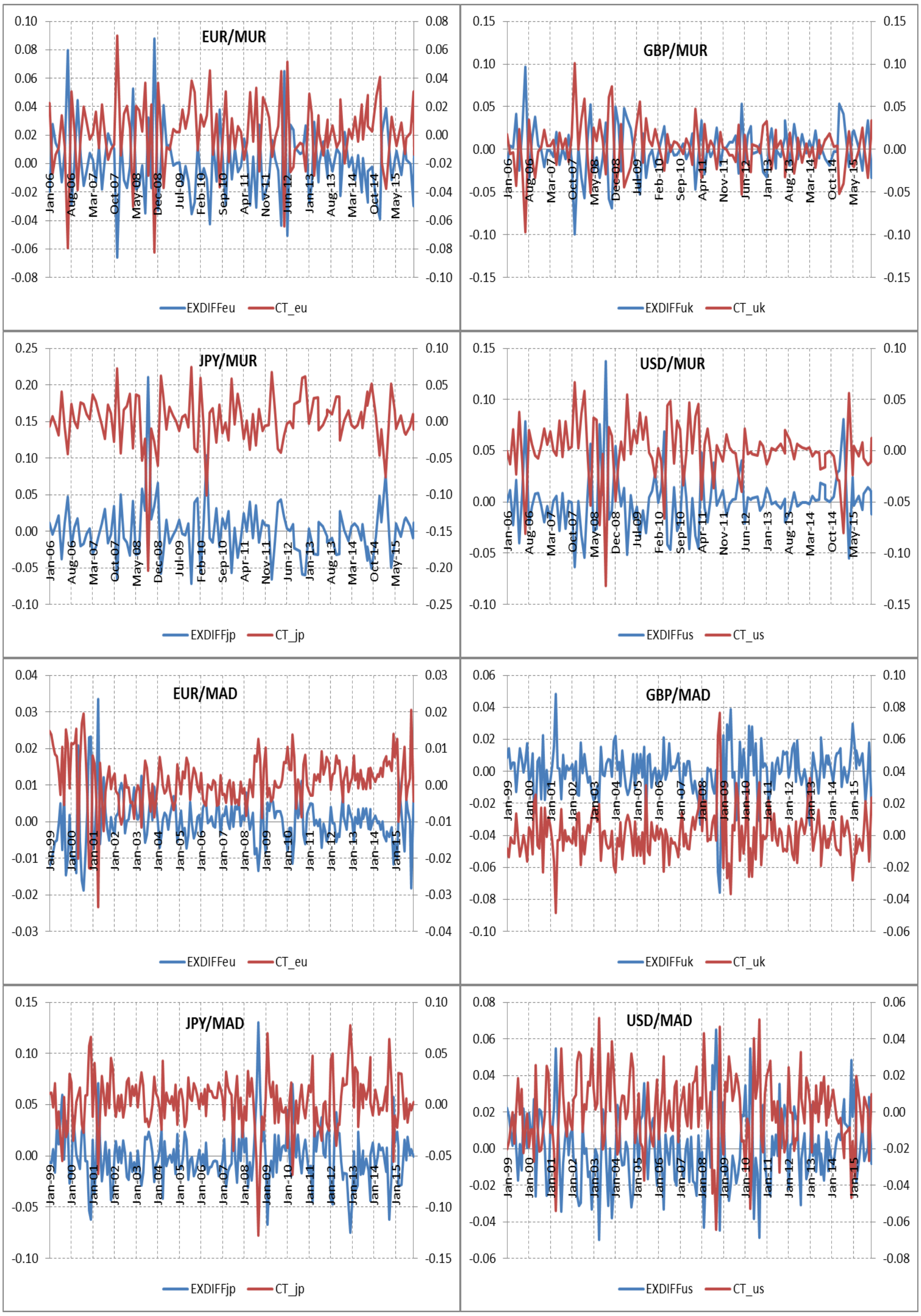


Figure 3.2: Continue



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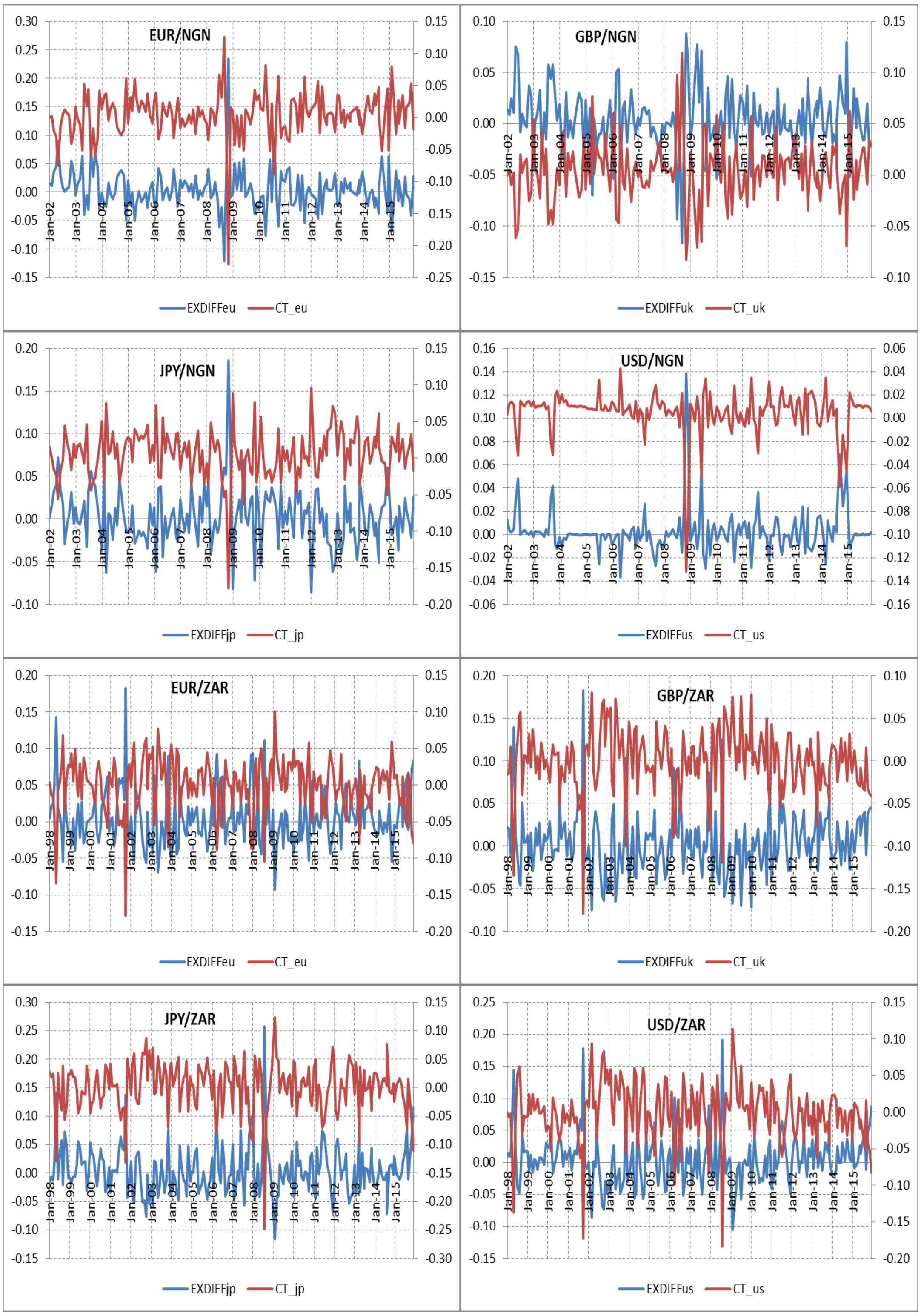
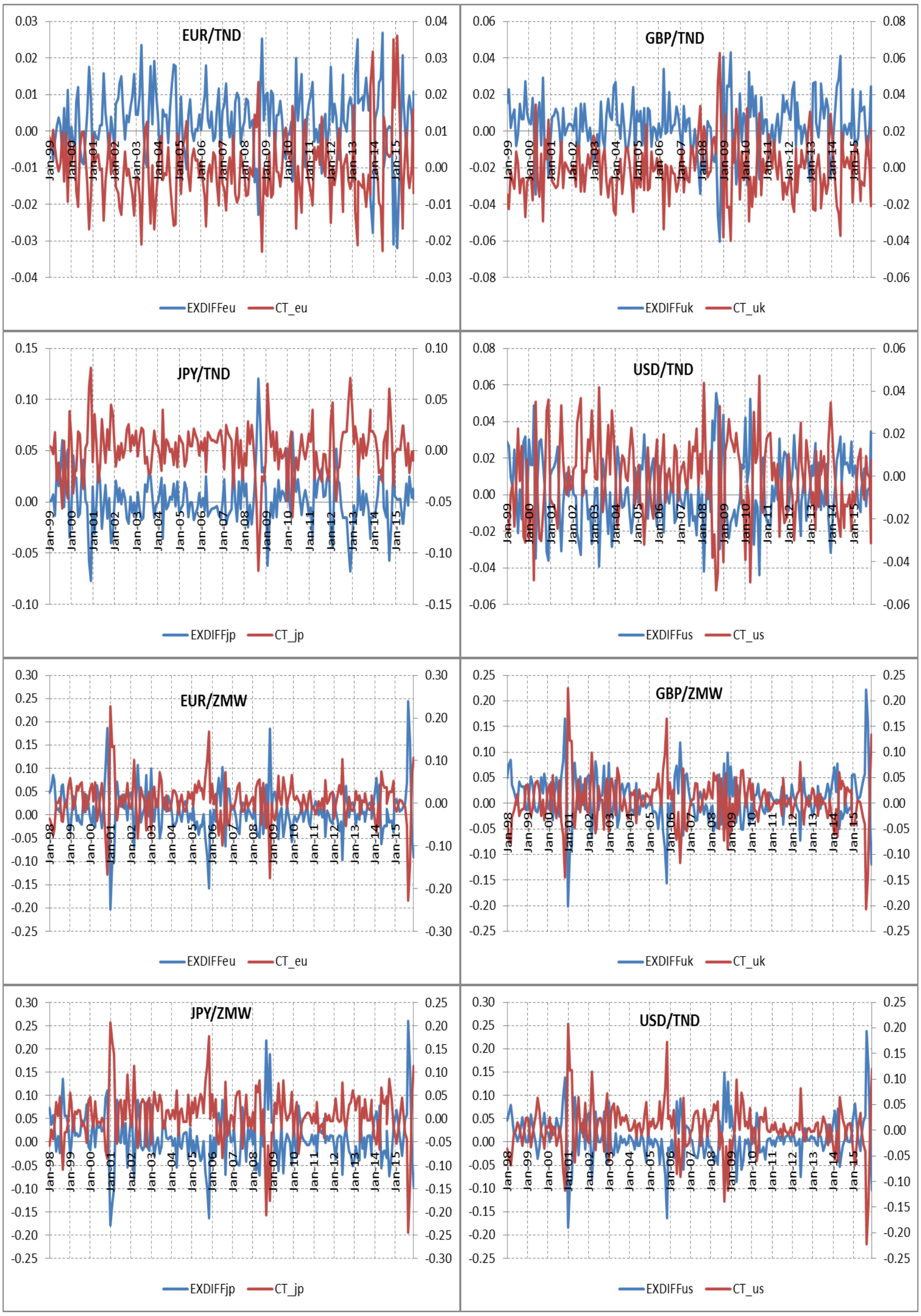


Figure 3.2: Continue



3.5.6 Impact of Bid/Ask Rates on Fama's β

Some currency pairs with large bid/ask spread may have the potential of eroding the gains of currency carry trade and influence the UIP test results as alluded to in the previous section. Consequently, the researcher re-estimates statistically significant coefficients in Table 3.9 using bid/ask exchange rates to assess their impact on these coefficients. But for data unavailability, it would have been interesting to re-estimate for all the currency pairs used for study. Table 3.15 presents results of significant coefficients (up to 10% level of significance) for mid-rates of exchange as used in Table 3.9 and re-estimation of β using bid/ask exchange rates on these same set of currency pairs. In each case, regression estimations are conducted for the *full sample, pre-crisis, crisis period* and *post-crisis period* to examine the impact the bid/ask spread may have on the significance or otherwise of the β coefficients.

From Table 3.15, it is observed that the mid-rate estimation (left panel) suggests that six currency pairs were statistically significant during the full sample period, three currency pairs during the pre-crisis, eleven pairs during the crisis and nine currency pairs during the post-crisis period. Thus rejecting the null hypothesis of the uncovered interest parity condition for all those currency pairs.

Interestingly, using the bid/ask rates reveals that there is not enough evidence to reject the null hypothesis for all the six currency pairs for the *full sample* and *the pre-crisis period*. In the case of the crisis period five currency pairs (EUR/TND, USD/GHS, GBP/BWP, JPY/KES and GBP/EGP) out of eleven currencies are found to be statistically significant. Thus, the researcher found no evidence to reject the null hypothesis for the remaining six. Last but not least, during the post-crisis period three (JPY/ZAR, EUR/MUR and JPY/EGP) out of nine currency pairs are statistically significant and the remaining six are not significant using the bid/ask rates. This is an indication the exchange rates bid/ask spread may have serious implications for carry trade returns of Africa's emerging and frontier markets.

The researcher also found that two currency pairs (EUR/TND and EUR/ZAR) from Table 3.10 posted negative historical returns over the period studied even though according to the Fama UIP regression (using mid-rates) they were expected to generate statistically significant excess positive returns. This confirms the position in the academic literature that the failure of uncovered interest rate parity does necessarily translate into profitable currency carry trade (Moosa, 2008; Olmo and Pilbeam, 2009) and at the same time justify the results of the bid/ask exchange rates.

Table 3.15: β Parameter Estimates of Fama's Regression-Bid/Ask

		Mid-Rates		Bid/Ask Rates	
Full Sample		**β**	**P-Value**	**β**	**P-Value**
	EUR/ZAR	-0.115	0.027	0.071	0.338
	GBP/ZAR	-0.151	0.062	0.151	0.309
	GBP/KES	-0.022	0.079	-0.011	0.304
	EUR/TND	0.018	0.029	0.013	0.355
	JPY/MUR	0.029	0.051	0.007	0.281
	GBP/MUR	0.006	0.081	0.004	0.370
Pre-Crisis					
	USD/TND	0.015	0.082	0.005	0.395
	EUR/ZAR	-0.157	0.010	-0.063	0.555
	JPY/ZAR	-0.207	0.023	0.317	0.163
Crisis Period					
	GBP/ZAR	0.230	0.035	-0.132	0.279
	USD/EGP	0.053	0.001	0.001	0.961
	EUR/EGP	-0.148	0.050	0.006	0.956
	EUR/TND	0.042	0.000	0.048	0.000
	USD/MUR	0.110	0.071	0.041	0.444
	EUR/MUR	0.077	0.043	0.004	0.922
	USD/GHS	0.040	0.072	0.061	0.030
	GBP/BWP	-0.217	0.038	-0.257	0.021
	JPY/KES	-0.464	0.041	-0.320	0.056
	GBP/KES	-0.063	0.051	-0.042	0.142
	GBP/EGP	0.129	0.003	-0.257	0.021
Post-Crisis					
	USD/ZAR	-0.062	0.000	-0.438	0.122
	USD/KES	-4.096	0.036	-0.013	0.146
	EUR/ZAR	-0.054	0.004	-0.031	0.866
	EUR/MUR	-0.014	0.074	-0.038	0.023
	JPY/ZAR	-0.052	0.020	-0.650	0.077
	JPY/EGP	-0.089	0.008	-0.139	0.012
	JPY/KES	-6.598	0.011	-0.024	0.262
	JPY/MUR	0.032	0.021	0.003	0.792
	GBP/ZAR	-0.050	0.003	-0.005	0.606

Note: Table 3.15 presents β coefficients of Fama's UIP regression results with their probability values (p-values) for mid exchange rates and bid/ask exchange rates for selected currency pairs.

On the other hand, a large number of currency pairs (see Table 3.10) generated excess positive historical returns using the naïve calculations, but were statistically insignificant according to the Fama UIP hypothesis testing (i.e. regression based). This implies that the researcher did not find statistical evidence against the UIP and, for that matter, profitability for these currency combinations, but found 'economic' evidence against the UIP (Burnside, 2015). In his study, Burnside (2015) argued that statistical evidence against the UIP (i.e. UIP failure through the Fama regression) for currencies of emerging markets is relatively rare, but as long as the strategy produces excess positive returns or is profitable in itself it is 'economic' evidence against the UIP. Thus the currency pairs USD/EGP, USD/GHS, USD/ZMW, USD/MAD, USD/BWP, USD/NGN, USD/KES, USD/MUR, EUR/GHS, EUR/ZMW, EUR/MAD, EUR/BWP, EUR/NGN, EUR/KES, EUR/MUR, JPY/GHS, JPY/EGP, JPY/ZMW, JPY/MAD, JPY/TND, JPY/BWP, JPY/NGN, JPY/KES, GBP/EGP, GBP/GHS, GBP/ZMW, GBP/MAD, GBP/BWP and GBP/NGN are all profitable but their profitability cannot be explained by regression-based UIP hypothesis testing. It would be interesting if future research looked into the factors that may explain this phenomenon.

3.6 Chapter Summary and Concluding Remarks

The main objective of this chapter was to empirically test the profitability or otherwise of currency carry trade targeting African currencies, specifically ten currencies of African emerging and frontier markets. After a brief background to this objective, the study presented a review of relevant literature. The researcher subsequently presented the specifications of the statistical and econometric models employed to achieve this objective. After ordinary least squares performed poorly in capturing the statistical properties of the African currency carry trade data, the study employed Huber's robust regression, which appears to be more robust in capturing the statistical properties of the African currency carry trade return series. Basically, Huber's robust regression was used to estimate the uncovered interest parity hypothesis for all the forty currency pairs used for the study. The regression results as well as the actual estimation of the naïve currency carry trade returns (both individual currency pairs and portfolio) were presented and discussed. The presentation of results and discussions were done for the full sample and three different regimes: pre-financial crisis period, the crisis period, and the post financial crisis period. The study reveals that holding currency carry trade investment in the selected African currencies over the period studied (1998-2015) would not have been 'statistically' profitable for the full sample and pre-crisis period. But in the case of the crisis and post-crisis periods a handful of currency pairs were statistically profitable. These returns are generally susceptible to downside or crash risk.

The study also suggests that contrary to the findings that currency carry trade returns do not diminish with time (Darvas, 2009), African currency carry trade returns fluctuated over time within the period studied. Furthermore, the study concludes that the risk adjusted performance of African currency carry trade intensified during the period of global financial crisis, outperforming other major asset classes, (mainly the equity market).

The researcher observed that many of Africa's currencies are not as liquid as the currencies of the developed countries, and that currency transactions in Africa are usually over-the-counter (OTC), with the banks and other financial institutions trading in foreign exchange. In the extant literature a large number of studies focus on the derivative markets trading in highly liquid currencies other than many of the African currencies in this study, except for the emerging market countries, notably South Africa, Morocco and Egypt. The illiquidity of the African currencies will make the implementation of carry trade strategy more expensive than the highly liquid currencies. This implies that the excess positive returns recorded herein may be eroded by the high transaction cost that may come with trading in African currencies, thus reducing the profits.

In the next chapter the researcher subjects the returns of the currency carry trade from Africa's emerging and frontier markets to strict proof using risk-adjusted measures to ascertain whether this strategy is a prudent investment and could be classified as an asset class.

CHAPTER 4

Carry Trade as a Prudent Investment in Africa

4.0 Introduction

The previous chapter looked at the profitability of African currency carry trades funded by the four most traded currencies with very low interest rates relative to the African interest rates. In this chapter, the researcher scrutinised the returns to ascertain whether they constitute a prudent or viable investment and also have the potential to be classified as an asset class. The chapter is divided into five main sections with the section one presenting a brief background to the study. The second section reviews related academic literature for the study and this is followed by section three which accounts for methods and procedures which were followed to achieve this objective. The data for the study is also presented under section three. Section four presents the results and discussions of the study followed by section five which presents the summary and conclusions of the chapter.

4.1 Background on Carry Trade as Asset Class

In the previous chapter (see section 3.5.3 of chapter 3), it was established that the African currency carry trade of a significant number of the currency pairs studied was profitable, whilst evidence of profitability could not be established for some currency pairs. In spite of the profitability of some of these African currencies, the question still remains as to whether they can be classified as an alternative asset class and, for that matter, a prudent investment, or whether those profits could be at best described as luck or just by chance. For any instrument or strategy to be considered an asset class or a prudent investment at least one of two major criteria must be met, as espoused in the works of Korhonen and Kunz (2009). Firstly, the risk-adjusted performance of this asset must match or even do better than the equity index. Thus higher risk must be adequately compensated with higher returns. Secondly, that asset should be suitable to be used as an alternative asset in lieu of other asset classes, particularly equity in portfolios' asset allocation. This means that the correlation coefficient between the asset and other asset classes, stock market returns in particular, should be small or at best negative. In their study, Korhonen and Kunz (2009) tested for the viability of currency carry trade as a prudent investment by using these criteria with the G10 currencies as both target and funding currencies and concluded that currency carry trades could be classified as a prudent investment. The problem however is that the study failed to look at any emerging and frontier markets, particularly African countries. This raises the question as to whether those findings for such highly liquid currencies of the world could be applied to the less liquid emerging and frontier markets of Africa. Furthermore, their study failed to address whether the currency carry trade could be classified as an asset class and also the impact the currency carry trade may have on the risk-adjusted performance of existing portfolios - something which was later addressed in the works of Das et al. (2013). In their study, Das et al. (2013) assessed the viability of currency carry trade by using realised returns of Carry Trade Portfolio and PowerShares DB G10 Currency Harvest (DBV). Also, their works relied heavily on the highly liquid G10 currencies, ignoring the emerging and frontier markets. Though their study looked at the impact of currency carry trade on the risk-adjusted performance when included in an existing portfolio or when it substitutes a particular asset in the portfolio, their work failed to show the extent of contribution the currency carry trade makes to the risk-adjusted performance of the portfolio. Their findings were also based on realised returns of a sophisticated currency carry trade index of G10 Carry Index and PowerShares DB G10 Currency Harvest (DBV) rather than the carry trade in its simple naïve form. This current study thus proceeds to explore the viability of the currency carry trade in its simple form, targeting African currencies as to whether it is a prudent investment or otherwise against these criteria, and also to evaluate the extent of the impact African currencies carry trade may have on the risk-adjusted performance of existing portfolios. Specifically, the study assesses the risk-adjusted performance of currency carry trades of individual African countries and compares them with the risk-adjusted performance of their respective stock market indices. Secondly, the researcher examines the correlations between the African currencies carry trade returns and the traditional stock market returns to ascertain whether currency carry trade could be used as an alternative investment. Thirdly, the study evaluates the impact of currency carry trade as an alternative to other asset classes and as a complement in a conventional portfolio. Finally the researcher determines the real contribution of African currencies carry trades to the risk-adjusted performance of an existing conventional portfolio.

4.2 Related Literature Review

The purpose of this chapter will be to find out, given the perceived high volatility of the African currency market, whether currency carry trade funded by the low-interest currencies in the world is a prudent investment or just left to chance. The currency carry trade has been well established in the literature as a prudent investment which can trade as an alternative asset class or augment existing portfolios. Adding to existing portfolios will enhance the performance of such portfolios by using risk-adjusted performance measures (Das et al., 2013). Two main criteria must be satisfied for an asset to be classified as a prudent investment (Korhonen and Kunz, 2009); The first one is that the risk-adjusted performance of currency carry trades should match or outperform the risk-adjusted performance of the equity indices[10]. The second is that the asset in question should be suitable as an alternative investment[11]. According to the UIP this strategy of borrowing a low yielding currency and investing it in a high yielding currency should generate zero excess return, as the theory postulates that the high yielding currency is expected to decrease or depreciate to close up any gains. However, a number of studies reviewed concluded that the UIP does not hold and, for that matter, this violation generates very good profits (Ackermann et al., 2012; Ames et al., 2013; Brunnermeier et al., 2008; Burnside et al., 2010, 2006; Menkhoff et al., 2012a).

Portfolio managers across the globe have been regularly searching for new asset classes that generate superior returns and at the same time diversify their portfolios. Investors have been looking at assets such as international stocks, commodities, emerging market stocks, and real estate because of their lower correlations with conventional asset classes (Ferri, 2010; Marston, 2011). The hedge funds industry has also been involved in the search for alternative investments (Popova et al., 2007). The last two decades have seen the introduction of a variety of new instruments designed exclusively for the purpose of currency carry trading. One such instrument is the Deutsche Bank's G10 Carry Spot index which is a portfolio constructed within the G10 currencies. Thus the Deutsche Bank's G10 Carry Spot index takes a long position in the three highest yielding currencies and takes a short position in the three lowest yielding currencies within the bucket of the G10 currencies. Many of these indices emerged during the period between March and April 2007 and are generally categorised into simple and sophisticated, depending on the carry trade allocation rules followed. The CSFB and Barclays indices, which use mean-variance optimisation to select their respective index weights, are considered more sophisticated than the Deutsche Bank's G10 Carry Spot index. These sophisticated indices have lower aggregate weights for highly correlated currencies, and vice versa (Galati et al., 2007).

The CSFB strategy reallocates every ten months the frequently traded currencies together with other emerging market indices, whereas the Deutsche Bank's G10 Carry Spot index does the reallocation on ten main currencies together with eleven emerging market currencies. The Barclays Intelligent Currency Carry Trade Index, on the other hand, reallocates every month within the ten major currencies (Korhonen and Kunz, 2009). Other forms of structured currency carry trade instruments have emerged in the financial markets and are issued in the form of collateralised foreign exchange obligations (CFXOs). These CFXOs are issued based on the cash flows from the underlying currency carry trades (Lynch, 2007). Korhonen and Kunz, (2009) argue that the fact

[10] That means higher risk should be awarded with adequately higher profits

[11] Thus there should be a small or negative correlation between the currency carry trade and say the stock market.

that the international rating agencies such as Fitch, Moody's and S&P have issued methodology documents and guidelines as to how they will rate CFXOs and other similar instruments is enough indication that the currency carry trade is becoming a standard asset class.

Furthermore, currency carry trades have been an object of interest to larger institutional traders or participants such as Commodity trading advisors (CTAs) and hedge funds, over the last few decades (Galati and Melvin, 2004). However, retail investors have also surfaced in the market, operating with margin accounts and taking leveraged positions across currencies, even though their positions may not influence the exchange rate movement as much as the institutional traders (Galati et al., 2007).

Empirically, the most relevant work on the viability of currency carry trade as a prudent investment or an asset class can only be traced to Das et al. (2013) and Korhonen and Kunz (2009). Das et al. (2013) studied the viability of currency carry trade as an asset class, using the Sharpe ratio and other related portfolio performance measures such as the Sortino ratio, the adjusted Sharpe ratio, and VaR over a 22-year period (1989 to 2011). The authors used daily currency carry trade data from Bloomberg Professional and evaluated its performance against some other asset classes. They further added the currency carry trades to other asset classes to form a portfolio to examine the role of the currency carry trade in the performance of that portfolio. They concluded that the currency carry trade, when included in an existing portfolio, improves the performance of that portfolio. They further argued that the risk-return profile of that portfolio also receives a major boost when currency carry trade is included in the portfolio.

Korhonen and Kunz (2009), on the other hand, investigated whether the currency carry trade in its simple could be considered as a prudent investment or mere lottery. They used exchange and interest rate data from the G10 currency countries from January, 1993 to April, 2009 and benchmarked stock market data on the S&P 500, the FTSE 100, the NIKKEI 225 as well as the MSCI World. They found, inter alia, that the currency carry trades outperform equity indices regardless of the risk measure. Thus using the risk- adjusted measures (Sharpe ratio, reward-to-VaR, and conditional Sharpe ratio) the risk-adjusted average returns for currency carry trade strategies were found to be higher than the equity indices. They concluded that currency carry trade could be categorised as prudent investment as the risk-return profile was found to be better than that of the stock markets.

It is clear from the foregoing discussion that the currency carry trade has been found to be a prudent investment or an asset class which investors can trade elsewhere in the world and in particular among the G10 currencies. Investors can equally add or supplement their existing portfolios with the currency carry trade to enhance their portfolios' performance (Das et al., 2013; Korhonen and Kunz, 2009). The problem, however, is that most of these studies concentrated on the major world currencies (G10 currencies).

4.3 Methodology and Description of Data

This section presents the methods and analytical procedures employed by the study to ascertain the viability or otherwise of the African currencies carry trades. These methods are captured under four main headings. The first subsection presents how the monthly returns of African currency carry trade for individual currency pairs and portfolios are estimated. The second subsection presents and specifies the various portfolio performance evaluation measures adopted for the study, while the third subsection presents the formula for the Sharpe ratio decomposition to ascertain the contribution of each individual asset in a portfolio. In the fourth and last subsection, the researcher present a brief description of the data and the data sources.

4.3.1 Carry Trade Returns and Portfolios

The researcher calculates the currency carry trade in its simplest form for all the individual target currencies (i.e. African currencies) against the four funding currencies. The African currencies carry trade is calculated with equation 4.1, specified as follows:

$$Z_t = \left(r^a_{t,t+1} - r^b_{t,t+1}\right) - \left(S^{a/b}_{t+1} - S^{a/b}_t\right) \tag{4.1}$$

where Z_t is the currency carry trade returns, $r^a_{t,t+1}$ is the interest rate of target currency country, $r^b_{t,t+1}$ is the interest rate of the funding currency country, $S^{a/b}_{t+1}$ is the exchange rate between the target country and funding country one month from today, and $S^{a/b}_t$ is the spot or today's exchange rate between the target currency and the funding currency.

The study implemented the currency carry trade strategy by taking a long position in the seven high-yielding African currencies, namely, the South African Rand (ZAR), Egyptian Pound (EGP), Moroccan Dirham (MAD), Nigerian Naira (NGN), Ghanaian Cedi (GHS), Botswana Pula (BWP), and Tunisian Dinar (TND), and a short position in four of the low-yielding currencies among the most traded currencies in world, namely, the US Dollar (USD), Euro (EUR), Japanese Yen (JPY), and British Pound Sterling (GBP), thus generating 28 currency pairs and carry trade returns. The risk-adjusted performances of these carry trade returns from seven African countries are compared to their respective African stock market performance. The researcher also estimated the Spearman's correlation coefficients among the various carry trade returns and with their respective stock markets to assess their diversification properties. The size and direction of the correlation coefficients between the stock market returns and carry trade returns will give a fair indication of whether the African currency carry trade could be used as an alternative asset class or otherwise. The researcher generates five portfolios out of these currency pairs. The first portfolio simultaneously takes a short position for all the four low yielding currencies of the first world selected for the study and a long position in all the seven high yielding African currencies similar to the G10 currency carry index (Brunnermeier et al., 2008). The remaining four portfolios take a short position in the USD, JPY, EUR, and GBP in succession and a long position in the seven African currencies. This generates African currency carry trade portfolios funded by the USD, JPY, EUR and the GBP respectively.

The performance of these five African currencies carry trades portfolios as an alternative asset class in asset allocation are compared to the S&P 500 stock index in two ways. First, the researcher constructs a representative equally weighted portfolio made up of S&P 500, MSCI World Stock Index, US Treasury Bills and US 10-year bond. The researcher implements an alternative portfolio by replacing the S&P 500 stock index with the African currencies carry trades and evaluates the risk-adjusted performance of the representative and the alternative portfolios. This is repeated for all the currency carry trade portfolios generated by the study. Second, using the same representative portfolio, the researcher included the currency carry trade portfolios one after the other in order to assess how the individual currency carry trade portfolios will impact on an existing portfolio. Thus the researcher compared the performance of the representative equally weighted portfolio *with* and *without* the carry trade component in it.

4.3.2 Performance Measures

For ease of comparison, the study calculates the four moments (i.e. mean, standard deviation, skewness and kurtosis) of the monthly returns of the various currencies carry trades assets and portfolios and the various benchmark indices used for the study. In addition to these four moments the study also employs other risk-adjusted performance measures (i.e. the Sharpe ratio as specified in equation 3.6, adjusted Sharpe ratio (ASR), Value-at-risk (VaR) and Sortino ratio) as used in the works of Das et al., (2013).

4.3.2.1 Sortino Ratio

The Sortino ratio is a modification of the Sharpe ratio which seeks to differentiate harmful volatility from general volatility by taking into account the standard deviation of negative asset returns, called downside deviation (Das et al., 2013). The Sortino ratio subtracts minimum acceptable return (MAR) from the portfolio's return, and then divides that by the downside deviation. Unlike the Sharpe ratio which penalises both upside and downside volatility, the Sortino ratio penalises only the downside volatility (Cogneau and Hubner, 2009a, 2009b). A large Sortino ratio indicates a low probability of a large loss. And since investors are more concerned about downside volatility than the upside volatility the Sortino ratio is perceived to be superior to the Sharpe ratio. It is calculated as follows:

$$Sortino\ ratio_p = \frac{R_p - MAR}{\sqrt{SV(R_p)}} \tag{4.3}$$

where R_p is the expected return of the portfolio, MAR is the minimum acceptable return, and the SV is the semi-variance or variance of the negative asset or portfolio returns.

4.3.2.2 Adjusted Sharpe Ratio

The last, but not least, performance measure that the researcher used to evaluate African currency carry trade returns vis-a-vis other asset classes is the adjusted Sharpe ratio (ASR). This measure includes all the moments of the portfolio returns and therefore a Sharpe ratio adjusted for the negative skewness and excess kurtosis (Das et al., 2013) which characterise the African currency carry trade returns. The ASR, according to Pezier and White (2008) as cited in Das et al. (2013), is defined as:

$$\text{ASR} = \text{Sharpe} \times \left[1 + \left(\frac{\text{Skewness}}{6}\right)\text{Sharpe} - \left\{\frac{\text{Kurtosis}-3}{24}\right\} \times \text{Sharpe}^2\right] \tag{4.4}$$

4.3.3 Sharpe Contribution

This section looks at the methodology to assess the real impact of the African currency carry trades on the conventional portfolios. According to Steiner (2011) individual asset contributions to the Sharpe Ratio, which is a risk-adjusted performance measure, can be derived through the Information Ratio decomposition procedures. The derivation and the specification of Sharpe contribution is as follows:

$$S_p = \frac{R_p - R_f}{\sigma_p} = \frac{r_p}{\sigma_p} \tag{4.5}$$

The researcher decomposed the r_p linearly into asset contributions by multiplying the excess returns of individual assets r_i by their weights w_i:

$$S_p = \frac{\sum_{i=1}^{n} w_i . r_i}{\sigma_p} = \sum_{i=1}^{n} \frac{w_i . r_i}{\sigma_p} \tag{4.6}$$

The researcher further decomposed the volatility, which could be viewed as the sum of the weighted marginal contributions to portfolio volatility:

$$\sigma_p = \sum_{i=1}^{n} w_i . \frac{\partial \sigma_p}{\partial w_i} \tag{4.7}$$

$$\frac{\partial \sigma_p}{\partial w_i} = \frac{\sigma_{i,p}}{\sigma_p} = \rho_{i,p} . \sigma_i \tag{4.8}$$

$$\sigma_p = \sum_{i=i}^{n} w_i . \rho_{i,p} . \sigma_i \tag{4.9}$$

$$S_p = \sum_{i=1}^{n} \frac{w_i . r_i}{\sigma_p} . \frac{w_i . \rho_{i,p} . \sigma_i}{\sigma_p} . \frac{\sigma_p}{w_i . \rho_{i,p} . \sigma_i} \tag{4.10}$$

$$S_p = \sum_{i=1}^{n} \frac{w_i . \rho_{i,p} . \sigma_i}{\sigma_p} . \frac{1}{\rho_{i,p}} . \frac{r_i}{\sigma_i} \tag{4.11}$$

Thus the study employs equation 4.11 to determine the contributions of individual assets, including the currency carry trade, on the risk-adjusted performance of an existing conventional portfolio.

4.3.4 Data

After assessing the profitability of currency carry trade in the previous chapter, this current chapter proceeds to use seven African countries (three emerging markets and four frontier markets) as target currencies and funded by the US Dollar (USD), Japanese Yen (JPY), British Pounds Sterling (GBP), and the Euro (EUR) for the Euro zone countries, which are all classified under S&P Dow

Jones Country Classification as Developed Markets. The African countries selected for this study comprise South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia. Monthly interbank interest rates and exchange rates are obtained for all the currency pairs of the seven African countries with the developed countries, totalling 28 currency pairs. Data were collected for the period of January 2002 to December 2014. All the data were downloaded from the Quantec EasyData, INET BFA, Bloomberg and Thomson Reuters Datastream. Monthly currency carry trade returns were generated for all the 28 currency pairs using equation 4.1. As a benchmark of the equity markets the study selected the stock market indices of the seven target currency countries including JSE African All Share Index (JALSH) and others from the developed world such as MSCI World Index, and S&P 500. Other debt instruments used were the US 10 Year Bond and the 90-Day Treasury bill for the USA, United Kingdom, Japan and the Euro Area as risk-free rate from the perspective of investors.

4.4 Results and Discussion

The results are captured under five main subsections. The first subsection presents the basic statistics and performance of African currency carry trade, while the second looks at the risk-return relationship of the currency carry trade returns where returns are plotted against their respective standard deviations. The third subsection constructs an equally weighted currency carry trade portfolio for African currencies and compares it with other benchmark indices used for the study. The fourth subsection assesses the impact the African currency carry trade may have on existing conventional portfolios either as a complement or substitute. The final subsection examines the Sharpe ratio contribution of African currency carry trade to existing conventional portfolios. Thus this subsection attempts to measure the exact extent of the contribution that the African currency carry trade may have on a portfolio when it is included in that portfolio.

4.4.1 Basic Statistics and Performance of African Currency Carry Trade

Table 4.1 presents the basic statistical description of currency carry trade returns and the returns of African stock markets selected for the study spanning the period of February 2002 to December 2014. The four moments of mean, standard deviation, skewness and kurtosis of the returns of all the 28 currency pairs alongside seven African stock market returns selected for the study are presented. The Sharpe ratio, Sortino ratio, value-at-risk (VaR), and the adjusted Sharpe ratio (ASR) results for the African currency carry trade and the stock market returns of seven African countries are also presented.

Table 4.1: Performance of Carry Trade and Stock Monthly Returns

Asset	Average	Std Dev.	Kurtosis	Skewness	Sortino	Rf Rate	Sharpe	ASR	VaR(norm)	VaR(hist)
USD/BWP	0.0033	0.0342	0.5663	-0.2935	0.0986	0.0012	0.0631	0.0628	-0.0529	-0.0531
USD/EGP	0.0031	0.0160	69.5573	-6.8792	0.1464	0.0012	0.1197	-0.0159	-0.0232	-0.0127
USD/GHS	0.0034	0.0214	5.0386	-0.0410	0.1636	0.0012	0.1057	0.0999	-0.0318	-0.0389
USD/MAD	0.0024	0.0192	0.7512	-0.1795	0.1079	0.0012	0.0644	0.0641	-0.0292	-0.0303
USD/NGN	0.0050	0.0192	19.4738	-3.4056	0.2583	0.0012	0.2006	0.0216	-0.0265	-0.0243
USD/ZAR	0.0045	0.0383	3.1966	-0.6787	0.1294	0.0012	0.0862	0.0834	-0.0585	-0.0585
USD/TND	0.0007	0.0181	0.4436	-0.2339	-0.0229	0.0012	-0.0264	-0.0264	-0.0290	-0.0304
GBP/BWP	0.0044	0.0358	3.3653	-0.2046	0.1395	0.0021	0.0622	0.0613	-0.0546	-0.0519
GBP/EGP	0.0019	0.0265	8.3166	-0.9385	0.0482	0.0021	-0.0079	-0.0079	-0.0417	-0.0401
GBP/GHS	0.0026	0.0298	1.7296	0.4817	0.0823	0.0021	0.0149	0.0149	-0.0465	-0.0486
GBP/MAD	0.0014	0.0154	4.2096	1.2300	0.0405	0.0021	-0.0496	-0.0486	-0.0240	-0.0194
GBP/NGN	0.0040	0.0296	1.6965	0.2383	0.1559	0.0021	0.0622	0.0619	-0.0448	-0.0478
GBP/ZAR	0.0036	0.0354	0.9041	-0.4671	0.1028	0.0021	0.0404	0.0402	-0.0547	-0.0581
GBP/TND	-0.0002	0.0159	1.3931	0.4105	-0.1071	0.0021	-0.1493	-0.1435	-0.0263	-0.0243
EUR/BWP	0.0044	0.0363	12.0201	-1.3564	0.1313	0.0032	0.0340	0.0333	-0.0553	-0.0464
EUR/EGP	0.0016	0.0289	8.3992	-1.4699	0.0264	0.0032	-0.0553	-0.0547	-0.0459	-0.0427
EUR/GHS	0.0016	0.0301	2.0361	0.5775	0.0323	0.0032	-0.0514	-0.0509	-0.0478	-0.0468
EUR/MAD	0.0006	0.0048	-0.1136	-0.0257	-0.1073	0.0032	-0.5369	-0.5750	-0.0073	-0.0084
EUR/NGN	0.0031	0.0354	11.6408	-1.6522	0.0798	0.0032	-0.0013	-0.0013	-0.0550	-0.0519
EUR/ZAR	0.0030	0.0344	0.7205	-0.4810	0.0793	0.0032	-0.0064	-0.0064	-0.0535	-0.0606
EUR/TND	-0.0011	0.0089	0.9463	0.3436	-0.2879	0.0032	-0.4800	-0.3760	-0.0158	-0.0159
JPY/BWP	0.0059	0.0416	2.7713	-0.6651	0.1712	0.0001	0.1381	0.1290	-0.0625	-0.0654
JPY/EGP	0.0039	0.0273	6.4588	-1.2449	0.1456	0.0001	0.1371	0.1169	-0.0410	-0.0383
JPY/GHS	0.0043	0.0318	1.4426	0.2496	0.1614	0.0001	0.1319	0.1296	-0.0479	-0.0507
JPY/MAD	0.0033	0.0252	4.7903	-0.8240	0.1280	0.0001	0.1256	0.1142	-0.0381	-0.0360
JPY/NGN	0.0059	0.0339	4.8933	-0.8390	0.2136	0.0001	0.1700	0.1425	-0.0499	-0.0437
JPY/ZAR	0.0052	0.0441	6.1242	-1.3670	0.1292	0.0001	0.1160	0.1036	-0.0674	-0.0694
JPY/TND	0.0016	0.0240	4.1620	-0.8453	0.0319	0.0001	0.0602	0.0588	-0.0380	-0.0319
Tunisia-SR	0.0073	0.0382	1.3735	0.3040	0.2815	0.0012	0.1597	0.1559	-0.0556	-0.0491
Botswana-SR	0.0074	0.0502	1.6419	-0.5428	0.1838	0.0012	0.1250	0.1206	-0.0751	-0.0908
Egypt-SR	0.0153	0.0907	1.2556	-0.5060	0.2341	0.0012	0.1555	0.1492	-0.1339	-0.1432
Ghana-SR	0.0060	0.0673	1.8303	-0.0193	0.1104	0.0012	0.0720	0.0713	-0.1046	-0.1044
Morocco-SR	0.0024	0.0672	1.1479	0.0865	0.0305	0.0012	0.0185	0.0185	-0.1081	-0.0925
Nigeria-SR	0.0047	0.0891	2.8433	-0.3202	0.0579	0.0012	0.0391	0.0389	-0.1419	-0.1155
South Africa-SR	0.0102	0.0801	2.1185	-0.4530	0.1643	0.0012	0.1128	0.1090	-0.1215	-0.1348

Note: Table 4.1 presents the performance measures of currency carry trade returns of seven African currencies (Tunisian Dinar, Botswana Pula, Egyptian Pound, Ghanaian Cedi, Moroccan Dirham, Nigerian Naira and South African Rand) financed by borrowing the four currencies from the developed world, namely, the United States Dollar (USD), Euro (EUR), Great British Pound (GBP) and Japanese Yen (JPY) from January 2002 to November 2014. ASR denotes Adjusted Sharpe Ratio, which is the Sharpe ratio adjusted for skewness and kurtosis. The SR attached to Tunisia, Botswana, Egypt, Ghana, Morocco, Nigeria and South Africa denotes monthly stock returns for their respective all share indices. The US Treasury bill rate is used as a proxy for risk-free (Rf Rate) for the estimation of Sharpe ratios.

Table 4.1 shows that the currency carry trade strategy has four funding currencies (USD, EUR, GBP and JPY) and seven target currencies (TND, GHS, MAD, NGN, ZAR, BWP and EGP) from Africa's emerging and frontier markets. Except for the EUR/TND and GBP/TND currency pairs which have negative historical returns, all the other currency pairs show positive average returns. Standard deviations of the respective returns currency carry trade are generally lower than the standard deviations of stock market returns. It is instructive to note however that the returns of the stock markets are generally higher than the returns of the currency carry trade of these African countries. This is consistent with the principle that the higher the risk the higher the rate of return (see Figure 4.1). The skewness and kurtosis of the average returns largely conform to the position in the literature that the currency carry trade returns usually exhibit large excess kurtosis and negative skewness (Burnside et al., 2010). The returns data is predominantly negatively skewed though GBPGHS, GBPMAD, GBPNGN, GBPTND and EURGHS returns are positively skewed. The African stock market data are largely positively skewed, consistent with stock returns behaviour in the literature (Alagidede, 2008). These predominantly negatively skewed returns of the currency carry trade reinforce the argument that the carry trade strategy produces negative returns in most cases. In 15 out of the 28 currency pairs (USDEGP, USDNGN, EURBWP, EURNGN, EUREGP, GBPEGP, JPYEGP, JPYZAR, USDGHS, JPYNGN, JPYMAD, GBPMAD, JPYTND, GBPBWP and USDZAR) it can be observed from Table 4.1 that the returns exhibit large excess kurtosis which, is an indication of abrupt crash risk or the peso effect[12] (Burnside et al., 2010). The stock market returns however have a reasonable amount of positive kurtosis. Thus crash risk or peso effect in Africa is related to the currency carry trade returns rather than the stock market returns.

The risk-adjusted performance of the currency carry trade of African currencies compared to their respective stock markets has been impressive. As indicated in Table 4.1, the Sharpe ratio of Nigerian Naira (0.2006) carry trade financed by US Dollars outperforms all stock markets in Africa between the periods of February 2002 and December 2014. Tunisia, Egypt and Botswana stock markets however produced some impressive Sharpe ratios of 0.1597, 0.1555 and 0.1250 respectively. The profitable currency carry trades of Africa's emerging and frontier market appear to be dominating their stock market counterparts, using a number of risk-adjustment performance measures. The Sortino ratio, Adjusted Sharpe ratio, and value-at-risk all point to the fact that the few profitable currency carry trade dominated stock market performance over the period studied.

[12] The peso effect is a term in the international finance lexicon which originates from the Mexican peso currency crisis which was sparked by the sudden devaluation of the Mexican peso against the US dollar in December 1994 which resulted in widespread financial crisis ignited by capital flight. Thus currency crash risk is usually referred to as the peso effect.

The differences in VaR under normal distribution and VaR from the historical series suggests that the currency carry trade of Africa's emerging and frontier markets does not exhibit Gaussian distribution behaviour, which is confirmed by the leptokurtic behaviour of the skewness and kurtosis. The Sharpe ratios therefore are adjusted for skewness and kurtosis using the Adjusted Sharpe Ratio. Using the Adjusted Sharpe ratio to compare performances, the stock markets of Tunisia, Egypt and Botswana outperforms almost all the currency carry trade performance. This could be explained by the fact the currency carry trade returns exhibit thickness or fatness in their tails and are more negatively skewed than their stock market counterparts. That notwithstanding, currency carry trade still outperforms a number of the other stock markets in Africa selected for this thesis.

The Sortino ratio from Table 4.1 shows that the stock market of Tunisia has a performance superior to all the carry trade and stock market returns for the period from February 2002 to December 2004. Since it has been established in chapter three of this study that the currency carry trade is a by-product of market disequilibrium and market inefficiencies, it can therefore be inferred that the situation in Tunisia is an indication that the Tunisian stock market is relatively efficient. This is followed by the USDNGN currency carry trade return which has the next highest Sortino ratio (0.2583). Other high performing currency pairs rubbing shoulders with the stock markets of Egypt, Botswana and South Africa are the JPYNGN, JPYBWP, USDGHS, JPYGHS and GBPNGN. The Sortino ratio measures the returns of the individual per unit of downside risk or negative semi-variance. It is therefore not surprising that the stock market returns are performing better than the currency carry trade, since the currency carry trade returns are generally negatively skewed.

From Table 4.2 it can be observed that the returns of the African currency carry trade are largely showing negative correlations and, in a few instances, weak positive correlations among themselves and also with the stock market returns. That is, the positive correlations are small and the negative correlations are quite large, meaning that the currency carry trade assets can be combined to make a good portfolio. Correlations of the stock markets returns with the currency carry trade returns also exhibit weak positive and strong negative correlations, which is also an indication that formulating a portfolio with African currencies carry trade and stock markets returns will not be out of place.

Table 4.2: Correlation Matrix for Monthly Carry Trade and Stock Returns

	USD/BWP	*USD/EGP*	*USD/GHS*	*USD/MAD*	*USD/NGN*	*USD/ZAR*	*USD/TND*	*JPY/BWP*	*JPY/EGP*	*JPY/GHS*	*JPY/MAD*	*JPY/NGN*
USD/BWP	1.000											
USD/EGP	-0.054	1.000										
USD/GHS	0.001	-0.065	1.000									
USD/MAD	0.312	-0.060	0.114	1.000								
USD/NGN	0.047	-0.035	0.039	-0.025	1.000							
USD/ZAR	0.318	-0.036	0.044	0.155	0.091	1.000						
USD/TND	0.325	-0.061	0.168	0.942	-0.028	0.169	1.000					
JPY/BWP	0.748	-0.132	0.033	0.278	0.072	0.283	0.247	1.000				
JPY/EGP	0.009	0.507	-0.011	-0.017	-0.015	-0.058	-0.032	0.202	1.000			
JPY/GHS	0.044	-0.081	0.669	-0.164	0.140	0.033	-0.154	0.271	0.112	1.000		
JPY/MAD	0.294	-0.092	0.080	0.461	0.124	0.123	0.383	0.527	0.136	0.567	1.000	
JPY/NGN	0.081	-0.100	0.063	-0.137	0.591	0.022	-0.171	0.433	0.355	0.462	0.424	1.000
JPY/ZAR	0.301	-0.082	0.055	0.145	0.084	0.845	0.149	0.418	0.384	0.127	0.224	0.276
JPY/TND	0.302	-0.094	0.119	0.391	0.129	0.131	0.399	0.515	0.132	0.609	0.967	0.425
EUR/BWP	0.452	-0.080	0.015	-0.140	0.029	0.214	-0.121	0.376	-0.078	0.095	0.000	0.055
EUR/EGP	-0.211	0.546	-0.077	-0.277	-0.130	-0.414	-0.264	-0.207	0.505	-0.014	-0.164	-0.013
EUR/GHS	-0.245	0.004	0.620	-0.706	0.044	-0.092	-0.626	-0.191	0.019	0.610	-0.299	0.157
EUR/MAD	-0.281	0.078	-0.123	-0.921	-0.003	-0.152	-0.891	-0.224	0.099	0.174	-0.380	0.144
EUR/NGN	-0.389	-0.009	-0.013	-0.617	0.483	-0.157	-0.568	-0.313	0.106	0.146	-0.278	0.430
EUR/ZAR	0.201	-0.047	0.016	-0.031	0.012	0.782	-0.004	0.204	0.125	0.063	0.042	0.062
EUR/TND	-0.165	0.048	0.029	-0.741	-0.005	-0.074	-0.485	-0.219	0.026	0.134	-0.422	0.026
GBP/BWP	0.647	-0.124	0.040	0.070	-0.119	0.194	0.070	0.486	-0.080	0.045	0.077	-0.052
GBP/EGP	-0.261	0.540	-0.039	-0.352	-0.114	-0.371	-0.345	-0.289	0.415	-0.053	-0.303	-0.050
GBP/GHS	-0.159	-0.046	0.674	-0.459	-0.090	-0.046	-0.400	-0.121	-0.046	0.565	-0.210	0.024
GBP/MAD	0.080	-0.073	0.052	0.205	-0.259	0.042	0.173	0.066	-0.094	-0.044	0.059	-0.212
GBP/NGN	-0.255	-0.031	-0.006	-0.506	0.494	-0.066	-0.493	-0.211	0.058	0.124	-0.226	0.394
GBP/ZAR	0.174	-0.091	0.049	-0.064	0.031	0.822	-0.043	0.152	0.017	0.033	-0.049	0.032
GBP/TND	0.070	-0.068	0.104	0.060	-0.253	0.046	0.163	0.009	-0.107	-0.019	-0.066	-0.235
BWP_STR	0.062	-0.031	0.198	0.305	0.153	0.020	0.304	0.059	-0.058	0.094	0.183	0.075
EGP_STR	0.039	0.071	0.163	0.187	0.131	0.076	0.218	0.039	0.092	0.193	0.246	0.119
GHS_STR	-0.060	-0.268	0.397	-0.006	0.096	0.011	0.066	-0.106	-0.146	0.227	-0.057	-0.011
MAD_STR	0.010	-0.003	-0.002	0.249	0.237	0.090	0.251	0.083	0.155	0.010	0.204	0.142
NGN_STR	-0.091	-0.103	0.096	0.160	0.210	-0.096	0.177	-0.068	0.013	0.048	0.101	0.096
ZAR_STR	0.122	-0.020	0.123	0.385	-0.002	0.122	0.358	0.189	0.017	0.080	0.291	0.037
TND_STR	0.098	0.086	0.058	0.311	0.013	-0.123	0.362	0.047	0.023	0.000	0.187	-0.049

Note: This Table shows the correlations between all the monthly returns of currency carry trade for African countries and stock market returns for the same countries under study for the period of February 2002 to December 2014.

Table 4.2 Continues

	JPY/ZAR	*JPY/TND*	*EUR/BWP*	*EUR/EGP*	*EUR/GHS*	*EUR/MAD*	*EUR/NGN*	*EUR/ZAR*	*EUR/TND*	*GBP/BWP*	*GBP/EGP*	*GBP/GHS*
JPY/ZAR	1.000											
JPY/TND	0.230	1.000										
EUR/BWP	0.166	0.021	1.000									
EUR/EGP	-0.246	-0.148	-0.050	1.000								
EUR/GHS	-0.069	-0.219	0.119	0.172	1.000							
EUR/MAD	-0.099	-0.331	0.111	0.312	0.662	1.000						
EUR/NGN	-0.066	-0.225	0.091	0.330	0.479	0.568	1.000					
EUR/ZAR	0.772	0.066	0.233	0.127	0.040	0.056	0.108	1.000				
EUR/TND	-0.065	-0.214	0.118	0.231	0.609	0.717	0.486	0.089	1.000			
GBP/BWP	0.163	0.078	0.734	-0.109	-0.031	-0.079	-0.244	0.181	-0.052	1.000		
GBP/EGP	-0.262	-0.294	-0.099	0.813	0.254	0.353	0.300	0.020	0.251	-0.051	1.000	
GBP/GHS	-0.051	-0.154	0.045	0.046	0.839	0.414	0.193	0.009	0.401	0.143	0.182	1.000
GBP/MAD	0.005	0.027	-0.108	-0.149	-0.124	-0.180	-0.379	-0.045	-0.191	0.309	-0.035	0.422
GBP/NGN	-0.010	-0.203	0.049	0.200	0.390	0.444	0.751	0.110	0.330	0.029	0.365	0.348
GBP/ZAR	0.757	-0.032	0.193	-0.091	0.085	0.060	0.056	0.882	0.083	0.227	0.095	0.104
GBP/TND	-0.002	0.006	-0.072	-0.108	0.023	-0.072	-0.266	-0.010	0.162	0.294	0.001	0.510
BWP_STR	-0.008	0.176	0.024	-0.090	-0.106	-0.327	0.002	-0.037	-0.217	-0.072	-0.189	-0.146
EGP_STR	0.098	0.272	0.046	0.018	-0.028	-0.163	0.087	0.066	-0.047	-0.005	-0.154	-0.075
GHS_STR	0.017	-0.006	-0.054	-0.207	0.284	-0.021	0.077	-0.037	0.135	-0.029	-0.172	0.299
MAD_STR	0.175	0.204	-0.097	-0.126	-0.203	-0.276	0.096	-0.003	-0.175	-0.119	-0.201	-0.210
NGN_STR	-0.038	0.111	-0.054	0.041	-0.065	-0.190	0.155	-0.024	-0.089	-0.111	-0.089	-0.189
ZAR_STR	0.124	0.266	0.045	-0.106	-0.207	-0.321	-0.068	0.057	-0.275	-0.068	-0.266	-0.250
TND_STR	-0.125	0.219	-0.038	0.071	-0.209	-0.333	-0.102	-0.116	-0.115	-0.054	-0.100	-0.201

Table 4.2 Continues

	GBP/MAD	*GBP/NGN*	*GBP/ZAR*	*GBP/TND*	*BWP_STR*	*EGP_STR*	*GHS_STR*	*MAD_STR*	*NGN_STR*	*ZAR_STR*	*TND_STR*
GBP/MAD	1.000										
GBP/NGN	0.049	1.000									
GBP/ZAR	0.052	0.212	1.000								
GBP/TND	0.916	0.099	0.079	1.000							
BWP_STR	-0.176	-0.072	-0.103	-0.194	1.000						
EGP_STR	-0.139	-0.054	-0.064	-0.112	0.210	1.000					
GHS_STR	0.018	0.084	0.005	0.100	0.117	0.046	1.000				
MAD_STR	-0.092	0.032	-0.049	-0.105	0.193	0.304	0.028	1.000			
NGN_STR	-0.298	0.009	-0.122	-0.281	0.237	0.336	0.193	0.307	1.000		
ZAR_STR	-0.174	-0.261	-0.054	-0.228	0.454	0.492	0.002	0.324	0.197	1.000	
TND_STR	-0.081	-0.234	-0.243	-0.044	0.254	0.276	0.001	0.249	0.179	0.300	1.000

4.4.2 Risk-Return Profile of African Currency Carry Trade

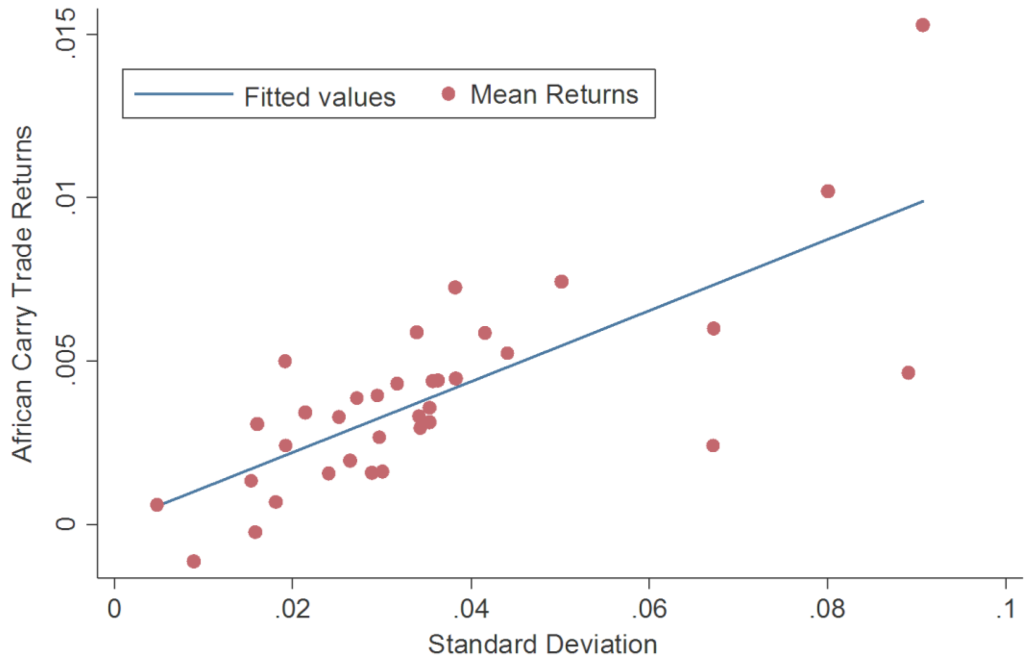


Figure 4.1: Currency Returns and Standard Deviation

Figure 4.1 plots the monthly mean return of currency carry trade calculated by taking a short (selling) position in four major currencies (USD, EUR, JPY and GBP) and a long (buying) position in seven African currencies, namely, Botswanan Pula, Ghanaian Cedi, Egyptian Pound, Tunisian Dinar, Morocco Dirham, Nigerian Naira and South African Rand. It can be observed from Figure 4.1 that there is a risk-return trade-off between the monthly mean returns of currency carry trade and their respective standard deviations. Thus higher returns attract higher risk and vice versa, which is the usual behaviour of all financial assets and, for that matter,risky investment (Reilly and Brown, 2003). This behaviour of the currency carry trade from African emerging and frontier markets is consistent with the behaviour of risky asset classes of all kinds. It will therefore be difficult to reject the fact that currency carry trade from Africa's emerging and frontier markets could be classified as an asset class.

4.4.3 Equally Weighted Carry Trade Portfolios

The study constructed one equally weighted portfolio for currency carry trade strategy which short sells the US dollar, Euro, Japanese yen and Great British Pound Sterling and takes a long buying position in the Botswana Pula, Ghana Cedi, Egyptian Pound, Tunisia Dinar, Morocco Dirham, Nigerian Naira and South African Rand. This generates a total of 28 currency pairs and the monthly returns of these currency pairs are equally weighted in the formulation of a single carry trade portfolio and are used as a proxy for Africa's currency carry trade index and compared with other asset classes. The Johannesburg Stock Exchange Africa All Share Index (JALSH) is used as a proxy for the African Stock Index. This is justified because the JALSH commands almost 80% capitalisation of all African stock markets put together, as noted in the works of Alagidede (2008). As benchmark indices, the study adopts the Morgan Stanley International All World Stock Index (MSCI), the Standard and Poor 500 index (S&P 500), and the MSCI Emerging Market Index. Further, the study employs the US 10-year Bond as a proxy for the international bond index. Table 4.3 shows the descriptive statistics of the portfolio returns and their risk-adjusted performances, while Table 4.4 shows the correlation matrix of these indices making up the portfolio.

Table 4.3: Descriptive Statistics and Risk-Adjusted Performance of Individual Assets

	Average Return	SD	Kurtosis	Skewness	Sortino	Sharpe Ratio	ASR	VaR(normal)	VaR(historical)
S&P 500	0.0012	0.2329	1.8311	1.5029	0.0014	0.0000	0.0000	-0.3819	-0.2233
MSCI	0.0037	0.0474	3.2043	-1.1180	0.0759	0.0544	0.0534	-0.0742	-0.0919
JALSH	0.0102	0.0801	2.0860	-0.4516	0.1643	0.1128	0.1090	-0.1215	-0.1348
CT PORT	0.0027	0.0091	0.6398	-0.4868	0.2801	0.1668	0.1622	-0.0123	-0.0147
BOND	0.0029	0.0008	-1.0036	-0.3068	-	2.0789	11.9984	0.0015	0.0014
USD CT	0.0032	0.0123	1.5224	-0.6648	0.2689	0.1654	0.1560	-0.0170	-0.0186
JPY CT	0.0043	0.0219	2.6712	-0.7394	0.2175	0.1899	0.1680	-0.0318	-0.0357
EUR CT	0.0019	0.0147	0.5096	-0.1331	0.0883	-0.0877	-0.0876	-0.0223	-0.0250
GBP CT	0.0025	0.0149	1.1795	0.2160	0.1643	0.0272	0.0273	-0.0219	-0.0201

Note: Table 4.3 shows the four moments of returns (from February 2002-December 2014) for the selected asset classes and the currencies carry trade portfolios generated by the researcher. CT PORT is the African carry trade portfolio comprising shorting all the four funding currencies simultaneously and longing all the target currencies as well. The USD CT, JPY CT, EUR CT and the GBP CT are the African currency carry trades financed by the USD, JPY, EUR and GBP respectively. The Value-at-Risk is calculated at the 95% confidence level for the normal distribution and the historical VaR.

Table 4.3 compares the risk-adjusted performance of the currency carry trades in Africa to some some selected stock market indices across the globe. The performances of the S&P 500, MSCI World Index, JALSH and 10-year US bonds are compared to the carry trades of African currencies financed by the USD, JPY, EUR and GBP. Also, the study compares the composite portfolio of African currency carry trade constructed by the researcher against these asset classes. It is evident from Table 4.3 that except for the the 10-year bond, the African currencies carry trade portfolios largely outperform the stock market indices. Apart from the EUR CT and GBP CT, the Sharpe ratios for the remaining currency carry trade portfolios are surprisingly beating the S&P 500, MSCI world index and the JSE Africa All Share Index. This could be explained by the general attractiveness of the large interest rate differential associated with African countries and the developed countries such as Japan, the United States of America, and Britain, and the Euro area. Also, the volatility (standard deviation) associated with the currency carry trade returns in Africa appears to be lower than the volatility associated with the returns of the stock markets in Africa. The Sortino ratio, which penalises only the downside risk of the portfolios, appears to agree with the Sharpe ratio in all cases except one. The JSE Africa All Share Index over the period outperformed the currency carry trade portfolio funded by the EUR. It would therefore be fair to conclude that the currency carry trade funded by the EUR is prone to downside risk as compared to the stock market returns, since returns per unit of downside risk are lower than that of JALSH. The behaviour or the risk-adjusted performance of the currency carry trade funded by EUR can be traced to the European financial crisis as discussed in chapter three of this study. This is because the period studied actually captures the successive financial crisis periods witnessed across the European continent and their worldwide spillover effects.

The risk-adjusted performance measures seem to agree unanimously since the adjusted Sharpe ratio as well as the VaR (5%) for both normal and historical returns all point to better performance of the currency carry trade ahead of the stock market indices. These results are consistent with the findings of earlier works (Brunnermeier et al., 2008; Das et al., 2013; Korhonen and Kunz, 2009).

Table 4.4: Correlation Matrix of Conventional Asset Classes with Currency Carry Trade Portfolios

	S&P 500	*MSCI*	*JALSH*	*CT PORT*	*TBILL*	*BOND*	*USCT*	*JPCT*	*EUCT*	*GBCT*
S&P 500	1.00									
MSCI	0.07	1.00								
JALSH	0.04	0.28	1.00							
CT PORT	0.08	0.39	0.12	1.00						
TBILL	0.00	0.02	0.06	-0.02	1.00					
BOND	-0.04	-0.01	0.10	0.01	0.76	1.00				
US CT	0.07	0.57	0.29	0.60	0.05	0.17	1.00			
JP CT	0.06	0.49	0.20	0.84	0.05	-0.02	0.50	1.00		
EU CT	0.01	-0.24	-0.12	0.50	-0.12	-0.05	-0.14	0.12	1.00	
GB CT	-0.06	-0.12	-0.31	0.46	-0.09	-0.05	0.08	0.09	0.50	1.00

Note: The Table shows the correlations between the returns of the selected asset classes and the currencies carry trade portfolios generated by the researcher. CT PORT is the African carry trade portfolio comprising shorting all the four funding currencies simultaneously and longing all the target currencies as well. The US CT, JP CT, EU CT and the GB CT are the African currency carry trade financed the USD, JPY, EUR and GBP respectively. The data collected from February 2002 to December 2014.

Table 4.4 presents the correlation matrix between the currency carry trade portfolio returns and other asset classes. A careful examination of the Table reveals that there appears to be generally either very weak positive correlation or negative correlations between the stock market returns in particular and the currency carry trade portfolios. This is an indication that the African currency carry trade could be a very good candidate for portfolio diversification with other risky assets. The MSCI world Index and the JALSH are negatively correlated with the African currency carry trade funded by the EUR and GBP. Including the MSCI world index and the JALSH in a portfolio with African currency carry trade would therefore be justified. The fixed income securities (bonds and

Treasury bills) are also largely correlated with the African currency carry trade portfolios which could also be a justification for their inclusion into a portfolio with African carry trade.

4.4.4 Impact of African Currency Carry Trade Portfolio Performance

This section presents the results of the impact the currency carry trade (specifically the African currency carry trade) has on an existing conventional portfolio. The section is in two parts; the first part looks at the currency carry trade as an alternative to the stock market index, in particular the S&P 500. Thus the researcher assessed the impact of currency carry trade when the S&P 500 is replaced by the African currency carry trade in the same portfolio. In the second part, the researcher complements the performance of an existing portfolio by adding the African currencies carry trade to it. The study maintains equal weighting for all the assets for ease of comparison.

4.4.4.1 Currency Carry Trade as Substitute for Equity Index

The researcher constructs an equally weighted portfolio with the JSE Africa All Share Index, MSCI World Index, US 10-year Bond and S&P 500 allocating 25% each of the capital. This statistical description and the risk-adjusted performance of this portfolio are presented in Table 4.5. The portfolio generates a monthly mean return of 0.45% with a Sharpe (0.051) and Sortino (0.097) ratios calculated from data spanning from February 2002 to December 2014. Table 4.5 reveals that although the representative portfolio has relatively higher volatility (standard deviation) it exhibits positive skewness and kurtosis at reasonable levels. As shown in Table 4.5 the researcher presents the five portfolios of currency carry trade as a substitute for the S&P 500 in succession. Replacing the S&P 500 with the African currency carry trade (CT PORT) it can be observed that the mean monthly return of the portfolio increases from 0.45% to 0.49%, with relatively lower portfolio volatility (standard deviation). The risk-adjusted performance of the portfolio improves as Sharpe (0.051) and Sortino (0.097) ratios increase to 0.064 and 0.202 respectively. This could partly be explained by the relatively low standard deviation associated with African currency carry trade returns. Not only the Sharpe and Sortino saw the improvement but the adjusted Sharpe ratio and the VaR (5%) are also significantly improved.

Next, the researcher takes out the African currency carry trade (CT PORT) and substitutes it with the USD funded African currency carry trade. This portfolio produces a monthly mean return of 0.50%, which is an improvement over the previous portfolio in terms of absolute returns. All the risk-adjusted performance measures for this study, as presented in Table 4.5, exhibit significant improvement over the representative portfolio. A critical examination of Table 4.5 reveals that the currency carry trade financed by the Japanese Yen, Euro and Great British Pound Sterling are all exhibiting impressive risk-adjusted performances. Sharpe ratio, Sortino ratio, adjusted Sharpe ratio and VaR (5%) are consistent in showing that the USD CT and JPY CT produce superior performance as compared to all the other portfolios considered in the study.

Table 4.5: Portfolio Perfomance with African Carry Trade Alternative to Stocks

	African Currency Carry Trade as an Alternative to Stocks					
Assets in the Portfolio	**Representative Portfolio**	**CT PORT**	**USD CT**	**JPY CT**	**EUR CT**	**GBP CT**
JSE Africa All Share Index	25%	25%	25%	25%	25%	25%
MSCI World Index	25%	25%	25%	25%	25%	25%
US 10 Year Bond	25%	25%	25%	25%	25%	25%
S & P 500	25%					
CT PORT		25%				
USD CT			25%			
JPY CT				25%		
EUR CT					25%	
GBP CT						25%
Average Return	0.45%	0.49%	0.50%	0.53%	0.47%	0.49%
Standard Deviation	6.52%	2.67%	2.76%	2.85%	2.55%	2.51%
Kurtosis	1.736	4.697	4.555	5.950	3.772	3.713
Skewness	1.026	-1.096	-1.041	-1.341	-0.906	-0.969
Sortino Ratio	0.097	0.202	0.204	0.205	0.202	0.216
Sharpe Ratio	0.051	0.064	0.140	0.181	0.059	0.108
Adjusted Share Ratio	0.051	0.062	0.124	0.139	0.058	0.102
VaR(normal)	-0.103	-0.039	-0.040	-0.042	-0.037	-0.036
VaR(historical)	-0.083	-0.049	-0.050	-0.045	-0.045	-0.045

Note: Table 4.5 shows a four asset portfolio representative portfolio with the various carry trade portfolios replacing the S&P 500 index in different scenarios. CT PORT is the African carry trade portfolio comprising shorting all the four funding currencies simultaneously and longing all the target currencies as well. The US CT, JP CT, EU CT and the GB CT are the African currency carry trade financed the USD, JPY, EUR and GBP respectively. The data collected from February 2002 to December 2014.

It is again evident that all five African currency carry trades outperform the S&P 500 when included in a portfolio and also reinforces the point that African currency carry trade can be used as an alternative asset class in constructing a portfolio with a reasonable amount of diversification properties. The researcher noted also that the African carry trade portfolio funded with the Japanese Yen has superior diversification properties when added to a portfolio compared to the other carry trade portfolios considered. This may be attributed to the relatively lower volatility (standard deviation) of JPY funded carry trades and more importantly, the lower or negative correlation between the JPY CT and the portfolio.

4.4.4.2 Currency Carry Trade as Complementary Asset Class

The researcher repeats the representative portfolio in Table 4.6 and now adds the five African currencies carry trade portfolios used in section 4.5.4.1 in succession. The basic statistical moments and the risk-adjusted performance of the representative portfolio remain unchanged. The study looked at adding the currency carry trade by altering the asset weights for the entire five assets, which brings the asset weights to 20% equally across the portfolio. Comparing the portfolios *with* and *without* currency carry trade reveals that, generally, the portfolios with the currency carry trade component in them outperform the ones without the currency carry trade. This finding is for all the African currency carry trades except the EUR funded carry trade. This finding could be attributed to the fact that the African currency carry trade largely correlates negatively with the financial markets of the developed world. In addition to the negative correlation between the currency carry trade and other risky assets of the developed countries, the risk associated with currency carry trade appears to be relatively lower when compared with other risky assets. Hence there exist significant diversification benefits whenever the African currencies carry trade is combined with other risky assets. So, investors seeking to improve the risk-adjusted performance of their investment and to reduce their portfolio risks could benefit from the inclusion of the currency carry trade in their portfolio. However, it is important to note that the JPY, USD and GBP generate superior risk-adjusted performances when combined with other asset classes. It is observed again from Table 4.6 that the inclusion of African currency carry trade significantly reduces the volatility of the portfolio, perhaps due to the fact that the carry trade portfolios themselves have lower volatility compared to the stock market. Furthermore, the Table reveals that the VaR (5%) for the portfolio reduces significantly when the currency carry trade is included in the representative portfolio.

4.4.5 Sharpe Ratio Contribution

This section presents the results of the extent of influence that African currency carry trade has on the representative portfolio (Table 4.5 and 4.6). The results are in two parts; the first part looks at the impact when the currency carry trade is used as substitute, and the second part looks at the currency carry trade contribution to performance when it is added to the representative portfolio. Table 4.7 presents Sharpe ratio decomposition for the representative portfolio and the five other portfolios that include the currency carry trades. The representative portfolio has a Sharpe ratio of 0.0557. The JSE Africa All Share Index (0.0346) contributes a major part of this Sharpe ratio, followed by bond (0.0112), with the remaining shared among the MSCI World Index (0.0099), and the S&P 500 (0.0000).

Table 4.6: Impact of African Carry Trade in a Dummy Portfolio

	African Currency Carry Trade Included in a Dummy Portfolio					
Assets in the Portfolio	**Representative Portfolio**	**CT PORT**	**USD CT**	**JPY CT**	**EUR CT**	**GBP CT**
JSE Africa All Share Index	25%	20.00%	20.00%	20.00%	20.00%	20.00%
MSCI World Index	25%	20.00%	20.00%	20.00%	20.00%	20.00%
US 10 Year Bond	25%	20.00%	20.00%	20.00%	20.00%	20.00%
S & P 500	25%	20.00%	20.00%	20.00%	20.00%	20.00%
CT PORT		20.00%				
USD CT			20.00%			
JPY CT				20.00%		
EUR CT					20.00%	
GBP CT						20.00%
Average Return	0.45%	0.41%	0.42%	0.45%	0.40%	0.49%
Standard Deviation	6.52%	5.25%	5.29%	5.33%	5.21%	2.51%
Kurtosis	1.736	1.736	1.748	1.828	1.706	3.713
Skewness	1.026	0.995	0.969	0.898	1.073	-0.969
Sortino Ratio	0.097	0.108	0.110	0.116	0.105	0.216
Sharpe Ratio	0.051	0.076	0.080	0.081	0.015	0.108
Adjusted Share Ratio	0.051	0.077	0.081	0.082	0.015	0.102
VaR(normal)	-0.103	-0.082	-0.083	-0.083	-0.082	-0.036
VaR(historical)	-0.083	-0.066	-0.067	-0.067	-0.064	-0.045

Note: Table 4.6 shows a four asset portfolio representative portfolio which is augmented to five asset portfolio with the various carry trade portfolios. CT PORT is the African carry trade portfolio comprising shorting all the four funding currencies simultaneously and longing all the target currencies as well. The US CT, JP CT, EU CT and the GB CT are the African currency carry trade financed the USD, JPY, EUR and GBP respectively. The data collected from February 2002 to December 2014.

Table 4.7 reveals that substituting the S&P 500 with the African currency carry portfolio (CT PORT) brings remarkable improvement in the Sharpe ratio for the portfolio and consequently pushes up the historical performance of all the other assets in the portfolio. Suddenly, the contribution of the JSE Africa All Share Index has moved up to 0.0847, the MSCI index also increases to 0.0242, with the bonds also seeing significant increase of 0.0164. All the existing risky assets in the representative portfolio moved up more than twice their initial contribution to the risk-adjusted performance (Sharpe ratio) of the portfolio. The contribution of the African currency carry trade in absolute terms is 0.0143, which is more than five times the performance of the S&P 500 in a similar portfolio. Further, it can be observed that the inclusion of currency carry trade in the portfolio contributed more than the absolute 0.0143 of the Sharpe ratio since its inclusion triggered some tremendous jumps in the performance of all the assets in the portfolio within the same historical period of February 2002 to December 2014.

Table 4.7: Impact of African Currency Carry Trade on Portfolio Perfomance

	Contribution of African Currency Carry Trade to Portfolio Sharpe Ratio					
Assets in the Portfolio	**Representative Portfolio**	**CT PORT**	**USD CT**	**JPY CT**	**EUR CT**	**GBP CT**
JSE Africa All Share Index	25%	25%	25%	25%	25%	25%
MSCI World Index	25%	25%	25%	25%	25%	25%
US 10 Year Bond	25%	25%	25%	25%	25%	25%
S & P 500	25%					
CT PORT		25%				
USD CT			25%			
JPY CT				25%		
EUR CT					25%	
GBP CT						25%
Asset in the Portfolio	**Asset Contribution to Sharpe Ratio**					
JSE Africa All Share Index	0.0346	0.0847	0.0819	0.0792	0.0887	0.0900
MSCI World Index	0.0099	0.0242	0.0234	0.0226	0.0253	0.0257
US 10 Year Bond	0.0112	0.0164	0.0265	0.0153	0.0172	0.0174
S & P 500	0.0000					
CT PORT		0.0143				
USD CT			0.0291			
JPY CT				0.0366		
EUR CT					-0.0127	
GBP CT						0.0040
Portfolio Sharpe Ratio	**0.0557**	**0.1396**	**0.1608**	**0.1537**	**0.1185**	**0.1372**

Note: Table 4.7 shows the decomposition of Sharpe ratios for the various portfolios when the S&P 500 is replaced by the currency carry trade portfolios funded by the USD, JPY, EUR and GBP to determine the real impact of currency carry trade on the risk-adjusted performance of portfolio. The African Carry Trade (CT PORT) is a portfolio that takes a short position in four different currencies (USD, JPY, EUR and GBP) and takes a long position on seven African currencies (BWP, NGN, GHS, EGP, TND, MAD and ZAR). Data collected from February 2002-December 2014.

Next, the study replaces the CT PORT with the African currency carry trade funded by the United States dollar (USD CT) for the same historical period chosen for the study. The results show that the currency carry trade once again has shed some light on the risk-adjusted performance of the portfolio, which is consistent with the contribution made by the CT PORT. All the assets in the portfolio expand more than twice their original contribution to the portfolio’s Sharpe ratio. This time the absolute contribution of the USD CT (0.0291) in the portfolio is more than the contribution of the MSCI World Index and the US 10-year bond, thus exhibiting the potency of its diversification abilities. Subsequently, the researcher takes out the US CT from the portfolio and substitutes it with currency carry trade financed by the Japanese Yen (JPY CT). This again triggered another massive improvement in the risk-adjusted performance of the portfolio. This is an indication that the African currencies carry trade financed by the Japanese Yen is profitable and also has the potential to provide diversification benefits to a portfolio of risky assets.

The inclusion of the JPY CT influences the performance of the other assets, as was in the case of the CT PORT and USD CT. However, in the case of the JPY CT its absolute contribution to the portfolio Sharpe ratio is actually greater than the CT PORT and US CT contributions to their respective portfolios. Again, and more importantly, within the portfolio the JPY CT outperformed all the assets except the JSE Africa All Share Index, meaning that the JPY CT contributed 0.0366 to the portfolio Sharpe ratio, which is more than the contribution of bonds (0.0153) and the MSCI World Index (0.0226). Among the currency carry trade portfolios constructed for the study, the African currency carry trade funded by the Euro (EUR CT) contributed less in absolute terms (-0.0127) but in real terms, when included in a portfolio of risky assets, it has a significant potential to improve the risk-adjusted performance of the representative portfolio. The EUR CT influences the portfolio's Sharpe ratio to increase to 0.1185, higher than that of the reperesentative portfolio.

The last, but certainly not least, portfolio replaces the EUR CT with the GB CT. Historically, the study's GBP-funded portfolio has been a great performing strategy and this is manifested clearly when included in the representative portfolio. The Sharpe ratio of the representative portfolio increased dramatically to 0.1372, considerably higher than the performance of the representative portfolio. The absolute contribution of the GBP CT (0.0040) is however lower than all the assets in the portfolio. It is worth noting the emerging trend in Table 4.7. The researcher observes that the absolute contributions of the EUR CT and GBP CT are lower relative to their counterpart currency carry trade portfolios, but they have strong diversification abilities to improve the Sharpe ratios of their respective portfolios.

Table 4.8: Impact of African Carry Trade as a Complement to Existing Portfolio

	African Currency Carry Trade Included in a Dummy Portfolio					
Assets in the Portfolio	**Representative Portfolio**	**CT PORT**	**USD CT**	**JPY CT**	**EUR CT**	**GBP CT**
JSE Africa All Share Index	25%	20.00%	20.00%	20.00%	20.00%	20.00%
MSCI World Index	25%	20.00%	20.00%	20.00%	20.00%	20.00%
US 10 Year Bond	25%	20.00%	20.00%	20.00%	20.00%	20.00%
S & P 500	25%	20.00%	20.00%	20.00%	20.00%	20.00%
CT PORT		20.00%				
USD CT			20.00%			
JPY CT				20.00%		
EUR CT					20.00%	
GBP CT						20.00%
Asset in the Portfolio	**Asset Contribution to Sharpe Ratio**					
JSE Africa All Share Index	0.0346	0.0344	0.0342	0.0339	0.0347	0.0349
MSCI World Index	0.0099	0.0098	0.0098	0.0097	0.0099	0.0100
US 10 Year Bond	0.0112	0.0111	0.0110	0.0110	0.0112	0.0113
S & P 500	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CT PORT		0.0103				
USD CT			0.0121			
JPY CT				0.0161		
EUR CT					0.0073	
GBP CT						0.0098
Portfolio Sharpe Ratio	**0.0557**	**0.0656**	**0.0671**	**0.0707**	**0.0631**	**0.0660**

Note: Table 4.8 shows the decomposition of Sharpe ratios for the various portfolios when the existing four assets portfolio is augmented to five assets by the currency carry trade portfolios funded by USD, JPY, EUR and GBP to determine the real impact of currency carry trade on the risk-adjusted performance of portfolio. The African Carry Trade (CT PORT) is a portfolio that takes a short position in four different currencies (USD, JPY, EUR and GBP) and takes a long position on seven African currencies (BWP, NGN, GHS, EGP, TND, MAD and ZAR). Data collected from February 2002-December 2014.

Table 4.8 presents the results of the Sharpe ratio decomposition of the representative portfolio when African currency carry trade is added to the existing portfolio. The representative portfolio of Table 4.7 is replicated, and instead of replacing the S&P 500, the researcher keeps all assets in the portfolio and adds the African currencies carry trade by readjusting the portfolio weights to accommodate the new asset. The researcher observed that after adding the CT PORT to the representative portfolio there seems to be an improvement in the portfolio Sharpe ratio, albeit not as significant as the one recorded in Table 4.7 when the S&P was replaced with the CT PORT. The Sharpe ratio increases from 0.0557 to 0.0656 with the CT PORT’s absolute contribution of 0.0103 more than twice the value of the S&P 500 contribution. The trend is similar across all the other four currency carry trade portfolios. In fact, in the case of the CT PORT, USD CT and the JPY CT, it appears that the inclusion of currrency carry trade actually reduces the contributions of the existing individual assets in their respective portfolios compared to the representative portfolio. This could be attributed to the high volatility as well the low contribution of the S&P 500 to the portfolio. On the other hand, including the EUR CT and the GBP CT in their respective portfolios not only improved the Sharpe ratio of the portfolio but also increased the individual contributions of the various assets in the portfolio. These increases were, however, marginal compared to the increases observed in Table 4.7.

From the foregoing discussion, it is evident that the impact of currency carry trade on portfolio Sharpe ratio is more pronounced when it replaces the S&P 500 in the representative portfolio (see Table 4.7) and marginal when it augments the representative portfolio (see Table 4.8). This is because, the S&P 500 has almost perfect positive correlation with the representative portfolio and the five other portfolios constructed thereof (see Appendix F) and so may not present much diversification value to these portfolios. The currency carry trades on the other hand (predominantly) negatively correlate with the underlying portfolios and for that matter offer significant amount of diversification benefits to the portfolio. Thus substituting the S&P 500 which has virtually no diversification benefits with the currency carry trade improves the Sharpe ratio much more than just adding the currency carry trade to the representative portfolio.

4.5 Chapter Summary and Conclusions

From the outset, the aim of this chapter was to subject the historical returns generated by the African currency carry trade to strict proof to ascertain whether they represent a prudent or viable investment and can be classified as an alternative asset class. To achieve this objective the study reviewed relevant literature and set out its methodology with detailed specifications of the models used to measure the viability of these returns. The data and the data sources were also presented and, subsequently, the results and detailed discussions presented in section four of the chapter. The researcher documents that the risk-adjusted performance of African currency carry trade largely outperforms the stock market indices and in some cases matches the stock market performance. Almost all the currency pairs examined in this study show some profitability tendencies and most importantly display diversification properties. The researcher further concludes that including the African currency carry trade in a portfolio causes a dramatic risk-adjusted performance of the portfolio. The findings also show that substituting the stock index in a conventional portfolio influences the portfolio to perform well, especially when the stock index to be replaced moves in the same direction as the African currency carry trade. Analysis of the Sharpe ratios for portfolios that include African currency carry trade also revealed that the currency carry trade makes a significant contribution to the performance of the portfolio. On the basis of these findings it appears that the African currency carry trade, to a very large extent, satisfies the criteria of an asset class and, for that matter, may constitute a prudent investment. In the next chapter the researcher performs a value-at-risk analysis on the African currency carry trade in an attempt to predict its worst possible losses using conditional VaR or expected shortfall.

CHAPTER 5

Value at Risk (VaR) Analysis of African Currency Carry Trade

5.0 Introduction

The previous chapter dealt with how prudent Africa's currency carry trade could be as an alternative asset class and suggests it may well be an alternative investment opportunity for investors. It is however worth mentioning that currency carry trade is a very risky strategy and, in particular, Africa's well known volatile financial environment makes it even riskier for the investing community. This current study thus takes a tour into modeling a value-at-risk framework for Africa's currency carry trade to attempt to predict the worst possible losses that could be incurred over time. The value-at-risk (VaR) prediction is imperative because the supervisory or regulatory authorities of banks (who are likely candidates for the Africa's currency carry trade strategy) favour the quantitative modeling of predicting future losses of their investment activities to mitigate the fragility of the sector. The achievement of the objective of the study is describedunder five main sections. The first section presents the background and the motivation for the study whilst the second section presents a review of related academic literature. Section three presents the econometric and statistical methods employed to predict or estimate the VaR for the African currency carry trade - the generalised autoregressive conditional heteroskedasticity (GARCH) model which is used to model the conditional mean and conditional variance and subsequent calculation of the VaR (with accompanying backtesting tools) of African currency carry trade. Section four presents and discusses the empirical results from the study. And, finally, section five deals with the summary and conclusions of the study.

5.1 Background on Carry Trade and VaR

As noted earlier in chapters three and four, the currency carry trade strategy has become extremely popular the world over, albeit plagued with a significant amount of downside risks. Throughout the literature the historical returns of currency carry trade have suffered severely during the global financial crisis, particularly over the last two decades. This phenomenon has been primarily because of the dislocation of interest rates and exchange rates during major financial crisis. Evidence in the extant literature suggests that there is a tendency for some currencies with high interest rates to rather appreciate and to further widen the carry trade opportunities between the two currencies (Melvin and Taylor, 2009). This adds to the uncertainties around the currency carry trade that makes it a very high risk investment, especially to the risk-averse masses, although historically the strategy has recorded very attractive returns. Currency carry trade in general exhibits some unique features such as high Sharpe ratios, high Sortino ratios[13], negative skewness, excess kurtosis and appears to have excessive crash risk (as espoused in the studies of Brunnermeier et al. 2008). The currency carry trade fragility or the susceptibility of the strategy to peso events has been captured widely in the extant literature of behavioural finance (Brunnermeier et al., 2008; Burnside, 2011; Burnside et al., 2011; Hoffmann et al., 2013; Lee and Chang, 2013; Marca, 2007; Menkhoff et al., 2012a; Wang et al., 2013). The risk behaviours of the currency carry trades across the developed markets appear to be similar over time for at least the past two decades, a period which includes the financial crises of 2007 to 2009 - crises experienced across globe. In the extant literature it appears that the currency carry trade unwinds during these stressful market environments, which is an indication that investors could very likely suffer severer losses of their investment (Wang et al., 2013). It is instructive to note that as much as the aforementioned characteristics of the risks inherent in the currency carry trade are observed across the globe, the African currency carry trade exhibits some other unique characteristics which appear to differ from the status quo. From chapter three of this thesis the researcher learnt that the currency carry trade targeting African currencies are generally resilient during financial crises. In other words, when the stock markets of the developed markets are on their knees as a result of a crisis, the researcher found that some African currency carry trades returns showing some attractive performances. This is an indication that there appears to be some unique characteristics of the African currency carry trades, as discussed in section 3.5.3.3 in chapter three of this thesis. The unique characteristics, inter alia, emanate from the negative correlation between the African markets and the world and also the fact that the African markets are not well integrated with the world market. This chapter examines the value-at-risk of the African currency carry trade funded by the USD, EUR, JPY and GBP using ARMA (1, 0)-GARCH (1, 1) with Gaussian (normal), Student t and Skewed Student t innovations. The researcher further calculates the conditional value-at-risk (CVaR) or expected shortfall (ES) since the value-at-risk has been criticised as not being coherent as the expected shortfall.

5.2 Related Literature Review

Even though the UIP suggests that the difference in interest rate of two currencies is exactly offset by exchange rate changes, evidence in the literature suggest otherwise. Thus instead of the currency with the low interest rate appreciating against the currency with the high interest rate, it rather has a tendency to depreciate against the high interest rate currency (Melvin and Taylor, 2009). Brunnermeier et al. (2008) show that measures such as large Sharpe ratios, negative

[13] As evident in chapter four of this thesis and corroborated by the studies of Wang et al. (2013)

skewness, and positive excess kurtosis are uniquely associated with currency carry trade returns. They further contend that carry trades also appear to involve excessive risk over long horizons. Carry trades in recent studies appear to unwind during stressful market conditions, which is an indication that investors of carry trade could potentially incur some losses. Wang et al. (2013) demonstrated that the currency carry trade will exhibit negative skewness and positive kurtosis in the event that carry trade returns are calculated under a short position in Japanese Yen (JPY) and a long position in another high interest rate currency. Thus the negative skewness and excess kurtosis associated with carry trade returns are caused by crash risk, confirming the popular saying of foreign currency traders that "exchange rates go up by the stairs and down by the elevator" (Brunnermeier et al., 2008, p. 4).

In the extant literature the excess return from currency carry trade which comes about as a result of the failure of the UIP has been explained by factors such as liquidity risk and peso event risk or crash risk. Liquidity risk can be explained as a risk that arises as a result of lack of marketability of an investment, in this case currency carry trade. This means the investment cannot be bought or sold quickly enough to prevent or minimise losses. This risk is largely attributed to wide bid-ask spreads or large price movements (especially to the downside). Crash risk or peso event risk of carry trade is the downside risk of the trade. According to the extant literature, exchange rate movements between high interest rate and low interest rate currencies are almost all the time negatively skewed. This simply means there are more negative returns than there are positive ones within a specified period of time. This characteristic is attributable to crash risk or peso event risk (Bacchetta and Wincoop, 2010; Brunnermeier et al., 2008; Burnside et al., 2007; Lustig and Verdelhan, 2007; Melvin and Taylor, 2009).

Value-at-Risk (VaR) is a very important measure of managing market risk. VaR is the measure of the worst expected loss of currency carry trade portfolio over a given time horizon at a given confidence level. VaR is therefore used by the researcher to capture and reflect the risk involved in currency carry trades (Wang et al., 2013). The nature of currency carry trade returns do not conform to a normal distribution and so traditional models may underestimate or overestimate the VaR, particularly because the normality assumption of the standardised residuals which is somehow not consistent with the behaviour of currency carry trade returns (Brunnermeier et al., 2008). McAleer (2009) presented the management of market risk and monitoring under the Basel II Accord and the "Ten Commandments" for optimising VaR.

In the academic literature, ARCH-type models have been used to model VaR (Giot and Laurent, 2003). Alexander and Lazar (2006) built on the ARCH-type models and provided the mixture GARCH (1, 1) for exchange returns. More recent literature shows the use of skew-normal mixture and Markov-switching GARCH processes to capture the skewness in the distribution of stock returns (Haas, 2010).

There appears to be only one empirical study which examines value-at-risk on the currency carry trade returns in the academic literature. Wang et al. (2013) performed a VaR analysis on currency carry trade using generalised autoresgressive conditional heteroskadasticity (GARCH) with different innovation settings (i.e. normal, student t, skew normal and skew t distributions). The authors used 3-month interbank interest and weekly exchange rates data drawn from Australia (AUD), Canada (CAD), New Zealand (NZD), Norway (NOK), and Argentina (ARS) as target currency countries, and Japan (JPY) as funding currency country. Their study was aimed at defining the appropriate innovation settings to model the peculiar characteristics of skewness associated with currency carry trade. They concluded that the skew-density GARCH models are usually superior to other normal and t GARCH models. In particular, they concluded that, if there is large excess kurtosis and skewness in the currency carry trade, then the skew student t ARMA(1, 1)-GARCH(1, 1) model is most appropriate to accurately capture its risk. The scope of their study however, failed to account for the actual losses in worst case situations. Also their study calibrated the VaR without looking at the more coherent measure of risk, the conditional VaR or the expected shortfall. The currencies used for their study were predominantly from the developed markets and excluded African currencies entirely. This current study will attempt to address the afore mentioned issues. Thus the current study examines the VaR and expected shorfall of African currency carry trades with three innovation settings using the generalised autoregressive conditional heteroskedasticity (GARCH). The study further attempts to predict the expected shortfall or the average losses to be incurred given that the VaR is exceeded.

5.3 Methodology and Data Description

This part of the study adopts the ARIMA (1, 0)-GARCH (1, 1) model to examine the value-at-risk of the returns of African currency carry trade among 28 currency pairs (i.e. seven African currencies as the target currencies funded by four developed world currencies). The generalised autoregressive heteroskedasticity (GARCH) model is used to model the conditional mean and conditional variance of the African currency carry trade with three different innovations (Gaussian, Student t, and Skewed t distributions). The researcher subsequently used the model to calculate the value-at-risk of the African currency carry trade. To check the accuracy of this model, the researcher performs a value-at-risk backtesting using the log likelihood ratios of Kupiec (1995) and dynamic quantile regression of Engle and Manganelli (2004). A major weakness of the VaR is that it "provides no indication of the extent of the losses that may be suffered beyond the threshold amount indicated by this measure"(Wang et al., 2013). As a result, the study will further calculate the conditional value-at-risk (CVaR) or Expected Shortfall (ES) as proposed by Rockafellar and Uryasev (2002) to deal with the average losses beyond the indicated threshold amount.

5.3.1 The Volatility Model

Ordinarily, the volatility of the African currency carry trade would have been the standard deviation of the return series (i.e. how dispersed the returns are from their mean return). However, as established in the literature, financial assets exhibit time varying volatility and for that matter the standard deviation may not be able to capture the statistical properties of this time varying volatility. The researcher thus followed the model specification of Angelidis et al. (2004) to model the conditional mean and conditional variance using the Autoregressive Conditional Heteroskedasticity (ARCH) originally proposed by Engle (1982). The researcher denotes y_t as the returns series for African currency carry trade. It then follows that y_t is decomposed into two parts, the predictable and unpredictable parts, algebraically expressed in equation 5.1:

$$y_t = \mathrm{E}(y_t|I_{t-1}) + \varepsilon_t \tag{5.1}$$

whereI_{t-1}, E, and ε_t represent the information at time *t-1,* conditional mean operator and the unpredictable component of y_t respectively. From equation 5.1 the conditional mean return would be the *k-th* order autoregressive process, AR (*k*) as expressed in equation 5.2. Thus the autoregressive process takes care of some amount of autocorrelation in the data.

$$\mathrm{E}(y_t|I_{t-1}) \equiv c_0 + \sum_{i=1}^{k} c_i y_{t-i} \tag{5.2}$$

As equation 5.2 models the conditional mean (i.e. the predictable component of the return series y_t), the unpredictable element could be expressed as an ARCH in the form as specified in equation 5.3:

$$\varepsilon_t = \sigma_t z_t \tag{5.3}$$

where z_t is an *i.i.d* process, with mean and variance of zero and one respectively. Furthermore, the conditional variance of the unpredictable component ε_t is time- varying and positive (Angelidis et al., 2004) usually denoted as σ_t and this is captured by Engle's (1982) ARCH model. The ARCH model expresses today's conditional variance as linear function of yesterday's squared returns as specified in equation 5.4:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-1}^2 \tag{5.4}$$

It is expected that both α_0 and α_i for *i*=1,…..,q must not be negative in order for the conditional variance to be positive. Bollerslev (1986) introduced a generalized ARCH, popularly referred to as GARCH (p, q), by including the lagged conditional variance in the ARCH model, as defined in equation 5.5:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} b_j \sigma_{t-j}^2 \tag{5.5}$$

where $\alpha_0 > 0$, $\alpha_i \geq 0$ for *i*=1,…..,q, and $b_j \geq 0$ for *j*= 1, ….,p. The ε_t process is said to be stationary if $\sum_{i=1}^{q} \alpha_i + \sum_{j=1}^{p} b_j < 1$ and the unconditional variance could be estimated with equation 5.6:

$$\sigma^2 = \frac{\alpha_0}{1 - \sum_{i=1}^{q} \alpha_i - \sum_{j=1}^{p} b_j} \tag{5.6}$$

Thus $\sum_{i=1}^{q} \alpha_i + \sum_{j=1}^{p} b_j < 1$ is a sufficient condition to guarantee the positivity condition of the conditional variance. It is usually referred to as the persistence and shows how fast or otherwise the conditional volatility dissipates to revert to the unconditional variance. GARCH (p, q) has the advantage of capturing many of the statistical properties of the financial assets, which include volatility clustering where periods of high volatility are followed by periods of high volatility and vice versa, fat tailed returns, and volatility mean reverting where periods of either low or high volatility are eventually reverted to a normal volatility (Engle and Patton, 2001).

The model is however also criticised that it requires large number of observations to estimate reliable results and is also sometimes unstable during out-of-sample forecasting (Angelidis et al., 2004).

As has been the tradition, the ARCH-type models are usually estimated through maximum likelihood estimation (MLE). The MLE has the "assumption of independently and identically distributed standardised innovations, z_t, and for D$(z_t; \upsilon)$ denoting their density function, the log-likelihood function of $\{y_t(\theta)\}$ for a sample of T observations" (Angelidis et al., 2004, p. 5) and it is specified as follows:

$$L_T(\{y_t\};\theta) = \sum_{t=1}^{T} [\ln[D(z_t(\theta);\nu)] - \tfrac{1}{2}\ln(\sigma_t^2(\theta))] \tag{5.7}$$

where θ represents the density function as well as the conditional mean and variance parameters to be estimated. Since the maximum likelihood estimator $\hat{\theta}$ can be found by maximising equation 5.7 the researcher maximised the equation to obtain the log likelihood function for the sample of T observations as follows:

For normally distributed standardised innovations:

$$L_T(\{y_t\};\theta) = -\tfrac{1}{2}\,[T ln(2\pi) + \sum_{t=1}^{T} z_t^2 + \sum_{t=1}^{T} \ln(\sigma_t^2)] \tag{5.8}$$

For standardised t-distributed innovations:

$$L_T(\{y_t\};\theta) = T\left[ln\Gamma\left(\tfrac{\upsilon+1}{2}\right) - ln\Gamma\left(\tfrac{\upsilon}{2}\right) - \tfrac{1}{2}\ln[\pi(\upsilon-2)]\right] \tag{5.9}$$

$$\frac{1}{2}\sum_{i=1}^{T}[\ln(\sigma_t^2) + (1+\upsilon)\ln(1+\tfrac{z_t^2}{\upsilon-2})] \tag{5.10}$$

The log-likelihood of a standardised (zero mean and unit variance) skewed-student t is:

$$L_T(\{y_t\};\theta) = T\{ln\Gamma\left(\frac{\upsilon+1}{2}\right) - ln\Gamma\left(\frac{\upsilon}{2}\right) - 0.5\ln[\pi(\upsilon-2)] + \ln\left(\frac{2}{\xi+\frac{1}{\xi}}\right) + \ln(\delta)$$

$$-0.5\sum_{t=1}^{T}\{ln\sigma_t^2 + (1+\nu)\ln[1+\frac{(z_t+m)^2}{\nu-2}\xi^{-2I_t}]\} \tag{5.11}$$

where

$$I_t = \begin{cases} 1\ if\ z_t \geq -\frac{m}{s} \\ -1\ if\ z_t < -\frac{m}{s} \end{cases}$$

ξ is the asymmetry parameter, υ is the degrees of freedom of the distribution.

$$\mathrm{m} = \frac{\Gamma\left(\frac{\upsilon-1}{2}\right)\sqrt{\upsilon}-2}{\sqrt{\pi\Gamma\frac{\upsilon}{2}}}\left(\xi-\frac{1}{\xi}\right)$$

$$\mathrm{s} = \sqrt{\left(\xi^2+\frac{1}{\xi^2}-1\right)-\mathrm{m}^2}$$

These log-likelihood functions are maximised to obtain the maximum likelihood estimates of the parameters. Since the quasi-maximum likelihood estimator (QMLE) is established in the literature to be more robust (Bollerslev and Wooldridge, 1992; Weiss, 1986), the researcher employed it to do the estimations of the parameters.

5.3.2 Value-at-Risk Model

After measuring the volatility in the returns of African currency carry trade with the GARCH models, the researcher estimated Value-at-Risk (VaR) which measures the worst possible losses as follows:

$$Z_t = \mu_t + \varepsilon_t \tag{5.12}$$

where $\boldsymbol{\varepsilon_t|\mathfrak{I}_{t-1}\sim(0,\sigma_t^2)}$, μ_t is the conditional mean of Z_t, and σ_t is the conditional variance of Z_t.

The VaR measure with coverage probability p would then be defined as the conditional quantile, $\mathrm{VaR}_{t|t-1}(p)$, where:

$$\boldsymbol{Pr}\left(\boldsymbol{Z_t} \leq \mathrm{VaR}_{\mathrm{t|t-1}}(\mathbf{p}) \middle| \mathfrak{J}_{\mathbf{t-1}}\right) = \boldsymbol{p} \tag{5.13}$$

After measuring the VaR, the researcher proceeds to measure the conditional VaR or expected shortfall, to actually determine the extent of loss beyond the indicated threshold.

5.3.3 Evaluation of Value-at-Risk Model

One extremely important concern of the regulatory institutions and other financial institutions of modelling of value-at-risk of financial assets is the accuracy of the VaR estimates. Indeed, according to Diebold and Lopez (1996) value-at-risk forecasts are unlikely to demonstrate the properties of accurate forecast. This current study therefore uses four accuracy measures as suggested by Stavroyiannis and Zarangas (2013) to assess the accuracy of both in-sample and out-of-sample forecast. The four accuracy measures employed for the study are the dynamic quantile test of Engle and Manganelli (DQ), the Kupiec Likelihood test of unconditional coverage probability (LR_{uc}), the expected shortfall (ESF1 and ESF2), and the success and failure ratio.

5.3.3.1 Success and Failure Ratios

It is important for market makers to backtest their VaR to see whether the pre-specified value-at-risk at a particular confidence interval was either violated or not with the actual situation of returns generated over the period. The violation here refers to the periods where the losses incurred by the portfolio exceed the predicted VaR. The pre-specified value-at-risk has already predicted a certain number of times losses will exceed the VaR estimates and for that matter a more accurate VaR is expected to produce a number of violations which will be approximately equal to the number of violations specified by the confidence level. Thus once this expectation is met, the specified VaR model at a particular confidence level is said to be accurate. However, inaccuracies could arise in the form of underestimation or overestimation of the VaR. A situation where the actual number of violations are more than the violations pre-specified at a particular confidence level, the model is said to be an underestimating the VaR, whereas the opposite is true for overestimation of the VaR (i.e. if the actual violations are fewer than the pre-specified VaR). The researcher tested the success-failure rate with a simple formula of $\frac{x}{T}$, where x represents the number of violations for a specific confidence interval and T also represent the total number observations for the study.

5.3.3.2 Kupiec LR Test

Because it is almost impossible to have the violations of the pre-specified VaR model at a particular confidence level to be exactly the same as the actual violations recorded over the period, there ought to be a framework to capture reasonable excesses of violations which could be as a result of bad luck. This will help reduce the incidence of type 1 and type 2 errors rejecting a good model and accepting a bad model respectively. The most popular model to address this problem is the Kupiec likelihood ratio test (LR_{uc}) also known as Proportion of Failures (POF) proposed by Paul H. Kupiec in his classic study "*Techniques for Verifying the Accuracy of Risk Measurement Models*"(Kupiec, 1995). The null hypothesis for the Kupiec's LR test is that the model is correct and the number violations follow binomial distributions as specified in equation 5.14:

$$LR_{uc} = -2\ln\left(\frac{p^x(1-p)^{T-x}}{(\frac{x}{T})^x\left[1-\left(\frac{x}{T}\right)\right]^{T-x}}\right) - \chi^2(1) \tag{5.14}$$

where *x* represents the number of violations, *T* is the number of observations in the sample, and *p* is the specified confidence level. LR_{uc} is expected to be asymptotically chi-square distributed with one degree of freedom under the null hypothesis that the model is correct. Thus the null hypothesis is rejected if the LR_{uc} statistic is found to be greater than the critical value of the chi-square distribution (χ^2) or the researcher fails to reject the null if the statistic is found to be less than the critical value. Rejecting the null hypothesis means that the model is inaccurate and is either overestimating or underestimating the risk.

5.3.3.3 Dynamic Quantile Test of Engle-Manganelli

One of the weaknesses of the Kupiec LR test is its inability to capture whether violations cluster (i.e. whether today's violation is influenced by the previous day's violation) or are independent of each other. Meaning that the Kupiec conditional coverage likelihood ratio will not capture a situation where extreme losses are followed by extreme losses which have the potential of plunging any institution into bankruptcy and reducing the VaR model into a useless model. The dynamic quantile test of Engle-Manganelli deals with this limitation. The dynamic quantile test employs a linear regression model to link current violations to past violations in order to test the conditional efficiency hypothesis (Engle and Manganelli, 2004, 1999).

Let $Hit(a) = I_t(a) - a$ be the demeaned process on a associated to $I_t(a)$:

$$Hit_t(a) = \begin{cases} 1 - a, & if\ r_t < VaR_{t|t-1}(a) \\ -a, & else \end{cases} \tag{5.15}$$

Considering the following regression model:

$$Hit_t(a) = \delta + \sum_{k=1}^{K} \beta_k Hit_{t-k} + \sum_{k=1}^{K} \gamma_k \mathrm{g}[Hit_{t-k}(a), Hit_{t-k-1}(a), \dots z_{t-k}, z_{t-k-1}, \dots] + \varepsilon_t \tag{5.16}$$

where ε_t is an independent and identically distributed random variable and where g(.) is a function of past violations and also a function of z_{t-k}, from the available information set Ω_{t-1}.

The null hypothesis test of conditional efficiency leads to the testing of the joint nullity of coefficients, β_k, γ_k, and of constant δ.

$$H_o: \delta = \beta_k = \gamma_k = 0, \forall k = 1, \dots .. K \tag{5.17}$$

Hence there is no correlation between current and past VaR violations since $\beta_k = \gamma_k = 0$, where the unconditional coverage hypothesis is verified when $\delta = 0$.

The Wald statistics, noted DQ_{cc}, together with the test of conditional efficiency hypothesis as specified in equation 5.18:

$$DQ_{cc} = \frac{\widehat{\Psi}' Z' Z \Psi}{a(1-a)} \longrightarrow \chi^2(2K + 1) \tag{5.18}$$

An alternative model that could have been used to capture the clustering of exceedances or temporal dependence of VaR breaks, is the Christoffersen (1998) independence and conditional coverage tests. Even though these tests (independence and conditional coverage) have been widely used in the extant literature to verify VaR methods, they are equally criticised for two reasons (Chen and Lu, 2011, p. 321). First, the temporal dependence or the sequential VaR breaks test only consider the dependence of order one (i.e. two consecutive periods – weeks in the case of this study). For example, if there are 5 sequential VaR breaks or violations like 010**11111**010……. etc. (where 1 is a break and 0 is no break) then the Christoffersen's conditional coverage test will identify 4 times two-sequential breaks, and not all the 5 sequential violations, therefore the penalty between different models is always not large.

The dynamic quantile test is more powerful in this regard since it will penalise the model much more by identifying all 5 sequential VaR violations. The second problem with the Christoffersen conditional coverage test is that the Markov chain only accounts for the effects of the previous period's VaR breaks and not any other exogenous variable. The dynamic quantile test of Engle and Manganelli 2004 again overcomes this weakness.

5.3.3.4 Expected Shortfall and Tail Measure

The value-at-risk as a measure of risk is criticised in the literature as not being a coherent measure of risk (Artzner et al., 1999, 1997) since it, inter alia, does not satisfy the sub-additivity property of portfolios. For example, a two asset portfolio may have a higher risk than the sum of their individual risks in clear violation of the sub-additivity and diversification principle (Scaillet, 2004). The expected shortfall is found to be a more coherent measure of risk. It represents the "expected value of losses conditional on the loss being larger than the VaR". This is specified as follows:

$$\mu_p = E\left(Y_t \middle| Y_t > v_p\right) \tag{5.19}$$

The expected shortfall can be categorised into ESF1 and ESF2, where the ESF1 reflects the expected amount of loss beyond VaR level, and ESF2 is the same expected value of loss beyond VaR divided by the value of VaR (Hendricks, 1996).

5.3.4 Data and Preliminary Analysis

This section presents a description of the data for the study and discussion of some of their inherent statistical properties. The study calculates weekly currency carry trade returns for 28 currency pairs using the traditional naïve currency carry trade model (see equation 3.5 of chapter three). The choice of the weekly carry trade returns was important given the relatively smaller number of observations in the monthly returns used in the previous chapters. To capture the conditional volatility using the generalised autoregressive conditional heteroskedasticy (GARCH) requires a relatively larger observations in order to converge. Also the currency carry trade is a short term investment and investors would be interested to know their worst possible losses within a relatively high frequency series. These calculations were based on the collected exchange rate data of seven African currencies; South African Rand (ZAR), Egyptian Pound (EGP), Moroccan Dirham (MAD), Nigerian Naira (NGN), Ghanaian Cedis (GHS), Botswana Pula (BWP) and Tunisian Dinar (TND) paired with the four developed world currencies; US Dollar (USD), Euro Area Euro (EUR), Japanese Yen (JPY) and the Great British Pound (GBP).

The strategy takes a long position (buy) of all seven African high interest rate currencies (target currencies) and takes a short (selling) position of all the developed world low interest rate currencies (funding currencies). In addition to the weekly exchange, the researcher collected weekly interbank interest rate with 1-month investment horizon for all the selected (African and developed) countries and subsequently generated the currency carry trade return series. All the exchange rate data were gleaned from Bloomberg and INET BFA, whereas the interest rate data were obtained from the International Monetary Fund, International Financial Statistics, and the Central Banks of some of the selected countries. Overall, the weekly data covers the period of 7th January, 2001 to 20th December, 2015 generating 781 weekly observations for all the 28 currency pairs except for the Nigeria Naira against the Japanese Yen, which starts from 9th December, 200,1 with total observations of 733. It is worth noting that this period includes some major global economic events including the global upsurge in oil prices between 2007 and the early part of 2008, the Euro-zone debt crisis some time in 2009, and the infamous global financial crisis of 2007 to 2009 which heavily crushed most financial markets across the globe. The researcher analysed the data with Oxmetrics 7 for the estimation of the GARCH parameters and Kupiec Likelihood Ratio, Expected Shortfall, Success and Failure Ratio, and Dynamic Quantile Test of Engle and Manganelli (2002).

Table 5.1 presents descriptive statistics of weekly returns of African currency carry trades. There are four major blocks of the currency carry trade strategies in the Table. The first block takes a short position in the Japanese Yen (JPY) and a long position in the seven African currencies (BWP, EGP, GHS, MAD, NGN, ZAR and TND). The second block shorts the EUR and longs the same basket of African currencies, whereas the third and fourth short the United States Dollar and Great British Pound respectively, with long positions in the seven African countries. These blocks altogether produce 28 currency pairs and 28 different currency carry trade assets targeting African currencies. Table 5.1 shows the four moments (mean, standard of deviation, skewness and kurtosis) of the return distribution. It can be observed that all the currency pairs involved in the study's currency carry trade strategy reported positive weekly returns except the EURZAR, EURTND, and GBPTND which posted negative returns over the sample period. It follows that the EURTND, which posted a weekly average return of -0.0094, was the worst performing currency carry trade strategy over the sample period for the study, with the EURZAR and GBPTND posting -0.0094 and -0.0073 respectively.

It is further observed that the JPY and USD funded currency carry trade targeting the African currencies are all showing positive weekly average returns. It is therefore not surprising that a significant number of the high performing African currency carry trades emanate from those financed by JPY and USD. Indeed, the highest return recorded over the sample period is the USDBWP (0.2868) currency pair, followed by the JPYGHS (0.1638), JPYNGN (0.1403) and JPYBWP (0.1368) respectively. Although other currency pairs like the EURNGN, GBPGHS, GBPNGN, EURGHS and GBPBWP generated some attractive returns over the sample period the African currencies paired with the USD and the JPY are the most dominant in terms of high weekly average returns. This is an indication that on the basis of excess positive weekly returns, the USD and the JPY perform better as funding currencies compared to the GBP and EUR, even though the GBP also appears to be performing better than the EUR (see Table 5.1). This is partly attributable to the fact that the currencies of the selected African countries usually exhibit persistent depreciation against the USD whiles the Japanese have also for a long period of time maintained a very low interest rate which culminates in very large interest rate differential between Japan and the selected African countries.

On the part of the African currencies, the Botswana Pula, Ghanaian Cedis and Nigeria Naira are very good candidates or target currencies that produced very attractive weekly currency carry trade returns regardless of the funding currency selected. The Botswana Pula produces excess positive carry trade returns against all the funding currencies for the study, but posted its highest weekly return, and for that matter the highest returns for the entire 28 currency pairs, with the USD followed by the JPY, GBP and EUR respectively. The Ghanaian Cedis and Nigerian Naira likewise also perform very well as target currencies in terms of weekly carry trade returns, irrespective of which currencies would be used as funding currencies. It is however noteworthy that the Ghanaian Cedis has its highest return when paired with the JPY, followed by the USD, GBP and lastly the EUR. The Nigerian Naira also posted its highest weekly return when paired up with the JPY, followed by the EUR, USD and finally the GBP. South Africa and Tunisia generally posted not too encouraging weekly average returns pairing them up with all the four first world currencies and in some cases generated negative weekly average returns. Though the ZAR and TND generated relatively low weekly average returns, it can be observed that their best returns over the sample period are recorded when they are paired with the JPY and USD, followed by the GBP and EUR in that order. The returns behaviour of the Moroccan Dirham and Egyptian Pound against the funding currencies is not any different from the aforementioned African currencies.

Interestingly, the returns pattern for the MAD and the EGP are exactly the same. Their highest returns are both recorded when paired against the Japanese Yen and the second best returns are when they are paired with the United States Dollar. The Great British Pound and the Euro also follow as the third and fourth best returns respectively.

Overall, it can be observed that African currencies carry trade financed by the Japanese Yen and United States Dollar produce superior weekly returns than the other first world currencies used as funding currency for the study.

Table 5.1: Descriptive Statistics of Weekly African Currency Carry Trades Returns

Currency Pair	Mean	SD	Skew	Kurt	Min	Max	JB	LBQ(10)
JPYBWP	0.001368	0.1706	-0.1388	378.58	-3.3505	3.3374	4590461***	188.41***
JPYEGP	0.000922	0.0127	-1.0628	10.09	-0.1009	0.0495	1784.13***	49.40***
JPYGHS	0.001638	0.0170	0.8224	11.87	-0.0975	0.1231	2656.71***	85.59***
JPYMAD	0.000680	0.0124	-0.5775	6.72	-0.0739	0.0603	493.89***	42.15***
JPYNGN	0.001403	0.1777	0.1697	344.95	-3.3371	3.3609	3571235***	181.91***
JPYZAR	0.000483	0.0221	-0.8965	7.02	-0.1353	0.0758	630.80***	32.53***
JPYTND	0.000439	0.0116	-0.6426	6.60	-0.0669	0.0523	476.48***	40.32***
EURBWP	0.000901	0.0170	-0.6601	6.63	-0.1007	0.0603	485.63***	20.09**
EUREGP	0.000389	0.0132	-1.1280	11.84	-0.1122	0.0508	2687.51***	63.28***
EURGHS	0.001106	0.0173	0.9375	14.17	-0.1053	0.1364	4187.70***	67.05***
EURMAD	0.000135	0.0030	-2.3331	28.46	-0.0348	0.0085	21809.00***	43.03***
EURNGN	0.001204	0.0115	-0.2401	23.79	-0.0790	0.1120	14069.95***	17.96*
EURZAR	-0.000082	0.0182	-0.6318	5.52	-0.0954	0.0735	258.47***	51.39***
EURTND	-0.000094	0.0046	0.2316	4.73	-0.0178	0.0251	104.52***	47.50***
USDBWP	0.002868	0.0170	1.1922	9.69	-0.0621	0.1324	1642.40***	20.67**
USDEGP	0.000499	0.0066	-8.7098	123.87	-0.1106	0.0231	485261.1***	119.29***
USDGHS	0.001212	0.0124	1.9982	33.69	-0.0961	0.1292	264220.6***	21.30**
USDMAD	0.000258	0.0091	-0.0542	5.09	-0.0365	0.0548	142.91***	59.92***
USDNGN	0.001204	0.0115	-0.2401	23.79	-0.0790	0.1120	14069.95***	17.96*
USDZAR	0.000061	0.0195	-0.7500	5.55	-0.1062	0.0647	285.27***	37.30***
USDTND	0.000017	0.0081	0.0118	4.71	-0.0335	0.0479	95.49***	69.08***
GBPBWP	0.000902	0.0169	-0.8183	8.37	-0.1234	0.0571	1026.4***	11.69
GBPEGP	0.000410	0.0124	-0.9789	13.94	-0.1086	0.0591	4017.01***	52.75***
GBPGHS	0.001134	0.0166	1.1078	15.65	-0.0993	0.1428	5386.71***	65.39***
GBPMAD	0.000169	0.0081	-0.0937	8.58	-0.0597	0.0417	1013.95***	39.74***
GBPNGN	0.001108	0.0173	-0.1553	8.86	-0.0935	0.1123	1118.78***	13.68
GBPZAR	0.000049	0.0180	-0.5112	5.93	-0.0971	0.0789	313.38***	59.14***
GBPTND	-0.000073	0.0080	-0.0753	7.68	-0.0566	0.0414	713.28***	46.54***

The sample is made up of 781 weekly observations for each of the currency pairs spanning 07/01/2001 to 20/12/2015 except for JPY/NGN which contains 733 (i.e. from 09/12/2001-20/12/2015). We denote '***', '**' and '*' as 1%, 5% and 10% level of significance. SD representation standard deviation, kurt for kurtosis and skew also referring to skewness. Others include min, max, JB and LBQ(10) which represent minimum, maximum, Jarcque-Bera, and Ljung-Box test statistic for serial correlation at 10 lags.

The second moment is the variance or the standard deviation as shown in Table 5.1, which measures volatility in the weekly mean returns distribution of the African currency carry trade (i.e. how the returns are dispersed around their mean). It is a known fact that there is a significant amount of volatility in the African financial markets and the standard deviation is used to capture the unconditional volatility in the return series. The standard deviations of all of the 28 currency pairs range from as high as 17.7748 for the JPYNGN carry trade to as low as 0.2969 for the currency pair of EURMAD. Currencies with high volatility such as the Botswana Pula (17.7748), Nigerian Naira (17.0647) and South African Rand (2.2078) were all paired with the Japanese Yen, and were also equally posting very attractive weekly average returns. Thus they appear to be consistent with the maxim in finance that higher risk should be adequately compensated with higher returns, though some very high returns such as the carry trade returns of the USDBWP and JPYGHS are associated with reasonably lower volatility of 1.7035 and 1.6986 respectively.

Apart from the currency pairs of JPYNGN, JPYBWP and JPYZAR, all the other currency pairs for the study are posting standard deviation below the rule of thumb of 2. The researcher also observes from Table 5.1 that the returns for seven currency pairs of the USDMAD (0.9143), USDTND (0.8140), GBPMAD (0.8060), GBPTND (0.8045), USDEGP (0.6645), EURTND (0.4563) and EURMAD (0.2969) are associated with relatively low volatility of less than one. It is worth noting that all the seven currencies pairs are drawn from three northern African countries (i.e. Egypt, Morocco and Tunisia) and the apparent low volatility in their currency carry trade returns could be partly attributed to the financial stability and the strength of the currencies within that region. The remaining currency pairs all fall between one and two, which is relatively low volatility compared to the volatility of currency carry trades established in the literature.

Table 5.1 also reveals the third and fourth moments of the African currency carry trade returns distribution (skewness and kurtosis). The skewness measures the asymmetry in the return distribution whereas the kurtosis measures the tails and the peakedness of the probability density function of the carry trade returns. The researcher observes that 8 out of the 28 currency pairs exhibit positive skewness with the remaining 20 currency pairs showing negative skewness in their respective returns distributions. The positive skewed returns indicate that the returns distribution extends towards more positives and the negative skewed returns extend towards more negative returns. Largely, currency trade returns from Ghana, Botswana, Nigeria and Tunisia financed by all the four funding currencies (USD, GBP, JPY and EUR) are exhibiting the positively skewed returns distribution.

Though skewness indicates asymmetry of returns distribution, which is a deviation from normality of returns, risk averse investors would always prefer positive skewness to negative skewness. As many as twenty of the currency pairs for this study exhibited negative skewness coupled with large excess kurtosis. These characteristics of the African currency carry trade are consistent with findings of currency carry trade established in the extant literature. The kurtosis recorded for all of the 28 currency pairs are in excess of 3, which is a violation of the normality assumption. The violation of the normality assumption is further reinforced by the Jarcque-Bera statistics with their associated probabilities which are highly statistically significant, indicating that the weekly returns of the African currency carry trade are not normally distributed. Large excess kurtosis witnessed for most of the currency carry trade returns are an indication of peakness and fatter tails of the probability density function of the weekly returns which is usually referred to as leptokurtic distribution. This behaviour of negative skewness and large excess kurtosis serves as evidence of the presence of the 'peso effect' or crash risk which is consistent with currency carry trades returns behaviour established in the literature. The peso effect, or the crash risk, means that there could be abrupt losses incurred by investors in African currency carry trade and the large excess kurtosis measures the speed with which the losses could occur. The Ljung-Box Q-Statistics (LBQ) for the returns series are calculated for 10 lags for all of the 28 currency pairs to test for the presence or otherwise of serial correlation. Except for the GBPBWP and GBPNGN currency pairs, all the other 26 currency pairs exhibit signs of autocorrelation. Thus the null hypothesis of all the serial correlations up to the 10^{th} lag are jointly zero is rejected. This suggests that modelling the conditional variance processes with GARCH an AR (q) term would be appropriate.

In Figures 5.1 to 5.4, the researcher plots the returns series of the African currency carry trade for all of the 28 currency pairs to further observe their behaviour. All the currency pairs studied exhibit volatility clustering, which is consistent with an important stylised fact in modelling conditional variance. Thus periods of low volatility in the returns are followed by periods of low volatility, whereas periods of high volatility are followed by periods of high volatility. This volatility clustering characteristic of the returns is an indication that the appropriate model to be used to model the conditional variance and its consequent estimation of value-at-risk (VaR) is the GARCH model. Appendix C shows the graph of autocorrelation functions (ACF) and partial autocorrelation function (PACF) for the weekly returns and squared weekly returns. It is evident from the graphs that there exist some serial correlations in the data. This strengthens the position of the Ljung-Box Q-Statistics observed in Table 5.1. With this important evidence it would be appropriate to model our VaR estimation through ARMA (1, 0)-GARCH (1, 1).

Figure 5.1: GBP Funded Carry trade Returns Plots

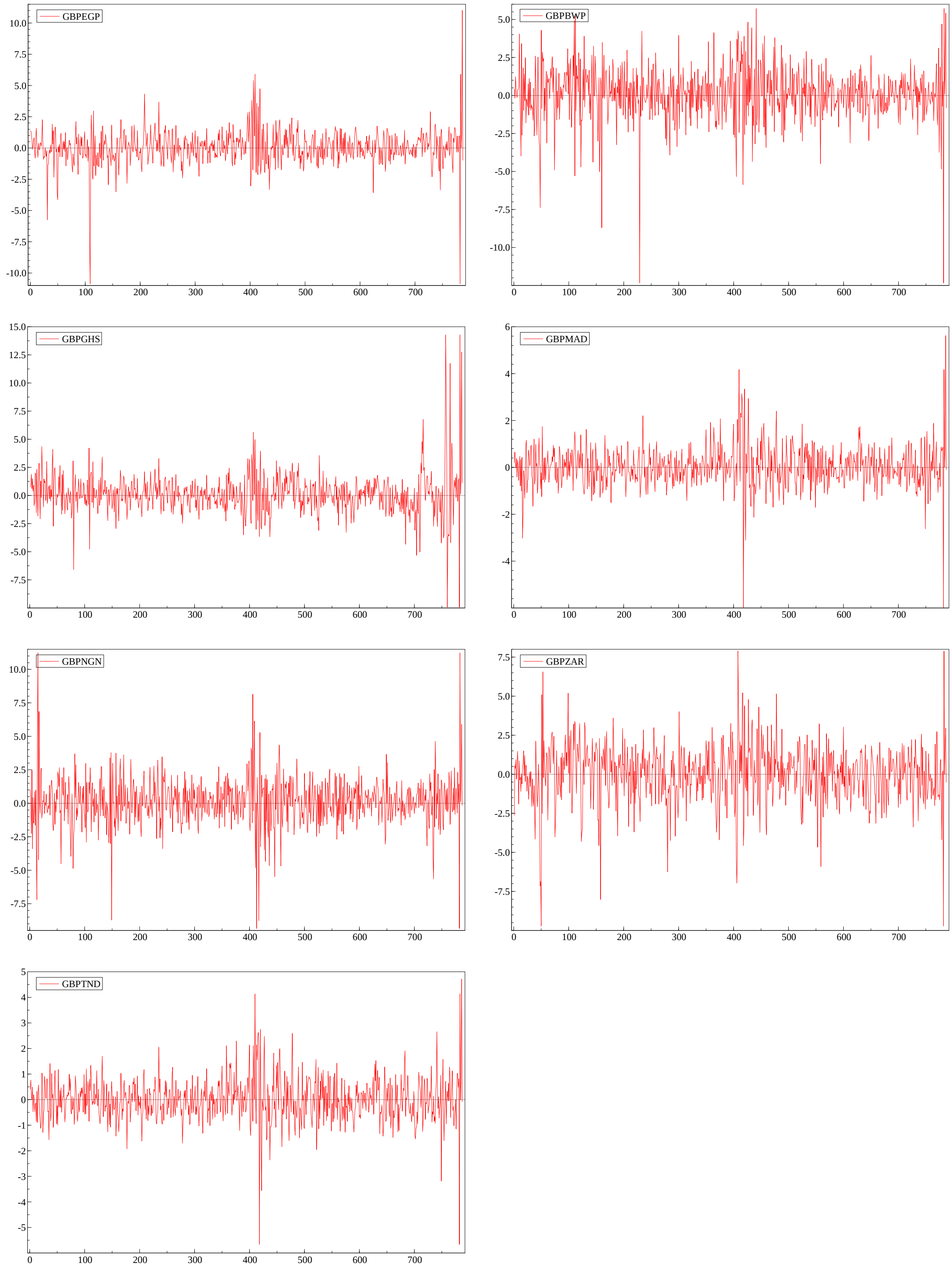


Figure 5.1 shows the data plots for the returns of currency carry trade strategy which takes a short position in the GBP and takes a long position in the African currencies studied (BWP, GHS, TND, ZAR, NGN, MAD, EGP). It can be observed that all the series exhibit volatility clustering and so choice of GARCH is appropriate to fit the data.

Figure 5.2: USD Funded Carry trade Returns Plots

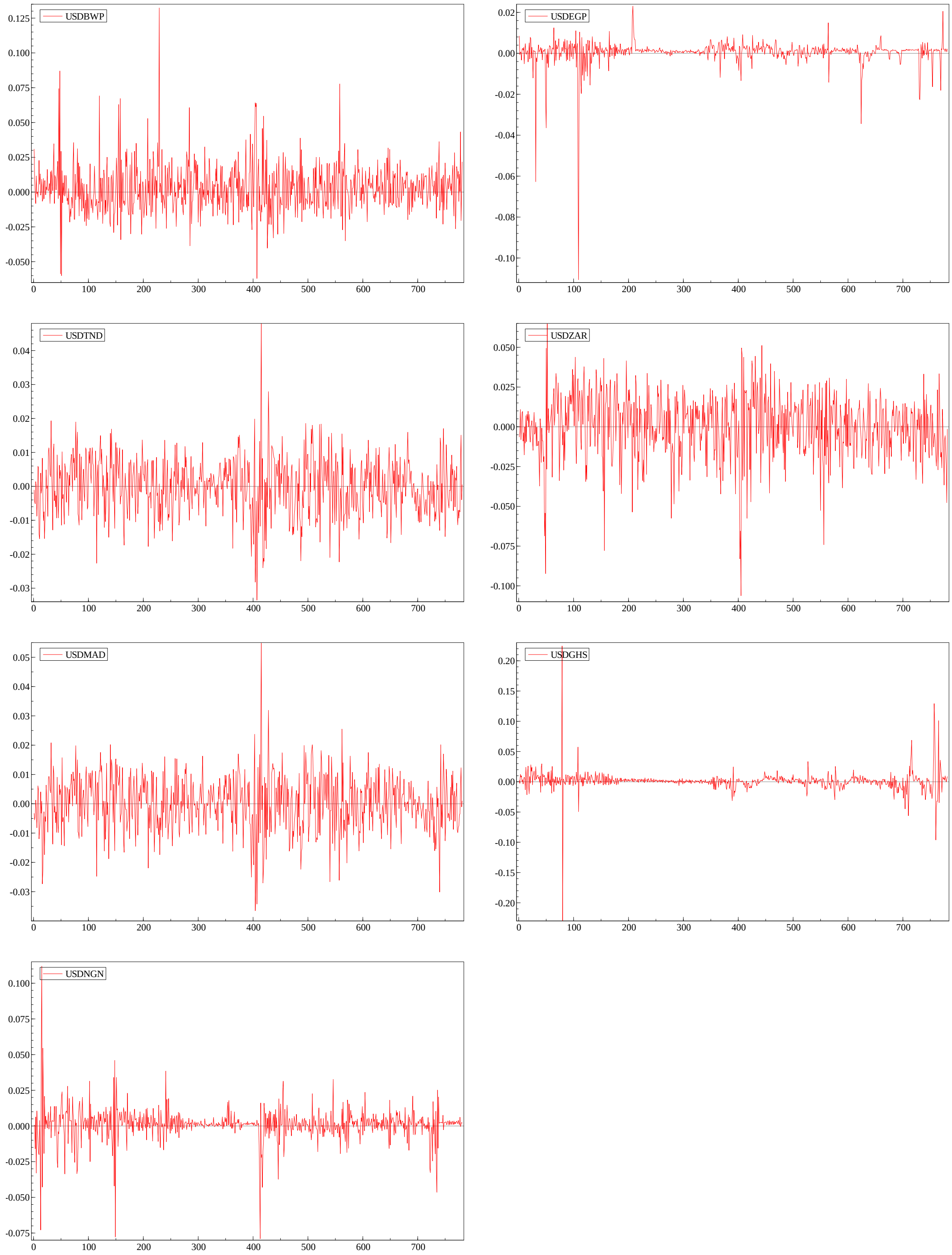


Figure 5.2 presents the plots for currency carry trade returns targeting seven African currencies and financed by borrowing in the US Dollars. There appears to be high degree of persistence in volatility in the data. Also periods of high volatility are followed by periods of high volatility and periods of low volatility are followed by periods of low volatility in all seven currency pairs (volatility clustering).

Figure 5.3: EUR Funded Carry trade Returns Plots

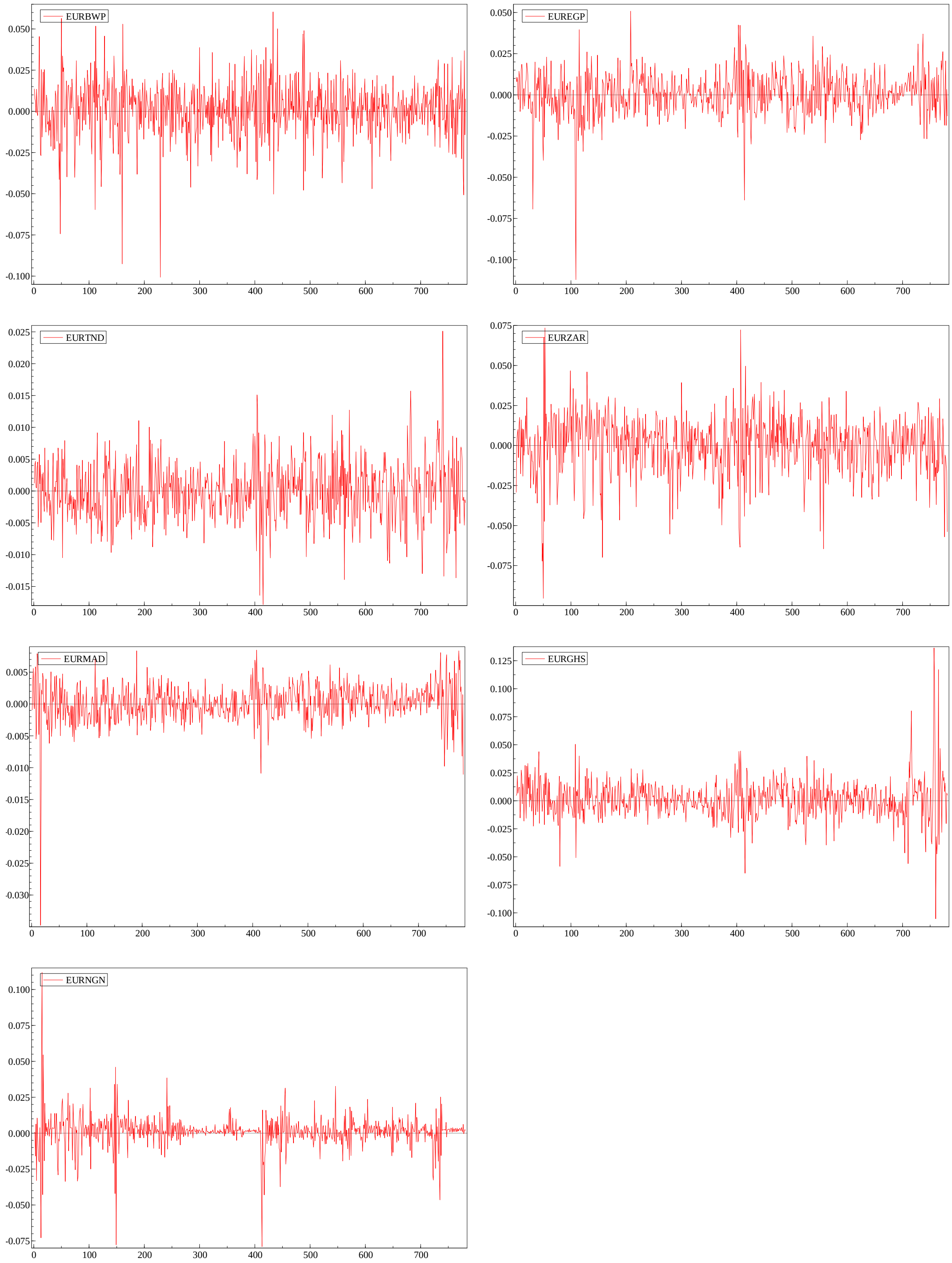


Figure 5.3 presents the plots for currency carry trade returns targeting seven African currencies (BWP, GHS, MAD, NGN, TND, EGP and ZAR) which is financed by borrowing Euro. The data series for all seven currency carry trade strategies exhibit persistence and volatility clustering.

Figure 5.4: JPY Funded Carry trade Returns Plots

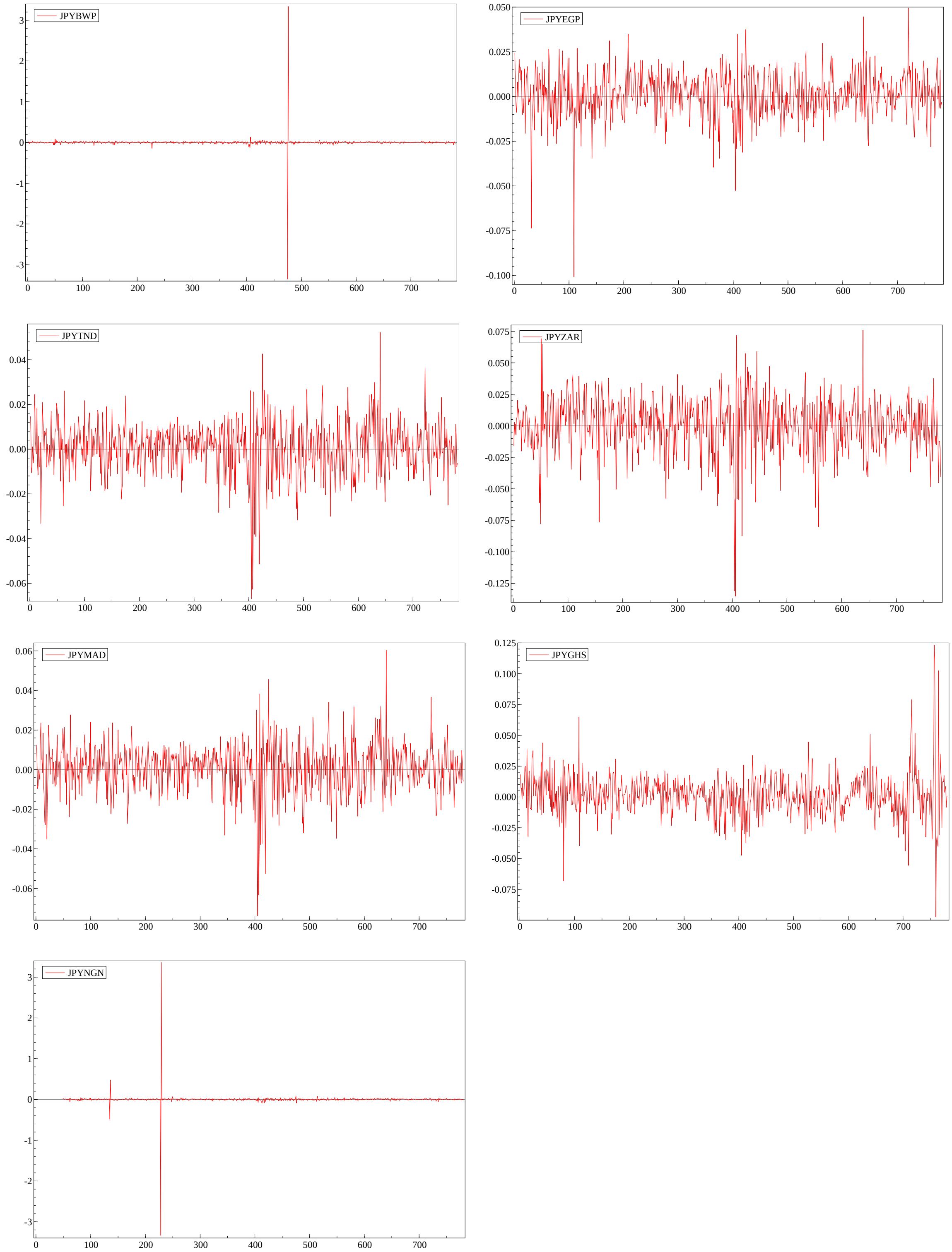


Figure 5.4 presents the plots for currency carry trade returns targeting seven African currencies (BWP, GHS, MAD, NGN, TND, EGP and ZAR), financed by borrowing Japanese Yen. There appears to be high degree of persistence in volatility and volatility clustering in the data except for JPYNGN where volatility appears to be relatively low with some sharp spikes.

5.4 Empirical Results and Discussion

In this section, the researcher presents the results of the empirical analysis of the study. The section is divided into three subsections to present the results of the unit root test, GARCH, and the VaR estimation respectively.

5.4.1 Results of Unit Root Test

In order perform the generalised autoregressive conditional heteroskedasticity the researcher had to check for stationarity of the African currency carry trade returns series with ADF and PP unit root test models as specified in section 5.3.3. Weekly currency carry trade returns (2001 to 2015) involving seven African currencies (BWP, GHS, EGP, ZAR, TND, NGN and MAD) as target currencies and four developed world currencies (USD, EUR, JPY and GBP) as funding currencies generating 28 currency pairs were tested. Both ADF and PP unit root results show that all 28 currency pairs were found to be stationary at level. These results are presented in Tables E1 and E2 in Appendix E.

5.4.2 GARCH Estimation Results

In this section, the researcher presents the results of the empirical analysis of generalised autoregressive conditional heteroskedasticity. In order to perform the value-at-risk for the various currency pairs, the study estimated the conditional volatility with ARMA (1, 0)-GARCH (1, 1) for three different distributions (Gaussian, student t, and skewed student t) for the returns innovation or residuals. These estimations were performed for all twenty currency pairs involving the seven African currencies (BWP, EGP, GHS, MAD, ZAR, NGN and TND) as the target currencies against the four developed world currencies (USD, JPY, EUR and GBP) as the funding currencies. Tables A1 to A4 in Appendix A, present the results of the ARMA (1, 0)-GARCH (1, 1) model for Gaussian (normal), student t, and skewed student t distributions. Table A1 presents the African currency carry trade strategy funded by the US dollar, whiles Tables A2 to A4 present the carry trade strategy financed by borrowing the currencies in the EUR, JPY and GBP respectively. Generally, the skewed t distribution performs better in fitting the volatility clustering or the persistence in the African currency carry trade returns, which is consistent with the position in the extant literature that the currency carry trade exhibits leptokurtosis as shown in Table 5.1 and can be better fitted with models that can capture these properties (Wang et al., 2013). It is therefore not surprising that the skewed t distribution fits the data better relative to the Gaussian and the student t distribution.

The ARCH and GARCH effects for almost all the currency pairs were found to be statistically significant, indicating that both the previous period's squared returns (ARCH) and the previous period's volatility (GARCH) affect current volatility for the currency carry trade returns studied. The model is also found to be stable in almost all the twenty currency pairs studied, even though a handful of the currency pairs (USDNGN, USDGHS, and EURNGN) exhibit extremely high persistence in excess of the positivity constraint of unity, which appear not to decay overtime. These three currency pairs therefore would be excluded from the analysis since they appear to be unstable for the sample period of the study. The behaviour of alpha (α) and beta (β) for all the remaining currency pairs is largely consistent with the established behaviour of financial assets in the literature. They follow the positivity constraint of $\alpha + \beta < 1$, albeit exhibiting high persistence of close to unity, which reveals that the persistence in the volatility of African currency carry trade decay slowly. There is also a high degree of stability of the GARCH model for the currency pairs which exhibit $\alpha + \beta < 1$. It is noteworthy that a few of the currency pairs (e.g. EURBWP and JPYBWP) exhibit a relatively low persistence, indicating a faster decay of conditional volatility of the returns within the sample period of the study. This faster mean reverting behaviour of the EURBWP and JPYBWP could be attributed to the fast-growing nature of the Botswana capital markets and, for that matter, their currency.

5.4.3 VaR Estimation

This section presents results and discussion of *in-sample* and *out-of-sample* VaR estimation with their accuracy measures. The researcher employed a range of VaR quantiles from 0.9500 to 0.9975 for short position VaR and 0.0025 to 0.0500 for long position VaR for each of the twenty eight currency pairs under study, drawn from seven African currencies (BWP, EGP, GHS, MAD, NGN, ZAR and TND) and four developed world currencies (USD, EUR, JPY and GBP). The researcher used GARCH estimation results to calculate the one-step-ahead value-at-risk for the long and short weekly trading positions for the afore-mentioned number of confidence intervals for all twenty eight currency carry trade strategies that shorts four developed currencies and longs seven African currencies, under the Gaussian, student *t* and skewed *t* distributions of the error term. The choice of these distributions of returns innovations was against the backdrop of there being very little known in academic literature about the African currency carry trade returns and its risk behaviour. Thus it is appropriate to model the risk profile using the VaR with the Gaussian distribution since that appears to be the standard and the starting point for econometric modelling of time series data. Secondly, the study employs student t distribution in order to capture the fat tails of the returns as revealed in the descriptive statistics of the African currency carry trade returns in Table 5.1.

Finally, the African currency carry trade returns in Table 5.1, apart from the fat tails (large excess kurtosis), also exhibit a significant amount of skewness and deviate significantly from normality, as corroborated by the Jarcque-Bera statistic (usually referred to as leptokurtosis). As a result of these statistical properties the researcher employed the skewed student t distribution in an attempt to capture them in the VaR model. The skewed student t distribution was expected to capture the fat tails as well as the skewness in the returns distribution for all the currency pairs studied.

The VaR estimations are calculated for both in-sample and out-of-sample for the sample period under study. The accuracy and the validity of the in-sample and out-of-sample VaR are examined by performing the accuracy measures of success or failure ratio, the Kupiec likelihood ratio with its p-value, the expected shortfall measures (ESF1 and ESF2), and the dynamic quantile test statistic of Engle and Manganelli with its p-value, for all twenty currency pairs under the three distributions chosen for the study.

The results for the in-sample VaR for both short and long weekly trading positions with their corresponding accuracy measures under skewed *t* distribution are presented in Tables 5.2 to 5.9. The in-sample and out-of-sample results for the Gaussian (normal) and Student t distributions for the twenty eight currency pairs are presented in Tables B1 to B32 in Appendix B. In-sample accuracy measures are generally equivalent to backtesting the VaR model. Generally, the approach is to count the number of VaR breaks or the number of times actual losses exceeded the predicted VaR model and compare this number to the pre-specified VaR level. The model is found to be accurate if the number of exceedances is as close as possible to the number implied by the VaR quantile the study is trying to model. In-sample VaR results presented in Tables 5.2 to 5.9 for all the model estimations indicate that the VaR quantile of 0.25% to 5% are largely well calibrated under the skewed student t distribution for most of the currency pairs. Thus in most instances under the skewed student t distribution the success and failure rates of the short and long trading positions respectively are found not to be statistically different from the pre-specified VaR quantiles. This is confirmed by the Kupiec likelihood ratio test, which fails to reject the null hypothesis that 'the failure or success equals the pre-specified VaR'. The dynamic quantile test of Engle and Manganelli, which accounts for the conditional and unconditional coverage probability, also produces results consistent with the Kupiec likelihood ratio test. Thus essentially the dynamic quantile also fails to reject the null hypothesis of $H_o: \delta = \beta_k = \gamma_k = 0, \forall k = 1, \ldots\ldots K$,which is an indication that there is no correlation between current and past VaR breaks since $\beta_k = \gamma_k = 0$. Thus in the majority of the currency carry trade strategies evaluated under the skewed distributions our VaR models are found to be valid and accurate.

Table 5.2: In Sample Short VaR of African Carry Trade Funded by US Dollars

					Skewed Student t Distribution			
					Short Position			
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.9500**	0.9590	1.4239	0.2328	0.0491	1.5414	11.3800	0.0773
	0.9750	0.9795	0.6949	0.4045	0.0613	1.5675	4.0515	0.6697
	0.9900	0.9885	0.1746	0.6761	0.0757	1.4527	10.0110	0.1242
	0.9950	0.9910	1.9935	0.1580	0.0806	1.3292	29.2060	0.0001
	0.9975	**0.9949**	**1.6479**	**0.1993**	0.0884	1.3448	2.3692	0.8828
USDEGP	**0.9500**	0.9526	0.1152	0.7343	0.0066	1.5794	7.3702	0.2880
	0.9750	**0.9795**	**0.6949**	**0.4045**	0.0088	1.7019	2.2027	0.9001
	0.9900	0.9910	0.0879	0.7668	0.0109	1.6406	0.3848	0.9990
	0.9950	**0.9962**	**0.2292**	**0.6321**	0.0152	1.7342	0.2566	0.9997
	0.9975	0.9962	0.4834	0.4869	0.0152	1.2848	0.6543	0.9954
USDGHS	**0.9500**	0.9603	1.8740	0.1710	0.0337	2.3607	2.6869	0.8470
	0.9750	0.9731	0.1116	0.7384	0.0395	2.3105	6.7435	0.3452
	0.9900	0.9885	0.1746	0.6761	0.0696	2.8757	9.9742	0.1257
	0.9950	0.9949	0.0023	0.9617	0.0792	4.1276	0.1114	1.0000
	0.9975	0.9962	0.4834	0.4869	0.1000	4.1436	0.6543	0.9954
USDMAD	**0.9500**	0.9513	0.0300	0.8626	0.0173	1.2496	2.4461	0.8745
	0.9750	0.9770	0.1254	0.7233	0.0201	1.1752	2.4556	0.8734
	0.9900	0.9910	0.0879	0.7668	0.0247	1.1036	0.3848	0.9990
	0.9950	0.9974	1.1382	0.2860	0.0401	1.0975	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDNGN	**0.9500**	0.9501	0.0001	0.9935	0.0179	1.4530	3.7612	0.7090
	0.9750	0.9757	0.0146	0.9038	0.0218	1.3158	2.4781	0.8709
	0.9900	0.9949	2.2859	0.1306	0.0309	1.2854	1.9326	0.9258
	0.9950	0.9974	1.1382	0.2860	0.0356	1.1535	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDZAR	**0.9500**	0.9462	0.2292	0.6321	0.0332	1.2412	4.1119	0.6615
	0.9750	0.9718	0.3093	0.5781	0.0345	1.1612	3.0587	0.8014
	0.9900	0.9923	0.4605	0.4974	0.0402	1.1228	0.6116	0.9962
	0.9950	0.9962	0.2292	0.6321	0.0429	1.0611	0.2566	0.9997
	0.9975	0.9987	0.5679	0.4511	0.0415	1.0380	0.4692	0.9982
USDTND	**0.9500**	0.9488	0.0241	0.8765	0.0153	1.2609	2.8425	0.8283
	0.9750	0.9770	0.1254	0.7233	0.0173	1.1810	2.3589	0.8839
	0.9900	0.9923	0.4605	0.4974	0.0221	1.1548	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0249	1.0805	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	0.0479	1.0792	0.4692	0.9982

Note: The Table shows the short postion in-sample backtesting results of the African currency carry trade financed by borrowing the low interest US Dollar. The value-at-risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.3: In Sample Long VaR of African Carry Trade Funded by US Dollars

Carry Trade	*Quan-tile*	Failure Rate	Kupiec LRT	Kupiec P-Value	Expected Shortfall 1	Expected Shortfall 2	Dynamic Q Statistics	Dynamic Q P-Value
				Skewed Student t Distribution				
				Long Position				
USDBWP	**0.0500**	0.0538	0.2292	0.6321	-0.0264	1.2590	3.0651	0.8006
	0.0250	0.0269	0.1116	0.7384	-0.0278	1.1271	3.0581	0.8015
	0.0100	0.0013	9.5690	0.0020	-0.0303	1.1209	5.9989	0.4233
	0.0050	0.0000	-	0.0000	-	-	3.9246	0.6869
	0.0025	**0.0000**	**-**	**0.0000**	-	-	1.9574	0.9236
USDEGP	**0.0500**	0.0563	0.6356	0.4253	-0.0099	4.6111	5.5440	0.4762
	0.0250	**0.0282**	**0.3093**	**0.5781**	-0.0144	3.8891	10.6080	0.1013
	0.0100	0.0154	1.9508	0.1625	-0.0202	3.2619	3.6943	0.7180
	0.0050	**0.0077**	**0.9697**	**0.3248**	-0.0348	3.3993	1.5016	0.9594
	0.0025	0.0064	3.3202	0.0684	-0.0405	2.5808	5.1943	0.5191
USDGHS	**0.0500**	0.0499	0.0001	0.9935	-0.0164	1.5396	17.7340	0.0069
	0.0250	0.0243	0.0146	0.9038	-0.0187	1.3434	2.6621	0.8499
	0.0100	0.0026	6.2145	0.0127	-0.0196	1.5340	4.3727	0.6264
	0.0050	0.0013	3.0963	0.0785	-0.0223	1.5332	2.1737	0.9031
	0.0025	0.0013	0.5679	0.4511	-0.0223	1.1915	0.4692	0.9982
USDMAD	**0.0500**	0.0512	0.0241	0.8765	-0.0178	1.3367	1.6110	0.9518
	0.0250	0.0218	0.3500	0.5541	-0.0224	1.3511	3.4964	0.7445
	0.0100	0.0102	0.0046	0.9457	-0.0273	1.3215	0.4550	0.9983
	0.0050	0.0077	0.9697	0.3248	-0.0279	1.2322	1.5016	0.9594
	0.0025	0.0051	1.6479	0.1993	-0.0276	1.1643	2.3692	0.8828
USDNGN	**0.0500**	0.0627	2.4778	0.1155	-0.0209	1.9116	8.2413	0.2210
	0.0250	0.0307	0.9815	0.3218	-0.0247	1.6257	14.7260	0.0225
	0.0100	0.0090	0.0879	0.7668	-0.0290	1.4956	13.4660	0.0362
	0.0050	0.0038	0.2292	0.6321	-0.0179	1.4471	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0215	1.1665	0.0280	1.0000
USDZAR	**0.0500**	0.0551	0.4078	0.5231	-0.0434	1.2759	7.8737	0.2475
	0.0250	0.0205	0.6949	0.4045	-0.0595	1.2833	11.3210	0.0790
	0.0100	0.0090	0.0879	0.7668	-0.0724	1.2604	13.5220	0.0355
	0.0050	0.0064	0.2833	0.5945	-0.0681	1.1779	0.5227	0.9976
	0.0025	0.0051	1.6479	0.1993	-0.0657	1.0935	2.3692	0.8828
USDTND	**0.0500**	0.0512	0.0241	0.8765	-0.0156	1.3120	3.8486	0.6972
	0.0250	0.0230	0.1254	0.7233	-0.0188	1.2945	2.4556	0.8734
	0.0100	0.0102	0.0046	0.9457	-0.0224	1.2442	10.9960	0.0885
	0.0050	0.0051	0.0023	0.9617	-0.0217	1.2611	0.1114	1.0000
	0.0025	0.0051	1.6479	0.1993	-0.0217	1.1285	2.3692	0.8828

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest US Dollar. The value-at-risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.4: In Sample Short VaR of African Carry Trade Funded by Japanese Yen

				Skewed Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	0.9565	0.7175	0.3970	0.1405	1.3117	4.0591	0.6687
	0.9750	0.9795	0.6949	0.4045	0.2601	1.1972	10.8180	0.0942
	0.9900	0.9936	1.1705	0.2793	0.0617	1.0436	53.9910	0.0000
	0.9950	1.0000	-	0.0000	-	-	3.9246	0.6869
	0.9975	**1.0000**	**-**	**0.0000**	-	-	1.9574	0.9236
JPYEGP	**0.9500**	0.9590	1.4239	0.2328	0.0242	1.3088	5.4805	0.4838
	0.9750	**0.9821**	**1.7761**	**0.1826**	0.0296	1.2656	3.9864	0.6785
	0.9900	0.9949	2.2859	0.1306	0.0397	1.4011	1.9326	0.9258
	0.9950	**0.9962**	**0.2292**	**0.6321**	0.0413	1.2819	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0471	1.1839	0.0280	1.0000
JPYGHS	**0.9500**	0.9539	0.2572	0.6121	0.0362	1.3737	0.8057	0.9919
	0.9750	0.9770	0.1254	0.7233	0.0473	1.3298	3.0876	0.7978
	0.9900	0.9923	0.4605	0.4974	0.0708	1.4215	0.6116	0.9962
	0.9950	0.9962	0.2292	0.6321	0.0797	1.5143	0.2566	0.9997
	0.9975	0.9962	0.4834	0.4869	0.0797	1.3248	0.6543	0.9954
JPYMAD	**0.9500**	0.9501	0.0001	0.9935	0.0237	1.3114	5.6311	0.4658
	0.9750	0.9744	0.0118	0.9137	0.0288	1.2602	2.7501	0.8395
	0.9900	0.9885	0.1746	0.6761	0.0334	1.2014	0.8281	0.9913
	0.9950	0.9949	0.0023	0.9617	0.0376	1.2632	0.1114	1.0000
	0.9975	0.9974	0.0011	0.9730	0.0484	1.3710	0.0280	1.0000
JPYNGN	**0.9500**	0.9577	0.9653	0.3259	0.1597	1.3009	3.7275	0.3830
	0.9750	0.9905	9.3555	0.0022	0.0555	1.4699	7.3189	0.2924
	0.9900	0.9973	5.5037	0.0190	0.0681	1.5132	3.9227	0.6871
	0.9950	0.9986	2.7421	0.0977	0.0860	1.4799	1.9495	0.9243
	0.9975	0.9986	0.4546	0.5002	0.0860	1.1947	0.3830	0.9990
JPYZAR	**0.9500**	0.9501	0.0001	0.9935	0.0373	1.2388	6.6438	0.3551
	0.9750	0.9808	1.1675	0.2799	0.0447	1.2359	2.3445	0.8855
	0.9900	0.9923	0.4605	0.4974	0.0508	1.2338	0.6116	0.9962
	0.9950	0.9974	1.1382	0.2860	0.0725	1.4205	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	0.0758	1.6247	0.4692	0.9982
JPYTND	**0.9500**	0.9501	0.0001	0.9935	0.0219	1.2819	4.1350	0.6584
	0.9750	0.9757	0.0146	0.9038	0.0271	1.2503	2.5427	0.8637
	0.9900	0.9910	0.0879	0.7668	0.0313	1.2279	0.3848	0.9990
	0.9950	0.9962	0.2292	0.6321	0.0368	1.2963	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0443	1.2997	0.0280	1.0000

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Japanese Yen. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.5: In Sample Long VaR of African Carry Trade Funded by Japanese Yen

				Skewed Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.0500**	0.0487	0.0300	0.8626	-0.1404	4.1563	7.1173	0.3101
	0.0250	0.0269	0.1116	0.7384	-0.2234	4.8242	14.7290	0.0225
	0.0100	0.0077	0.4605	0.4974	-0.6464	9.7978	16.6160	0.0108
	0.0050	0.0038	0.2292	0.6321	-1.2103	14.4820	0.2566	0.9997
	0.0025	**0.0026**	**0.0011**	**0.9730**	-1.7467	16.9040	0.0280	1.0000
JPYEGP	**0.0500**	0.0435	0.7175	0.3970	-0.0292	1.6316	2.8004	0.8335
	0.0250	**0.0243**	**0.0146**	**0.9038**	-0.0365	1.5494	2.8091	0.8324
	0.0100	0.0090	0.0879	0.7668	-0.0546	1.6856	13.4940	0.0358
	0.0050	**0.0077**	**0.9697**	**0.3248**	-0.0590	1.4932	33.3130	0.0000
	0.0025	0.0064	3.3202	0.0684	-0.0639	1.3543	84.6300	0.0000
JPYGHS	**0.0500**	0.0538	0.2292	0.6321	-0.0308	1.3936	5.0215	0.5411
	0.0250	0.0256	0.0118	0.9137	-0.0373	1.3044	2.5122	0.8671
	0.0100	0.0090	0.0879	0.7668	-0.0426	1.2287	0.3848	0.9990
	0.0050	0.0038	0.2292	0.6321	-0.0484	1.2392	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0578	1.1433	0.0280	1.0000
JPYMAD	**0.0500**	0.0499	0.0001	0.99345	-0.0257	1.3595	3.0006	0.8088
	0.0250	0.0256	0.0118	0.9137	-0.0312	1.2538	17.9550	0.0063
	0.0100	0.0115	0.1746	0.6761	-0.0363	1.1507	25.1240	0.0003
	0.0050	0.0051	0.0023	0.9617	-0.0422	1.0979	0.1114	1.0000
	0.0025	0.0013	0.5679	0.4511	-0.0331	1.0629	0.4692	0.9982
JPYNGN	**0.0500**	0.0423	0.9653	0.3259	-0.1639	5.6757	3.9528	0.6831
	0.0250	0.0205	0.6590	0.4169	-0.3046	7.7152	18.0600	0.0061
	0.0100	0.0082	0.2598	0.6102	-0.6826	12.3090	16.3710	0.0119
	0.0050	0.0055	0.0299	0.8628	-0.9973	14.0550	0.1548	0.9999
	0.0025	0.0027	0.0149	0.9028	-1.9120	21.4000	0.0458	1.0000
JPYZAR	**0.0500**	0.0525	0.1009	0.7507	-0.0509	1.3783	11.5190	0.0736
	0.0250	0.0243	0.0146	0.9038	-0.0663	1.3325	6.6106	0.3584
	0.0100	0.0128	0.5698	0.4503	-0.0792	1.1833	39.2450	0.0000
	0.0050	0.0038	0.2292	0.6321	-0.0896	1.2747	0.2566	0.9997
	0.0025	0.0013	0.5679	0.4511	-0.1310	1.4786	0.4692	0.9982
JPYTND	**0.0500**	0.0448	0.4574	0.4988	-0.0242	1.3743	2.3254	0.8875
	0.0250	0.0230	0.1254	0.7233	-0.0308	1.2993	12.3260	0.0551
	0.0100	0.0128	0.5698	0.4503	-0.0353	1.1446	22.0740	0.0012
	0.0050	0.0051	0.0023	0.9617	-0.0396	1.1203	0.1114	1.0000
	0.0025	0.0038	0.4834	0.4869	-0.0428	1.0208	0.6543	0.9954

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Japanese Yen. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.6: In Sample Short VaR of African Carry Trade Funded by Euro

				Skewed Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9526	0.1152	0.7343	0.0335	1.3026	1.2023	0.9768
	0.9750	0.9782	0.3500	0.5541	0.0377	1.2707	2.2065	0.8998
	0.9900	0.9923	0.4605	0.4974	0.0477	1.2494	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0507	1.1304	0.1114	1.0000
	0.9975	**0.9987**	**0.5679**	**0.4511**	0.0603	1.0063	0.4692	0.9982
EUREGP	**0.9500**	0.9526	0.1152	0.7343	0.0234	1.2923	3.9684	0.6810
	0.9750	**0.9795**	**0.6949**	**0.4045**	0.0290	1.2388	4.0594	0.6686
	0.9900	0.9949	2.2859	0.1306	0.0399	1.3744	1.9326	0.9258
	0.9950	**0.9962**	**0.2292**	**0.6321**	0.0429	1.2401	0.2566	0.9997
	0.9975	0.9987	0.5679	0.4511	0.0508	1.4428	0.4692	0.9982
EURGHS	**0.9500**	0.9475	0.1009	0.7507	0.0354	1.3386	1.6571	0.9484
	0.9750	0.9744	0.0118	0.9137	0.0449	1.2770	2.7420	0.8405
	0.9900	0.9898	0.0046	0.9457	0.0671	1.2431	11.3660	0.0777
	0.9950	0.9962	0.2292	0.6321	0.0718	1.3626	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0934	1.3358	0.0280	1.0000
EURMAD	**0.9500**	0.9539	0.2572	0.6121	0.0051	1.3261	2.6874	0.8469
	0.9750	0.9757	0.0146	0.9038	0.0058	1.2495	7.1489	0.3073
	0.9900	0.9910	0.0879	0.7668	0.0068	1.1837	13.0330	0.0425
	0.9950	0.9974	1.1382	0.2860	0.0077	1.2678	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	0.0084	1.2577	0.4692	0.9982
EURNGN	**0.9500**	0.9501	0.0001	0.9935	0.0179	1.4533	3.7612	0.7090
	0.9750	0.9757	0.0146	0.9038	0.0218	1.3160	2.4781	0.8709
	0.9900	0.9949	2.2859	0.1306	0.0309	1.2856	1.9326	0.9258
	0.9950	0.9974	1.1382	0.2860	0.0356	1.1537	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
EURZAR	**0.9500**	0.9526	0.1152	0.7343	0.0333	1.2938	5.1950	0.5191
	0.9750	0.9744	0.0118	0.9137	0.0393	1.2185	2.6742	0.8485
	0.9900	0.9872	0.5698	0.4503	0.0449	1.1170	1.5105	0.9588
	0.9950	0.9949	0.0023	0.9617	0.0481	1.0975	0.1114	1.0000
	0.9975	0.9974	0.0011	0.9730	0.0595	1.0186	0.0280	1.0000
EURTND	**0.9500**	0.9526	0.1152	0.7343	0.0094	1.3297	1.5037	0.9593
	0.9750	0.9718	0.3093	0.5781	0.0108	1.2302	4.7583	0.5752
	0.9900	0.9910	0.0879	0.7668	0.0137	1.2517	0.3848	0.9990
	0.9950	0.9923	0.9697	0.3248	0.0143	1.1449	1.5016	0.9594
	0.9975	0.9974	0.0011	0.9730	0.0201	1.1984	0.0280	1.0000

Note: The Table shows the short postion in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.7: In Sample Long VaR of African Carry Trade Funded by Euro

				Skewed Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0576	0.9116	0.3397	-0.0372	1.4376	10.0800	0.1213
	0.0250	0.0256	0.0118	0.9137	-0.0482	1.4247	2.6564	0.8506
	0.0100	0.0115	0.1746	0.6761	-0.0600	1.3494	10.0110	0.1242
	0.0050	0.0038	0.2292	0.6321	-0.0892	1.5514	0.2566	0.9997
	0.0025	**0.0026**	**0.0011**	**0.9730**	-0.0966	1.5322	0.0280	1.0000
EUREGP	**0.0500**	0.0423	1.0391	0.3080	-0.0290	1.4698	11.8160	0.0662
	0.0250	**0.0218**	**0.3500**	**0.5541**	-0.0374	1.4631	8.2944	0.2173
	0.0100	0.0102	0.0046	0.9457	-0.0516	1.5358	11.3660	0.0777
	0.0050	**0.0051**	**0.0023**	**0.9617**	-0.0690	1.7598	52.3510	0.0000
	0.0025	0.0038	0.4834	0.4869	-0.0830	1.7516	151.5400	0.0000
EURGHS	**0.0500**	0.0487	0.0300	0.8626	-0.0321	1.3877	2.2268	0.8977
	0.0250	0.0256	0.0118	0.9137	-0.0406	1.2959	2.7420	0.8405
	0.0100	0.0102	0.0046	0.9457	-0.0485	1.2637	0.4550	0.9983
	0.0050	0.0051	0.0023	0.9617	-0.0502	1.2391	0.1114	1.0000
	0.0025	0.0026	0.0011	0.9730	-0.0525	1.1830	0.0280	1.0000
EURMAD	**0.0500**	0.0512	0.0241	0.8765	-0.0059	1.3791	2.8180	0.8313
	0.0250	0.0218	0.3500	0.5541	-0.0077	1.3618	2.6265	0.8541
	0.0100	0.0051	2.2859	0.1306	-0.0151	1.7873	1.9188	0.9270
	0.0050	0.0026	1.1382	0.2860	-0.0223	2.1329	0.9476	0.9875
	0.0025	0.0013	0.5679	0.4511	-0.0348	2.8448	0.4692	0.9982
EURNGN	**0.0500**	0.0627	2.4778	0.1155	-0.0209	1.9122	8.2413	0.2210
	0.0250	0.0307	0.9815	0.3218	-0.0247	1.6261	14.7260	0.0225
	0.0100	0.0090	0.0879	0.7668	-0.0290	1.4959	13.4660	0.0362
	0.0050	0.0038	0.2292	0.6321	-0.0179	1.4474	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0215	1.1666	0.0280	1.0000
EURZAR	**0.0500**	0.0499	0.0001	0.9935	-0.0444	1.3882	9.2195	0.1616
	0.0250	0.0307	0.9815	0.3218	-0.0495	1.2494	13.1740	0.0404
	0.0100	0.0115	0.1746	0.6761	-0.0632	1.1826	10.0110	0.1242
	0.0050	0.0077	0.9697	0.3248	-0.0621	1.0665	1.5016	0.9594
	0.0025	0.0013	0.5679	0.4511	-0.0723	1.0617	0.4692	0.9982
EURTND	**0.0500**	0.0512	0.0241	0.8765	-0.0092	1.2499	5.6888	0.4589
	0.0250	0.0218	0.3500	0.5541	-0.0109	1.2218	7.9318	0.2432
	0.0100	0.0102	0.0046	0.9457	-0.0120	1.1373	0.4550	0.9983
	0.0050	0.0038	0.2292	0.6321	-0.0127	1.0975	0.2566	0.9997
	0.0025	0.0013	0.5679	0.4511	-0.0139	1.0239	0.4692	0.9982

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.8: In Sample Short VaR of African Carry Trade Funded by GBP

				Skewed Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9462	0.2292	0.6321	0.0320	1.3137	5.8643	0.4386
	0.9750	0.9770	0.1254	0.7233	0.0366	1.2813	2.6600	0.8502
	0.9900	0.9923	0.4605	0.4974	0.0432	1.2174	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0416	1.0808	0.1114	1.0000
	0.9975	**0.9987**	**0.5679**	**0.4511**	0.0405	1.0041	0.4692	0.9982
GBPEGP	**0.9500**	0.9526	0.1152	0.7343	0.0249	1.2822	20.6270	0.0021
	0.9750	**0.9821**	**1.7761**	**0.1826**	0.0318	1.2777	39.4920	0.0000
	0.9900	0.9923	0.4605	0.4974	0.0433	1.1978	65.2300	0.0000
	0.9950	**0.9949**	**0.0023**	**0.9617**	0.0407	1.0726	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	0.0367	1.0063	0.4692	0.9982
GBPGHS	**0.9500**	0.9501	0.0001	0.9935	0.0365	1.3536	4.0788	0.6660
	0.9750	0.9782	0.3500	0.5541	0.0506	1.3499	16.3410	0.0120
	0.9900	0.9885	0.1746	0.6761	0.0583	1.2170	0.8281	0.9913
	0.9950	0.9962	0.2292	0.6321	0.0101	1.2971	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0925	1.2028	0.0280	1.0000
GBPMAD	**0.9500**	0.9513	0.0300	0.8626	0.0166	1.3121	2.0063	0.9191
	0.9750	0.9770	0.1254	0.7233	0.0191	1.2647	2.4556	0.8734
	0.9900	0.9910	0.0879	0.7668	0.0225	1.2099	13.0240	0.0427
	0.9950	0.9949	0.0023	0.9617	0.0259	1.1660	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	0.0417	1.2480	0.4692	0.9982
GBPNGN	**0.9500**	0.9475	0.1009	0.7507	0.0326	1.2290	6.0098	0.4221
	0.9750	0.9782	0.3500	0.5541	0.0389	1.1946	2.5825	0.8591
	0.9900	0.9923	0.4605	0.4974	0.0534	1.1646	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0641	1.0789	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	0.0815	1.1069	0.4692	0.9982
GBPZAR	**0.9500**	0.9424	0.9116	0.3397	0.0327	1.2960	5.7454	0.4523
	0.9750	0.9757	0.0146	0.9038	0.0397	1.2794	2.4918	0.8694
	0.9900	0.9898	0.0046	0.9457	0.0452	1.2286	0.4550	0.9983
	0.9950	0.9936	0.2833	0.5945	0.0531	1.1598	0.5227	0.9976
	0.9975	0.9962	**0.4834**	0.4869	0.0607	1.1083	0.6543	0.9954
GBPTND	**0.9500**	0.9539	0.2572	0.6121	0.0165	1.3287	4.1990	0.6498
	0.9750	0.9808	1.1675	0.2799	0.0206	1.3327	5.6381	0.4649
	0.9900	0.9898	0.0046	0.9457	0.0251	1.2596	10.9960	0.0885
	0.9950	0.9936	0.2833	0.5945	0.0265	1.2008	0.5227	0.9976
	0.9975	0.9962	0.4834	0.4869	0.0297	1.1475	0.6543	0.9954

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest British Pound. The value at risk estimations were done through the ARMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.9: In Sample Long VaR of African Carry Trade Funded by GBP

Carry Trade	*Quan-tile*	Failure Rate	Kupiec LRT	Kupiec P-Value	Expected Shortfall 1	Expected Shortfall 2	Dynamic Q Statistics	Dynamic Q P-Value
				Skewed Student t Distribution				
				Long Position				
GBPBWP	**0.0500**	0.0435	0.7175	0.3970	-0.0409	1.5735	**2.8406**	0.8286
	0.0250	0.0256	0.0118	0.9137	-0.0495	1.4473	6.7097	0.3485
	0.0100	0.0090	0.0879	0.7668	-0.0685	1.5099	0.3671	0.9991
	0.0050	0.0051	0.0023	0.9617	-0.0823	1.5431	0.1114	1.0000
	0.0025	**0.0026**	**0.0011**	**0.9730**	-0.0105	1.7195	0.0280	1.0000
GBPEGP	**0.0500**	0.0448	0.4574	0.4988	-0.0276	1.5864	7.1944	0.3032
	0.0250	**0.0230**	**0.1254**	**0.7233**	-0.0373	1.6091	7.5778	0.2707
	0.0100	0.0128	0.5698	0.4503	-0.0471	1.5766	9.1864	0.1634
	0.0050	**0.0090**	**1.9935**	**0.1580**	-0.0547	1.5222	29.1490	0.0001
	0.0025	0.0051	1.6479	0.1993	-0.0694	1.6101	106.5900	0.0000
GBPGHS	**0.0500**	0.0461	0.2572	0.6121	-0.0316	1.4318	2.3608	0.8837
	0.0250	0.0243	0.0146	0.9038	-0.0402	1.3620	7.1847	0.3041
	0.0100	0.0115	0.1746	0.6761	-0.0446	1.2467	9.6670	0.1394
	0.0050	0.0051	0.0023	0.9617	-0.0512	1.2417	0.1114	1.0000
	0.0025	0.0038	0.4834	0.4869	-0.0505	1.0986	0.6543	0.9954
GBPMAD	**0.0500**	0.0435	0.7175	0.3970	-0.0157	1.3777	4.2593	0.6416
	0.0250	0.0243	0.0146	0.9038	-0.0178	1.2843	2.6632	0.8498
	0.0100	0.0051	2.2859	0.1306	-0.0328	1.5900	1.9326	0.9258
	0.0050	0.0038	0.2292	0.6321	-0.0387	1.5438	0.2566	0.9997
	0.0025	0.0038	0.4834	0.4869	-0.0387	1.3585	0.6543	0.9954
GBPNGN	**0.0500**	0.0487	0.0300	0.8626	-0.0369	1.3940	6.5097	0.3686
	0.0250	0.0294	0.6006	0.4383	-0.0443	1.2893	24.5980	0.0004
	0.0100	0.0141	1.1680	0.2798	-0.0572	1.1932	16.3960	0.0118
	0.0050	0.0077	0.9697	0.3248	-0.0658	1.1400	1.5016	0.9594
	0.0025	0.0051	1.6479	0.1993	-0.0641	1.0477	2.3692	0.8828
GBPZAR	**0.0500**	0.0448	0.4574	0.4988	-0.0432	1.3451	7.6829	0.2623
	0.0250	0.0256	0.0118	0.9137	-0.0496	1.2296	2.4940	0.8691
	0.0100	0.0077	0.4605	0.4974	-0.0709	1.2081	16.6160	0.0108
	0.0050	0.0051	0.0023	0.9617	-0.0673	1.1214	0.1114	1.0000
	0.0025	0.0013	0.5679	0.4511	-0.0715	1.0842	0.4692	0.9982
GBPTND	**0.0500**	0.0423	1.0391	0.3080	-0.0166	1.3673	4.1240	0.6599
	0.0250	0.0179	1.7761	0.1826	-0.0193	1.4029	2.6286	0.8538
	0.0100	0.0077	0.4605	0.4974	-0.0268	1.4532	0.6116	0.9962
	0.0050	0.0064	0.2833	0.5945	-0.0289	1.3333	0.5227	0.9976
	0.0025	0.0038	0.4834	0.4869	-0.0359	1.3247	0.6543	0.9954

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest British Pound. The value at risk estimations were done through the ARMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test, and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Furthermore, the dynamic quantile test shows the there is no clustering of exceedances, which means the exceedances are randomly distributed for most of the currency pairs used for the study. In-sample VaR results for the Gaussian and Student t distributions are equally not bad, except that the skewed t distribution performs better. The study also reveals that although the skewed t generally fits the African currency carry trade returns well, calibration of VaR for a few currency pairs under this distribution performs poorly relative to the student t and the Gaussian distributions. For instance, the in-sample VaR calibration for the short trading position of the USDMAD and long trading position for the USDGHS are better modelled by the Gaussian (normal) relative to the skewed t and student t distributions. The EUREGP and JPYGHS show similar results for the Gaussian but in the case of these two currency pairs they perform better for both short and long trading positions. The student t distribution, on the other hand, performs very well with the EURMAD, GBPMAD and GBPTND for both short and long trading positions. Aside from these exceptions, all the other currency pairs used for the study can be correctly specified under ARMA (1, 0)-GARCH (1, 1)-skewed t distribution. Even though expected shortfall measures do not directly rank the models the figures produced signal risk managers as to the extent of losses that could be incurred when the VaR is violated. Generally, the expected shortfall 1 and 2 for the skewed distributions are relatively lower than the other distributions for the study.

Next, the study forecasts $t+h$ out-of-sample VaR (where h is the time horizon of forecasts, which is one week in this current study) and implements the validity and accuracy measures discussed under the in-sample backtesting. These forecasts are performed for both short and long trading positions and the testing procedure follows the approach proposed by Giot and Laurent (2003) with a few modifications.

The researcher performed the first estimation on the full sample less the last five years of data to predict one-week-ahead VaR for both short and long trading positions. These predicted one-week-ahead VaR estimations were then compared with the observed returns with a number of statistical tests. At the i^{th} iteration where i runs from 2 to 5*52 (thus 52 weeks in a year, producing a total of five years of data), the estimation sample is increased to include one more week and the VaR estimates are forecast and recorded. Any time i is a multiple of 20, the model is re-estimated to update the ARMA (1, 0)-GARCH (1, 1) parameters under the Gaussian, student t and skewed t distribution of innovations. Thus the model parameters are updated every 20 trading weeks, which means the researcher is assuming an estimation window of 20 weeks for the parameters. This iteration continues until all weeks (less the last one) have been included in the estimation sample.

Table 5.10: Out of Sample Short VaR of African Carry Trade Funded by US Dollars

Skewed Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.9500**	0.9731	3.4780	0.0622	0.0404	1.3823	2.9150	0.0878
	0.9750	0.9885	2.4090	0.1206	0.0524	1.4285	1.9329	0.1644
	0.9900	0.9923	0.1519	0.6967	0.0605	1.2258	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	0.0777	1.2269	0.0696	0.7920
	0.9975	**0.9962**	**0.1620**	**0.6873**	0.0777	1.0536	0.1889	0.6638
USDEGP	**0.9500**	0.9577	0.3410	0.5593	0.0068	1.7099	0.3239	0.5693
	0.9750	**0.9731**	**0.0385**	**0.8445**	0.0087	1.5909	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	0.0113	1.9517	0.1399	0.7084
	0.9950	**0.9962**	**0.0756**	**0.7833**	0.0149	2.0614	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0149	1.5356	0.1889	0.6638
USDGHS	**0.9500**	0.9577	0.3410	0.5593	0.0407	1.4366	0.3239	0.5693
	0.9750	0.9769	0.0405	0.8406	0.0524	1.3559	0.0394	0.8426
	0.9900	0.9885	0.0592	0.8077	0.0643	1.1564	0.0622	0.8031
	0.9950	0.9962	0.0756	0.7833	0.1292	1.0664	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDMAD	**0.9500**	0.9654	1.4454	0.2293	0.0165	1.2268	1.2955	0.2550
	0.9750	0.9846	1.1405	0.2855	0.0199	1.1889	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0255	1.2732	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0255	1.1191	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0255	1.0005	0.1889	0.6638
USDNGN	**0.9500**	0.9577	0.3410	0.5593	0.0150	1.5251	0.3239	0.5693
	0.9750	0.9808	0.3852	0.5348	0.0184	1.4874	0.3550	0.5513
	0.9900	0.9923	0.1519	0.6967	0.0268	1.2809	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	0.0327	1.1314	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDZAR	**0.9500**	0.9731	3.4780	0.0622	0.0288	1.2174	2.9150	0.0878
	0.9750	0.9808	0.3852	0.5348	0.0294	1.0644	0.3550	0.5513
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDTND	**0.9500**	0.9423	0.3093	0.5781	0.0133	1.2299	0.3239	0.5693
	0.9750	0.9731	0.0385	0.8445	0.0140	1.1465	0.0394	0.8426
	0.9900	0.9962	1.2989	0.2544	0.0142	1.3607	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0142	1.1751	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0142	1.0394	0.1889	0.6638

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest USD Dollar. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.11: Out of Sample Long VaR of African Carry Trade Funded by US Dollars

Skewed Student t Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.0500**	0.0346	1.4454	0.2293	-0.0231	1.2343	1.2955	0.2550
	0.0250	0.0192	0.3852	0.5348	-0.0246	1.0831	0.3550	0.5513
	0.0100	0.0000	-	0.0000	-	-	2.6263	0.1051
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
USDEGP	**0.0500**	0.0423	0.3410	0.5593	-0.0112	1.7099	0.3239	0.5693
	0.0250	**0.0231**	**0.0405**	**0.8406**	-0.0149	1.5909	0.0394	0.8426
	0.0100	0.0154	0.6539	0.4187	-0.0166	1.9517	0.7615	0.3829
	0.0050	**0.0115**	**1.6287**	**0.2019**	-0.0203	2.0614	2.2342	0.1350
	0.0025	0.0077	1.8028	0.1794	-0.0283	1.5356	2.8109	0.0936
USDGHS	**0.0500**	0.1000	10.7400	0.0010	-0.0185	1.5724	13.6840	0.0002
	0.0250	0.0538	6.7073	0.0096	-0.0203	1.3635	8.8757	0.0029
	0.0100	0.0077	0.1519	0.6967	-0.0392	1.4980	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0223	1.5328	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0223	1.2060	0.1889	0.6638
USDMAD	**0.0500**	0.0462	0.0830	0.7733	-0.0183	1.3087	0.0810	0.7760
	0.0250	0.0231	0.0405	0.8406	-0.0213	1.2631	0.0394	0.8426
	0.0100	0.0115	0.0592	0.8077	-0.0276	1.1796	0.0622	0.8031
	0.0050	0.0077	0.3250	0.5686	-0.0284	1.0836	0.3788	0.5382
	0.0025	0.0038	0.1620	0.6873	-0.0301	1.0014	0.1889	0.6638
USDNGN	**0.0500**	0.0654	1.1861	0.2761	-0.0173	1.7130	1.2955	0.2550
	0.0250	0.0308	0.3311	0.5650	-0.0154	1.4803	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0294	2.3112	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0294	1.6492	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0294	1.1939	0.1889	0.6638
USDZAR	**0.0500**	0.0500	0.0000	1.0000	-0.0362	1.1643	0.0000	1.0000
	0.0250	0.0115	2.4090	0.1206	-0.0581	1.1842	1.9329	0.1644
	0.0100	0.0038	1.2989	0.2544	-0.0741	1.0887	0.9946	0.3186
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
USDTND	**0.0500**	0.0462	0.0830	0.7733	-0.0151	1.2828	0.0810	0.7760
	0.0250	0.0269	0.0385	0.8445	-0.0170	1.1440	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-0.0216	1.0361	0.1399	0.7084
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest USD Dollar. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.12: Out-of-Sample Short VaR of African Carry Trade Funded by JPY

Skewed Student t Distribution								
Short Position								
Carry Trade	***Quan-*** **tile**	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	0.9500	0.0000	1.0000	0.0182	-3.5906	0.0000	1.0000
	0.9750	0.9654	0.8823	0.3476	0.0191	0.2478	0.9862	0.3207
	0.9900	0.9808	1.7617	0.1844	0.0184	5.6645	2.2378	0.1347
	0.9950	0.9923	0.3250	0.5686	0.0290	2.4599	0.3788	0.5382
	0.9975	**0.9962**	0.1620	0.6873	0.0141	1.6604	0.1889	0.6638
JPYEGP	**0.9500**	0.9577	0.3410	0.5593	0.0267	1.4247	0.3239	0.5693
	0.9750	**0.9846**	**1.1405**	**0.2855**	0.0358	1.6709	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0413	1.5111	0.0622	0.8031
	0.9950	**0.9885**	**1.6287**	**0.2019**	0.0413	1.3029	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0471	1.2085	2.8109	0.0936
JPYGHS	**0.9500**	0.9385	0.6811	0.4092	0.0529	1.4737	0.7287	0.3933
	0.9750	0.9615	1.6642	0.1970	0.0569	1.3983	1.9329	0.1644
	0.9900	0.9846	0.6539	0.4187	0.0803	1.5074	0.7615	0.3829
	0.9950	0.9885	1.6287	0.2019	0.0729	1.4579	2.2342	0.1350
	0.9975	0.9885	4.4977	0.0339	0.0729	1.2950	8.5174	0.0035
JPYMAD	**0.9500**	0.9462	0.0791	0.7786	0.0285	1.5021	0.0810	0.7760
	0.9750	0.9539	3.8347	0.0502	0.0303	1.3443	4.7732	0.0289
	0.9900	0.9731	5.1412	0.0234	0.0357	1.3098	7.5214	0.0061
	0.9950	0.9846	3.6197	0.0571	0.0401	1.3472	5.6359	0.0176
	0.9975	0.9923	1.8028	0.1794	0.0484	1.4787	2.8109	0.0936
JPYNGN	**0.9500**	-	-	-	-	-	-	-
	0.9750	-	-	-	-	-	-	-
	0.9900	-	-	-	-	-	-	-
	0.9950	-	-	-	-	-	-	-
	0.9975	-	-	-	-	-	-	-
JPYZAR	**0.9500**	0.9577	0.3410	0.5593	0.0365	1.2810	0.3239	0.5693
	0.9750	0.9846	1.1405	0.2855	0.0442	1.3776	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0758	2.0753	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0758	1.8666	0.0696	**0.7920**
	0.9975	0.9962	0.1620	0.6873	0.0758	1.6960	0.1889	0.6638
JPYTND	**0.9500**	0.9308	1.8171	0.1777	0.0234	1.3580	2.0243	0.1548
	0.9750	0.9577	2.6544	0.1033	0.0278	1.3219	3.1953	0.0739
	0.9900	0.9731	5.1412	0.0234	0.0319	1.2344	7.5214	0.0061
	0.9950	0.9885	1.6287	0.2019	0.0395	1.3577	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0443	1.3927	2.8109	0.0936

Note: The Table shows the short postion out-of-sample results of the African currency carry trade financed by borrowing the low interest Japanese Yen. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.13: Out-of-Sample Long VaR of African Carry Trade Funded by JPY

				Skewed Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.0500**	0.0385	0.7890	0.3744	-0.0302	1.0177	0.7287	0.3933
	0.0250	0.0115	2.4090	0.1206	-0.0455	-0.1664	1.9329	0.1644
	0.0100	0.0038	1.2989	0.2544	-0.0287	-4.5925	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0287	-7.1991	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0287	-35.5560	0.1889	0.6638
JPYEGP	**0.0500**	0.0269	3.4780	0.0622	-0.0206	1.2491	2.9150	0.0878
	0.0250	0.0115	2.4090	**0.1206**	-0.0261	1.1411	**1.9329**	**0.1644**
	0.0100	0.0000	-	0.0000	-	-	2.6263	0.1051
	0.0050	0.0000	-	0.0000	-	-	**1.3065**	**0.2530**
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYGHS	**0.0500**	0.0615	0.6811	0.4092	-0.0337	1.3729	0.7287	0.3933
	0.0250	0.0346	0.8823	0.3476	-0.0415	1.2328	0.9862	0.3207
	0.0100	0.0231	3.2801	0.0701	-0.0382	1.0456	4.4911	0.0341
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYMAD	**0.0500**	0.0308	2.3324	0.1267	-0.0227	1.2721	2.0243	0.1548
	0.0250	0.0154	1.1405	0.2855	-0.0237	1.1631	0.9862	0.3207
	0.0100	0.0038	1.2989	0.2544	-0.0348	1.2429	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0348	1.0861	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYNGN	**0.0500**	-	-	-	-	-	-	-
	0.0250	-	-	-	-	-	-	-
	0.0100	-	-	-	-	-	-	-
	0.0050	-	-	-	-	-	-	-
	0.0025	-	-	-	-	-	-	-
JPYZAR	**0.0500**	0.9577	0.3410	0.5593	-0.0481	1.2810	1.2955	0.2550
	0.0250	0.9846	1.1405	0.2855	-0.0502	1.3776	0.0394	0.8426
	0.0100	0.9962	1.2989	0.2544	-0.0725	2.0753	0.1399	0.7084
	0.0050	0.9962	0.0756	0.7833	-	1.8666	1.3065	0.2530
	0.0025	0.9962	0.1620	0.6873	-	1.6960	0.6516	0.4195
JPYTND	**0.0500**	0.0308	2.3324	0.1267	-0.0190	1.2920	2.0243	0.1548
	0.0250	0.0115	2.4090	0.1206	-0.0241	1.2709	1.9329	0.1644
	0.0100	0.0077	0.1519	0.6967	-0.0275	1.1058	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0301	1.0278	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the long positon out-of-sample results of the African currency carry trade financed by borrowing the low interest Japanese Yen. The value at risk estimations were done through the ARMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.14: Out of Sample Short VaR of African Carry Trade Funded by Euro

Skewed Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9731	3.4780	0.0622	0.0299	1.2626	2.9150	0.0878
	0.9750	0.9846	1.1405	0.2855	0.0310	1.1080	0.9862	0.3207
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EUREGP	**0.9500**	0.9462	0.0791	0.7786	0.0228	1.2662	0.0810	0.7760
	0.9750	**0.9769**	0.0405	**0.8406**	0.0293	1.2247	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	0.0333	1.1801	0.1399	0.7084
	0.9950	**0.9923**	0.3250	**0.5686**	0.0333	1.0143	0.3788	0.5382
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURGHS	**0.9500**	0.9462	0.0791	0.7786	0.0556	1.4129	0.0810	0.7760
	0.9750	0.9654	0.8823	0.3476	0.0590	1.3136	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0897	1.3882	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	0.1083	1.3744	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	0.1364	1.5498	0.1889	0.6638
EURMAD	**0.9500**	0.9346	1.1861	0.2761	0.0053	1.2468	1.2955	0.2550
	0.9750	0.9731	0.0385	0.8445	0.0055	1.1979	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	0.0071	1.0957	0.1399	0.7084
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURNGN	**0.9500**	0.9577	0.3410	0.5593	0.0150	1.5252	0.3239	0.5693
	0.9750	0.9808	0.3852	0.5348	0.0184	1.4874	0.3550	0.5513
	0.9900	0.9923	0.1519	0.6967	0.0268	1.2809	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	0.0327	1.1314	0.0696	0.7920
	0.9975	1.0000		0.0000			0.6516	0.4195
EURZAR	**0.9500**	0.9769	4.9183	0.0266	0.0280	1.2042	3.9676	0.0464
	0.9750	0.9885	2.4090	0.1206	0.0311	1.1241	1.9329	0.1644
	0.9900	0.9962	1.2989	0.2544	0.0339	1.0775	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURTND	**0.9500**	0.9615	0.7890	0.3744	0.0117	-	253.9300	0.0000
	0.9750	0.9731	0.0385	0.8445	0.0133	-	558.6200	0.0000
	0.9900	0.9885	0.0592	0.8077	0.0170	-	1370.8000	0.0000
	0.9950	0.9962	0.0756	0.7833	0.0251	-	2663.9000	0.0000
	0.9975	0.9962	0.1620	0.6873	0.0251	-	5432.7000	0.0000

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.15: Out of Sample Long VaR of African Carry Trade Funded by Euro

				Skewed Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0462	0.0830	0.7733	-0.0333	1.3136	0.0810	0.7760
	0.0250	0.0192	0.3852	0.5348	-0.0438	1.2367	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0470	1.1670	0.9946	0.3186
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	**0.0000**	**-**	**0.0000**	**-**	**-**	0.6516	0.4195
EUREGP	**0.0500**	0.0385	0.7890	0.3744	-0.0227	1.2677	0.7287	0.3933
	0.0250	**0.0077**	**4.3648**	**0.0367**	-0.0282	1.4028	3.1953	0.0739
	0.0100	0.0077	0.1519	0.6967	-0.0282	1.0688	0.1399	0.7084
	0.0050	**0.0000**	-	**0.0000**	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURGHS	**0.0500**	0.0731	2.5675	0.1091	-0.0365	1.4819	2.9150	0.0878
	0.0250	0.0538	6.7073	0.0096	-0.0401	1.3069	8.8757	0.0029
	0.0100	0.0231	3.2801	0.0701	-0.0532	1.2965	4.4911	0.0341
	0.0050	0.0192	6.1239	0.0133	-0.0428	1.1911	10.5840	0.0011
	0.0025	0.0115	4.4977	0.0339	-0.0474	1.1309	8.5174	0.0035
EURMAD	**0.0500**	0.0423	0.3410	0.5593	-0.0064	1.3159	0.3239	0.5693
	0.0250	0.0231	0.0405	0.8406	-0.0081	1.1825	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-0.0104	1.1619	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0098	1.0671	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURNGN	**0.0500**	0.0654	1.1861	0.2761	-0.0173	1.7130	1.2955	0.2550
	0.0250	0.0308	0.3311	0.5650	-0.0154	1.4803	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0294	2.3112	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0294	1.6492	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0294	1.1939	0.1889	0.6638
EURZAR	**0.0500**	0.0500	0.0000	1.0000	-0.0410	1.4545	0.0000	1.0000
	0.0250	0.0385	1.6642	0.1970	-0.0440	1.2439	1.9329	0.1644
	0.0100	0.0115	0.0592	0.8077	-0.0584	1.2451	0.0622	0.8031
	0.0050	0.0115	1.6287	0.2019	-0.0584	1.0847	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-0.0645	1.0450	0.1889	0.6638
EURTND	**0.0500**	0.0500	0.0000	1.0000	-0.0098	-	0.0000	1.0000
	0.0250	0.0346	0.8823	0.3476	-0.0103	-	0.9862	0.3207
	0.0100	0.0154	0.6539	0.4187	-0.0120	-	0.7615	0.3829
	0.0050	0.0154	3.6197	0.0571	-0.0120	-	5.6359	0.0176
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.16: Out-of-Sample Short VaR of African Carry Trade Funded by GBP

				Skewed Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9731	3.4780	0.0622	0.0283	1.3050	2.9150	0.0878
	0.9750	0.9846	1.1405	0.2855	0.0308	1.2000	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0312	1.0741	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	**1.0000**	-	0.0000	-	-	0.6516	0.4195
GBPEGP	**0.9500**	0.9885	11.6010	0.0007	0.0203	1.3181	8.0972	0.0044
	0.9750	**0.9962**	7.3749	0.0066	0.0290	1.4951	4.7732	0.0289
	0.9900	0.9962	1.2989	0.2544	0.0290	1.1741	0.9946	0.3186
	0.9950	**1.0000**	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPGHS	**0.9500**	0.9692	2.3324	0.1267	0.0629	1.5539	2.0243	0.1548
	0.9750	0.9769	0.0405	0.8406	0.0767	1.4019	0.0394	0.8426
	0.9900	0.9885	0.0592	0.8077	0.1031	1.3838	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	0.1300	1.3554	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	0.1427	1.4498	0.1889	0.6638
GBPMAD	**0.9500**	0.9615	0.7890	0.3744	0.0140	1.2248	0.7287	0.3933
	0.9750	0.9885	2.4090	0.1206	0.0181	1.1531	0.7287	0.1644
	0.9900	0.9962	1.2989	0.2544	0.0169	1.0154	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPNGN	**0.9500**	0.9654	1.4454	0.2293	0.0254	1.1275	1.2955	0.2550
	0.9750	0.9923	4.3648	0.0367	0.0248	1.0855	3.1953	0.0739
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPZAR	**0.9500**	0.9654	1.4454	0.2293	0.0250	1.1369	1.2955	0.2550
	0.9750	0.9962	7.3749	0.0066	0.0303	1.1897	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.65163	0.2530
GBPTND	**0.9500**	0.9731	3.4780	0.0622	0.0167	1.3974	2.9150	0.0878
	0.9750	0.9808	0.3852	0.5348	0.0179	1.2175	0.3550	0.5513
	0.9900	0.9962	1.2989	0.2544	0.0266	1.4101	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0266	1.2431	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.2655	1.1116	0.1889	0.6638

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest British Pound. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

Table 5.17: Out-of-Sample Long VaR of African Carry Trade Funded by GBP

Carry Trade	*Quan-tile*	Failure Rate	Kupiec LRT	Kupiec P-Value	Expected Shortfall 1	Expected Shortfall 2	Dynamic Q Statistics	Dynamic Q P-Value
				Skewed Student t Distribution				
				Long Position				
GBPBWP	**0.0500**	0.0385	0.7890	0.3744	-0.0313	1.3797	0.7287	0.3933
	0.0250	0.0231	0.0405	0.8406	-0.0363	1.2308	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-0.0466	1.1241	0.1399	0.7084
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
GBPEGP	**0.0500**	0.0423	0.3410	0.5593	-0.0201	1.3902	0.3239	0.5693
	0.0250	**0.0077**	**4.3648**	**0.0367**	-0.0346	1.9747	3.1953	0.0739
	0.0100	0.0077	0.1519	0.6967	-0.0346	1.4786	0.1399	0.7084
	0.0050	**0.0077**	**0.3250**	**0.5686**	-0.0346	1.2219	0.3788	0.5382
	0.0025	0.0038	0.1620	0.6873	-0.0357	1.1918	0.1889	0.6638
GBPGHS	**0.0500**	0.0808	4.4040	0.0359	-0.0325	1.4901	5.1822	0.0228
	0.0250	0.0538	6.7073	0.0096	-0.0386	1.3714	8.8757	0.0029
	0.0100	0.0269	5.1412	0.0234	-0.0998	1.3149	7.5214	0.0061
	0.0050	0.0231	9.0387	0.0026	-0.0420	1.1860	17.0780	0.0000
	0.0025	0.0115	4.4977	0.0339	-0.0463	1.1584	8.5174	0.0035
GBPMAD	**0.0500**	0.0500	0.0000	1.0000	-0.0138	1.3950	0.0000	1.0000
	0.0250	0.0346	0.8823	0.3476	-0.0148	1.2065	0.9862	0.3207
	0.0100	0.0038	1.2989	0.2544	-0.0262	1.6313	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0262	1.4068	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0262	1.2354	0.1889	0.6638
GBPNGN	**0.0500**	0.0308	2.3324	0.1267	-0.0307	1.4192	2.0243	0.1548
	0.0250	0.0192	0.3852	0.5348	-0.0372	1.3371	0.3550	0.5513
	0.0100	0.0154	0.6539	0.4187	-0.0403	1.1375	0.7615	0.3829
	0.0050	0.0038	0.0756	0.7833	-0.0423	1.2284	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0423	1.0972	0.1889	0.6638
GBPZAR	**0.0500**	0.0423	0.3410	0.5593	-0.0342	1.2323	0.3239	0.5693
	0.0250	0.0192	0.3852	0.5348	-0.0422	1.1416	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0590	1.0119	0.9946	0.3186
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
GBPTND	**0.0500**	0.0654	1.1861	0.2761	-0.0142	1.3590	1.2955	0.2550
	0.0250	0.0308	0.3311	0.5650	-0.0164	1.3499	0.3550	0.5513
	0.0100	0.0077	0.1519	0.6967	-0.2574	1.6818	0.1399	0.7084
	0.0050	0.0077	0.3250	0.5686	-0.0257	1.4554	0.3788	0.5382
	0.0025	0.0077	1.8028	0.1794	-0.0257	1.2817	2.8109	0.0936

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest British Pound. The value-at-risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with skewed student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test. Data collected from January 2001-December 2015.

The researcher performed the first estimation on the full sample less the last five years of data to predict one-week-ahead VaR for both short and long trading positions. These predicted one-week-ahead VaR estimations were then compared with the observed returns with a number of statistical tests. At the i^{th} iteration where i runs from 2 to 5*52 (thus 52 weeks in a year producing a total of five years of data), the estimation sample is increased to include one more week and the VaR estimates are forecast and recorded. Any time i is a multiple of 20, the model is re-estimated to update the ARMA (1, 0)-GARCH (1, 1) parameters under the Gaussian, student t and skewed t distribution of innovations. Thus the model parameters are updated every 20 trading weeks, which means the researcher is assuming an estimation window of 20 weeks for the parameters. This iteration continues until all weeks (less the last one) have been included in the estimation sample. The researcher subsequently computes the failure and success rates by comparing the short and long forecasted VaR_{t+1} with the observed African currency carry trade return z_{t+1} for all weeks within the five year period. Furthermore, all the other validity and accuracy measures discussed earlier in this section are calculated and the results are presented. Tables 5.10 to 5.17 present the results of the out-of-sample short and long forecasted VaR_{t+1} (under skewed student t distribution of innovation) with their associated validity and accuracy measures. Similar results under Gaussian (normal) and student t distribution at the Appendix B.

The out-of-sample VaR results generally underperform results from the in-sample VaR backtesting discussed earlier in this section. Notwithstanding the underperformance relative to the in-sample VaR analysis, the researcher observed that a significant number of the forecasted VaR for both short and long trading of the currency pairs under study were found to be properly calibrated. Further, the tables reveal that the estimations performed under the skewed student *t* distributions show a massive improvement over the Gaussian and student t distributions. Even though the VaR model under skewed student t distribution produces superior VaR forecasts and measures of accuracy a good number of the currency pairs performed better under the normal and student t distributions than the skewed t distributions. The forecast VaR for short and long trading positions of African currency carry trade involving the EURBWP, EUREGP, JPYGHS and JPYTND performs better under normal distribution of the error term. Furthermore, the results show that the forecasts of short and long trading position VaR of the currency carry trade strategy involving JPYEGP, GBPGHS, GBPMAD and GBPTND are best modelled with student t distribution of the residual or the innovation. The forecast for the remaining twenty currency pairs performs better under the skewed student t distribution of innovations. Failure and success rate are largely not statistically different from the pre-specified VaR.

This is confirmed by the Kupiec likelihood ratio test statistic its corresponding p-value which fails to reject the null hypothesis of ‘success and failure equals pre-specified VaR’. The Engle and Manganelli (2004) test statistic and its corresponding probability value also largely fails to reject its null hypothesis for a significant number of the currency pairs. Even though the VaR estimations are largely correctly calibrated for the various quantiles investigated, it is instructive to note that in almost all instances where the model failed the risks, especially for 0.25% to 1% nominal VaR estimates are consistent with the findings of earlier studies. The expected shortfall measures again reveal slightly lower losses for correctly calibrated VaR forecasts under the skewed student t distributions.

Figures E1 to E28, in Appendix E, present graphical analysis of post estimation of the univariate ARMA (1, 0)-GARCH (1, 1), which includes the graphical analysis of long and short position value-at-risk with empirical quantile of 0.025 and 0.975. From various graphs it can be observed from the kernel density function that the standardised residuals for all the currency pairs studied do not exhibit normality. The residual plots also exhibit volatility clustering, indicating that the generalised autoregressive conditional heteroskedasticity is a good fit for the return series. It can observed that the analysis of the long and short VaR in most of the cases exhibit reasonable VaR breaks, whereas a handful of them show excessive VaR.

Table 5.18 presents a summary of the conditional VaR, or expected shortfall, in an attempt to predict the worst possible losses that could be incurred by African currency carry traders for all twenty eight currency pairs used in the study. For the purposes of comparison and ranking of the worst possible losses for the various currency pairs, the study adopts the 5% quantile for the long position VaR for both in-sample and out-of-sample. The 5% quantile was chosen for this analysis because it appears to be well calibrated for both in-sample and out-of-sample VaR for all twenty eight currency pairs except the JPYNGN which appears to be invalid for the out-of-sample analysis. The table ranks these twenty currency pairs according to their risk exposure in terms which of the currency pairs attracts higher losses as against the ones that attract lower losses. The expected shortfall basically measures the average losses that could be incurred on condition the losses exceed the value at risk or the average amout of losses the investors should expect on their currency carry trade investment at a certain confidence (significance) level. In Table 5.18, under in-sample VaR, the currency pairs with the highest expected average loss in a worst case scenario is the JPYNGN which posted -16.39%, while the currency pair with the expected average losses is EURMAD with -0.59%.

Table 5.18: Predicted Worst Losses Using Expected Shortfall

In-Sample VaR at 5% Quantile				Out-of-SampleVaR at 5% Quantile			
Currency	**Mean**	**SD**	**ESF**	**Currency**	**Mean**	**SD**	**ESF**
JPYNGN	0.140%	17.77%	-16.39%	JPYZAR	0.048%	2.21%	-4.81%
JPYBWP	0.137%	17.06%	-14.04%	EURZAR	-0.008%	1.82%	-4.10%
JPYZAR	0.048%	2.21%	-5.09%	EURGHS	0.111%	1.73%	-3.65%
EURZAR	-0.008%	1.82%	-4.44%	USDZAR	0.006%	1.95%	-3.62%
USDZAR	0.006%	1.95%	-4.34%	GBPZAR	0.005%	1.80%	-3.42%
GBPZAR	0.005%	1.80%	-4.32%	JPYGHS	0.164%	1.70%	-3.37%
GBPBWP	0.090%	1.69%	-4.09%	EURBWP	0.090%	1.70%	-3.33%
EURBWP	0.090%	1.70%	-3.72%	GBPGHS	0.113%	1.66%	-3.25%
GBPNGN	0.111%	1.73%	-3.69%	GBPBWP	0.090%	1.69%	-3.13%
EURGHS	0.111%	1.73%	-3.21%	GBPNGN	0.111%	1.73%	-3.07%
GBPGHS	0.113%	1.66%	-3.16%	JPYBWP	0.137%	17.06%	-3.02%
JPYGHS	0.164%	1.70%	-3.08%	USDBWP	0.287%	1.70%	-2.31%
JPYEGP	0.092%	1.27%	-2.92%	EUREGP	0.039%	1.32%	-2.27%
EUREGP	0.039%	1.32%	-2.90%	JPYMAD	0.068%	1.24%	-2.27%
GBPEGP	0.041%	1.24%	-2.76%	JPYEGP	0.092%	1.27%	-2.06%
USDBWP	0.287%	1.70%	-2.64%	GBPEGP	0.041%	1.24%	-2.01%
JPYMAD	0.068%	1.24%	-2.57%	JPYTND	0.044%	1.16%	-1.90%
JPYTND	0.044%	1.16%	-2.42%	USDGHS	0.121%	1.24%	-1.85%
EURNGN	0.120%	1.15%	-2.09%	USDMAD	0.026%	0.91%	-1.83%
USDNGN	0.120%	1.15%	-2.09%	EURNGN	0.120%	1.15%	-1.73%
USDMAD	0.026%	0.91%	-1.78%	USDNGN	0.120%	1.15%	-1.73%
GBPTND	-0.007%	0.80%	-1.66%	USDTND	0.002%	0.81%	-1.51%
USDGHS	0.121%	1.24%	-1.64%	GBPTND	-0.007%	0.80%	-1.42%
GBPMAD	0.017%	0.81%	-1.57%	GBPMAD	0.017%	0.81%	-1.38%
USDTND	0.002%	0.81%	-1.56%	USDEGP	0.050%	0.66%	-1.12%
USDEGP	0.050%	0.66%	-0.99%	EURTND	-0.009%	0.46%	-0.98%
EURTND	-0.009%	0.46%	-0.92%	EURMAD	0.014%	0.30%	-0.64%
EURMAD	0.014%	0.30%	-0.59%	JPYNGN	0.140%	17.77%	-

Note: Table 5.18 shows predicted expected shortfall for long trading position under the in-sample and the out-of-sample forecast and ranks the losses according to the highest potential losses to lowest potential loss. The SD means standard deviation and ESF means expected shortfall. The VaR quantile is 5%.

In the case of the JPYNGN, where the expected shortfall is -16.39%, it follows that the worst 5% of the returns, the average loss that would be incurred on the African currency carry trade investment in one week, will equal -16.39% (i.e. the value of the investment will reduce by 16.39%). The EURMAD on the other hand will post an average loss of -0.59% in the worst 5% of the returns in a week. Thus in the worst case scenario, there is 5% chance that investment in the EURMAD carry trade will lose an average of 0.59%, which is the least risky relative to the other twenty currency pairs.

In addition to the JPYNGN, Table 5.18 also shows that the JPYBWP also exhibits a very high potential average losses of -14.04% in a single week which is only second to the JPYNGN. It is therefore not surprising that these two currency pairs (JPYNGN and JPYBWP) with the highest potential losses are both charaterised by over 17% standard deviation whilst the lowest expected shortfall also attracts the lowest standard deviation (0.30%), which confirms their risk profiles. Thus the expected shortfall computations for these currency pairs are consistent with their standard deviations as both point to how risky they are. Other currency pairs with very low potential losses at 5% probability are the USDEGP (-0.99%) and the EURTND (-0.99%). Currency pairs such as the JPYZAR, EURZAR, USDZAR, GBPZAR and GBPBWP are all showing potential average losses above -4% in one week in the worst 5% returns, which appears to be moderately risky. The remaining currency pairs are ranging between -1.56% to -3.72% average potential losses over the period under study.

Overall, it appears that the African currency carry trade financed by the Japanese Yen shows higher potential losses relative to the other funding currencies employed in the study. The two currency pairs with the highest potential losses are both financed by the Japanese Yen and they are immediately followed by the JPYZAR as the currency pair with next highest potential losses. On the part of the target currencies, the South African Rand appears to be dominant in terms of currency pairs with moderate potential average losses (above 4%).

Table 5.18 presents the ranking from an out-of-sample perspective. Apart from a few exceptions such as the JPYBWP which significantly reduced from -14.04% to -3.02% potential average loss, and the JPYNGN which could not converge under the out-of-sample forecast, the in-sample and out-of-sample appear to show similar results. Again, with the exception of the JPYBWP and JPYNGN, in the out-of-sample forecasts, the standard deviations of the currency pairs are consistent with the forecast potential average losses measured with the expected shortfall.

5.5 Chapter Summary and Concluding Remarks

This chapter sought to empirically examine the value-at-risk (VaR) of African currency carry trade returns, a strategy which involves borrowing funds from low interest currencies (USD, GBP, JPY and EUR) and investing them in selected high interest African currencies (BWP, EGP, GHS, MAD, NGN, ZAR and TND). The low interest currencies are referred to as funding currencies, while the high interest African currencies represent the target currencies. To start with, the chapter gave a background and the motivation for the study, which was followed by an extensive review of the academic literature on this subject matter, and situated the current study in this ongoing academic discourse. Next, the chapter presented a general methodology and a brief description of the statistical properties of African currency carry trade returns. The volatility model employed for the study was the ARMA (1, 0)-GARCH (1, 1) with Gaussian, student t and skewed t distribution of the return innovation. The justification and specification of this volatility model were equally presented with accompanying statistical measures for the evaluations of the various long and short VaR forecasts. Finally, the chapter presented and discussed the empirical results of the study, stressing that the results obtained for the study are largely consistent with the existing literature. The chapter concluded that the ARMA(1, 0)-GARCH(1, 1) with all the three distributions selected for the study, satisfactorily captures the VaR of most of the African currency carry trade strategies both for short and long trading positions. Although all three distributions performed fairly well, especially with in-sample backtesting, the skewed student *t* distribution outperformed the Gaussian and student *t* in almost all the currency pairs for the study, which is highly consistent with the position in the existing literature. With regards to the out-of-sample forecast, the performances of Gaussian and student *t* were not desirable relative to the very strong performance of the skewed student t distribution. Thus the performance of the skewed student t distribution is intensified relative to the Gaussian and student *t* with out-of-sample short and long positions VaR forecasts. The study further concluded that the Japanese Yen as funding currency appears to be risky relative to the other funding currencies studied in terms of potential losses expected to be incurred on the African currency carry trade investment. The South African Rand as a target currency against all the four funding currencies showed moderate risk. The next chapter investigates the implications of the African currency carry trade returns (and its risk) for Africa stock markets.

CHAPTER 6

Implications of Carry Trade on Stock Returns in Africa

6.0 Introduction

In the previous chapters the researcher has looked at the profitability of African currency carry trades, their viability as an asset class and the value-at-risk analysis of these returns. This chapter concentrates on the relationship between the African currency carry trade and the returns of African stock markets under five main sections. The first section presents a brief background of the study which is followed by a review of the related literature in the second section. The third section presents the methodology of the study where the econometric models used for the study are specified; preliminary analysis of the data is also presented in this section. The empirical results of the vector autoregressive Granger causality test and the dynamic conditional correlation GARCH and their discussions are presented in section four. Section five presents the summary and concluding remarks of the entire chapter.

6.1 Background of Stock and Carry Trade Returns Nexus

The objective of this part of the study was to investigate the implications of the African currency carry trade funded by the four major currencies in the world (i.e. USD, EUR, JPY and GBP) on the returns of African Stock Markets. The previous chapters have dealt with African currency carry trades profitability and their value at risk. The researcher documents a moderate amount of currency carry trade profits in African currencies. This chapter tests the relationship between the returns of African currency carry trade and the returns of stock market returns. In spite of the individual uniqueness of asset classes within the financial markets, they are known in the academic literature to have some form of correlation or other (Elder, 2012), and so the a priori expectation is that the carry trade returns of African currencies may have some form of relationship with their stock markets counterparts. Indeed, currency carry trade profits usually attract more investment funds from carry trading investors and most of these funds could find their way into the stock markets and also strengthen the target currencies. Thus the performance of stock markets cannot be delinked from the performance of currency carry trade (Elder, 2012). Since their performances are almost inseparable, their associated volatilities are usually transmitted across. Tse and Zhao (2012) document that there are significant proportions of volatility spillovers between the US stock market and currency carry trade. Fung et al. (2013) selected some stocks in Asia and measured their relationship with the currency carry trade returns and also documented significant causality between the currency carry trade and the Asian stock market returns.

They also document significant volatility spillover between the currency carry trade and the Asian stock market returns. These studies were conducted on developed and emerging market countries in the Americas and Asia. Tse and Zhao (2012) examine the lead-lag in mean and volatility relationship between the US stock markets proxied by the S&P 500 Index futures and the currency carry trade daily returns generated by the G10 currencies index of Bloomberg from January 1995 to September 2010. They found that the currency carry trade returns are highly correlated with US stock returns but there is no Granger-Causality between the two assets in either direction. Their studies however reveal significant volatility spillovers which flow from the stock market to the currency carry trade market but not from currency carry trade to the stock market. Minh (2016) studied the relationship between currency carry trade and stock market returns by using Japanese yen-based and the US dollar-based currency carry trade strategies targeting Australia, New Zealand and China and the stock markets of both funding and target currency countries. They concluded, among other things, that there is a significant positive association between currency carry trade and stock market performance in target currency countries, whilst the relationship between the currency carry trade and stock markets of the funding currency countries was found to be mixed. The association between US dollar-based currency carry trade and US stock markets was found to be negative, whilst that of yen-based currency carry trade and the Japanese stock market have positive association. Furthermore, using three alternative proxies for currency carry trade activity (i.e. a currency-specific profit measure, a currency-specific futures position variable, and the Deutsche Bank G10 Currency Futures Harvest Index), Cheung et al. (2012) studied the implications of the currency 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. Except for the studies of Minh (2016), it appears that all other previous studies on the relationship between the stock market and currency carry trade have used realised returns series generated from existing currency carry trade instruments, usually from Bloomberg, Barclays and other investment institutions.

In this particular study the researcher investigated the Granger causality and information transmission mechanism between the currency carry trade financed by borrowing from four developed countries (USD, EUR, JPY and GBP) and targeting or investing in seven African currencies (BWP, EGP, ZAR, GHS, TND, MAD and NGN) and the stock market returns of those seven African countries (Botswana, Egypt, South Africa, Ghana, Tunisia, Morocco and Nigeria). For each of the seven African countries, four currency trade strategies were conducted and all these four compared successively to the stock market returns of that country's market index.

For example, the Botswana stock index was compared to the currency carry trade returns of the USDBWP, EURBWP, GBPBWP and JPYBWP, and the relationship between them assessed. Thus the cross- market information transmission and causality were being assessed intra country for the seven the African countries used in the study.

6.2 Related Literature Review

The currency carry trade is a strategy which invests in assets-denominated high interest currencies (target currencies) financed by borrowing funds from low interest currencies (funding currencies). The uncovered interest parity (UIP) condition anticipates that any arbitrage opportunities arising from the interest rate differential between two currencies are eliminated by the exchange rate movements. This means that the currency carry trade strategy is expected 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 considered in the academic literature 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 Japanese yen-funded carry trade has been in the financial news for many years, principally because of the low interest rate associated with the yen currency. 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 in the academic literature focus more 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 academic literature (Curcuru et al., 2010). Just after the financial crisis in 2008 investors began borrowing money from the low-yielding currencies and investing them in high-yielding assets, including stocks in emerging markets (Shah, 2010; Szalay, 2012). The profitability of this currency carry trade strategy is sufficiently evidenced in the academic literature (Al-Ali, 2015; Brunnermeier et al., 2008; Burnside, 2015; Burnside and Eichenbaum, 2008; Darvas, 2009; Moosa and Halteh, 2012; Olmo and Pilbeam, 2009; Potì et al., 2014; Xanthopoulos, 2011) as dicussed in chapter three of this thesis.

The perception in the extant literature is that the yen carry trade moved the stock markets in target currency countries before its unwinding, and subsequently aggravated the global stock market slide in early 2007 (Hayashi, 2007). The yen carry trade unwinding partially contributed to the sharp decline of the global market in October 2008 (Fackler, 2008; Parkinson, 2008). It is further observed in the literature that the perception of carry trade unwinding alone can put selling pressure on the stock market of the target currency country (Cheung et al., 2012).

Academic studies on the relationship between the currency carry trades and stock markets, and their volatility spillovers, are relatively few in the academic literature, though some do exist. The studies of Fung et al. (2013), Cheung et al., (2012), Tse and Zhao (2012), Zhang et al. (2010) and Lee and Chang (2013) are the most relevant studies investigating the link between the currency carry trade and the stock markets. These studies predominantly concentrated on the cross-market predictive power of whether variations in currency carry trade (or stock market) are able to predict the performance of stock market (or currency carry trade), and their associated volatility spillover effects.

Tse and Zhao (2012) examined the link between the daily carry trade and U.S stock market returns using vector autoregression (VAR-Granger Causality) and the generalised autoregressive conditional heteroskedasticity (GARCH), specifically EGARCH. The authors used daily exchange rate data from the G10 currencies and three months euro-deposit rates, from January 1995 to September 2010, to calculate the currency carry trade which mimics the Deutsche Bank DB Currrency Harvest Index. They used the futures contracts on the S&P 500 index traded on the Chicago Mercantile Exchange (CME) as a proxy for the U.S stock market and found that the returns of the currency carry trade (or stock markets) had no predictive power over the future returns of stock markets (or currency carry trade). Tse and Zhao (2012) further concluded that there was significant volatility spillover from the US stock market to currency carry trade market but the reverse is not true.

Fung et al. (2013) intimate 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 curreny. Therefore 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 data from January 1995 to December 2011, in what appears to be an extention of the studies of Tse and Zhao (2012).

The authors constructed three currency carry trade baskets out of the DB G10 currencies, Asian currencies and a mixture of DB G10, and Asian currencies, and used as three different proxies for currency carry trade. Their study employed the use of the vector autoregressive (VAR Granger) to investigate the causality relationship between the currency carry trade and the stock market returns, and used DCC-GARCH to investigate the volatility spillover between the currency carry trade returns and the returns of the stock market. They found evidence of significant Granger causality from the carry trade returns to Indian, Japanese and Australian stock markets, even though upon introduction of the U.S stock market into the model (for robustness check), it turns out that carry trade Granger causes only the Australian and Japanese stock markets. Also, Fung et al. (2013) document 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 were that volatility flow from currency carry trade to stock markets and vice versa (i.e. bidirectional) and also 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. Their aim was to empirically evaluate the implications of the yen carry trades on the target currency countries' stock market returns. Cheung et al. (2012) used three different proxies for carry trade activity since there appeared to be some level of difficulty involved in the measurement of carry trade activity or scope. They used currency specific profit measure, a currency-specific futures position variable and the Deutsche Harvesst Index as proxies for currency carry trade activity and scope. Their study concentrated on five target countries including Australia, Britain, Canada, New Zealand and Mexico and found evidence to support the perception in the financial markets 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.

Zhang et al. (2010) document 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. This scenario worsens the exchange rate movements in the target currency countries and their respective stock markets.

Studies on the relationship between the currency carry trade and the US stock market found the currency carry trade to be significantly correlated to the stock markets (Tse and Zhao, 2012).

Currency carry trade investors world over, after the financial crisis that took place in 2007 through to 2009, found solace in the economies around the world with growth prospects where they sent money to invest in high-yielding financial assets. They invested in financial assets such as the stocks, bonds and other securities in these economies with growth potentials. The influx of capital into these receipient countries has the potential of strengthening their currencies and for that matter may also influence the performance of the stock markets. These high-yieding 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) concludes that in spite of individual uniqueness of assets, there appears to be closer correlations between assets classes in the financial markets post financial crisis. Tse and Zhao (2012) corroborate this in their study which sought to examine the relationship between the currency carry trade and the US stock markets. They found significant volatility spillover flowing from the US stock market to the currency carry trade market. Since their study was confined to the US only, it would be prudent to test the relationship of the equity market and currency carry trade in other parts of the world. In this current study, the researcher investigates the information transmission mechanism between the currency carry of carry trades targeting seven African currencies funded by four first world currencies (USD, EUR, JPY and GBP) and seven stock market indices in Africa.

The interest rate has been extremely low in Japan over a decade and continues to be low relative to other developed countries across the globe. 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. The African currencies, which are characterised by high interest rates, also offer some arbitrage opportunities and present an avenue for them to be targeted for the currency carry trade. The stock markets of the seven target African markets are also used for the analysis of the information transmission mechanism between the currency carry trade and the stock markets.

Plantin and Shin (2011) intimate 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 trade which is a concern to policymakers. In their study, Hattori et al. (2007) contend 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 trade over the globe, as investors borrow cheaply from Japan and invest the proceeds in high-yieding financial assets, such as stocks, abroad, thereby exerting pressure on not only the foreign exchange rates but also the stock markets of the receipient countries, especially during periods of carry trade unwinding.

Indeed, the players in the financial markets have in the recent past attributed the movements in stock market returns to the activities of the currency 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 distabilises 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 distabilises the market (Cheung et al., 2012).

The relationship between the currency carry trade and stock markets and the currency carry trade 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 (Baks and Kramer, 1999; Belke et al., 2010; Giese and Tuxen, 2007; Rüffer and Stracca, 2006).

Lee and Chang (2013) studied the link between spillovers of currency carry trade returns and U.S stock market returns for the period covering January 3, 1994 to March 28, 2012. Their research hypothesises "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" (Lee and Chang, 2013, p. 1). Lee and Chang (2013) used the G10 currencies, namely, the U.S. dollar (USD), Australian dollar (AUD), Canadian dollar (CAD), Swiss franc (CHF), German mark (GE) or Euro (EUR), British pound (GBP), Japanese yen (JPY), Norwegian krone (NOK), New Zealand dollar (NZD), and Swedish kronor (SEK), and the S&P 500 index futures to examine the magnitude of spillover effects of carry trade markets. Using the generalised vectorautogressive of Diebold and Yilmaz (2012), they found a significant positive relationship between spillovers of currency carry trade returns and stock market returns. They futher concluded that this relationship intensifies during bear markets rather than in bull markets.

All the aforementioned studies have focused their works on the G10 currencies and some other emerging markets which barely include African countries. Thus the causality relationship between the African currency carry trade and their respective stock markets remains unresearched and therefore necessitates this current study.

6.3 Methodology and Data Description

This chapter investigates the information linkages and the volatility spillover effects in returns of carry trade among African currencies and the African stock markets (Fung et al., 2013). The study employs the use of the vector autoregressive (VAR)-Granger Causality model to examine the causality relationship in weekly returns between the carry trade and stock markets. The researcher employs the use of Dynamic Conditional Correlation-Generalised Autoregressive Conditional Heteroskedasticity (DCC-GARCH) to examine the volatility spillover and information linkages between currencies carry trade and stock markets returns.

6.3.1 VAR Granger Causality

To test for causality and information transmission mechanism between the two assets under consideration the researcher first tests for unit root in the return series of these assets. The choice of the VAR becomes appropriate because both the currency carry trade returns and the stock market returns are all found to be stationary at levels. Thus they both follow the I(0) process and so are not cointegrated or do not have long run relationship. Johansen's test of cointegration confirms the stationarity of these data series and so the researcher models the causality with unrestricted VAR. Following Fung et al. (2013), the model is specified as follows:

$$CT_t = a_1 + \sum_{i=1}^{k} b_{1i}\, CT_{t-i} + \sum_{i=1}^{k} c_{1i}\, STOCK_{t-i} + \varepsilon_{1,t} \tag{6.1}$$

$$STOCK_t = a_2 + \sum_{i=1}^{k} b_{2i}\, CT_{t-i} + \sum_{i=1}^{k} c_{2i}\, STOCK_{t-i} + d_2 CRISIS_t + \varepsilon_{2,t} \tag{6.2}$$

where CT is the weekly returns of a currency carry trades whereas STOCK is the weekly returns of the stock markets. CRISIS is a dummy variable equal to 1 for the crisis period (as defined in section 3.5.3 in chapter 3) and zero otherwise, whereas $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are error terms. The model takes one pair of currency carry trade return and stock return for each estimation. Equations 6.1 and 6.2 show the sum of cross-asset which describes the total causality from the stock market to the carry trade market ($\sum c_{1i}$) and also the total causality from the carry trade market to the stock market ($\sum b_{2i}$). This is used to test the causality relationship between carry returns and stock returns among the twenty eight currency pairs.

6.3.2 Panel Vector Autoregression

Beyond the VAR-Granger causality in subsection 6.3.2, the study will implement a panel vector autoregression using the XTVAR approach (Cagala and Glogowsky, 2014) to observe the dynamics of currency carry trade implications for the stock markets in Africa. The panel vector autor regression follows the hypothesis formulated in subsection 6.3.1 and the specified as follows;

$$Z_{it} = \alpha_i Z_{it-1} + \beta_i Stock\ Return_{it-1} + \varepsilon_{1,it} \quad (6.3)$$

$$Stock\ Return_{it} = \alpha_i Stock\ Return_{it-1} + \beta_i Z_{it-1} + \varepsilon_{2,it} \quad (6.4)$$

Where the Z_{it} represents returns of carry trade returns whilst $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are error terms.

6.3.3 Dynamic Conditional Correlation (DCC-GARCH) Analysis

The conditional correlation between the currency carry trade returns and the returns of stock markets indices across the selected African countries could be used to gauge how the currency carry trades relate to the stock markets in Africa. Whereas it is established in the literature that stock markets return correlations are time-varying (Chelley-Steeley, 2005; Kearney and Lucey, 2004), studies have also shown that the currency carry trade returns correlation with the stock market is also time-varying in nature (Cheung et al., 2012b; Fung et al., 2013; Tse and Zhao, 2012). Traditionally, multivariate GARCH-type models are usually used to estimate such time-varying correlations in order that the time-varying relationships between time series could be adequately captured. This study employs the Dynamic Conditional Correlation, Generalised Autoregressive Conditional Heteroskedasticity (DCC-GARCH) standard procedure proposed by Engle (2002) to estimate time-varying conditional correlations between the currencies carry trade returns and the returns of the various stock market indices in the sample in this study. The purpose of this model is to enable the researcher to examine the conditional correlations and volatility transmission (spillover) from the currency carry trade (stock markets) to the stock markets (currency carry trade) within the individual African countries used. The DCC-GARCH is a very simple model to implement and it is described in the literature as a parsimonious parametric model which has been used widely by academic researchers (Hwang et al., 2013; Padhi and Lagesh, 2012). Chiang et al. (2007) in their study on the dynamic correlation analysis of financial contagion alluded to a number of strengths that DCC-GARCH has over the other alternative estimation models.

Firstly, the DCC-GARCH model directly accounts for heteroscedasticity when estimating the correlation coefficients of the standardised residuals. Secondly, in measuring a common factor, the DCC-GARCH model allows us to include additional regressors in the mean equation. Thirdly, the model can be used to examine multiple asset returns without adding too many parameters. The model is even more parsimonious in bivariate analysis of currency carry trade and stock market returns by capturing the dynamic conditional correlation behaviour between these two assets.

VECH-GARCH (Bollerslev and Engle, 1988), BEKK-GARCH (Baba et al., 1991), and the constant conditional correlation (CCC) model postulated by Bollerslev (1990) are all very good alternative models that could have been employed for the study. However, VECH and BEKK are costly in their estimation time, especially if the number of assets exceeds two (Chiang et al., 2007), and the constant conditional correlation (CCC) model has the limitation of being restrictive and unrealistic in its assumption of constant correlation between the data series (Silvennoinen and Teräsvirta, 2009). Although this current study is a bivariate analysis of African currency carry trades and stock market returns, the researcher adopts the DCC-GARCH model to estimate the conditional correlation for ease of comparison with earlier studies in the literature.

Following Fung et al. (2013) the variance system of the DCC-GARCH(1, 1)-*t* model is defined as follows:

$$\varepsilon_t = \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{pmatrix} | \psi_{t-1} \sim Student - t(0, H, \nu) \tag{6.5}$$

$$H_t = D_t R_t D_t \tag{6.6}$$

$$H_{ij,t} = Q_{ij,t} \frac{\sqrt{H_{ii,t} H_{jj,t}}}{\sqrt{Q_{ii,t} Q_{jj,t}}} \tag{6.7}$$

$$H_{ii,t} = \alpha_{ii} + \sum_{j=1}^{2} \beta_{ij} \varepsilon_{j,t-1}^2 + \gamma_i H_{ii,t-1} + \lambda_i \varepsilon_{i.t-1}^2 I_{\varepsilon_i < 0}(\varepsilon_{i,t-1}) \tag{6.8}$$

$$Q_t = (1 - \delta - \theta) Q_0 + \delta \varepsilon_{i,t-1} \varepsilon_{i,t-1} + \theta Q_{t-1} \tag{6.9}$$

where ψ_{t-1} represents information set at time $t-1$, H_t is the conditional covariance matrix, R_t is a time-varying correlation matrix, and D_t is a diagonal matrix of conditional standard deviation. The process of error terms follows student-t distribution.

The covariance terms are given by equation 6.7 and the variance terms are modeled as equation 6.8. The conditional correlation matrix is given by equation 6.9, where Q_0 represents the unconditional correlation matrix. In equation 6.8 the volatility spillover effect is captured by coefficient β_{ij}. Specifically, β_{ij} measures the volatility spillover from asset *j* to asset *i*. Coefficient γi measures the GARCH effect. Asymmetric volatility is captured by coefficient λi. The time-varying conditional correlation between the two markets is defined by equation 6.9, where coefficients δ and θ show that the conditional correlation (Q_t) varies with volatility.

6.3.4 Stationarity Testing

For time series analysis such as this, it is extremely important to test for the presence or otherwise of unit root in the series before using it for any form of econometric modeling. This is to avoid spurious results that cannot be trusted. And since this study uses weekly data to estimate the currency carry trade, the unit root test must be conducted on this new series. Thus the study employs the use of Augmented Dickey Fuller and Philip-Perron unit root tests to investigate for unit roots in the currency carry trade and the stock market returns series. The Augmented Dickey Fuller and Philip-Perron are specified in chapter three, section 3.4.1 of this thesis.

6.3.5 Data and Preliminary Analysis

The study collected weekly prices of stock market index from seven African countries, namely, South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia. The researcher also collected weekly interbank interest rate with one month investment horizon from the target countries (South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia) as well as the funding countries (United States of America, United Kingdom, Japan, and the Euro Area). All these data span January 2001 to December 2014 and were downloaded from Datastream, Quantec EasyData, BFA INET, and also the Central Banks of the countries involved in the study. Data on weekly exchange rates between the target currencies and the funding currencies were also collected for the same sample period, generating twenty eight currency pairs (with four pairs for each of the seven target African countries). The researcher calculated the weekly African currency carry trade returns for all the 28 currency pairs follows:

$$Z_{t+1} = \ln\left(1 + (i_t^* - i_t)\right) - \Delta S_{t+1} \tag{6.18}$$

where i_t^* is the interest rate of target countries (South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia) at time *t*, and i_t is the interest rate of the funding countries (United States of America, United Kingdom, Japan and the Euro Area), the log return of the interest rate differential is $\ln\left(1 + (i_t^* - i_t)\right)$, and $\Delta S_{t+1} = S_{t+1} - S_t$.

The weekly price indices of all the seven stock markets were also transformed into continuously compounded weekly returns using the formula:

$$R_t = [\ln(P_t) - \ln(P_{t-1})] \times 100 \tag{6.19}$$

where P_t and P_{t-1} are the current and the previous week's stock price respectively. The researcher therefore generated the stock index return series for the respective seven target African countries and thus matched same with the currency carry trade returns for these countries.

Before performing any empirical analysis it will be prudent to analyse the statistical properties of the data. Table 6.1 shows the descriptive statistics for the stock market returns for the seven African currencies used for the study, while Table 6.2 presents the descriptive statistics of the twenty currency pairs of currency carry trade returns.

Table 6.1: Descriptive Statistics of African Stock Market Returns

Market	Obs	Mean	Std Dev.	Skew	Kurtosis	Min	Max	Jarcque-Bera
Botswana	729	0.002	0.024	0.590	9.646	-0.119	0.167	1384.006***
Egypt	729	0.002	0.040	-1.008	8.024	-0.248	0.129	889.974***
Ghana	729	0.001	0.038	-0.388	5.711	-0.166	0.135	241.504***
Morocco	677	0.002	0.024	-0.667	6.279	-0.124	0.086	353.431***
Nigeria	729	0.001	0.038	-0.388	5.711	-0.166	0.135	241.504***
South Africa	729	0.002	0.039	-0.275	8.308	-0.201	0.242	865.185***
Tunisia	729	0.001	0.018	-0.728	8.966	-0.119	0.072	1145.469***

The obs is the total number of weekly observations per market. The *** represents statistical significance of 1%. Min, Max, Std Dev. and Skew represent minimum, maximum, standard deviation and skewness respectively. Except for Morocco where the sample period covers 11/01/2002 to 26/12/2014, all the other markets cover the period 12/01/2001 to 26/12/2014.

The seven stock markets used for the study produce positive average weekly returns with relatively low volatility or standard deviation. It can also be observed that, with the exception of Botswana, all the other market returns are negatively skewed and characterise by large excess kurtosis. This is an indication that the data series for the stock market returns deviate from the normality assumption. The deviation from normality characteristic is further strengthened by the Jarcque-Bera test statistic. The null hypothesis of normality of the series is flatly rejected for all seven stock markets included in the study.

Table 6.2: Descriptive Statistics of African Currency Carry Trade Weekly Returns

Carry Trade	Obs	Mean	Std Dev.	Skew	Kurtosis	Min	Max	Jarcque-Bera
EURBWP	729	0.0009	0.0169	-0.6934	6.9951	-0.1007	0.0603	543.2287***
EUREGP	729	0.0003	0.0131	-1.2442	12.6963	-0.1122	0.0508	3043.902***
EURGHS	729	0.0009	0.0144	0.0730	5.6936	-0.0647	0.0803	221.0241***
EURMAD	677	0.0001	0.0023	0.0115	3.9288	-0.0109	0.0085	24.34903***
EURNGN	729	0.0012	0.0116	-0.1444	24.1172	-0.0790	0.1120	13547.79***
EURZAR	729	0.0003	0.0182	-0.6363	5.6688	-0.0954	0.0735	265.5368***
EURTND	729	-0.0002	0.0043	0.0344	3.8690	-0.0178	0.0157	23.0807***
USDBWP	729	0.0027	0.0172	1.2432	9.9351	-0.0621	0.1324	1648.699***
USDEGP	729	0.0005	0.0067	-9.1473	130.1805	-0.1106	0.0231	501478.1***
USDGHS	729	0.0012	0.0150	-0.4357	146.8981	-0.2297	0.2244	628987.9***
USDMAD	677	0.0005	0.0091	-0.0233	5.3252	-0.0365	0.0548	152.567***
USDNGN	729	0.0012	0.0116	-0.1444	24.1172	-0.0790	0.1120	13547.79***
USDZAR	729	0.0005	0.0195	-0.8165	5.7654	-0.1062	0.0647	313.2929***
USDTND	729	0.0001	0.0082	-0.0170	4.8622	-0.0335	0.0479	105.3641***
JPYBWP	729	0.0016	0.1766	-0.1375	353.8054	-3.3505	3.3374	3738085***
JPYEGP	729	0.0009	0.0129	-1.0945	10.3114	-0.1009	0.0495	1769.273***
JPYGHS	729	0.0016	0.0149	0.1398	5.5071	-0.0682	0.0790	193.2904***
JPYMAD	677	0.0007	0.0125	-0.5982	6.9823	-0.0739	0.0603	487.7322***
JPYNGN	682	0.0015	0.1842	0.1630	321.2499	-3.3371	3.3609	2878128***
JPYZAR	729	0.0009	0.0223	-0.9468	7.1588	-0.1353	0.0758	634.2845***
JPYTND	729	0.0005	0.0117	-0.6653	6.6565	-0.0669	0.0523	459.8904***
GBPBWP	729	0.0010	0.0170	-0.8607	8.5166	-0.1234	0.0571	1014.427***
GBPEGP	729	0.0004	0.0124	-0.9969	14.4993	-0.1086	0.0591	4137.378***
GBPGHS	729	0.0011	0.0139	0.0762	5.4711	-0.0658	0.0676	186.1839***
GBPMAD	677	0.0003	0.0079	-0.0141	9.6737	-0.0597	0.0417	1256.387***
GBPNGN	729	0.0011	0.0173	-0.1262	9.2097	-0.0935	0.1123	1173.212***
GBPZAR	729	0.0003	0.0182	-0.5481	6.0115	-0.0971	0.0789	742.879***
GBPTND	729	-0.0001	0.0080	-0.0539	7.9442	-0.0566	0.0414	311.9719***

The Obs is the total number of weekly observations per market. The *** represents statistical significance of 1%. Min, Max, Std Dev and Skew represent minimum, maximum, standard deviation and skewness respectively. Except for Morocco (GBPMAD, JPYMAD, USDMAD and EURMAD) for which the sample period covers 11/01/2002 to 26/12/2014 and Nigeria (JPYNGN) (07/12/2001 to 26/12/2014), all the other markets cover the period 12/01/2001 to 26/12/2014.

Table 6.2 also presents the basic statistics of the currency carry trade of targeting seven African countries funded by the USD, JPY, EUR and JPY. In all, twenty eight currency pairs are generated with four currency pairs from each of the seven countries selected for the study. With the exception of GBPTND and EURTND, which produced negative historical returns for the sample period, all the other twenty seven currency pairs produced excess positive historical returns for the sample period with relatively moderate volatility. As discussed in chapter three in Tables 3.10 to 3.13, the currency carry trade returns are largely negatively skewed, albeit with a few being positively skewed. This is confirmed by the weekly carry trade returns characteristics in Table 6.2 of this chapter. These returns are predominantly characterised by large excess kurtosis, which is an indication that the African currency carry trade returns are leptokurtic, which is consistent with the position in the extant literature. The negative skewness coupled with the large excess kurtosis (leptokurtosis) is also pointing to the fact that the African currency carry trade exhibits crash risk or the peso effect. Table 6.2 also reveals non-normality of currency carry trade returns and that is confirmed by the Jarcque-Bera statistic significant at 1% for all twenty eight currency pairs.

6.4 Empirical Results and Discussion

In this section the researcher presents the results of the Vector Autoregressive model (VAR) and the Dynamic Conditional Correlation Generalised Autoregressive Conditional Heteroskedasticity (DCC-GARCH). The researcher organises this section into two parts. The first part looks at the Granger causality between the returns of currency carry trade of the selected African countries and their respective stock markets. The second part presents and discusses the results of the multivariate dynamic conditional correlation (DCC) generalised autoregressive conditional heteroskedasticity (GARCH) between the returns of African currency carry trade and stock markets.

6.4.1 Results of Unit Root Test

To perform any empirical analysis with VAR Granger causality and DCC-GARCH, the researcher first had to perform stationarity (unit root) test to ascertain whether the data series are stationary at level or after first differenced. This is necessary because the researcher can only use these time series data when they are stationary in order avert producing spurious results. The researcher therefore employed the two unit root test models, the Augmented Dickey Fuller (ADF) and the Philip-Perron (PP), and presents the results in Appendix E. The unit root tests (both ADF and PP) were conducted on the returns series of carry trade targeting seven African currencies financed by borrowing JPY, GBP, EUR and USD, generating 28 currency pairs. All of the 28 currency pairs were found to be stationary at level using the ADF. The results of ADF were corroborated by the results of PP in all the series studied.

Appendix E further presents results of the ADF and PP unit root test for the stock market index returns for the seven African countries (South Africa, Botswana, Ghana, Egypt, Morocco, Nigeria and Tunisia). The results were generally pointing to a rejection of the null hypotheses of presence of unit root in the data. Thus all the data series under investigation are found to be stationary at level and can now be used for econometric modelling. It appears that the two series under investigation, stock market returns and currency carry trade returns, are both I(0) process, which means that the researcher cannot use the Johansen vector error correction model (VECM) because of no cointegration between them, but must rather model unrestricted vector autoregression (VAR) for the series.

6.4.2 Granger Causality Results

Table 6.3 presents results of the Granger causality between the returns of the currency carry trade and African stock markets. Stock market indices of Botswana, Egypt, Ghana, Nigeria, Morocco, South Africa and Tunisia are considered in this study. These indices are individually pegged against currency carry trade in their respective countries. The currency carry trade for each African country's currency is calculated four times with four different funding currencies (EUR, GBP, USD and JPY), generating a total of 28 currency pairs.

Two null hypotheses were tested; the F-statistics with their respective probability values are shown in Table 6.3. The first null hypothesis posits that the African stock market returns do not Granger-cause the variations in the returns of African currency carry trade. The second hypothesis stipulates that the African currency carry trade returns do not Granger-cause the movement or changes observed in the returns of African stock markets indices.

In Botswana, the Botswana Pula is targeted for four currency carry trade strategies that take a long position in the Pula and short the EUR, USD, GBP and the JPY successively. Each of these four strategies is matched with the stock market index of Botswana in order to observe the stochastic trends in the variables. The first null hypothesis that states the the stock market does not cause currency carry trade cannot be rejected in all cases in Botswana. Thus regardless of the funding currency (be it USD, EUR, GBP or JPY) employed for the strategy the researcher does not have enough evidence to reject the null hypothesis, meaning that the null hypothesis of the stock market not causing the currency carry trade is upheld for the Botswana stock market and currency carry trade. On the other hand, the hypothesis that the Botswana currency carry trade returns do not Granger-cause the Botswana stock market index is rejected for all the funding currencies except for the currency carry trade strategy financed by the Japanese Yen. Thus there is ample evidence that, given the data and the sample period selected for the study, the EURBWP, GBPBWP and USDBWP currencies carry trades Granger cause the Botswana Stock market index, whereas JPYBWP may not cause the stock market index in Botswana.

The South African and Nigerian currencies carry trades and stock markets indices exhibit similar behaviour to the Botswanan. Thus the null hypotheses of African stock markets not Granger-causing the currency carry trade cannot be rejected for all four funding currencies. The South African stock market index and the Nigerian Stock Exchange Index do not Granger-cause currencies' carry trades returns generated from the EURZAR, USDZAR, GBPZAR, JPYZAR, EURNGN, USDNGN, GBPNGN and JPYNGN currency pairs. On the other hand, except for the Japanese Yen carry trade in Nigeria, the currency carry trades for all the other currency pairs (EURZAR, USDZAR, GBPZAR, JPYZAR, EURNGN, USDNGN, and GBPNGN) individually cause the stock market index in their respective countries. The null hypothesis that the currency carry trade does not cause stock market is rejected for all the currencies for the seven currency pairs involving South Africa and Nigeria with the four funding currencies (USD, EUR, GBP and JPY), though the researcher does not have enough evidence to reject the JPYNGN currency.

The researcher again observes from Table 6.3 that in Egypt, Ghana, Morocco and Tunisia, the null hypotheses of stock market returns not causing the carry trade are generally not rejected for almost all the funding currencies except for a few instances. For instance, in Egypt, the researcher has evidence to reject the null hypothesis that stock market returns do not Granger-cause EUR carry trade. Likewise in Ghana, Morocco and Tunisia the null of hypotheses of stock market returns not causing carry trade are rejected for the USD, GBP and EUR currencies carry trade respectively.

Table 6.3: Granger Causality of African Stock Markets and Currency Carry Trade

	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**		6.613	**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**

Note: 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 done by the use of 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.

The second null hypothesis that the currency carry trade does not Granger cause the stock market returns is largely rejected. This is very consistent with findings of causality in the finance literature as the currency carry trade has been observed to cause the stock market returns (Fung et al. 2013). In Morocco, all four currency (USD, EUR, GBP and JPY) carry trades were found to Granger cause the stock market returns of Morocco. Likewise in Ghana and Tunisia, except for the USD and GBP currency carry trades respectively where the null hypotheses cannot be rejected, all the currency carry trades were found to be causing the stock market returns of their respective countries.

Overall, it appears from Table 6.3 that there is significant evidence of causality between currency carry trade and the stock market returns in Africa and very little evidence of the stock market returns causing currency carry trade returns. Thus the currency carry trade is found in almost all cases to be causing or influencing movements in the returns of stock markets in Africa. As noted earlier, currency carry trades are usually observed when the uncovered interest rate parity condition or hypothesis is violated and the target currencies are mostly appreciating against the funding currencies. The phenomenon of target currency appreciation strengthens the profits that accrue to the currency 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 currency carry trade returns ultimately lead to high stock returns and vice versa.

6.4.3 Panel Vector Autoregression

This section extends the analysis of VAR-Granger causality in section 6.4.2 by putting together all the monthly series for the selected seven markets of Africa and investigate the dynamics between the currency carry trade and the stock markets returns using panel vector autoregression (PVAR). The PVAR results and impulse response function (IRF) statistics are presented in Appendix G of this thesis. Figures 6.1 to 6.8 present the impulse response function graphs which show how the stock markets of Africa's emerging and frontier markets respond to shocks in the currency carry trade strategies targeting these African currencies. Figure 6.1 shows the link between the USD funded carry trade and the stock markets of Africa whilst 6.2 looks at how shocks in the stock market returns influence movements in USD funded carry trade. Figure 6.1 reveals that unit shock in the innovation of the USD financed carry trade affects the stock market yields into the future at least within the short term. Positive shock in carry trade inspires favorable movements in the African stock markets yields at least for the first two months into the future and falls into equilibrium beyond two months. Shocks in the African stock markets on other hand triggers a sharp decline of USD carry trade returns into negative especially within the first month and stays negative until about six months where the returns stabilises into equilibrium (see Figure 6.2).

Figure 6.1: Response of Stock Market Returns to Shocks in USD Carry Trade

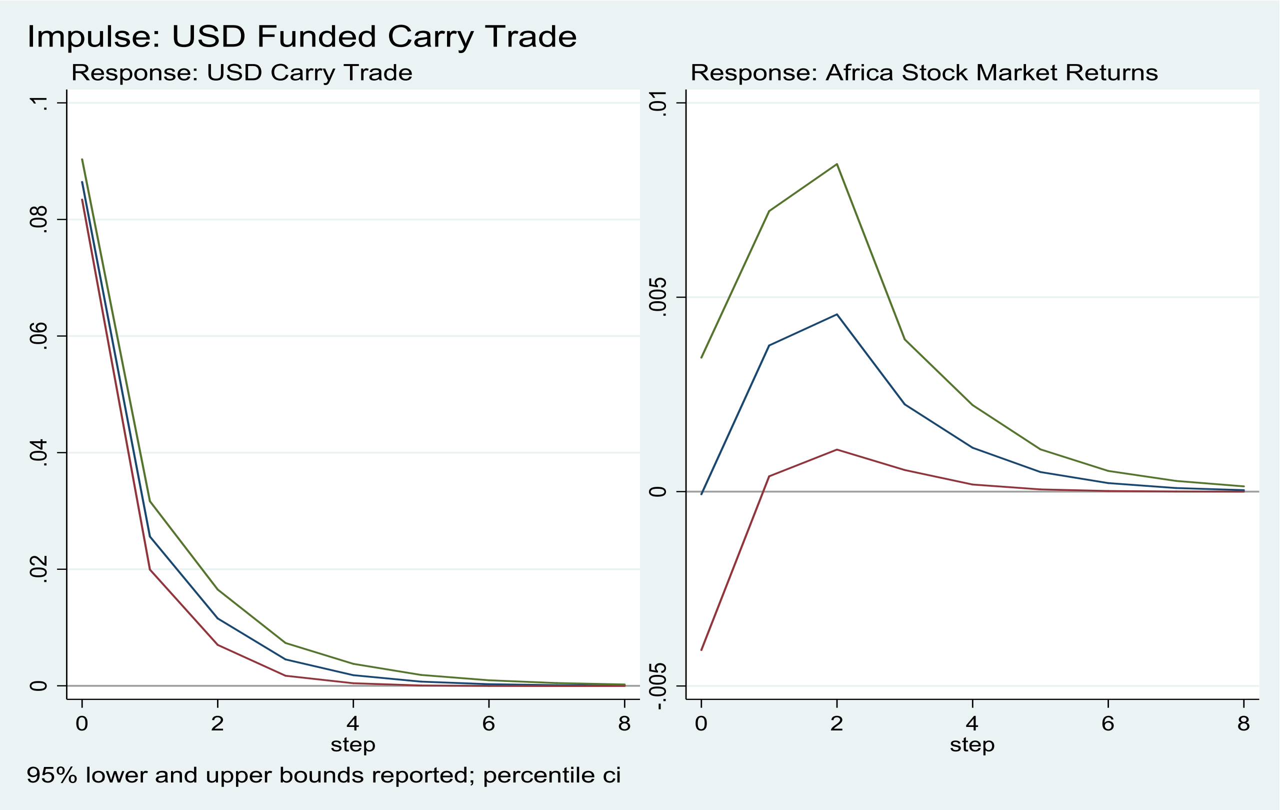


Figure 6.2: Response of USD Carry Trade to Shocks in Stock Market Returns

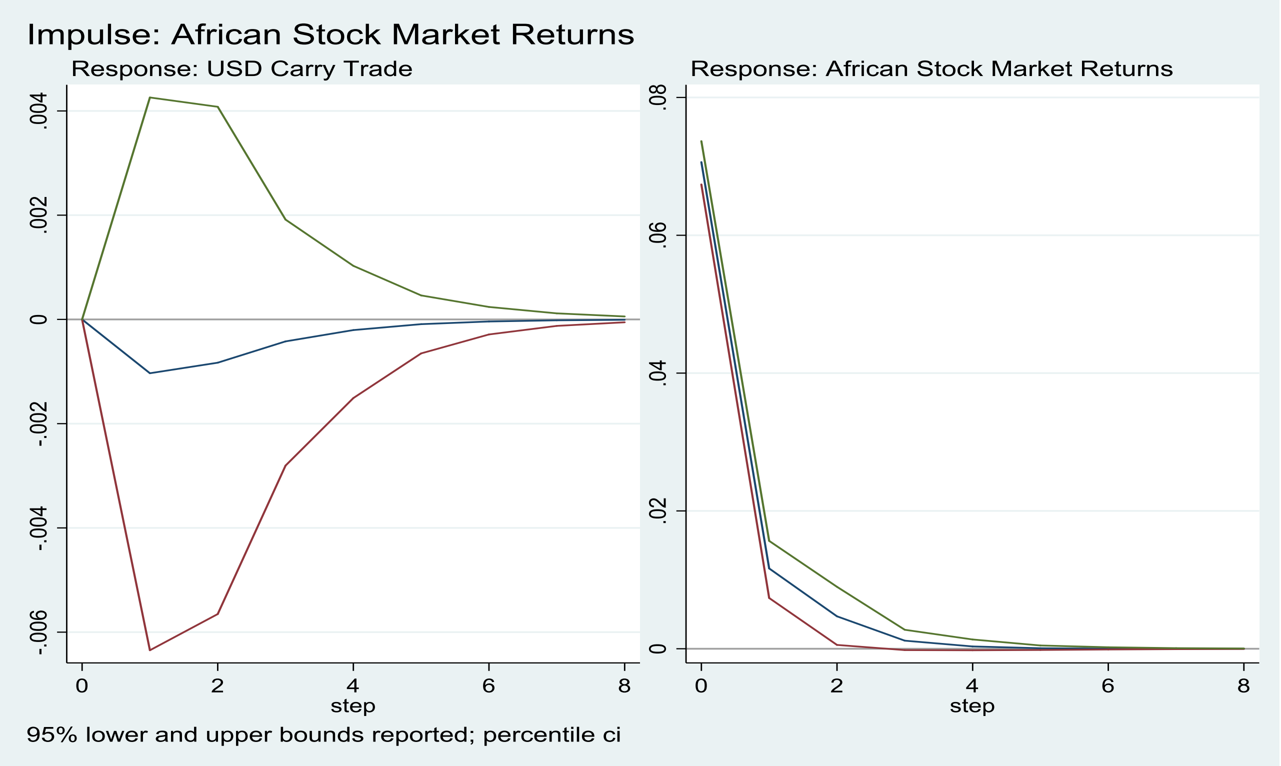


Figure 6.3 and 6.4 present the impulse responses between the EUR funded currency carry trade targeting the currencies of Africa's emerging and frontier markets and their stock markets. Shocks in residuals of EUR funded carry trade influence the stock market yields to increase within the short term, similar to the USD carry trade in Figure 6.1. In response to the shocks in the EUR funded carry trade the stock market returns increases in the first month and subsenquently decline slowly into equilibrium in the sixth month.

Figure 6.3: Response of Stock Market Returns to Shocks in EUR Carry Trade

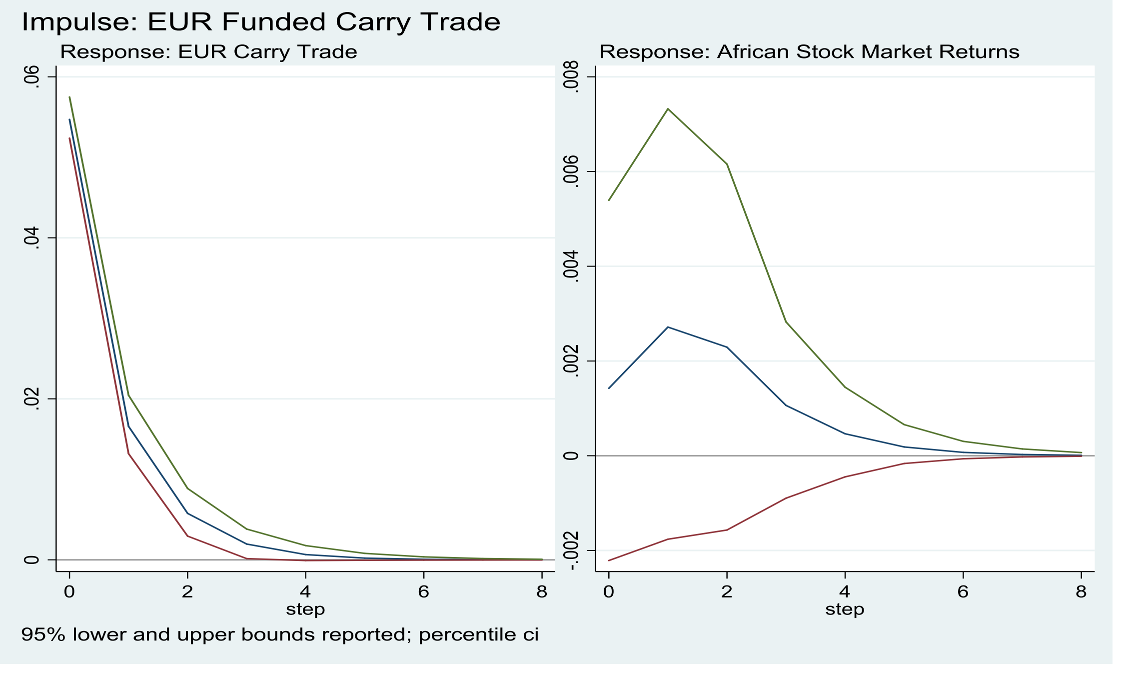
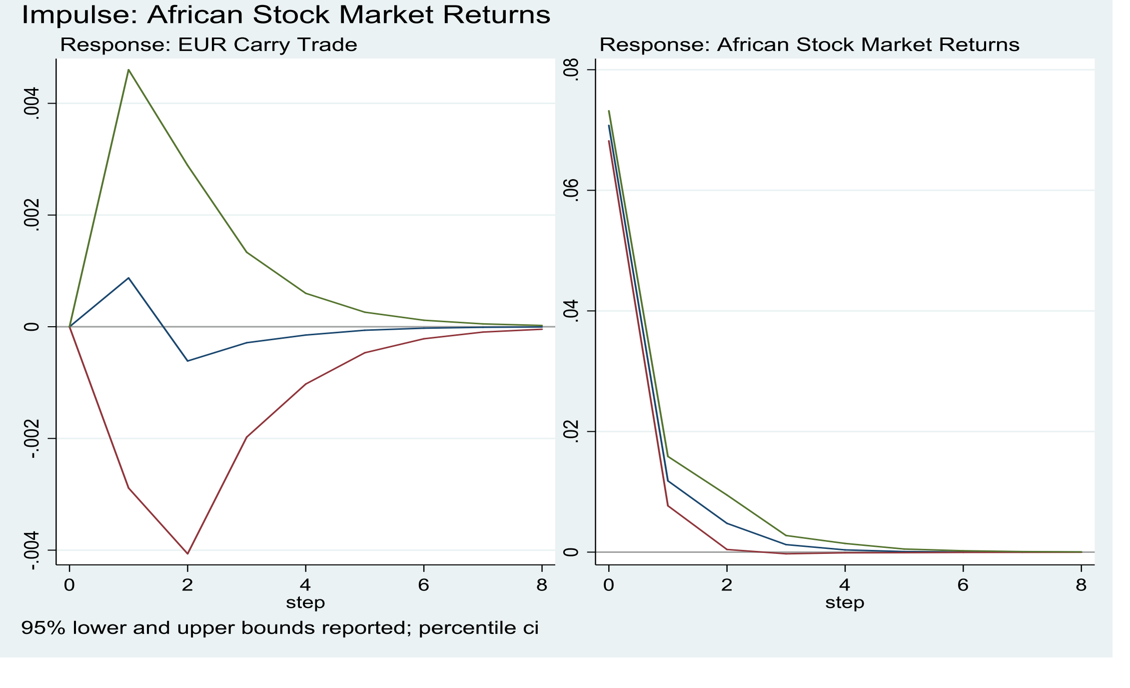


Figure 6.4: Response of EUR Carry Trade to Shocks in Stock Market Returns



In Figure 6.4, it is observed that a unit shock in the African stock markets will cause an erratic movement in the African currency carry trade. The African carry trade initially increases sharply and towards the second month declines abruptly into negative returns. The negative returns continues until it approaches equilibrium in the sixth month.

Figure 6.5: Response of in Stock Market Returns to Shocks JPY Carry Trade

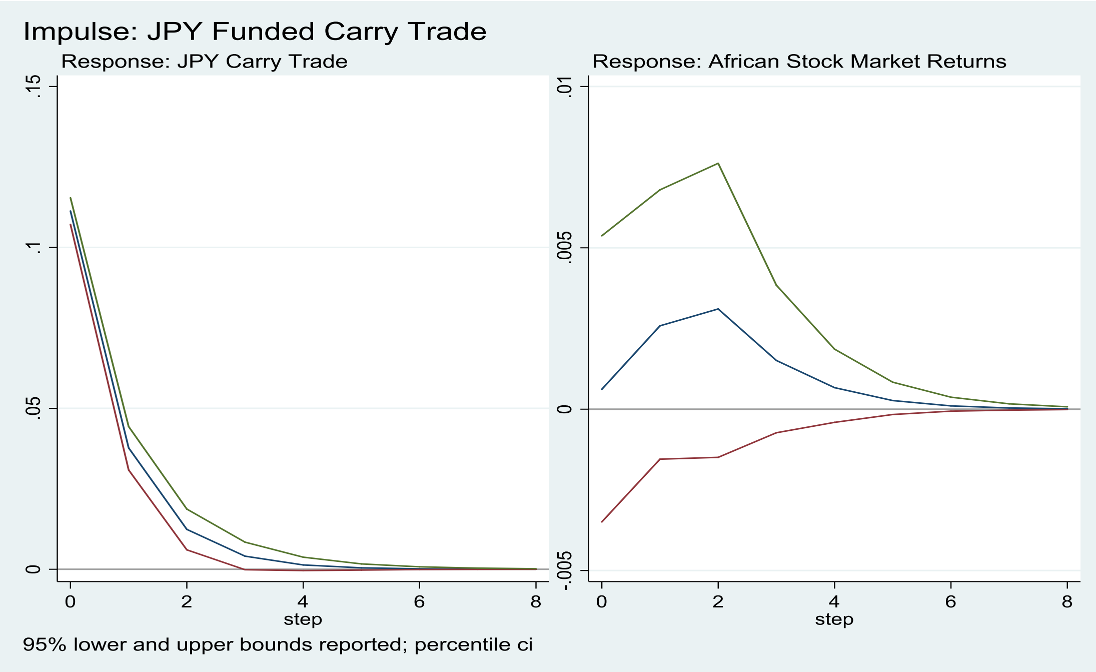
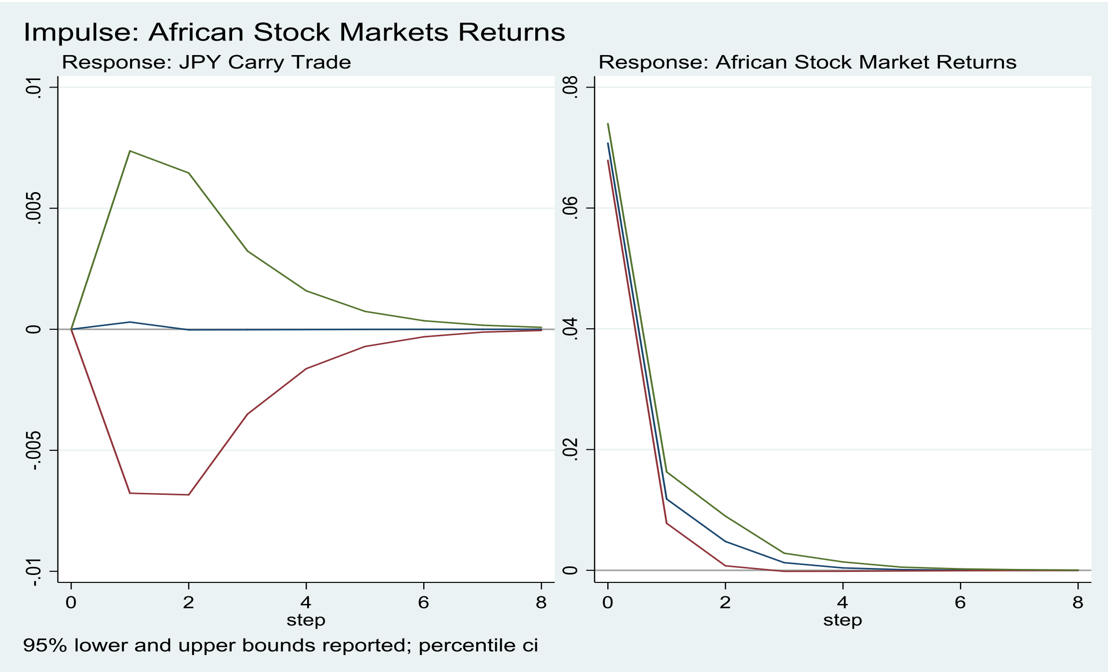


Figure 6.6: Response of JPY Carry Trade to Shocks in Stock Market Returns



The impulse responses between the Japanese yen carry trade and the African stock markets are presented in Figures 6.5 and 6.6. Consistent with the EUR and USD carry trade, shocks in the JPY funded carry trade has a positive impact on African stock market yield at least in the short run. A unit shock in JPY financed carry trade leads to an upward movement of the African stock markets yields up the second month beyond which the it experiences a decline and stabilises into equilibrium in six months time. The influence of the stock markets shocks on the JPY carry trade on other hand appears to be marginal or indifferent (see Figure 6.6). The JPY carry trade marginally increases and reverts to equilibrium within the first two months in response to shocks flowing from the African stock markets.

Figure 6.7: Response of Stock Market Returns to Shocks in GBP Carry Trade

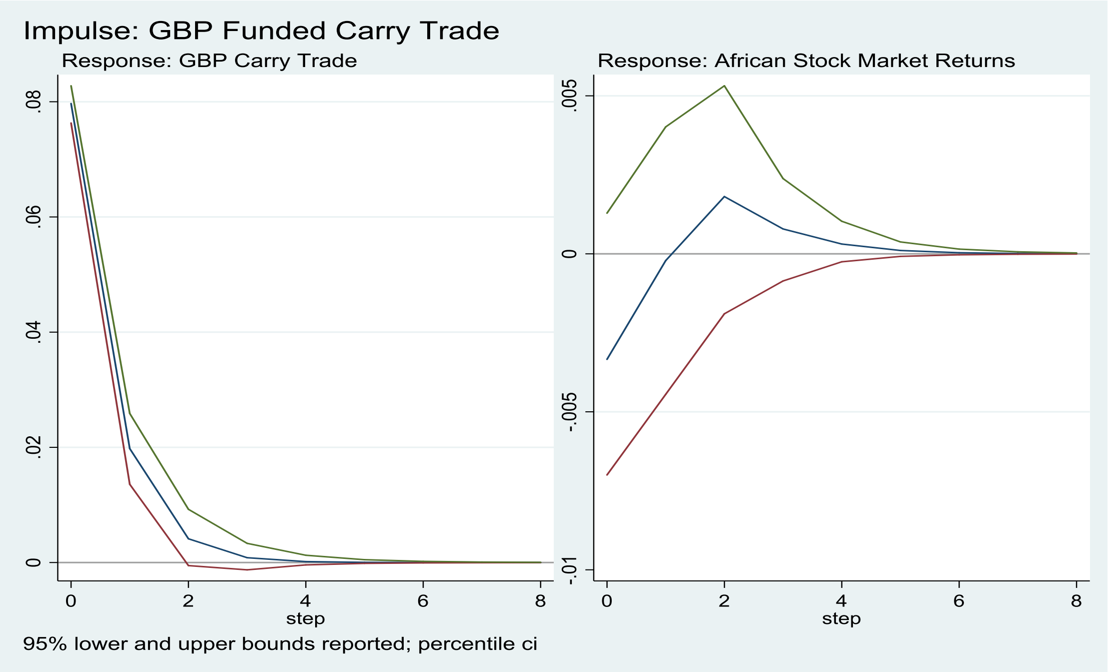
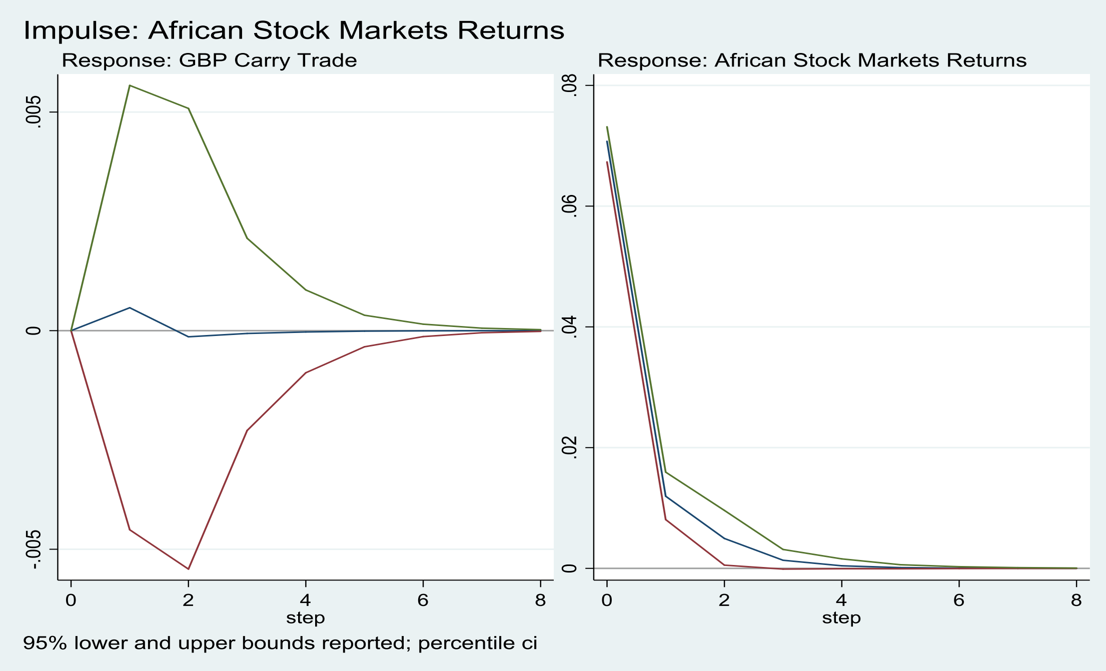


Figure 6.7 presents how the stock markets of Africa respond to shocks in GBP carry trade returns over the period 1998-2015. Understandably, the African stock market returns respond positively to shocks in the GBP funded carry trade. The stock markets yield increase sharply from negative to positive yields and peaks at the second month beyond which it declines into a steady state towards the sixth month. Lastly, Figure 6.8 shows how the GBP funded carry trade respond to the shocks in the African Stock Markets Returns. Within the first two months, the GBP carry trade increases and drops quickly into negative beyond which it approaches equilibrium.

Figure 6.8: Response of GBP Carry Trade to Shocks in Stock Market Returns



Overall, shocks in currency carry trade regardless of the funding currency have significant influence on the movements of stock markets yields. It is worth noting that these shocks are short term in nature and similar across the funding currencies. Naturally, currency carry trade opportunities in a country will attract foreign investors to invest financial assets (including stocks) domiciled in that particular country. As demand for financial assets (stocks in particular) increases, there will be increase in price resulting in capital gains for shareholders. But these gains may be shortlived as unwinding of carry trade within the short period would cause a sharp in decline in these gains. Generally the reaction of the currency carry trades in response to shocks in the African stock markets were relatively weak which is consistent with the VAR-Granger causality analysis in the previous section.

6.4.4 Results of Dynamic Conditional Correlation-GARCH

Tables 6.4a and 6.4b present the results of the DCC-AR (1)-GARCH (1, 1)-*t* model which is used to investigate the volatility spillover effect of the currency carry trade and the stock market returns in Africa. This standard Engle (2002) multivariate time-domain DCC-GARCH model is employed to assess the volatility spillover for these two assets (currency carry trade and stock market returns) in order to capture the statistical properties of the time-varying nature of both stock returns and carry trade returns. For a time series analysis of this nature, the researcher first employed the Augmented Dickey Fuller test (ADF) and Philip-Perron (PP) to test for stationarity or unit root in the data and results of the two tests are shown in Tables E1 and E2 (for the currency carry trade returns) and Table E3 (for stock market returns), in Appendix E. The study tested and confirmed the presence of ARCH effect and volatility clustering in the two series of currency carry trade and stock markets. The choice of DCC-GARCH therefore seems appropriate. From Tables 6.4a and 6.4b, the researcher observes that the estimations of the currency carry trade and stock market returns volatilities for the all the countries used for the study have all satisfied the non-negativity constraint and that $\alpha + \beta < 1$. This is an indication 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 currency carry trade and the stock market returns.

Table 6.4a: Multivariate DCC-GARCH Between African Stock Markets and Carry Trades

		EUR FUNDED			GBP FUNDED		
Market	**Parameter**	**Estimate**	**Std Errors**	**t-statistic**	**Estimate**	**Std Errors**	**t-statistic**
Botswana	ρ	-0.0368	0.0379	-0.9711	0.0012	0.0345	0.0353
	α	0.0333	0.0330	1.0100	0.0000	0.0000	0.0552
	β	0.0781	0.5527	0.1413	0.5814	0.4370	1.3300
	ν	5.2441***	0.5106	10.2700	4.9494***	0.4272	11.5900
	L-L	3526.5040			3761.6280		
Egypt	ρ	-0.0575	0.0394	-1.4610	-0.0051	0.0389	-0.1319
	α	0.0000	0.0000	0.0000	0.0221	0.0305	0.7227
	β	0.8129**	0.4047	2.0090	0.0000	0.5477	0.0000
	ν	6.6429***	0.8994	7.3860	5.8304***	0.6384	9.1330
	L-L	3404.1620			3680.5860		
Ghana	ρ	-0.0151	0.0368	-0.4103	-0.0261	0.0358	-0.7294
	α	0.0000	0.0000	0.0090	0.0000	0.0000	0.0000
	β	0.2962	23.2750	0.0127	0.7684**	0.3859	1.9910
	ν	8.7238***	1.6672	5.2330	8.5258***	1.5687	5.4350
	L-L	3335.4260			3612.9580		
Nigeria	ρ	0.0654*	0.0352	1.8580	0.0404	0.0855	0.4718
	α	0.0083	0.0202	0.4121	0.0152**	0.0079	1.9290
	β	0.8736***	0.0848	10.3100	0.9727***	0.0170	57.2500
	Df	4.5670***	0.4027	11.3400	10.7135***	2.3859	4.4900
	L-L	3800.6810			3491.7340		
Morocco	ρ	0.1525***	0.0383	-3.9850	0.0251	0.0542	0.4640
	α	0.0000	0.0000	0.4590	0.0530**	0.0262	2.0220
	β	0.3124	1.7622	0.1773	0.8242***	0.0644	12.8100
	ν	9.1333***	1.6686	5.4740	8.4141***	1.5808	5.3230
	L-L	4838.1000			4046.4230		
South Africa	ρ	0.0030	0.0595	0.0510	0.1148***	0.0378	3.0400
	α	0.0073	0.0066	1.0950	0.0078	0.0250	0.3139
	β	0.9829***	0.0095	103.7000	0.0000	0.6030	0.0000
	ν	10.1838***	1.9364	5.2590	10.0016***	1.9717	5.0730
	L-L	3180.6970			3185.9470		
Tunisia	ρ	-0.0513	0.0372	-1.3780	-0.0286	0.0499	-0.5731
	α	0.0000	0.0000	0.0161	0.0207	0.0228	0.9072
	β	0.2694	1.3861	0.1943	0.9026***	0.0756	11.9400
	ν	9.3473***	1.8678	5.0050	7.5620***	1.1748	6.4370
	L-L	4580.902			4210.0540		

Table 6.4a shows the results of Engle (2002) DCC-AR (1)-GARCH (1, 1) with student t distribution. ρ is measures correlation, while α and β are respectively the ARCH and GARCH parameters under the restrictive condition of non-negativity satisfying α+ β <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. The researcher denotes ***,**, and * as 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.

From Tables 6.4a and 6.4b, it appears that the arch parameter α in the conditional correlation equation is producing very small numbers, in most cases not significantly different from zero, even though the a few of these parameters were significant, such as the Nigerian and Moroccan both paired against the Great British Pound. The GARCH parameter β in our DCC (1, 0)-GARCH (1, 1) is predominantly large and significant in many of the markets and currency pairs. The same observation is made on the conditional correlation coefficient across the pairs of currency carry trade and the stock markets. These characteristics reveal that the conditional volatility of the stock market returns are influenced more by the previous volatility of the currency carry trade than their lagged returns. Thus there is more of a GARCH effect than there is for ARCH effect. The large GARCH coefficients are also a demonstration of a significant amount of fluctuation of the return volatility over time. A cursory observation of Table 6.4a reveals that Nigeria and Morocco exhibit ample evidence of both ARCH and GARCH effect, which satisfies the positivity constraint of $\alpha + \beta < 1$ though closer to unity. This is also an indication that there is a high degree of persistence in the return volatility and evidence of mean reversion. An increase in volatility is also established in the literature as a condition for increased volatility spillover between the two assets (King and Wadhwani, 1990; Padhi and Lagesh, 2012). Thus there appears to be a modest amount of evidence of volatility spillover from the currency carry trade market to the stock market returns dotted across the countries selected for the study. Specifically there was 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. This is also an indication that the conditional correlations between the African currency carry trades and stock market returns are dynamic and time- varying.

Though this is consistent with the position established in the literature (Cheung et al., 2012b; Fung et al., 2013; Minh, 2016; Tse and Zhao, 2012), this present study shows only a few cases of volatility spillover considering the number of currency pairs studied. This seemingly low number of volatility spillover cases among the currency pairs studied 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 trading activities expected to take place to influence this volatility transmission may be very few or even non-existent.

Table 6.4b: Multivariate DCC-GARCH Between African Stock Markets and Carry Trades

		USD FUNDED			JPY FUNDED		
Market	**Parameter**	**Estimate**	**Std Errors**	**t-statistic**	**Estimate**	**Std Errors**	**t-statistic**
Botswana	ρ	0.0126	0.0344	0.3670	-	-	-
	α	0.0000	0.0000	0.0000	-	-	-
	β	0.8274	0.6405	1.2920	-	-	-
	ν	5.3695***	0.5289	0.0000	-	-	-
	L-L	3760.1200			-		
Egypt	ρ	0.0350	0.0311	1.1230	-0.0328	0.0435	-0.7545
	α	0.0488	0.0390	1.2520	0.0127	0.0212	0.6001
	β	0.0000	0.3783	0.0000	0.9108***	0.1025	8.8850
	ν	3.1644***	0.1205	26.2700	6.0197	0.6920	8.6990
	L-L	4629.4570			3605.6140		
Ghana	ρ	0.0118	0.0358	0.3291	-0.0185	0.0419	-0.4414
	α	0.0000	0.0000	0.0012	0.0040	0.0103	0.3849
	β	0.3623	0.7232	0.5009	0.9698***	0.0407	23.8100
	ν	3.8557***	0.2682	14.3700	8.4808***	1.4728	5.7580
	L-L	4014.9870			3564.7310		
Nigeria	ρ	0.0118	0.0358	0.3291	-0.0014	0.0292	-0.0462
	α	0.0000	0.0000	0.0012	0.0000	0.0000	0.0017
	β	0.3623	0.7232	0.5009	0.0385	6.0930	0.0063
	ν	3.8557***	0.2682	14.3700	2.8936***	0.1026	28.2000
	L-L	4014.9870			2550.0290		
Morocco	ρ	0.1263***	0.0417	3.0300	0.0812**	0.0378	2.1490
	α	0.0046	0.0165	0.2819	0.0000	0.0000	0.0164
	β	0.9004***	0.0819	10.9900	0.7801	0.8652	0.9017
	ν	9.2940***	1.7267	5.3830	8.4450	1.3601	6.2090
	L-L	3938.8760			3729.8280		
South Africa	ρ	0.0128	0.0394	0.3257	0.0782*	0.0417	-1.8780
	α	0.0000	0.0000	0.0047	0.0862	0.0543	1.5870
	β	0.0030	1.6096	0.0018	0.0825	0.1941	0.4249
	ν	10.2950***	2.0678	4.9790	8.7684***	1.5213	5.7640
	L-L	3118.9290			3031.0870		
Tunisia	ρ	0.1429***	0.0348	4.1040	0.05279	0.040299	1.31
	α	0.0000	0.0000	0.0103	0.0000	0.0000	0.3108
	β	0.1262	1.1181	0.1129	0.6619	0.8257	0.8017
	ν	9.1611***	1.8522	4.9460	7.4433	1.1817	6.2990
	L-L	4195.2590			3954.0290		

Note: Table 6.4b shows the results of Engle (2002) DCC-AR (1)-GARCH (1, 1) with student t distribution. ρ is measures correlation, while α and β are respectively the ARCH and GARCH parameters under the restrictive condition of non-negativity satisfying α+ β <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. The researcher denotes ***,**, and * as 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.

Figure 6.9: DCC of JPY Currency Carry Trade and Stock Markets

Figure 6.10: DCC of USD Currency Carry Trade and Stock Markets

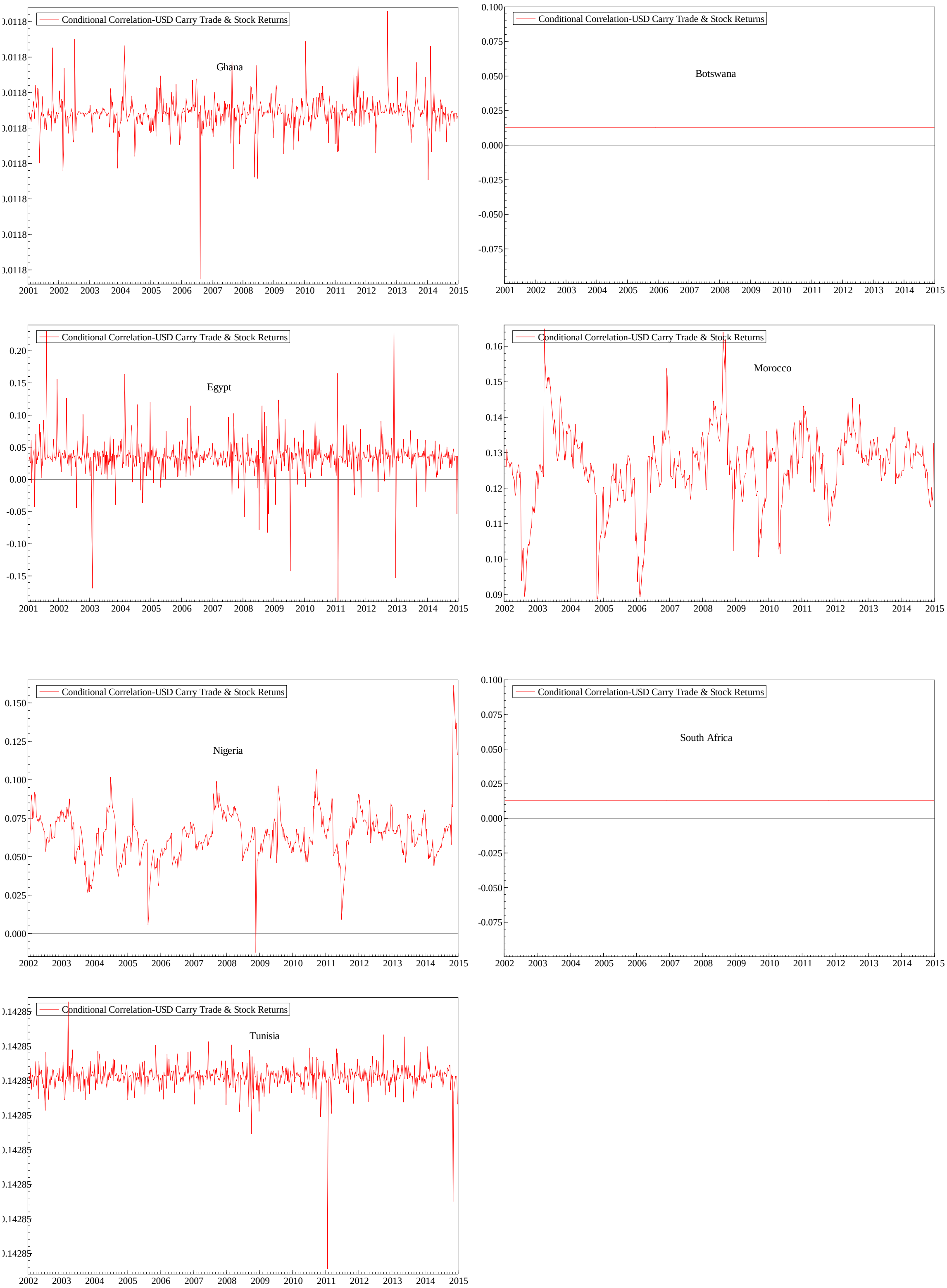
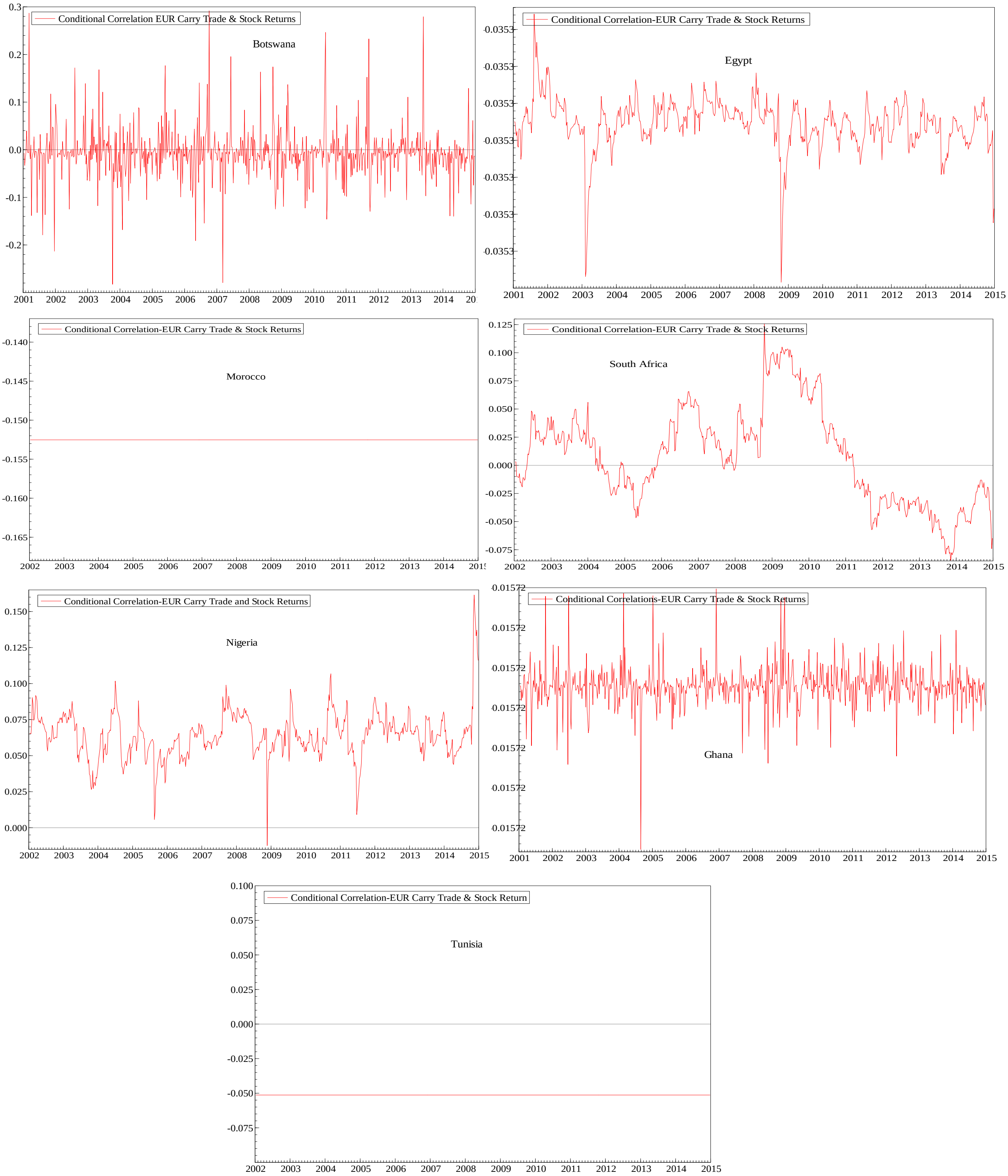


Figure 6.11: DCC of GBP Currency Carry Trade and Stock Markets

Figure 6.12: DCC of EUR Currency Carry Trade and Stock Markets



Figures 6.1 presents the conditional correlation plots between the currency carry trade of African currencies funded by the Japanese Yen. From a visual examination of the graphs the currency carry trade targeting the Tunisian Dinar financed by borrowing the Yen appears not to correlate with the Tunisian stock market index. Figure 6.2 presents the conditional correlation plots for African currencies carry trade financed by borrowing the USD and Figure 6.3 shows similar plots for African currencies carry trade funded by the Great British Pound. South African and Botswanan currencies carry trade funded by the USD appear (on the face of the plots) to have zero or no conditional correlation with their respective stock markets. Figure 6.4 on the other hand indicates conditional correlations between African currencies targeted carry trade financed by borrowing Euro and the stock market indices of the selected African countries. Tunisian Dinar and Moroccan Dirham against the Euro currency carry trade are showing signs of no correlation with their respective stock market indices.

6.5 Chapter Summary and Concluding Remarks

The main aim of this chapter was to empirically examine the implications of the currency carry trade targeting African currencies for the returns of stock markets in Africa. More specifically, the chapter sought to examine the causality (if any) and volatility spillover or information transmission between the variations in the African currency carry trade and stock markets of Africa. And also the impulse responses between the entire carry trade strategy of Africa and the stock makets of Africa put together. To achieve this objective the background and the motivation for the study were articulated in section 6.1 of this chapter. A review of existing empirical studies on the subject and the various methodologies or approaches employed was conducted. Three main econometric models (unrestricted VAR-Granger causality, Panel VAR and DCC-GARCH) were used to examine the relationship between the African currency carry trade and stock market returns. Since there were no unit roots and for that matter no cointegration in the returns of the currency carry trade and stock markets the study employed the use of an unrestricted vector autoregressive model with Granger causality test and, further, used the dynamic conditional correlation multivariate GARCH model to capture the volatility spillover for all twenty eight currency pairs over the period of 2001 to 2014. Also a panel vector autoregression using the XTVAR approach was also employed to examine the impulse responses between the carry trade and stock markets yield. The researcher records that, generally, the African currency carry trade returns significantly Granger cause the stock markets of target currency countries which was corrobroted by the panel VAR analysis. The currency pairs JPYBWP, JPYNGN, JPYGHS, GBPTND, USDGHS and GBPEGP were notable exceptions out of the 28 currency pairs where causality flow from currency carry trade to stock markets returns could not be established. Again, the stock market returns generally do not Granger-cause the currency carry trade returns except for currency pairs EUREGP, USDGHS and GBPMAD where the researcher found evidence of causality flow from the stock markets to the currency carry trade markets. Furthermore, the study found evidence of volatility spillover flowing from the currency carry trade to stock markets for a significant number of currency pairs. Specifically, ten currrency pairs (EUREGP, GBPGHS, EURNGN, GBPNGN, GBPMAD, EURZAR, GBPTND, JPYEGP, JPYGHS and USDMAD) out of twenty eight had evidence of volatility spillover from carry trade to their respective stock markets. These mixed findings are all supported by earlier studies in the academic literature (Cheung et al., 2012b; Fung et al., 2013; Minh, 2016; Tse and Zhao, 2012). The next chapter recaps and summarises all the findings for the four separate essays and suggests directions for future studies.

CHAPTER 7

Summary, Conclusions and Policy Recommendations

7.0 Introduction

In this chapter, the researcher summarises the main findings of the study and policy recommendations of the four separate essays in the last four chapters. The chapter is divided into four main subsections. The first subsection presents the summary of the entire thesis which culminated in the four separate essays. The main findings and conclusions of these separate essays and their interlinkages are presented in section two of this chapter. The third section presents some policy recommendations. The fourth and final section accounts for the limitations of the study and contains suggestions for future research work.

7.1 Summary of the Study

The study sought to investigate the viability or otherwise of the very popular trading strategy called currency carry trade where investors borrow funds from countries with very low interest rates and invest these funds in financial assets of countries with high interest rates. Even though according to the uncovered interest parity hypothesis this strategy should produce zero returns, on the contrary it has been consistently generating very attractive returns comparable to, and in most instances higher than, the returns of most stock market indices in the world. This macroeconomic theory anomaly has transformed into an investment asset and in most cases has become institutionalised across major financial markets of the world. As a result, a good number of actively traded currency carry trade indices have been put together by major players in the international financial markets. Examples of these indices include the Deutsche Bank Currency Carry USD Index, the G10 Currency Future Harvest, and Barclays Capital Intelligent Carry Index, which are all based on the most liquid currencies of the world, mostly the G10 currencies. These developments on the international financial markets landscape have stimulated academic interest in recent times. Issues such as the deviation of the uncovered interest parity hypothesis, the profitability and unwinding of currency carry trade, categorisation of currency carry trade as an asset class, and the risks inherent in the strategy have been widely discussed in the academic literature. The importance of these issues to the economic development of nations cannot be overemphasised since the financial markets of every country represent the nerve centre of that country’s economic development. Thus a vivid understanding of these issues would inform policy direction. Interestingly, almost all of these studies are concentrated on the developed countries and regions of the world, interspersed with some emerging markets of the Americas, Europe and Asia, but with very little or no work on the African currencies.

This current study engages the academic community on a number of the aforementioned issues, focusing on the African continent. Historically, African currencies are perceived to be characterised by low liquidity and high volatility and for that reason their impact on global currency markets is often seen as minimal or non-existent. However, in the last two decades, developments in the African financial markets landscape have stimulated a lot of interest from investors all over the world to invest in African securities, which generally have a very attractive yield and consequently have made Africa a key player in the future of global financial market. Thus the emergence of currency carry trade market on the international financial market must also be a relevant issue to the African financial markets. A review of the extant literature revealed that there is very little or no research work on currency carry trade targeting the African currencies. This apparent lack of studies into whether the currency carry trade strategy is profitable amongst African currencies which could pass as an asset class, inherent risk and its relationship with the African stock markets remains the rationale for this current study.

The main objective of this study was to empirically investigate the viability or otherwise of currency carry trade strategy which targets African currencies as a financial asset and to establish how this trade relates to the African stock markets. Thus the study specifically sought:

1. To evaluate the profitability of the currency carry trade targeting African currencies funded by some selected first world currencies with lower interest rate.

2. To explore how the African currencies targeted carry trade (in its simple form) could represent a prudent investment or viable alternative asset class, using risk-adjusted performance measures.

3. To examine a value-at-risk (VaR) analysis of African currency carry trade returns using generalised autoregressive conditional heteroskedasticity (GARCH) models.

4. To investigate the relationship or the information transmission mechanism between returns of African currency carry trade and the returns of their respective Stock Markets.

The study addressed these specific objectives in four separate essays with each essay constituting a chapter to this thesis. Chapter three of this thesis addressed the first specific objective and thus answered the question whether the currency carry trade in its simple form targeting African currencies is profitable. This chapter, inter alia, investigated the deviation of the uncovered interest parity theory in the African context. Chapter four addressed the second specific objective and answered the question whether the African currency carry trade strategy can be classified as an asset class. Chapter five of this thesis addressed the third specific objective of the study which answered the question of how the value-at-risk of the African currency carry trade should be modeled. Finally, Chapter six addressed the fourth and last specific objective and answered the research question of whether there exists any form of relationship between the returns of African currency carry trade in African countries and their respective stock market returns.

In order to achieve these specific objectives the study employed different econometric and statistical models. A combination of statistical tools and econometric modeling, particularly Huber's robust regression, was used to accomplish the objective of examining the profitability or otherwise of the currency carry trade strategy among African currencies. The robust regression, which was mainly justified by the presence of heavy outlying data points of the currency carry trade returns series, was used to test the uncovered interest rate parity hypothesis and the statistical tools were used to estimate the naïve currency carry trade returns among the currencies selected for the study. For the second objective the study used risk-adjusted portfolio performance measures (Sharpe ratio, Sortino ratio, and Adjusted Sharpe ratio) to evaluate the historical performance of the African currency carry trade and compared it to the risk-adjusted performance of some selected benchmark indices. The third objective was to perform a value-at-risk analysis of the African currency carry trade using generalised autoregressive conditional heteroskedasticity (GARCH) models with Gaussian (normal), student *t* and skewed student *t* distributions of innovation or the error term. Finally, the fourth objective, which examined the causality and information transmission mechanism or volatility spillover between the African currencies carry trade and their stock market counterpart, was accomplished through the Vector Autoregressive (VAR) Granger causality and the Dynamic Conditional Correlation-Generalised Autoregressive Conditional Heteroskedasticity (DCC-GARCH).

7.2 Findings and Conclusions of the Study

The key findings and conclusions of the study, presented in sections 7.2.1 to 7.2.4, are drawn from the various findings observed under each of the specific objectives. These specific objectives actually form four separate independent chapters (i.e. chapters 3 to 6). Consequently, this section is further divided into four subsections with each subsection presenting the main findings and conclusions of that objective. Thus first subsection highlights the main findings of the study on the profitability of African currency carry trade. The second subsection deals with the main findings and conclusions drawn from the study that evaluates the currency carry trade as an asset class and prudent investment. Findings and conclusions drawn from the value-at-risk analysis form the third subsection. The last subsection draws from the conclusions of the study on the relationship between returns of African currency carry trade and that of their respective stock markets.

7.2.1 Findings and Conclusions on Profitability of African Currency Carry Trades

Studying forty currency combinations involving four funding currencies from the developed world and ten target currencies from Africa's emerging and frontier markets (from 1998 to 2015), the researcher records that the naïve currency carry trade investment generates excess positive monthly returns in almost all the currency pairs. Specifically, apart from the USDZAR, USDTND, EURZAR, EURTND, GBPZAR and GBPTND which recorded negative returns over the period of 1998 to 2015, all the other 34 currency pairs posted positive returns. These returns are generally susceptible to downside or crash risk. The researcher however concludes that testing these naïve returns with Fama's UIP regression using mid exchange rates reveals that six (EUR/ZAR, JPY/ZAR, GBP/KES, EUR/TND, JPY/MUR and GBP/MUR) out of the forty currency pairs generate statistically significant currency carry trade profits. None of these six currency pairs was statistically significant using the bid/ask exchange rates indicating that holding currency carry trade investment in Africa over the period of 1998 to 2015 would not have been profitable for all the forty currency pairs studied. Thus the naïve carry trade returns (using mid-rates) may be overestimated since the study foud that bid and ask exchange rates spread further reduces the profits generated from the mid-rates.

Another finding of the study on the profitability of carry trade is that the uncovered interest parity condition does not hold in systematic fashion. That is though the researcher had no evidence to reject the null hypothesis for the full sample and pre-crisis period, a handful of currency pairs were found to be significant during the crisis and post-crisis period. In addition, the researcher also documents that contrary to the findings that carry trade does not diminish with time (Darvas, 2009), African currency carry trade returns fluctuated over time within the period studied.

The researcher shows that the currency carry trade returns of Africa are by-products of global financial crisis and market inefficiencies. Thus currency carry trade records some modest returns and Sharpe ratios during periods of financial crisis and outperforms the stock markets and the Deutsche Bank G10 FX Carry Trade Index. Not only does the strategy generate some positive returns during global financial crisis, it is also characterised by minimal risks, thus producing some decent risk adjusted returns.

It is worth noting that the results for the benchmark investment only show capital gains of stock market investment and disregarded the receipt of dividends by investors. In the real world the dividends will shore up the actual returns on the stock investment which may outperform the currency carry trade returns. These are consistent with points raised by Burnside et al. (2006) and Moosa (2008).

Finally, it is important to mention that in constructing the African currency carry trade portfolios the researcher only used the currency pairs with statistically significant returns according to the Fama UIP regression, some of which were even negative over the period under study. Thus if the researcher had constructed the currency carry trade portfolios on the basis of profitable currency pairs regardless of whether evidence against UIP is 'statistical' or 'economic', the African currency carry trade portfolio may have outperformed all the benchmark indices. This analysis may be an interesting area for future researchers to study.

7.2.2 Findings and Conclusions on Africa's Currency Carry Trade as an Asset Class

The study set out to investigate the viability of African currency carry trade as a prudent investment or alternative asset class. The researcher documents that the risk-adjustment performance of the naïve carry trade of African currencies largely outperforms the stock market indices and in some cases match the stock market performance. Almost all the currency pairs examined in this study showed some 'economic'profitability tendencies and, most importantly, displayed diversification properties. Thus the correlation between the African currency carry trade and other classes, mainly the stock market, was very small and in some cases negative. The diversification power of the individual currency pairs is not as potent as the portfolio of currencies. All five portfolios constructed for the study showed strong risk-adjusted performances compared to other asset classes used for the construction of the portfolio. The researcher concludes that including the African currency carry trade in a portfolio causes a dramatic risk-adjusted performance of the portfolio. The relatively low volatility associated with African currency carry trade, coupled with the weak positive and negative correlations with the stock markets returns, make it a good catalyst in improving the fortunes of a portfolio. The findings also show that substituting the stock index with carry trade in a conventional portfolio propels the portfolio to perform better especially when that stock index to be replaced moves in the same direction as the African currency carry trade. Adding the African currency to an existing portfolio in some cases may hamper the original performance of the existing assets even though the relatively low volatility will cause some marginal improvement in the risk-adjusted performance measures. The study also found that African currency carry trade contributes significantly to the risk-adjusted performance of a portfolio when included. In all the portfolios studied, it was observed that the African currency trade had a significant share of the Sharpe ratio of the portfolio. Not only the share, but the inclusion of African currency carry trade causes the existing assets to increase by about five-folds their original contribution. Thus portfolio managers should not always look at the actual or absolute contribution of African currency carry trade towards a conventional portfolio but at the ability to increase the shares of the existing assets. This is because these findings show that even a relatively small contribution could make a large difference if only the correlations between the assets are small or at best negative. The researcher concludes that the African currency carry trade is a viable asset class and one may explore its investment opportunities. Speculators or investors may look at the African currency carry trade portfolios, which have lower volatility compared to the single currency pairs.

7.2.3 Findings and Conclusions on the VaR Analysis of Africa's Currency Carry Trade

Currency carry trade in the academic literature is widely perceived as a highly risky strategy with its returns susceptible to crash risk or peso effects. Thus the usually positive interest rate differentials are mostly eroded by the conditional skewness of exchange movements. The currency carry trade strategy targeting African currencies appears even more risky since the exchange rates movements of African currencies are perceived to be volatile and mostly weak against the major currencies of the world. The study sought to examine the VaR of the African currency carry trade historical weekly returns generated over the period of 2001 to 2015 using generalised autoregressive conditional heteroskedasticity model with three different probability density functions to model the return innovations. Beyond the estimation of the conditional volatility through the ARMA(1, 0)-GARCH(1, 1) model which was eventually used to estimate the short position and long position VaR, the researcher employed a number of backtesting statistical models to test the accuracy of the VaR model. Generally, the study reveals that the volatility model of ARMA(1, 0)-GARCH(1, 1) is a good fit for the African currency carry trade returns in the estimation of its long and short position in-sample as well as out-of-sample VaR. The estimation of the volatility model with Gaussian, Student t and Skewed t distribution of return innovation suggested four main findings.

Firstly, the study revealed that the skewed student t density GARCH model is mostly superior to the traditional Gaussian (normal) and student t probability density functions, in the estimation of accurate in-sample and out-of-sample VaR of African currency carry trade returns. It appears this finding is as a direct result of the peculiar characteristics of skewness and large excess kurtosis (leptokurtosis) of the study's African currency carry trade returns. This finding is consistent with earlier studies in the academic literature. Wang et al. (2013), in particular, concluded that the

GARCH model with the skewed student t distribution appears to be more accurate in capturing risks in currency carry trade returns.

Secondly, the study found that there is a general absence of temporal dependence or clustering of VaR breaks in the returns of African currencies carry trade as the null hypothesis of the dynamic quantile statistic (Engle and Manganelli, 2004) could not be rejected in almost all cases. Thus the VaR violations of today are by no means significantly influenced by the violations of the previous period (i.e. with our weekly returns, this week's VaR breaks were found not be influenced by last week's VaR breaks). Interestingly, in cases where the Kupiec likelihood ratio (unconditional coverage) test is rejected in forecasting out-of-sample VaR, the researcher found that the dynamic quantile (conditional coverage) test cannot be rejected, which is convincing evidence that the VaR breaks or violations of African currency carry trade returns are not clustered, consistent with the findings of Slim et al. (2017).

Thirdly, the study also observed that there appears to be a trend of the empirical size of VaR breaks or exceedances being greater that the nominal VaR in almost all the instances where the accuracy of the VaR is rejected. Thus the in-sample and out-of-sample long and short VaR usually underestimate the VaR of African currency carry trade returns whenever it is not correctly calibrated. Though both underestimation and overestimation of VaR is bad news to currency carry traders and investors in general, the penalty for underestimating the risk inherent in the trade could lead to very serious losses. This finding reinforces the arguments in the academic literature that currency carry trade is indeed a risky investment (Brunnermeier et al., 2008; Burnside et al., 2010; Christiansen et al., 2011; Jurek, 2014).

Fourthly, the study found that the currency pairs JPYNGN and JPYBWP have the highest potential average losses beyond the VaR. Thus in a worst case scenario those currency pairs are the currency pairs which will lose most money in their investment, given 5% VaR quantile or less. It became evident that the Japanese Yen as a funding currency generally produces high potentiatial average losses relative to the other funding currencies studied. The researcher observed that the South African Rand as a target currency appears to be moderate in terms of the expected shortfall measure. The currency pairs USDEGP, EURTND and EURMAD, on the other hand, are found to be the least risky currency pairs because of their low potential average losses below 1% in 5% worst returns.

Other auxiliary findings documented by the study were that the 0.25% and 0.5% for long and short position VaR model mostly could not be forecast, particularly by the Kupiec unconditional coverage likelihood ratio test. This could be attributed to the fact that the data used for the study was not large enough for forecasting such small VaR quantiles. The dynamic quantile (conditional coverage) test, however, performs very well in forecasting these small quantiles. The study again noted that the student t density GARCH model is superior in the estimation of in-sample and out-of-sample long and short VaR in currency pairs that exhibit very low (negative) skewness, such as the GBPTND and GBPMAD.

7.2.4 Findings on the Implications of Carry Trade for Stock Market Returns

The main objective of this part of the study was to investigate the causality between the historical return of the African currency carry trade in its simple form and the historical returns of their respective African stock markets. Currency carry trade returns were generated by borrowing funds from the Euro zone, the USA, Japan and the United Kingdom and investing these funds in the selected African target countries (i.e. South Africa, Egypt, Morocco, Nigeria, Ghana, Botswana and Tunisia). Then the currency carry trade returns generated for these African countries were matched against their respective stock market index to observe any stochastic trends between the two series. Vector Autoregressive Granger Causality test and the DCC-GARCH were employed to test for causality and volatility spillover respectively between the currency carry trade and the stock market index. Panel Vector Autoregression was also used to examine the impulse responses between the carry trade and stock markets yield. Findings from this study were mixed but heavily supported by the existing academic literature, which is an indication that there appears to be no consensus on this particular subject.

Generally, the study found that the African currency carry trade returns significantly Granger causes the stock markets of target currency countries which was corroborated by their impulse responses. The currency pairs JPYBWP, JPYNGN, JPYGHS, GBPTND, USDGHS and GBPEGP were notable exceptions out of the 28 currency pairs where causality flow from currency carry trade to stock markets returns could not be established. The Japanese funded currency carry trade dominates the pack of exceptions across the countries selected for the study. In Ghana, Nigeria and Botswana, the currency carry trade financed by the Japanese Yen were found not to Granger cause the stock market indices of these countries respectively. Egypt and Tunisia, on the other hand, exhibit similar non-causality between the GBP funded currency carry trade and their stock market indices. Ghana is the only country where the USD funded currency carry trade was found not to Granger cause the stock market index.

Again, except for the EUREGP, USDGHS and GBPMAD currency pairs where the researcher found evidence of causality flow from the stock markets to the currency carry trade markets, there was no evidence of causality flow from stock market returns to the currency carry trade returns for the remaining 25 currency pairs. Thus the stock market indices in Africa generally do not Granger cause the currency carry trade markets in Africa, which is consistent with the work of Fung et al. (2013) and Cheung et al. (2012).

Furthermore, the study found evidence of volatility spillover flowing from the currency carry trade to stock market indices in the African countries studied, although not widespread. Specifically, ten currrency pairs (EGPEUR, GBPGHS, EURNGN, GBPNGN, GBPNGN, GBPMAD, EURZAR, GBPTND, JPYEGP, JPYGHS and USDMAD) out of the twenty eight currency pairs studied had evidence of volatility spillover from currency carry trade markets to their respective stock markets indices. It appears that information transmission from the currency carry trade markets to the stock markets and vice versa in Africa is quite weak and limited to a few currency pairs scattered across the African countries selected for the study, with Botswana conspicuously missing.

The researcher documents that in South Africa the volatility of the stock market index is influenced by only the volatility of the currency carry trade strategy financed by borrowing Euros. There was no evidence of volatility spillover or information transmission between the currency carry trade and the stock market where the currency carry trade is being financed by USD, GBP and JPY. Morocco's stock market volatility is found to be influenced by the volatility of currency carry trade of the Moroccan Dirham financed by the USD and GBP. Thus there appears to be volatility spillover from the USD and GBP funded currency carry trade to the stock market index of Morocco. Furthermore, the volatility of GBPGHS and JPYGHS currency carry trade in Ghana is also found to flow to the stock market index of the Ghana Stock Exchange. In the case of Tunisia, the GBPTND currency carry trade is the only strategy out of the four found to be influencing the stock market index of Tunisia. Volatility of the stock market index in Nigeria is also influenced by the volatility of currency carry trade financed by Euro and GBP. Finally, the Egyptian stock market and currency carry trade exhibit similar behaviour to that of Nigeria. The volatility of the Egyptian stock market is being influenced by the volatility of Euro and Japanese Yen funded currency carry trade.

All African countries put together, the study found that the generally the stock markets in Africa respond positively to shocks in the returns of carry trade whilst the carry trade returns only marginally respond to such shocks emanating from the stock markets.

7.2.5 Inter-Linkages between Findings

The examination of African currency carry trade monthly returns in chapter three, reveals that, using the naïve carry trade calculation, six (USDZAR, EURZAR, EURTND, USDTND, GBPEGP and GBPTND) out of the forty currency pairs studied, produced negative returns. The remaining 36 (see Table 3.10) currency pairs were all 'economically' profitable even though they were not statistically significant (using the regression-based).

Only two currency pairs (GBPTND and EURTND) produced negative weekly currency carry trade returns in chapter four. This means that the USDZAR, EURZAR, USDTND, and GBPEGP which produced negative monthly returns are at least 'economically' profitable under under weekly investment horizon, indicating that the currency carry trade strategy is more profitable for short term investment horizons. In chapter four also, it was revealed that the parametric VaR and the historical VaR were not consistent for most currency pairs, which is an indication that, the African currency carry trades returns are not normally distributed. This was confirmced in chapter five, where it was concluded that the skew t distribution fits African currency carry trade returns better, in predicting the VaR and expected shortfall.

In section 4.4.3 of chapter four, the USD funded currency carry trade portfolio appears to be dominating all the other portfolios using risk-adjusted performance measures. This is followed by the JPY carry trade portfolio, GBP and Euro carry trades, in that order. Generally, the JPY funded carry trade produced the highest mean returns followed by the USD funded carry trade portfolio. However, the risk-adjusted performance of USD funded carry outperforms the Japanese Yen funded carry trade, followed by the GBP and the EUR carry trade portfolios. This is because, the Japanese Yen carry trade targeting African currencies is riskier relative to the USD, GBP and the EUR funded carry trades. It is therefore not surprising that in chapter five, the JPY funded currency carry trades (i.e. JPYNGN, JPYBWP and JPYZAR) are showing the highest predicted expected shortfall relative to the other currency pairs. Except for GBPTND, all the currency carry trade returns which showed volatility spillover in chapter six were found to be profitable in chapters three and four. This is an indication that due to the profitability of these currency pairs, there might have been some carry trading activities to influence this transmission of volatility. Also almost all the profitable (both naïve and regression-based) currency pairs were found to Granger cause the stock markets.

7.3 Policy Implications and Recommendations of the Study

There are a number of policy issues emanating from the findings of the four separate essays captured in Chapters 3 to 6 of this study. The first three policy implications in this section emanated from *Objective 1*; the fourth and fifth policy implications emanated from *Objective 2* and *Objective 3* respectively; while the last policy implication emanated from *Objective 4*.

The first policy implication of the findings of this study is that some African currencies exhibit profit potential (both naïve and regression-based) and might attract the attention of investors. As a result the researcher recommends that the monetary policy framework of African economies should be strengthened to accommodate or attract these foreign capital flows as and when they came. The strengthening of the monetary environment is particularly important because the currency carry trade funds have the potential to affect African economies in two ways. That is, they have the potential boost the performance of the currency of the receipient economy and at the same time have the capacity to distabilise the entire financial markets with massive unwinding of the strategy. Increased demand in assets domiciled in the African economies is usually associated with increase demand in the currency of the target economy thereby causing the target currency to appreciate against the prediction of UIP and further widening the gains of carry trade. This phenomenon has a substantial potential to influence the currency to appreciate. On the other hand investors may reverse their positions by unwinding the strategy when there is high expectation of future losses. These expectations are fuelled by inter lia harsh economic conditions, unfavourable interest cut by the central bank, rapid depreciation of the target currency, and political instability in the target economy. This abrupt unwind of the carry trade may have devasting consequences on the economy especially if the monetary managers do not have sound regulatory and institutional framework to deal with the downside risk of this strategy.

Secondly, the mass influx of carry trade funds as a result of the trade being profitable also has the effect of weakening the funding currency and also causing overheating in the economy of the target currency. Monetary policy authorities of both the funding and target currency countries must note and formulate the right policies and institutional framework to deal with these issues which have the potential deteriorating the macroeconomic foundations of their respective countries.

The third major policy implication is inherent in the finding that the currency carry returns are susceptible to downside risk or crash risk. The study primarily used the uncovered interest parity condition to assess the profitability of the currency carry trade in Africa. In simple terms, the study took an unhedged position of this risky strategy. The researcher recommends that due to the risky nature of the strategy, Portfolio managers, hedge funds managers, investors (both individual and firm) must hedge their positions whenever they targeting African currencies to implement the carry trade strategy to mitigate their losses and maximise their gains.

Fourthly, the study also found that the currency carry trade targeting some currency pairs of Africa's emerging and frontier markets may present some important diversification benefits especially during the period of financial crisis. The researcher recommends that stakeholders in the international financial markets including the financial markets of African may have to consider including the African carry trade in the formulation of their portfolios. Additioanaly, the players in the market may consider indexing the African currency carry portfolio similar to the Deutsche Bank Carry Index which tracks the carry returns for the G10 currencies.

The fifth policy implication arises from our finding that the traditional approaches of modelling risk or the worst possible losses under unfavourable economic conditions for conventional portfolios may not work for the currency carry trade returns. Thus the study found that the skewed t distribution based model would be appropriate in this regard. Since carry trade may not desirable and may not also be preventable or curbed by the managers of the economy, it would be appropriate for the managers of African economies to build their capacity and the capacity of the players of their respective financial markets, to be equipped with right knowledge to examine the risk associated with this strategy. The international bodies such as the International Monetary Fund lead the way in building the capacity of central banks of member countries for onward transmission to the other players in the market.

The sixth and final policy implication is emanating from the finding that there is high information transmission mechanism flowing from the currency carry trade the stock markets much more than it is from the stock markets to carry trade. Thus the currency carry trade is closed linked with the performance of the stock markets in Africa. The currency carry trade activities may influence the stock markets in two main ways. First, some of the capital flow associated with the currency carry trade may find its way into the stock markets and thus improve upon the performance of the market. Second, since the carry trade strategy is short term in nature, investors may unwind their investment earlier then expected and quickly if they envisage any risk potential. This sudden withdrawal from the market may have dire consequences for the performance of the stock market. The researcher therefore on the basis of this recommend that the key stakeholders and policy makers should maintain sound macroeconomic foundations to keep traders in the markets and also improve the regulatory and institutional framework to track carry trade funds in order to be able to deal with the risks associated with the downside risk of the strategy.

7.4 Limitations of the Study and Suggestions for Future Research

Generally, the study has made a significant contribution to the academic literature on behavioural finance, in particular the existing knowledge of the currrency carry trade. However, it should be mentioned that although very important contributions to the literature were made, the study encountered a number of limitations which mainly affected the scope of this study.

This study examined the profitability or otherwise of currency carry trade among currencies of Africa financed by borrowing low-interest currencies (EUR, USD, JPY and GBP) in what appears to be an African continent-wide (in respect of emerging and frontier markets) study using Huber's robust regression. The researcher found evidence to conclude that the currency carry trade is statistically profitable in a handful of currency pairs over the entire period studied. The researcher would have wished to include all the currencies of emerging and frontier markets of Africa in the study but was not successful, due to unavailability or inaccessibility of quality and up-to-date interest rate and exchange rate data of some of the African countries. Even where the data was available, the time period required to do a longer historical analysis of the returns was mostly challenged, since most of the data starts from 2001. The researcher would have loved to examine the key drivers of carry trade profits (using panel regression) but failed because of unavailability of data. Thus these challenges limited the scope of this study of investigating the profitability or otherwise of the currency carry trade.

Also, the researcher would have loved to ascertain whether there are some currency carry trade activities by investors or the players in the financial market space across the African currencies using bank data, but could not accomplish this because of unavailability of data, time and the scope of the study. This area still remains a research gap in the literature which can be taken up in future research.

Although estimating the value-at-risk and conditional value-at-risk (CVaR) or expected shortfall (ESF) of the African currency carry trade returns for individual African currencies over the period of 2001-2015 at a wide range of confidence intervals (i.e. 0.25% to 5%) with GARCH-type models is a significant contribution to the academic literature, the researcher would have liked to expand the study to compare the VaR and CVaR of the currency carry trade of African currencies to other financial assets in Africa but could not do so because of time constraint. It would therefore not be out of place for future researchers to pay attention to the extension of this study.

Finally, although studies on the implication of currency carry trade on stock market index returns or the information transmission mechanism between the African currency carry trade and the stock markets in Africa produced very interesting results which enrich the existing academic literature this current study focused on the currency carry trades market and the stock market within the same country (i.e. intra-country analysis) where the four currency carry trade strategies per African currency were each pegged with the stock market index of the country in question. Had time and scope allowed, it would have been interesting to extend the study to measure causality, impulse responses and volatility spillover between the currency carry trades and stock market indices across African countries. Thus this gap in the literature is open to future academic research.

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APPENDICES

Appendix A: GARCH Results for Various African Currencies Carry Trade Returns with Gaussian, Student t and Skewed t Distribution of Innovation

Table A1: AR(1)-GARCH(1,1) Results for African Currency Carry Trade Financed by US Dollars (Weekly Returns)

				Funding Currency: US Dollars				
Currrency	**Cst(M)**	**Cst(V)**	**AR(1)**	**ARCH(Alpha1)**	**GARCH(Beta1)**	**Asymmetry**	**Tail**	**Log-likelihood**
				Gaussian Distribution				
BWP	0.0025***	0.2147**	-0.0602	0.2022***	0.7482***	-	-	2125.4380
	0.0005	**0.1244**	**0.0435**	**0.0145**	**0.0757**	-	-	
EGP	0.0009***	0.8981	0.5098***	0.5758*	0.7098***	-	-	3178.5770
	0.0003	**0.8579**	**0.0973**	**0.3034**	**0.0619**	-	-	
GHS	0.0030***	-0.0130	-0.0750	0.4777	0.9072***	-	-	618.9000
	0.0007	**0.0161**	**0.2363**	**0.3730**	**0.0072**	-	-	
MAD	0.0002	2.0296*	0.2627***	0.0815***	0.8924***	-	-	2633.3790
	0.0004	**1.0691**	**0.0363**	**0.0213**	**0.0249**	-	-	
NGN	0.0017***	0.0180	-0.0725	0.5864***	0.6084***	-	-	2735.8810
	0.0002	**0.0168**	**0.0752**	**0.1080**	**0.0510**	-	-	
ZAR	0.0000	0.2082**	0.2375***	0.1459***	0.8012***	-	-	2040.5610
	0.0008	**0.0901**	**0.0391**	**0.0341**	**0.0445**	-	-	
TND	-0.0001	1.7495*	0.2838***	0.0765***	0.8945***	-	-	2724.1920
	0.0004	**0.9890**	**0.0359**	**0.0199**	**0.0268**	-	-	
				Student t Distribution				
BWP	0.0022***	0.1821*	-0.0424	0.1033***	0.8323***	-	6.0302***	2158.1540
	0.0005	0.1051	**0.0365**	**0.0409**	**0.0656**	-	1.3575	
EGP	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-
GHS	0.0014***	0.0338***	0.1441***	0.7330***	0.5386***	-	3.2157***	839.3850
	0.0002	**0.0135**	**0.0503**	**0.1850**	**0.0523**	-	**0.5312**	
MAD	0.0004	1.7528**	0.2701***	0.0807***	0.8977***	-	14.1300**	2636.8130
	0.0004	**0.9492**	**0.0346**	**0.0187**	**0.0211**	-	**6.1394**	
NGN	0.0016***	0.0225	-0.1651***	1.5103	0.5908***	-	2.3223***	2852.0210
	0.0001	**0.0265**	**0.0392**	**1.2186**	**0.0663**	-	**0.3146**	
ZAR	0.0003	0.2069**	0.2270***	0.1353***	0.8105***	-	14.3846**	2043.8620
	0.0008	**0.0918**	**0.0385**	**0.0339**	**0.0466**	-	**6.6346**	
TND	0.0000	1.5900*	0.2919***	0.0737***	0.9002***	-	25.6035	2725.0570
	0.0004	**0.9194**	**0.0358**	**0.0185**	**0.0245**	-	**21.3870**	
				Skewed Student t Distribution				
BWP	0.2893***	0.1321*	-0.0581	0.0975***	0.8577***	0.2707***	7.1974***	-1426.9900
	0.0509	0.0793	**0.0369**	**0.0357**	**0.0546**	**0.0532**	1.8933	
EGP	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	
GHS	0.0013***	0.0322***	0.1368***	0.7136***	0.5479***	-0.0567	3.2119***	2795.3650
	0.0002	**0.0131**	**0.0516**	**0.1848**	**0.0538**	**0.0469**	**0.5301**	
MAD	0.0246	0.0156*	0.2652***	0.0817***	0.8995***	-0.1142**	17.4885**	-957.6290
	0.0389	**0.0087**	**0.0352**	**0.0182**	**0.0195**	**0.0554**	**9.1218**	
NGN	0.0014***	0.0213	-0.1703***	1.4528	0.6082***	-0.0762**	2.3127***	2854.2800
	0.0001	**0.0248**	**0.0387**	**1.2114**	**0.0661**	**0.0338**	**0.3180**	
ZAR	-0.0258	0.1632**	0.1989***	0.1253***	0.8333***	-0.2487***	19.0258*	-1542.5650
	0.0745	**0.0798**	**0.0384**	**0.0305**	**0.0431**	0.0559	**10.9780**	
TND	-0.0043	0.0150*	0.2872***	0.0762***	0.8996***	-0.0886*	32.1585	-870.1860
	0.0367	**0.0085**	**0.0367**	**0.0185**	**0.0228**	**0.0521**	**33.3640**	

Note: The Table shows parameter estimates for the AR(1)-GARCH(1,1) under Gaussian, Student and Skewed Student innovation settings for weekly carry trade returns financed by the USD. Each currency pair has a total of 781 observations from January 2001 to December 2015. The asterisks '***', '**' and '*' represent significance at 1%, 5% and 10% respectively. The standard errors are in parentheses below each parameter estimates.

Table A2: AR(1)-GARCH(1,1) Results for African Currency Carry Trade Financed by Euros (Weekly Returns)

Currrency	Cst(M)	Cst(V)	AR(1)	ARCH(Alpha1)	GARCH(Beta1)	Asymmetry	Tail	Log-likelihood
				Funding Currency: Euros				
				Gaussian Distribution				
BWP	0.0014**	0.6326	-0.1180***	0.2457	0.5574	-	-	2112.1900
	0.0006	0.7376	**0.0431**	**0.1581**	**0.3780**	**-**	**-**	
EGP	0.0012**	0.0790	0.2559***	0.1226*	0.8354***	-	-	2358.5240
	0.0006	**0.0793**	**0.0399**	**0.0647**	**0.0926**	**-**	**-**	
GHS	0.0007	0.1206	0.1964***	0.1740***	0.7714***	-	-	2218.4800
	0.0006	**0.0841**	**0.0410**	**0.0659**	**0.0832**	**-**	**-**	
MAD	0.0002*	0.1205	0.1855***	0.1451***	0.8569***	-	-	3565.9400
	0.0001	**0.0930**	**0.0378**	**0.0438**	**0.0188**	**-**	**-**	
NGN	0.0017***	0.0180	-0.0725	0.5864***	0.6084***	-	-	2735.8810
	0.0002	**0.0168**	**0.0752**	**0.1080**	**0.0510**	**-**	**-**	
ZAR	0.0005	0.3978*	0.2265***	0.1518***	0.7201***	-	-	2089.1010
	0.0008	**0.2385**	**0.0395**	**0.0486**	**0.1131**	**-**	**-**	
TND	-0.0002	1.3249**	0.1953***	0.1214***	0.8137***	-	-	3153.4520
	0.0002	**0.6728**	**0.0393**	**0.0398**	**0.0606**	**-**	**-**	
				Student t Distribution				
BWP	0.0016***	0.7632	-0.0996***	0.2173**	0.5272	-	5.5734***	2140.8400
	0.0005	**0.6876**	**0.0390**	**0.1125**	**0.3388**	**-**	**1.1689**	
EGP	0.0007	0.0292**	0.2601***	0.0995***	0.8871***	-	6.8671***	2392.7530
	0.0005	**0.0150**	**0.0355**	**0.0259**	**0.0243**	**-**	**1.8337**	
GHS	0.0005	0.0760	0.2057***	0.1261*	0.8473***	-	7.6287***	2230.3450
	0.0006	**0.0943**	**0.0389**	**0.0693**	**0.1031**	**-**	**1.9479**	
MAD	0.0002	0.1915**	0.2083***	0.1054***	0.8709***	-	9.0528***	3588.5730
	0.0001	**0.0793**	**0.0370**	**0.0262**	**0.0262**	**-**	**3.5362**	
NGN	0.0016***	0.0225	-0.1651***	1.5103	0.5908***	-	2.3223***	2852.0210
	0.0001	**0.0265**	**0.0392**	**1.2186**	**0.0663**	**-**	**0.3146**	
ZAR	0.0009	0.3596	0.2140***	0.1249**	0.7580***	-	8.6221***	2095.9780
	0.0008	**0.3647**	**0.0385**	**0.0617**	**0.1747**	**-**	**2.3562**	
TND	0.0009	0.3596	0.2140***	0.1249**	0.7580***	-	8.6221***	2095.9780
	0.0008	**0.3647**	**0.0385**	**0.0617**	**0.1747**	**-**	**2.3562**	
				Skewed Student t Distribution				
BWP	0.1145**	0.5303	-0.1007***	0.1711**	0.6484**	-0.1018**	5.7985***	-1453.86
	0.0586	**0.4868**	**0.0394**	**0.0825**	**0.2476**	**0.0515**	**1.2314**	
EGP	0.0008*	0.0282*	0.2597***	0.0994***	0.8881***	0.0320	6.7570***	2393.62
	0.0005	**0.0148**	**0.0356**	**0.0259**	**0.0238**	**0.0592**	**1.7741**	
GHS	0.2526***	1.9113***	0.0141	0.1587	-0.0785	0.2132*	12.0402	-418.492
	0.0962	**0.4915**	**0.0695**	**0.1072**	**0.1807**	**0.1127**	**8.4891**	
MAD	0.0180*	0.0018**	0.2073***	0.1059***	0.8724***	0.0408	9.0329	-7.7644
	0.0107	**0.0008**	**0.0373**	**0.0262**	**0.0259**	**0.0522**	**3.5640**	
NGN	0.0014***	0.0213	-0.1700***	1.4528	0.6082***	-0.0762**	2.3127***	2854.2800
	0.0001	0.0248	0.0387	1.2114	0.0661	0.0338	0.3180***	
ZAR	-0.0026	0.2037	0.1692***	0.0977**	0.8362***	-0.2343***	3.1328	-1490.61
	0.0766	**0.1636**	**0.0383**	**0.0478**	**0.0957**	**0.0492**	**0.0030**	
TND	-0.0214	0.0127*	0.1949***	0.1077***	0.8281***	0.0596	24.2610	-441.313
	0.0181	**0.0068**	**0.0389**	**0.0366**	**0.0603**	**0.0516**	**17.5030**	

Note: The Table shows parameter estimates for the AR(1)-GARCH(1,1) under Gaussian, Student and Skewed Student innovation settings for weekly carry trade returns financed by the Euros. Each currency pair has a total of 781 observations from January 2001 to December 2015. The asterisks '***', '**' and '*' represent significance at 1%, 5% and 10% respectively. The standard errors are in parentheses below each parameter estimates.

Table A3: AR(1)-GARCH(1,1) Results for African Currency Carry Trade Financed by JPY (Weekly Returns)

				Funding Currency: Japanese Yen (JPY)				
Currrency	**Cst(M)**	**Cst(V)**	**AR(1)**	**ARCH(Alpha1)**	**GARCH(Beta1)**	**Asymmetry**	**Tail**	**Log-likelihood**
				Gaussian Distribution				
BWP	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	
EGP	0.0011**	0.1357	0.2381***	0.0799*	0.8334***	-	-	2344.6230
	0.0005	**0.0885**	**0.0401**	**0.0469**	**0.0835**	-	-	
GHS	0.0018***	0.1934***	0.2561***	0.2340***	0.7075***	-	-	2206.9900
	0.0006	**0.0678**	**0.0426**	**0.0617**	**0.0543**	-	-	
MAD	0.0010**	0.0566**	0.2121***	0.1244***	0.8375	-	-	2412.3590
	0.0004	**0.0262**	**0.0368**	**0.0302**	**0.0351**	-	-	
NGN	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	
ZAR	0.0015	0.3458**	0.2024***	0.1302***	0.7979***	-	-	1801.4140
	0.0009	**0.1785**	**0.0440**	**0.0515**	**0.0683**	-	-	
TND	0.0007	0.0550**	0.1965***	0.1060***	0.8491***	-	-	2302.8540
	0.0004	**0.0248**	**0.0375**	**0.0294**	**0.0386**	-	-	
				Student t Distribution				
BWP	0.0028***	3.6774***	-0.0560	0.1250	0.1874	-	3.3544***	1819.9150
	0.0006	1.2906	**0.0353**	**0.0968**	**0.1156**	-	0.7485	
EGP	0.0015***	0.0889**	0.2318***	0.0920***	0.8470***	-	6.8234***	2241.8790
	0.0005	**0.0366**	**0.0368**	**0.0310**	**0.0409**	-	**1.5577**	
GHS	0.0015**	0.2056***	0.2532***	0.1887***	0.7312***	-	6.1884***	2099.5490
	0.0006	**0.0700**	**0.0401**	**0.0426**	**0.0461**	-	**1.3762**	
MAD	0.0012***	0.0430**	0.1990***	0.1057***	0.8640***	-	10.5676***	2272.7130
	0.0005	**0.0213**	**0.0371**	**0.0286**	**0.0336**	-	**3.3955**	
NGN	0.0018***	3.0202***	-0.0391***	0.4499***	-0.0018***	-	3.2350***	1928.8460
	0.0005	**0.8876**	**0.0007**	**0.1609**	**0.0000**	-	**0.7314**	
ZAR	0.0019**	0.2650	0.1788***	0.0991**	0.8433***	-	8.2101***	1814.2290
	0.0009	**0.1631**	**0.0385**	**0.0416**	**0.0662**	-	**2.3078**	
TND	0.0009**	0.0512**	0.1893***	0.0943***	0.8629***	-	12.5801***	2306.5850
	0.0005	0.0258	0.0367	0.0292	0.0414	-	4.9033	
				Skewed Student t Distribution				
BWP	0.0013*	3.5215***	-0.0543	0.1979*	0.1580**	-0.1749***	3.5011***	1952.6800
	0.0007	**1.0757**	**0.0405**	**0.1133**	**0.0702**	**0.0622**	**0.8104**	
EGP	0.0013***	0.0936**	0.2357***	0.0757***	0.8610***	-0.0783	6.0673***	2384.4350
	0.0005	**0.0389**	**0.0347**	**0.0287**	**0.0420**	**0.0549**	**1.3188**	
GHS	0.0017***	0.2227***	0.2534***	0.2086***	0.7108***	-0.0174	6.5399***	2226.3790
	0.0006	**0.0758**	**0.0394**	**0.0442**	**0.0497**	**0.0541**	**1.5062**	
MAD	0.0010**	0.0509**	0.1934***	0.1084***	0.8557***	-0.1171**	10.2732***	2420.7280
	0.0004	**0.0257**	**0.0369**	**0.0313**	**0.0395**	**0.0578**	**3.2827**	
NGN	0.0011*	2.9045***	-0.0607	0.4487***	0.0067	0.1105**	3.3229***	1930.1910
	0.0006	**0.8174**	**0.0459**	**0.1608**	**0.0167**	**0.0548**	**0.7588**	
ZAR	0.0007	0.2515*	0.1871***	0.1102***	0.8367***	-0.2210***	9.3191***	1960.2650
	0.0008	**0.1351**	**0.0364**	**0.0371**	**0.0581**	0.0604	**3.1419**	
TND	0.0008*	0.0561*	0.1857***	0.0901***	0.8621***	-0.1199**	11.4365***	2460.8140
	0.0004	**0.0296**	**0.0359**	**0.0301**	**0.0464**	**0.0514**	**4.0436**	

Note: The Table shows parameter estimates for the AR(1)-GARCH(1,1) under Gaussian, Student and Skewed Student innovation settings for weekly carry trade returns financed by the JPY. Each currency pair has a total of 781 observations from January 2001 to December 2015. The asterisk '***', '**' and '*' represent significance at 1%, 5% and 10% respectively. The standard errors are in parentheses below each parameter estimates.

Table A4: AR(1)-GARCH(1,1) Results for African Currency Carry Trade Financed by GBP (Weekly Returns)

Funding Currency: Great British Pounds Sterling (GBP)								
Currrency	**Cst(M)**	**Cst(V)**	**AR(1)**	**ARCH(Alpha1)**	**GARCH(Beta1)**	**Asymmetry**	**Tail**	**Log-likelihood**
Gaussian Distribution								
BWP	0.0953	0.3780	-0.0907**	0.1500**	0.7285***	-	-	-1484.7500
	0.0618	**0.3540**	**0.0407**	**0.0758**	**0.1683**	**-**	**-**	
EGP	0.0462	0.1902*	0.2635***	0.1075**	0.7484***	-	-	-1187.5970
	0.0477	**0.1096**	**0.0393**	**0.0479**	**0.1095**	**-**	**-**	
GHS	0.0933*	0.1975***	0.2110***	0.2452***	0.6826***	-	-	-1343.5900
	0.0537	**0.0629**	**0.0416**	**0.0623**	**0.0595**	**-**	**-**	
MAD	-0.0063	0.0284**	0.1726***	0.1053***	0.8471***	-	-	-854.2030
	0.0286	**0.0121**	**0.0394**	**0.0370**	**0.0430**	**-**	**-**	
NGN	0.1228***	0.1933***	-0.0141	0.2258***	0.7140***	-	-	-1427.7050
	0.0440	**0.0711**	**0.0387**	**0.0451**	**0.0512**	**-**	**-**	
ZAR	0.0096	0.1742***	0.22840***	0.1260***	0.8190***	-	-	-1489.9870
	0.0690	**0.0704**	**0.0388**	**0.0298**	**0.0370**	**-**	**-**	
TND	-0.0264	0.0216**	0.1835***	0.0743***	0.8897***	-	-	-867.4840
	0.0297	**0.0096**	**0.0393**	**0.0268**	**0.0303**	**-**	**-**	
Student t Distribution								
BWP	0.0965**	0.2235	-0.0931***	0.1396*	0.7912***	-	5.2466***	-1439.4510
	0.0482	0.2302	**0.0372**	**0.0815**	**0.1488**	**-**	1.1306	
EGP	0.0535	0.0721*	0.2365***	0.0811**	0.8625***	-	5.5296***	-1141.3700
	0.0437	**0.0390**	**0.0350**	**0.0341**	**0.0569**	**-**	**1.1938**	
GHS	0.0720	0.2385***	0.2011***	0.2018***	0.6929***	-	6.5064***	-1327.9720
	0.0520	**0.0722**	**0.0383**	**0.0484**	**0.0583**	**-**	**1.3559**	
MAD	-0.0046	0.0232**	0.1834***	0.0787***	0.8802***	-	10.3616***	-846.8740
	0.0291	**0.0114**	**0.0368**	**0.0269**	**0.0383**	**-**	**3.3712**	
NGN	0.1290***	0.2241***	-0.0307	0.2152***	0.7082***	-	13.2384***	-1424.6780
	0.0440	**0.0835**	**0.0395**	**0.0475**	**0.0574**	**-**	**5.0852**	
ZAR	0.0406	0.2090**	0.2231***	0.1089***	0.8210***	-	9.4690***	-1483.8160
	0.0726	**0.0875**	**0.0375**	**0.0295**	**0.0445**	**-**	**2.8853**	
TND	-0.0289	0.0177*	0.1936***	0.0537***	0.9151***	-	9.8853***	-858.4860
	0.0299	**0.0099**	**0.0362**	**0.0207**	**0.0314**	**-**	**2.9878**	
Skewed Student t Distribution								
BWP	0.0478	0.1221	-0.0918***	0.1059	0.8591***	0.1096*	5.3544***	-1437.3680
	0.0591	**0.2097**	**0.0375**	**0.0946**	**0.1577**	**0.0622**	**1.1644**	
EGP	0.0582	0.0718*	0.2358***	0.0807**	0.8632***	0.0151	5.4914***	-1141.3300
	0.0440	**0.0391**	**0.0353**	**0.0343**	**0.0572**	**0.0546**	**1.1614**	
GHS	0.0782	0.2413***	0.2015***	0.2026***	0.6908***	0.0164	6.4933	-1327.9190
	0.0544	**0.0727**	**0.0382**	**0.0486**	**0.0586**	**0.0491**	**1.3524**	
MAD	0.0015	0.0234**	0.1782***	0.0782***	0.8802***	0.0547	10.3098***	-846.2990
	0.0293	**0.0113**	**0.0369**	**0.0270**	**0.0381**	**0.0503**	**3.3731**	
NGN	0.1205***	0.2275***	-0.0292	0.2190***	0.7031***	-0.0719	14.8007**	-1423.7930
	0.0440	**0.0800**	**0.0397**	**0.0465**	**0.0543**	**0.0561**	**6.4724**	
ZAR	-0.0252	0.1601**	0.2023***	0.1010***	0.8473***	-0.1836***	8.9100***	-1477.3600
	0.0697	**0.0678**	**0.0368**	**0.0283**	**0.0389**	0.0467	**2.6843**	
TND	-0.0186	0.0181*	0.1852***	0.0534***	0.9146***	0.0912	9.8907***	-857.0770
	0.0298	**0.0100**	**0.0362**	**0.0210**	**0.0318**	**0.0579**	**2.9996**	

Note: The Table shows parameter estimates for the AR(1)-GARCH(1,1) under Gaussian, Student and Skewed Student innovation settings for weekly carry trade returns financed by the GBP. Each currency pair has a total of 781 observations from January 2001 to December 2015. The asterisks '***', '**' and '*' represent significance at 1%, 5% and 10% respectively. The standard errors are in parentheses below each parameter estimates.

Appendix B: In-Sample and Out-of-Sample Backtesting (for Gaussian and Student t) for African Currency Carry Trade Returns

Table B1: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by US Dollars

Carry Trade	*Quantile*	Success Rate	Kupiec LRT	Kupiec P-Value	Expected Shortfall 1	Expected Shortfall 2	Dynamic Q Statistics	Dynamic Q P-Value
Gaussian Distribution								
Short Position								
USDBWP	0.9500	0.9488	0.0241	0.8765	0.0441	1.4901	8.2930	0.2174
	0.9750	0.9693	0.9815	0.3218	0.0530	1.4963	5.2259	0.5152
	0.9900	0.9770	9.8137	0.0017	0.0580	1.4006	20.6190	0.0021
	0.9950	0.9834	13.1870	0.0003	0.0648	1.3923	33.8440	0.0000
	0.9975	0.9885	13.4750	0.0002	0.0679	1.4231	27.9290	0.0001
USDEGP	0.9500	0.9846	26.7560	0.0000	0.0093	1.5617	20.0550	0.0027
	0.9750	0.9898	8.9475	0.0028	0.0112	1.5290	7.1622	0.3061
	0.9900	0.9936	1.1705	0.2793	0.0120	1.5239	1.1295	0.9802
	0.9950	0.9962	0.2292	0.6321	0.0136	1.6791	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0165	1.8445	0.0280	1.0000
USDGHS	0.9500	0.9795	18.2570	0.0000	0.0455	1.9801	15.4900	0.0168
	0.9750	0.9859	4.5215	0.0335	0.0507	2.0024	6.9087	0.3294
	0.9900	0.9910	0.0879	0.7668	0.0689	2.1428	13.4940	0.0358
	0.9950	0.9923	0.9697	0.3248	0.0777	2.1077	33.3130	0.0000
	0.9975	0.9936	3.3202	0.0684	0.0844	2.1425	5.1943	0.5191
USDMAD	0.9500	0.9565	0.7175	0.3970	0.0180	1.2183	4.1094	0.6619
	0.9750	0.9808	1.1675	0.2799	0.0207	1.1605	3.3241	0.7672
	0.9900	0.9923	0.4605	0.4974	0.0262	1.0923	0.6116	0.9962
	0.9950	0.9974	1.1382	0.2860	0.0401	1.0964	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	0.0548	1.0147	0.4692	0.9982
USDNGN	0.9500	0.9642	3.6360	0.0565	0.0212	1.3360	5.5958	0.4700
	0.9750	0.9821	1.7761	0.1826	0.0200	1.3793	2.6286	0.8538
	0.9900	0.9898	0.0046	0.9457	0.0245	1.3751	0.4550	0.9983
	0.9950	0.9910	1.9935	0.1580	0.0246	1.2947	3.0596	0.8013
	0.9975	0.9923	5.3979	0.0202	0.0268	1.2409	9.1517	0.1652
USDZAR	0.9500	0.9629	2.9778	0.0844	0.0338	1.1933	7.0485	0.3164
	0.9750	0.9834	2.5303	0.1117	0.0356	1.1081	4.7610	0.5748
	0.9900	0.9949	2.2859	0.1306	0.0429	1.0462	1.9326	0.9258
	0.9950	0.9987	3.0963	0.0785	0.0415	1.0404	2.1737	0.9031
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDTND	0.9500	0.9513	0.0300	0.8626	0.0154	1.2296	3.8151	0.7017
	0.9750	0.9795	0.6949	0.4045	0.0179	1.1641	2.2027	0.9001
	0.9900	0.9936	1.1705	0.2793	0.0237	1.1490	1.1295	0.9802
	0.9950	0.9962	0.2292	0.6321	0.0272	1.0808	0.2566	0.9997
	0.9975	0.9987	0.5679	0.4511	0.0479	1.0758	0.4692	0.9982

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest USD dollars. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Gaussian(normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B2: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by US Dollars

Gaussian Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.0500**	0.0307	7.0374	0.0080	-0.0251	1.1709	7.7355	0.2581
	0.0250	0.0077	13.1300	0.0003	-0.0265	1.1236	9.6864	0.1385
	0.0100	0.0013	9.5690	0.0020	-0.0303	1.0361	5.9989	0.4233
	0.0050	0.0000	-	0.0000	-	-	3.9246	0.6869
	0.0025	**0.0000**	**-**	**0.0000**	-	-	1.9574	0.9236
USDEGP	**0.0500**	0.0282	9.2416	0.0024	-0.0163	2.5632	11.1480	0.0839
	0.0250	**0.0230**	**0.1254**	**0.7233**	-0.0183	2.3305	7.5907	0.2697
	0.0100	0.0115	0.1746	0.6761	-0.0271	2.9259	0.8281	0.9913
	0.0050	**0.0102**	**3.3066**	**0.0690**	-0.0298	2.8168	5.2085	0.5174
	0.0025	0.0102	10.5170	0.0012	-0.0298	2.5579	20.5550	0.0022
USDGHS	**0.0500**	0.0371	2.9778	0.0844	-0.0262	1.4184	18.3710	0.0054
	0.0250	0.0166	2.5303	0.1117	-0.0423	1.3904	6.9692	0.3237
	0.0100	0.0064	1.1705	0.2793	-0.0606	1.4894	1.1295	0.9802
	0.0050	0.0051	0.0023	0.9617	-0.0680	1.4035	0.1114	1.0000
	0.0025	0.0051	1.6479	0.1993	-0.0680	1.2557	2.3692	0.8828
USDMAD	**0.0500**	0.0563	0.6356	0.4253	-0.0174	1.3405	3.2193	0.7809
	0.0250	0.0282	0.3093	0.5781	-0.0212	1.3357	3.1931	0.7842
	0.0100	0.0141	1.1680	0.2798	-0.0246	1.3390	2.5085	0.8675
	0.0050	0.0102	3.3066	0.0690	-0.0273	1.3046	5.2085	0.5174
	0.0025	0.0090	7.8130	0.0052	-0.0276	1.2293	14.2640	0.0268
USDNGN	**0.0500**	0.0563	0.6356	0.4253	-0.0216	1.7757	5.1892	0.5198
	0.0250	0.0397	5.8859	0.0153	-0.0223	1.6425	15.4040	0.0173
	0.0100	0.0294	19.6050	0.0000	-0.0252	1.4919	66.3490	0.0000
	0.0050	0.0230	27.0790	0.0000	-0.0250	1.4376	62.5910	0.0000
	0.0025	0.0205	39.4710	0.0000	-0.0257	1.3466	123.3500	0.0000
USDZAR	**0.0500**	0.0640	2.9804	0.0843	-0.0413	1.3265	6.6873	0.3507
	0.0250	0.0371	4.1132	0.0426	-0.0499	1.2483	7.7200	0.2594
	0.0100	0.0141	1.1680	0.2798	-0.0679	1.2916	39.6510	0.0000
	0.0050	0.0102	3.3066	0.0690	-0.0676	1.2576	26.9900	0.0001
	0.0025	0.0077	5.3979	0.0202	-0.0691	1.2283	9.1517	0.1652
USDTND	**0.0500**	0.0538	0.2292	0.6321	-0.0154	1.3277	5.1531	0.5243
	0.0250	0.0282	0.3093	0.5781	-0.0180	1.2899	3.5921	0.7317
	0.0100	0.0166	2.9031	0.0884	-0.0205	1.2063	9.6065	0.1422
	0.0050	0.0090	1.9935	0.1580	-0.0234	1.2180	28.2190	0.0001
	0.0025	0.0051	1.6479	0.1993	-0.0217	1.2333	2.3692	0.8828

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest USD dollars. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Gaussian(normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B3: Out-of-Sample Value-at-Risk Backtesting of African Carry Trade Funded by US Dollars

Gaussian Distribution								
Short Position								
Carry Trade	***Quan-*** **tile**	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.9500**	0.9692	2.3324	0.1267	0.0391	1.4060	2.0243	0.1548
	0.9750	0.9846	1.1405	0.2855	0.0469	1.4861	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0524	1.3828	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	0.0605	1.4018	0.3788	0.5382
	0.9975	**0.9923**	1.8028	0.1794	0.0605	1.2907	2.8109	0.0936
USDEGP	**0.9500**	0.9808	6.7012	0.0096	0.0066	1.7380	5.1822	0.0228
	0.9750	**0.9808**	**0.3852**	**0.5348**	0.0066	1.5369	0.3550	0.5513
	0.9900	0.9846	0.6539	0.4187	0.0072	1.4463	0.7615	0.3829
	0.9950	**0.9846**	**3.6197**	**0.0571**	0.0072	1.3432	5.6359	0.0176
	0.9975	0.9846	7.8801	0.0050	0.0072	1.2606	17.3090	0.0000
USDGHS	**0.9500**	0.9731	3.4780	0.0622	0.0527	1.5478	2.9150	0.0878
	0.9750	0.9808	0.3852	0.5348	0.0485	1.4409	0.3550	0.5513
	0.9900	0.9846	0.6539	0.4187	0.0557	1.3013	0.7615	0.3829
	0.9950	0.9885	1.6287	0.2019	0.0690	1.2686	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0813	1.2875	2.8109	0.0936
USDMAD	**0.9500**	0.9769	4.9183	0.0266	0.0186	1.2534	3.9676	0.0464
	0.9750	0.9885	2.4090	0.1206	0.0186	1.1872	1.9329	0.1644
	0.9900	0.9962	1.2989	0.2544	0.0255	1.2196	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0255	1.0874	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDNGN	**0.9500**	0.9731	3.4780	0.0622	0.0172	1.5125	2.9150	0.0878
	0.9750	0.9846	1.1405	0.2855	0.0215	1.5930	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0257	1.5240	0.0622	0.8031
	0.9950	0.9885	1.6287	0.2019	0.0257	1.3845	2.2342	0.1350
	0.9975	0.9885	4.4977	0.0339	0.0257	1.2762	8.5174	0.0035
USDZAR	**0.9500**	0.9808	6.7012	0.0096	0.0294	1.1027	5.1822	0.0228
	0.9750	1.0000	-	0.0000	-	-	6.6667	0.0098
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.65163	0.4195
USDTND	**0.9500**	0.9500	0.0000	1.0000	0.0138	1.1935	0.0000	1.0000
	0.9750	0.9846	1.1405	0.2855	0.0151	1.1641	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0142	1.2703	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0142	1.1094	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195

The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Gaussian(normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B4: Out-of-Sample Value-at-Risk Backtesting of African Carry Trade Funded by US Dollars

Gaussian Distribution								
Long Position								
Carry Trade	***Quan-*** **tile**	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.0500**	0.0154	8.8948	0.0029	-0.0224	1.0736	6.5587	0.0104
	0.0250	0.0000	-	0.0000	-	-	6.6667	0.0098
	0.0100	0.0000	-	0.0000	-	-	2.6263	0.1051
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
USDEGP	**0.0500**	0.0500	0.0000	1.0000	-0.0102	5.8867	0.0000	1.0000
	0.0250	**0.0385**	**1.6642**	**0.1970**	-0.0128	4.7937	1.9329	0.1644
	0.0100	0.0269	5.1412	0.0234	-0.0133	4.5919	7.5214	0.0061
	0.0050	**0.0192**	**6.1239**	**0.0133**	-0.0166	5.0737	10.5840	0.0011
	0.0025	0.0115	4.4977	0.0339	-0.0249	6.7792	8.5174	0.0035
USDGHS	**0.0500**	0.0500	0.0000	1.0000	-0.0276	1.2316	0.0000	1.0000
	0.0250	0.0231	0.0405	0.8406	-0.0426	1.1501	0.0394	0.8426
	0.0100	0.0038	1.2989	0.2544	-0.0238	1.2873	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0238	1.1710	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0238	1.0806	0.1889	0.6638
USDMAD	**0.0500**	0.0538	0.0791	0.7786	-0.0178	1.3039	0.0810	0.7760
	0.0250	0.0269	0.0385	0.8445	-0.0211	1.3003	0.0394	0.8426
	0.0100	0.0154	0.6539	0.4187	-0.0247	1.2384	0.7615	0.3829
	0.0050	0.0115	1.6287	0.2019	-0.0276	1.1917	2.2342	0.1350
	0.0025	0.0115	4.4977	0.0339	-0.0276	1.0966	8.5174	0.0035
USDNGN	**0.0500**	0.0615	0.6811	0.4092	-0.0181	1.6522	0.7287	0.3933
	0.0250	0.0462	3.8347	0.0502	-0.0187	1.4917	4.7732	0.0289
	0.0100	0.0308	7.2970	0.0069	-0.0154	1.4133	11.3290	0.0008
	0.0050	0.0115	1.6287	0.2019	-0.0188	1.7898	2.2342	0.1350
	0.0025	0.0077	1.8028	0.1794	-0.0244	1.9463	2.8109	0.0936
USDZAR	**0.0500**	0.0654	1.1861	0.2761	-0.0338	1.1970	1.2955	0.2550
	0.0250	0.0192	0.3852	0.5348	-0.0466	1.1735	0.3550	0.5513
	0.0100	0.0115	0.0592	0.8077	-0.0581	1.0902	0.0622	0.8031
	0.0050	0.0038	0.0756	0.7833	-0.0741	1.1291	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0741	1.0425	0.1889	0.6638
USDTND	**0.0500**	0.0500	0.0000	1.0000	-0.0149	1.3064	0.0000	1.0000
	0.0250	0.0308	0.3311	0.5650	-0.0166	1.2007	0.3550	0.5513
	0.0100	0.0154	0.6539	0.4187	-0.0188	1.1107	0.7615	0.3829
	0.0050	0.0077	0.3250	0.5686	-0.0216	1.0558	0.3788	0.5382
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the long postion out-of-sample results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA (1, 0)-GARCH(1, 1) with Gaussian(normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B5: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by US Dollars

Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.9500**	0.9449	0.4078	0.5231	0.0442	1.5545	17.5590	0.0074
	0.9750	0.9667	1.9981	0.1575	0.0525	1.4914	9.6430	0.1405
	0.9900	0.9808	5.2664	0.0217	0.0630	1.4160	15.9210	0.0142
	0.9950	0.9885	4.8729	0.0273	0.0757	1.4054	26.2390	0.0002
	0.9975	**0.9923**	**5.3979**	**0.0202**	0.0795	1.3521	9.1517	0.1652
USDEGP	**0.9500**	0.9642	3.6360	0.0565	0.0074	1.6399	4.8883	0.5582
	0.9750	**0.9834**	**2.5303**	**0.1117**	0.0098	1.7030	3.0521	0.8023
	0.9900	0.9936	1.1705	0.2793	0.0120	1.7074	1.1295	0.9802
	0.9950	**0.9962**	**0.2292**	**0.6321**	0.0152	1.5658	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0137	1.2350	0.0280	1.0000
USDGHS	**0.9500**	0.9642	3.6360	0.0565	0.0357	2.4138	4.8164	0.5676
	0.9750	0.9795	0.6949	0.4045	0.0465	2.5997	5.2916	0.5070
	0.9900	0.9923	0.4605	0.4974	0.0776	3.6176	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0792	3.9052	0.1114	1.0000
	0.9975	0.9974	0.0011	0.9730	0.1409	5.3622	0.0280	1.0000
USDMAD	**0.9500**	0.9565	0.7175	0.3970	0.0180	1.2160	4.1094	0.6619
	0.9750	0.9846	3.4412	0.0636	0.0212	1.1726	3.6122	0.7290
	0.9900	0.9974	6.2145	0.0127	0.0401	1.1462	4.3727	0.6264
	0.9950	0.9974	1.1382	0.2860	0.0401	1.0115	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDNGN	**0.9500**	0.9526	0.1152	0.7343	0.0184	1.3925	4.005	0.6760
	0.9750	0.9834	2.5303	0.1117	0.0193	1.3513	3.0521	0.8023
	0.9900	0.9974	6.2145	0.0127	0.0356	1.4083	4.3727	0.6264
	0.9950	0.9974	1.1382	0.2860	0.0356	1.0475	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDZAR	**0.9500**	0.9616	2.3912	0.1220	0.0352	1.1839	6.2956	0.3909
	0.9750	0.9872	5.7864	0.0162	0.0367	1.1091	8.1528	0.2271
	0.9900	0.9987	9.5690	0.0020	0.0415	1.0851	5.9989	0.4233
	0.9950	1.0000	-	0.0000	-	-	3.9246	0.6869
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
USDTND	**0.9500**	0.9513	0.0300	0.8626	0.0154	1.2296	3.8151	0.7017
	0.9750	0.9834	2.5303	0.1117	0.0181	1.1856	3.0521	0.8023
	0.9900	0.9936	1.1705	0.2793	0.0237	1.1200	1.1295	0.9802
	0.9950	0.9974	1.1382	0.2860	0.0311	1.0700	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	0.0479	1.0256	0.4692	0.9982

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B6: In Sample Value-at-Risk of African Carry Trade Funded by US Dollars

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.0500**	0.0359	3.6360	0.0565	-0.0295	1.1456	4.8910	0.5579
	0.0250	0.0051	18.6810	0.0000	-0.0286	1.0574	12.6840	0.0483
	0.0100	0.0000	-	0.0000	-	-	7.8889	0.2464
	0.0050	0.0000	-	0.0000	-	-	3.9246	0.6869
	0.0025	0.0000	-	0.0000	-	-	1.9574	0.9236
USDEGP	**0.0500**	0.0653	3.5258	0.0604	-0.0088	5.1892	10.8040	0.0946
	0.0250	0.0346	2.6272	**0.1050**	-0.0129	3.9619	12.6340	0.0492
	0.0100	0.0154	1.9508	0.1625	-0.0202	4.0217	3.6943	0.7180
	0.0050	0.0102	3.3066	**0.0690**	-0.0281	3.2121	5.2085	0.5174
	0.0025	0.0064	3.3202	0.0684	-0.0405	2.9737	5.1943	0.5191
USDGHS	**0.0500**	0.0538	0.2292	0.6321	-0.0158	1.5601	19.7530	0.0031
	0.0250	0.0282	0.3093	0.5781	-0.0171	1.3590	3.0587	0.8014
	0.0100	0.0038	3.9091	0.0480	-0.0318	1.4138	3.0155	0.8069
	0.0050	0.0013	3.0963	0.0785	-0.0223	1.6196	2.1737	0.9031
	0.0025	0.0013	0.5679	0.4511	-0.0223	1.2608	0.4692	0.9982
USDMAD	**0.0500**	0.0602	1.6041	0.2053	-0.0172	1.3438	4.5194	0.6068
	0.0250	0.0282	0.3093	0.5781	-0.0212	1.3294	3.1931	0.7842
	0.0100	0.0128	0.5698	0.4503	-0.0248	1.3232	1.5105	0.9588
	0.0050	0.0090	1.9935	0.1580	-0.0276	1.2639	3.0596	0.8013
	0.0025	0.0077	5.3979	0.0202	-0.0279	1.1600	9.1517	0.1652
USDNGN	**0.0500**	0.0704	6.1193	0.0134	-0.0194	1.9643	14.6080	0.0235
	0.0250	0.0371	4.1132	0.0426	-0.0219	1.6504	17.4110	0.0079
	0.0100	0.0102	0.0046	0.9457	-0.0275	1.5705	11.3280	0.0788
	0.0050	0.0038	0.2292	0.6321	-0.0179	1.6132	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0215	1.2779	0.0280	1.0000
USDZAR	**0.0500**	0.0653	3.5258	0.0604	-0.0409	1.3412	7.4803	0.2787
	0.0250	0.0371	4.1132	0.0426	-0.0499	1.2434	7.7200	0.2594
	0.0100	0.0128	0.5698	0.4503	-0.0699	1.2824	39.2450	0.0000
	0.0050	0.0077	0.9697	0.3248	-0.0691	1.2639	1.5016	0.9594
	0.0025	0.0064	3.3202	0.0684	-0.0681	1.1689	5.1943	0.5191
USDTND	**0.0500**	0.0551	0.4078	0.5231	-0.0153	1.3358	4.8310	0.5657
	0.0250	0.0282	0.3093	0.5781	-0.0180	1.2883	3.5921	0.7317
	0.0100	0.0141	1.1680	0.2798	-0.0210	1.2213	8.6904	0.1918
	0.0050	0.0064	0.2833	0.5945	-0.0216	1.2617	0.5227	0.9976
	0.0025	0.0051	1.6479	0.1993	-0.0217	1.1839	2.3692	0.8828

Note: The Table shows the long postion in-sample backtesting results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B7: Out of Sample Value-at-Risk of African Carry Trade Funded by US Dollars

Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.9500**	0.9615	0.7890	0.3744	0.0368	1.4029	0.7287	0.3933
	0.9750	0.9885	2.4090	0.1206	0.0524	1.6121	1.9329	0.1644
	0.9900	0.9923	0.1519	0.6967	0.0605	1.4007	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	0.0777	1.3988	0.0696	0.7920
	0.9975	**0.9962**	**0.1620**	**0.6873**	0.0777	1.1921	0.1889	0.6638
USDEGP	**0.9500**	0.9692	2.3324	0.1267	0.0080	1.7866	2.0243	0.1548
	0.9750	**0.9808**	**0.3852**	**0.5348**	0.0105	1.6633	0.3550	0.5513
	0.9900	0.9923	0.1519	0.6967	0.0113	1.8409	0.1399	0.7084
	0.9950	**0.9962**	**0.0756**	**0.7833**	0.0149	1.9223	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0149	1.4590	0.1889	0.6638
USDGHS	**0.9500**	0.9615	0.7890	0.3744	0.0431	1.4213	0.7287	0.3933
	0.9750	0.9808	0.3852	0.5348	0.0607	1.3641	0.3550	0.5513
	0.9900	0.9923	0.1519	0.6967	0.0744	1.1576	0.1399	0.7084
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDMAD	**0.9500**	0.9769	4.9183	0.0266	0.0186	1.2460	3.9676	0.0464
	0.9750	0.9885	2.4090	0.1206	0.0198	1.1501	1.9329	0.1644
	0.9900	0.9962	1.2989	0.2544	0.0255	1.1247	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDNGN	**0.9500**	0.9654	1.4454	0.2293	0.0150	1.5379	1.2955	0.2550
	0.9750	0.9846	1.1405	0.2855	0.0215	1.4871	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0327	1.4212	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0327	1.0487	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDZAR	**0.9500**	0.9808	6.7012	0.0096	0.0294	1.0945	5.1822	0.0228
	0.9750	1.0000	-	0.0000	-	-	6.6667	0.0098
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
USDTND	**0.9500**	0.9539	0.0830	0.7733	0.0137	1.2074	0.0810	0.7760
	0.9750	0.9962	7.3749	0.0066	0.0142	1.6083	4.7732	0.0289
	0.9900	0.9962	1.2989	0.2544	0.0142	1.2325	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0142	1.0558	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B8: In Sample Value-at-Risk of African Carry Trade Funded by US Dollars

Student t Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
USDBWP	**0.0500**	0.0154	8.8948	0.0029	-0.0258	1.0978	6.5587	0.0104
	0.0250	0.0000	-	0.0000	-	-	6.6667	0.0098
	0.0100	0.0000	-	0.0000	-	-	2.6263	0.1051
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
USDEGP	**0.0500**	0.0423	0.3410	0.5593	-0.0112	27.9280	0.3239	0.5693
	0.0250	**0.0269**	**0.0385**	**0.8445**	-0.0132	5.2907	0.0394	0.8426
	0.0100	0.0154	0.6539	0.4187	-0.0166	3.9114	0.7615	0.3829
	0.0050	**0.0154**	**3.6197**	**0.0571**	-0.0166	2.5113	5.6359	0.0176
	0.0025	0.0077	1.8028	0.1794	-0.0283	2.5609	2.8109	0.0936
USDGHS	**0.0500**	0.1039	12.2770	0.0005	-0.0183	1.6417	15.8700	0.0001
	0.0250	0.0538	6.7073	0.0096	-0.0203	1.4649	8.8757	0.0029
	0.0100	0.0231	3.2801	0.0701	-0.0241	1.2364	4.4911	0.0341
	0.0050	0.0038	0.0756	0.7833	-0.0223	1.6622	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0223	1.3125	0.1889	0.6638
USDMAD	**0.0500**	0.0538	0.0791	0.7786	-0.0178	1.3194	0.0810	0.7760
	0.0250	0.0269	0.0385	0.8445	-0.0211	1.2835	0.0394	0.8426
	0.0100	0.0115	0.0592	0.8077	-0.0276	1.2496	0.0622	0.8031
	0.0050	0.0115	1.6287	0.2019	-0.0276	1.1035	2.2342	0.1350
	0.0025	0.0077	1.8028	0.1794	-0.0284	1.0261	2.8109	0.0936
USDNGN	**0.0500**	0.0731	2.5675	0.1091	-0.0164	1.7586	2.9150	0.0878
	0.0250	0.0308	0.3311	0.5650	-0.0154	1.6188	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0294	2.5468	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0294	1.8373	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0294	1.3438	0.1889	0.6638
USDZAR	**0.0500**	0.0692	1.8171	0.1777	-0.0333	1.2141	2.0243	0.1548
	0.0250	0.0192	0.3852	0.5348	-0.0466	1.1711	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0741	1.1813	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0741	1.0354	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
USDTND	**0.0500**	0.0500	0.0000	1.0000	-0.0149	1.3284	0.0000	1.0000
	0.0250	0.0346	0.8823	0.3476	-0.0159	1.1714	0.9862	0.3207
	0.0100	0.0154	0.6539	0.4187	-0.0188	1.0691	0.7615	0.3829
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest USD dollar. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B9: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

Gaussian Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9667	5.1774	0.0229	0.0347	1.3108	7.3614	0.2887
	0.9750	0.9821	1.7761	0.1826	0.0392	1.2828	2.6286	0.8538
	0.9900	0.9910	0.0879	0.7668	0.0464	1.2578	0.3848	0.9990
	0.9950	0.9923	0.9697	0.3248	0.0477	1.1741	1.5016	0.9594
	0.9975	**0.9949**	**1.6479**	**0.1993**	0.0507	1.1384	2.3692	0.8828
EUREGP	**0.9500**	0.9616	2.3912	0.1220	0.0251	1.2691	3.8025	0.7034
	0.9750	**0.9821**	**1.7761**	**0.1826**	0.0305	1.2428	5.8022	0.4457
	0.9900	0.9949	2.2859	0.1306	0.0399	1.4281	1.9326	0.9258
	0.9950	**0.9949**	**0.0023**	**0.9617**	0.0399	1.2946	0.1114	1.0000
	0.9975	0.9962	0.4834	0.4869	0.0429	1.2664	0.6543	0.9954
EURGHS	**0.9500**	0.9501	0.0001	0.9935	0.0358	1.3286	2.7543	0.8390
	0.9750	0.9706	0.6006	0.4383	0.0421	1.2593	6.8409	0.3358
	0.9900	0.9859	1.1680	0.2798	0.0570	1.2538	8.9227	0.1780
	0.9950	0.9898	3.3066	0.0690	0.0597	1.2058	26.9240	0.0001
	0.9975	0.9949	1.6479	0.1993	0.0608	1.2792	2.3692	0.8828
EURMAD	**0.9500**	0.9552	0.4574	0.4988	0.0049	1.3201	2.5855	0.8588
	0.9750	0.9731	0.1116	0.7384	0.0056	1.2508	6.3156	0.3888
	0.9900	0.9846	1.9508	0.1625	0.0060	1.1707	8.9690	0.1753
	0.9950	0.9923	0.9697	0.3248	0.0062	1.1772	1.5016	0.9594
	0.9975	0.9974	0.0011	0.9730	0.0077	1.3156	0.0280	1.0000
EURNGN	**0.9500**	0.9642	3.6360	0.0565	0.0212	1.3360	5.5958	0.4700
	0.9750	0.9821	1.7761	0.1826	0.0200	1.3793	2.6286	0.8538
	0.9900	0.9898	0.0046	0.9457	0.0245	1.3751	0.4550	0.9983
	0.9950	0.9910	1.9935	0.1580	0.0246	1.2947	3.0596	0.8013
	0.9975	0.9923	5.3979	0.0202	0.0268	1.2409	9.1517	0.1652
EURZAR	**0.9500**	0.9680	6.0660	0.0138	0.0369	1.2467	6.5095	0.3686
	0.9750	0.9846	3.4412	0.0636	0.0424	1.1672	3.6122	0.7290
	0.9900	0.9949	2.2859	0.1306	0.0481	1.1107	1.9326	0.9258
	0.9950	0.9962	0.2292	0.6321	0.0510	1.0109	0.2566	0.9997
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
EURTND	**0.9500**	0.9513	0.0300	0.8626	0.0093	1.3421	2.8143	0.8318
	0.9750	0.9718	0.3093	0.5781	0.0108	1.2700	4.7583	0.5752
	0.9900	0.9872	0.5698	0.4503	0.0125	1.2301	8.9725	0.1751
	0.9950	0.9923	0.9697	0.3248	0.0143	1.2273	1.5016	0.9594
	0.9975	0.9936	3.3202	0.0684	0.0146	1.1481	5.1943	0.5191

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B10: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

				Gaussian Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0589	1.2348	0.2665	-0.0362	1.4326	8.2415	0.2209
	0.0250	0.0333	1.9981	0.1575	-0.0437	1.4150	3.4654	0.7486
	0.0100	0.0192	5.2664	0.0217	-0.0529	1.3811	12.3530	0.0545
	0.0050	0.0141	8.6590	0.0033	-0.0569	1.3498	28.1850	0.0001
	0.0025	**0.0090**	**7.8130**	**0.0052**	-0.0658	1.3857	14.2640	0.0268
EUREGP	**0.0500**	0.0371	2.9778	0.0844	-0.0303	1.4658	8.9777	0.1748
	0.0250	**0.0192**	**1.1675**	**0.2799**	-0.0401	1.5141	10.3550	0.1105
	0.0100	0.0102	0.0046	0.9457	-0.0527	1.5952	11.3660	0.0777
	0.0050	**0.0077**	**0.9697**	**0.3248**	-0.0615	1.6124	33.3130	0.0000
	0.0025	0.0051	1.6479	0.1993	-0.0690	1.7476	106.5900	0.0000
EURGHS	**0.0500**	0.0487	0.0300	0.8626	-0.0321	1.3428	1.5659	0.9550
	0.0250	0.0269	0.1116	0.7384	-0.0394	1.2812	3.0581	0.8015
	0.0100	0.0128	0.5698	0.4503	-0.0452	1.2662	1.5105	0.9588
	0.0050	0.0077	0.9697	0.3248	-0.0454	1.2689	1.5016	0.9594
	0.0025	0.0064	3.3202	0.0684	-0.0473	1.2036	5.1943	0.5191
EURMAD	**0.0500**	0.0410	1.4239	0.2328	-0.0062	1.3510	3.3914	0.7584
	0.0250	0.0192	1.1675	0.2799	-0.0078	1.3449	2.2523	0.8951
	0.0100	0.0064	1.1705	0.2793	-0.0129	1.6021	1.1075	0.9812
	0.0050	0.0038	0.2292	0.6321	-0.0164	1.7910	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0198	1.9854	0.0280	1.0000
EURNGN	**0.0500**	0.0563	0.6356	0.4253	-0.0216	1.7757	5.1892	0.5198
	0.0250	0.0397	5.8859	0.0153	-0.0223	1.6425	15.4040	0.0173
	0.0100	0.0294	19.6050	0.0000	-0.0252	1.4919	66.3490	0.0000
	0.0050	0.0230	27.0790	0.0000	-0.0250	1.4376	62.5910	0.0000
	0.0025	0.0205	39.4710	0.0000	-0.0257	1.3466	123.3500	0.0000
EURZAR	**0.0500**	0.0576	0.9116	0.3397	-0.0410	1.4192	5.6955	0.4582
	0.0250	0.0423	7.9275	0.0049	-0.0444	1.2960	21.8340	0.0013
	0.0100	0.0269	15.3890	0.0001	-0.0499	1.1977	59.5100	0.0000
	0.0050	0.0154	10.8380	0.0010	-0.0541	1.1864	80.5630	0.0000
	0.0025	0.0102	10.5170	0.0012	-0.0592	1.1562	20.5550	0.0022
EURTND	**0.0500**	0.0461	0.2572	0.6121	-0.0095	1.2380	7.0319	0.3179
	0.0250	0.0218	0.3500	0.5541	-0.0109	1.1901	7.9318	0.2432
	0.0100	0.0102	0.0046	0.9457	-0.0120	1.1223	0.4550	0.9983
	0.0050	0.0038	0.2292	0.6321	-0.0127	1.0951	0.2566	0.9997
	0.0025	0.0013	0.5679	0.4511	-0.0139	1.0269	0.4692	0.9982

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B11: Out-of-Sample Value-at-Risk of African Carry Trade Funded by Euro

				Gaussian Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9769	4.9183	0.0266	0.0306	1.1819	3.9676	0.0464
	0.9750	0.9885	2.4090	0.1206	0.0309	1.1104	1.9329	0.1644
	0.9900	0.9962	1.2989	0.2544	0.0308	1.0075	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EUREGP	**0.9500**	0.9615	0.7890	0.3744	0.0256	0.0357	0.7287	0.3933
	0.9750	**0.9808**	**0.3852**	**0.5348**	0.0316	1.2200	0.3550	0.5513
	0.9900	0.9885	0.0592	0.8077	0.0320	1.1299	0.0622	0.8031
	0.9950	**0.9923**	**0.3250**	**0.5686**	0.0333	1.0857	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	0.0357	1.0257	0.1889	0.6638
EURGHS	**0.9500**	0.9462	0.0791	0.7786	0.0556	1.3924	0.0810	0.7760
	0.9750	0.9654	0.8823	0.3476	0.0590	1.3350	0.9862	0.3207
	0.9900	0.9769	3.2801	0.0701	0.0752	1.2430	4.4911	0.0341
	0.9950	0.9885	1.6287	0.2019	0.0897	1.3335	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.1083	1.3869	2.8109	0.0936
EURMAD	**0.9500**	0.9385	0.6811	0.4092	0.0046	1.2590	0.7287	0.3933
	0.9750	0.9731	0.0385	0.8445	0.0055	1.2711	0.0394	0.8426
	0.9900	0.9808	1.7617	0.1844	0.0060	1.1135	2.2378	0.1347
	0.9950	0.9923	0.3250	0.5686	0.0059	1.0841	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	0.0062	1.0649	0.1889	0.6638
EURNGN	**0.9500**	0.9731	3.4780	0.0622	0.0172	1.5125	2.9150	0.0878
	0.9750	0.9846	1.1405	0.2855	0.0215	1.5930	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0257	1.5240	0.0622	0.8031
	0.9950	0.9885	1.6287	0.2019	0.0257	1.3845	2.2342	0.1350
	0.9975	0.9885	4.4977	0.0339	0.0257	1.2762	8.5174	0.0035
EURZAR	**0.9500**	0.9885	11.6010	0.0007	0.0311	1.2184	8.0972	0.0044
	0.9750	0.9962	7.3749	0.0066	0.0339	1.1583	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.65163	0.4195
EURTND	**0.9500**	0.9346	1.1861	0.2761	0.0107	1.3865	1.2955	0.2550
	0.9750	0.9615	1.6642	0.1970	0.0127	1.3442	1.9329	0.1644
	0.9900	0.9731	5.1412	0.0234	0.0139	1.2146	7.5214	0.0061
	0.9950	0.9885	1.6287	0.2019	0.0166	1.2920	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0185	1.2843	2.8109	0.0936

Note: The Table shows theshort position out-of-sample results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B12: Out-of-Sample Value-at-Risk of African Carry Trade Funded by Euro

Gaussian Distribution								
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0462	0.0830	0.7733	-0.0333	1.3156	0.0810	0.7760
	0.0250	0.0308	0.3311	0.5650	-0.0378	1.1970	0.3550	0.5513
	0.0100	0.0115	0.0592	0.8077	-0.0461	1.1662	0.0622	0.8031
	0.0050	0.0038	0.0756	0.7833	-0.0470	1.2344	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0470	1.1306	0.1889	0.6638
EUREGP	**0.0500**	0.0308	2.3324	0.1267	-0.0225	1.2432	2.0243	0.1548
	0.0250	**0.0077**	**4.3648**	**0.0367**	-0.0282	1.4001	3.1953	0.0739
	0.0100	0.0077	0.1519	0.6967	-0.0282	1.1553	0.1399	0.7084
	0.0050	**0.0077**	**0.3250**	**0.5686**	-0.0282	1.0326	0.3788	0.5382
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURGHS	**0.0500**	0.0731	2.5675	0.1091	-0.0365	1.4443	2.9150	0.0878
	0.0250	0.0538	6.7073	0.0096	-0.0401	1.3062	8.8757	0.0029
	0.0100	0.0269	5.1412	0.0234	-0.0502	1.2896	7.5214	0.0061
	0.0050	0.0192	6.1239	0.0133	-0.0428	1.2655	10.5840	0.0011
	0.0025	0.0192	11.7760	0.0006	-0.0428	1.1628	29.1840	0.0000
EURMAD	**0.0500**	0.0346	1.4454	0.2293	-0.0068	1.1933	1.2955	0.2550
	0.0250	0.0077	4.3648	0.0367	-0.0104	1.3014	3.1953	0.0739
	0.0100	0.0077	0.1519	0.6967	-0.0104	1.0965	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0098	1.0391	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURNGN	**0.0500**	0.0615	0.6811	0.4092	-0.0181	1.6522	0.7287	0.3933
	0.0250	0.0462	3.8347	0.0502	-0.0187	1.4917	4.7732	0.0289
	0.0100	0.0308	7.2970	0.0069	-0.0154	1.4133	11.3290	0.0008
	0.0050	0.0115	1.6287	0.2019	-0.0188	1.7898	2.2342	0.1350
	0.0025	0.0077	1.8028	0.1794	-0.0244	1.9463	2.8109	0.0936
EURZAR	**0.0500**	0.0538	0.0791	0.7786	-0.0397	1.4862	0.0810	0.7760
	0.0250	0.0462	3.8347	0.0502	-0.0419	1.3115	4.7732	0.0289
	0.0100	0.0269	5.1412	0.0234	-0.0491	1.2292	7.5214	0.0061
	0.0050	0.0154	3.6197	0.0571	-0.0572	1.2329	5.6359	0.0176
	0.0025	0.0154	7.8801	0.0050	-0.0572	1.1357	17.3090	0.0000
EURTND	**0.0500**	0.0538	0.0791	0.7786	-0.0103	1.3116	0.0810	0.7760
	0.0250	0.0308	0.3311	0.5650	-0.0109	1.2398	0.3550	0.5513
	0.0100	0.0192	1.7617	0.1844	-0.0124	1.1486	2.2378	0.1347
	0.0050	0.0115	1.6287	0.2019	-0.0135	1.0853	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-0.0139	1.0536	0.1889	0.6638

Note: The Table shows the long position out-of-sampleresults of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Gaussian(normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test .

Table B13: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

				Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9654	4.3683	0.0366	0.0343	1.3319	6.2079	0.4003
	0.9750	0.9859	4.5215	0.0335	0.0419	1.3178	4.3059	0.6354
	0.9900	0.9936	1.1705	0.2793	0.0497	1.2002	1.1295	0.9802
	0.9950	0.9974	1.1382	0.2860	0.0552	1.1044	0.9476	0.9875
	0.9975	**1.0000**	**-**	**0.0000**	**-**	**-**	1.9574	0.9236
EUREGP	**0.9500**	0.9501	0.0001	0.9935	0.0229	1.2976	4.4172	0.6204
	0.9750	**0.9782**	**0.3500**	**0.5541**	0.0285	1.2481	9.6980	0.1380
	0.9900	0.9949	2.2859	0.1306	0.0399	1.4086	1.9326	0.9258
	0.9950	**0.9949**	**0.0023**	**0.9617**	0.0399	1.2104	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	0.0508	1.4827	0.4692	0.9982
EURGHS	**0.9500**	0.9475	0.1009	0.7507	0.0354	1.3502	1.6571	0.9484
	0.9750	0.9731	0.1116	0.7384	0.0441	1.2767	6.9676	0.3239
	0.9900	0.9885	0.1746	0.6761	0.0637	1.2294	9.9742	0.1257
	0.9950	0.9962	0.2292	0.6321	0.0718	1.3809	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0934	1.3537	0.0280	1.0000
EURMAD	**0.9500**	0.9501	0.0001	0.9935	0.0051	1.3253	3.3202	0.7677
	0.9750	0.9757	0.0146	0.9038	0.0058	1.2776	7.1489	0.3073
	0.9900	0.9910	0.0879	0.7668	0.0068	1.2165	13.0330	0.0425
	0.9950	0.9974	1.1382	0.2860	0.0077	1.3060	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	0.0084	1.2979	0.4692	0.9982
EURNGN	**0.9500**	0.9526	0.1152	0.7343	0.0184	1.3925	4.0050	0.6760
	0.9750	0.9834	2.5303	0.1117	0.0193	1.3513	3.0521	0.8023
	0.9900	0.9974	6.2145	0.0127	0.0356	1.4083	4.3727	0.6264
	0.9950	0.9974	1.1382	0.2860	0.0356	1.0475	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
EURZAR	**0.9500**	0.9680	6.0660	0.0138	0.0379	1.2509	6.5095	0.3686
	0.9750	0.9872	5.7864	0.0162	0.0449	1.1695	5.1306	0.5272
	0.9900	0.9962	3.9091	0.0480	0.0510	1.0470	3.0155	0.8069
	0.9950	1.0000	-	0.0000	-	-	3.9246	0.6869
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
EURND	**0.9500**	0.9526	0.1152	0.7343	0.0094	1.3604	1.5037	0.9593
	0.9750	0.9718	0.3093	0.5781	0.0108	1.2617	4.7583	0.5752
	0.9900	0.9898	0.0046	0.9457	0.0130	1.2560	0.4550	0.9983
	0.9950	0.9923	0.9697	0.3248	0.0143	1.1803	1.5016	0.9594
	0.9975	0.9974	0.0011	0.9730	0.0201	1.2338	0.0280	1.0000

Note: The Table shows the short postion in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA(1, 0)-GARCH(1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B14: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0627	2.4778	0.1155	-0.0359	1.4796	8.9421	0.1769
	0.0250	0.0320	1.4485	0.2288	-0.0444	1.4161	3.8667	0.6947
	0.0100	0.0141	1.1680	0.2798	-0.0569	1.3614	8.9696	0.1753
	0.0050	0.0077	0.9697	0.3248	-0.0668	1.3357	1.5016	0.9594
	0.0025	**0.0026**	**0.0011**	**0.9730**	-0.0966	1.6395	0.0280	1.0000
EUREGP	**0.0500**	0.0384	2.3912	0.1220	-0.0300	1.4904	7.1954	0.3032
	0.0250	**0.0179**	**1.7761**	**0.1826**	-0.0409	1.5305	11.7430	0.0680
	0.0100	0.0090	0.0879	0.7668	-0.0557	1.5790	13.4940	0.0358
	0.0050	**0.0051**	**0.0023**	**0.9617**	-0.0690	1.7227	52.3510	0.0000
	0.0025	0.0038	0.4834	0.4869	-0.0830	1.7142	151.5400	0.0000
EURGHS	**0.0500**	0.0487	0.0300	0.8626	-0.0321	1.3745	2.2268	0.8977
	0.0250	0.0243	0.0146	0.9038	-0.0415	1.2963	2.8091	0.8324
	0.0100	0.0102	0.0046	0.9457	-0.0485	1.2485	0.4550	0.9983
	0.0050	0.0051	0.0023	0.9617	-0.0502	1.2231	0.1114	1.0000
	0.0025	0.0013	0.5679	0.4511	-0.0585	1.3342	0.4692	0.9982
EURMAD	**0.0500**	0.0474	0.1152	0.7343	-0.0061	1.3804	5.1860	0.5202
	0.0250	0.0179	1.7761	0.1826	-0.0084	1.4045	4.0979	0.6634
	0.0100	0.0051	2.2859	0.1306	-0.0151	1.7435	1.9188	0.9270
	0.0050	0.0013	3.0963	0.0785	-0.0348	3.1677	2.1737	0.9031
	0.0025	0.0013	0.5679	0.4511	-0.0348	2.7666	0.4692	0.9982
EURNGN	**0.0500**	0.0704	6.1193	0.0134	-0.0194	1.9643	14.6080	0.0235
	0.0250	0.0371	4.1132	0.0426	-0.0219	1.6504	17.4110	**0.0079**
	0.0100	0.0102	0.0046	0.9457	-0.0275	1.5705	11.3280	0.0788
	0.0050	0.0038	0.2292	0.6321	-0.0179	1.6132	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0215	1.2779	0.0280	1.0000
EURZAR	**0.0500**	0.0602	1.6041	0.2053	-0.0412	1.4376	7.7266	0.2588
	0.0250	0.0410	6.8741	0.0087	-0.0446	1.2908	21.0180	0.0018
	0.0100	0.0192	5.2664	0.0217	-0.0555	1.1941	34.7770	0.0000
	0.0050	0.0102	3.3066	0.0690	-0.0592	1.1431	5.2085	0.5174
	0.0025	0.0038	0.4834	0.4869	-0.0634	1.0749	0.6543	0.9954
EURTND	**0.0500**	0.0448	0.4574	0.4988	-0.0096	1.2534	7.6644	0.2637
	0.0250	0.0218	0.3500	0.5541	-0.0109	1.1852	7.9318	0.2432
	0.0100	0.0090	0.0879	0.7668	-0.0126	1.1114	0.3848	0.9990
	0.0050	0.0038	0.2292	0.6321	-0.0127	1.0525	0.2566	0.9997
	0.0025	0.0000	-	0.0000	-	-	1.9574	0.9236

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B15: Out- of- Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

				Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.9500**	0.9731	3.4780	0.0622	0.0299	1.1801	2.9150	0.0878
	0.9750	0.9885	2.4090	0.1206	0.0309	1.0571	1.9329	0.1644
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EUREGP	**0.9500**	0.9423	0.3093	0.5781	0.0224	1.2510	0.3239	0.5693
	0.9750	**0.9769**	**0.0405**	0.8406	0.0293	1.2287	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	0.0333	1.1815	0.1399	0.7084
	0.9950	**0.9923**	0.3250	**0.5686**	0.0333	1.0159	0.3788	0.5382
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURGHS	**0.9500**	0.9462	0.0791	0.7786	0.0556	1.4358	0.0810	0.7760
	0.9750	0.9654	0.8823	0.3476	0.0590	1.3386	0.9862	0.3207
	0.9900	0.9846	0.6539	0.4187	0.0965	1.3033	0.7615	0.3829
	0.9950	0.9923	0.3250	0.5686	0.1083	1.3944	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	0.1364	1.5602	0.1889	0.6638
EURMAD	**0.9500**	0.9346	1.1861	0.2761	0.0053	1.2781	1.2955	0.2550
	0.9750	0.9731	0.0385	0.8445	0.0055	1.2291	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	0.0071	1.1345	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	0.0062	1.0115	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURNGN	**0.9500**	0.9654	1.4454	0.2293	0.0150	1.5379	1.2955	0.2550
	0.9750	0.9846	1.1405	0.2855	0.0215	1.4871	0.9862	0.3207
	0.9900	0.9962	1.2989	0.2544	0.0327	1.4212	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0327	1.0487	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURZAR	**0.9500**	0.9885	11.6010	0.0007	0.0311	1.1666	8.0972	0.0044
	0.9750	0.9962	7.3749	0.0066	0.0339	1.0761	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
EURTND	**0.9500**	0.9346	1.1861	0.2761	0.0107	1.3945	1.2955	0.2550
	0.9750	0.9615	1.6642	0.1970	0.0127	1.3429	1.9329	0.1644
	0.9900	0.9731	5.1412	0.0234	0.0139	1.2067	7.5214	0.0061
	0.9950	0.9885	1.6287	0.2019	0.0166	1.2788	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0185	1.2655	2.8109	0.0936

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest Euro. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B16: Out of Sample Value-at-Risk Backtesting of African Carry Trade Funded by Euro

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
EURBWP	**0.0500**	0.0462	0.0830	0.7733	-0.0333	1.3850	0.0810	0.7760
	0.0250	0.0231	0.0405	0.8406	-0.0411	1.2522	0.0394	0.8426
	0.0100	0.0038	1.2989	0.2544	-0.0470	1.2392	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0470	1.0404	0.0696	0.7920
	0.0025	**0.0000**	-	0.0000	-	-	0.6516	0.4195
EUREGP	**0.0500**	0.0385	0.7890	0.3744	-0.0227	1.2620	0.7287	0.3933
	0.0250	**0.0077**	4.3648	**0.0367**	-0.0282	1.3963	3.1953	0.0739
	0.0100	0.0038	1.2989	0.2544	-0.0273	1.1272	0.9946	0.3186
	0.0050	**0.0000**	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURGHS	**0.0500**	0.0731	2.5675	0.1091	-0.0365	1.4510	2.9150	0.0878
	0.0250	0.0538	6.7073	0.0096	-0.0401	1.2752	8.8757	0.0029
	0.0100	0.0231	3.2801	0.0701	-0.0532	1.2533	4.4911	0.0341
	0.0050	0.0154	3.6197	0.0571	-0.0445	1.1873	5.6359	0.0176
	0.0025	0.0115	4.4977	0.0339	-0.0474	1.0862	8.5174	0.0035
EURMAD	**0.0500**	0.0423	0.3410	0.5593	-0.0064	1.2837	0.3239	0.5693
	0.0250	0.0192	0.3852	0.5348	-0.0082	1.1845	0.3550	0.5513
	0.0100	0.0077	0.1519	0.6967	-0.0104	1.1283	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0098	1.0283	0.0696	0.7920
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
EURNGN	**0.0500**	0.0731	2.5675	0.1091	-0.0164	1.7586	2.9150	0.0878
	0.0250	0.0308	0.3311	0.5650	-0.0154	1.6188	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0294	2.5468	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0294	1.8373	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0294	1.3438	0.1889	0.6638
EURZAR	**0.0500**	0.0615	0.6811	0.4092	-0.0374	1.4463	0.7287	0.3933
	0.0250	0.0423	2.6544	0.1033	-0.0433	1.3043	3.1953	0.0739
	0.0100	0.0192	1.7617	0.1844	-0.0535	1.2273	2.2378	0.1347
	0.0050	0.0115	1.6287	0.2019	-0.0584	1.1651	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-0.0645	1.1260	0.1889	0.6638
EURTND	**0.0500**	0.0538	0.0791	0.7786	-0.0103	1.3162	0.0810	0.7760
	0.0250	0.0308	0.3311	0.5650	-0.0109	1.2347	0.3550	0.5513
	0.0100	0.0192	1.7617	0.1844	-0.0124	1.1325	2.2378	0.1347
	0.0050	0.0115	1.6287	0.2019	-0.0135	1.0596	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-0.0139	1.0411	0.1889	0.6638

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest USD dollars. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B17: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

				Gaussian Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	0.9962	58.4270	0.0000	0.0317	1.2896	35.0370	0.0000
	0.9750	0.9962	22.1680	0.0000	0.0317	1.0553	14.3540	0.0259
	0.9900	1.0000	-	0.0000	-	-	7.8889	0.2464
	0.9950	1.0000	-	0.0000	-	-	3.9246	0.6869
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
JPYEGP	**0.9500**	0.9693	7.0374	0.0080	0.0260	1.2871	7.7422	0.2576
	0.9750	**0.9872**	5.7864	**0.0162**	0.0335	1.3067	5.1306	0.5272
	0.9900	0.9949	2.2859	0.1306	0.0397	1.4095	1.9326	0.9258
	0.9950	**0.9949**	0.0023	0.9617	0.0397	1.2818	0.1114	1.0000
	0.9975	0.9962	0.4834	0.4869	0.0413	1.2534	0.6543	0.9954
JPYGHS	**0.9500**	0.9578	1.0391	0.3080	0.0374	1.3501	1.6487	0.9490
	0.9750	0.9770	0.1254	0.7233	0.0442	1.3333	3.0876	0.7978
	0.9900	0.9910	0.0879	0.7668	0.0642	1.4373	0.3848	0.9990
	0.9950	0.9923	0.9697	0.3248	0.0708	1.3649	1.5016	0.9594
	0.9975	0.9962	0.4834	0.4869	0.0797	1.5661	0.6543	0.9954
JPYMAD	**0.9500**	0.9578	1.0391	0.3080	0.0250	1.2880	7.1424	0.3079
	0.9750	0.9782	0.3500	0.5541	0.0301	1.2456	2.6208	0.8547
	0.9900	0.9923	0.4605	0.4974	0.0348	1.2740	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	0.0376	1.2722	0.1114	1.0000
	0.9975	0.9974	0.0011	0.9730	0.0484	1.4101	0.0280	1.0000
JPYNGN	**0.9500**	0.9768	13.7310	0.0002	0.0267	2.1928	15.4040	0.0173
	0.9750	0.9850	3.4967	0.0615	0.0293	0.7237	6.0040	0.4227
	0.9900	0.9945	1.8298	0.1762	0.0378	4.1843	1.5909	0.9532
	0.9950	0.9973	0.9111	0.3398	0.0362	2.4909	0.7756	0.9927
	0.9975	0.9986	0.4546	0.5002	0.0320	2.4007	0.3830	0.9990
JPYZAR	**0.9500**	0.9718	9.2416	0.0024	0.0405	1.2304	10.0060	0.1244
	0.9750	0.9898	8.9475	0.0028	0.0500	1.2679	7.1622	0.3061
	0.9900	0.9974	6.2145	0.0127	0.0615	1.4429	4.3727	0.6264
	0.9950	0.9987	3.0963	0.0785	0.0758	1.6820	2.1737	0.9031
	0.9975	0.9987	0.5679	0.4511	0.0758	1.5533	0.4692	0.9982
JPYTND	**0.9500**	0.9603	1.8740	0.1710	0.0232	1.2729	8.2675	0.2192
	0.9750	0.9757	0.0146	0.9038	0.0271	1.1928	2.5427	0.8637
	0.9900	0.9923	0.4605	0.4974	0.0322	1.2321	0.6116	0.9962
	0.9950	0.9962	0.2292	0.6321	0.0368	1.2928	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0443	1.3220	0.0280	1.0000

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B18: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

				Gaussian Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	0.0500	0.0077	45.0740	0.0000	-0.5879	3.6537	29.4850	0.0000
	0.0250	0.0038	22.1680	0.0000	-1.1401	5.1209	14.3540	0.0259
	0.0100	0.0026	6.2145	0.0127	-1.6899	5.9122	4.3727	0.6264
	0.0050	0.0013	3.0963	0.0785	-3.3505	9.6336	2.1737	0.9031
	0.0025	0.0013	0.5679	0.4511	-3.3505	8.8250	0.4692	0.9982
JPYEGP	0.0500	0.0435	0.7175	0.3970	-0.0296	1.5760	2.7522	0.8393
	0.0250	0.0256	0.0118	0.9137	-0.0358	1.5784	2.7420	0.8405
	0.0100	0.0141	1.1680	0.2798	-0.0453	1.6091	8.9227	0.1780
	0.0050	0.0102	3.3066	0.0690	-0.0512	1.6336	26.9240	0.0001
	0.0025	0.0090	7.8130	0.0052	-0.0546	1.5728	66.3160	0.0000
JPYGHS	0.0500	0.0474	0.1152	0.7343	-0.0310	1.4158	4.2823	0.6385
	0.0250	0.0333	1.9981	0.1575	-0.0342	1.2783	4.6941	0.5836
	0.0100	0.0179	4.0120	0.0452	-0.0363	1.2217	10.7070	0.0979
	0.0050	0.0115	4.8729	0.0273	-0.0390	1.1828	7.9601	0.2410
	0.0025	0.0038	0.4834	0.4869	-0.0484	1.3527	0.6543	0.9954
JPYMAD	0.0500	0.0499	0.0001	0.9935	-0.0255	1.4020	1.7963	0.9374
	0.0250	0.0333	1.9981	0.1575	-0.0286	1.2770	11.7110	0.0687
	0.0100	0.0166	2.9031	0.0884	-0.0313	1.2136	21.9930	0.0012
	0.0050	0.0115	4.8729	0.0273	-0.0363	1.1670	56.3290	0.0000
	0.0025	0.0064	3.3202	0.0684	-0.0419	1.1482	84.6300	0.0000
JPYNGN	0.0500	0.0055	49.0870	0.0000	-0.9734	5.0525	15.4040	0.0173
	0.0250	0.0055	16.7590	0.0000	-0.9734	4.0845	6.0040	0.4227
	0.0100	0.0041	3.3256	0.0682	-1.2921	4.2534	1.5909	0.9532
	0.0050	0.0027	0.9111	0.3398	-1.9120	5.2722	0.7756	0.9927
	0.0025	0.0027	0.0149	0.9028	-1.9120	4.8270	0.3830	0.9990
JPYZAR	0.0500	0.0538	0.2292	0.6321	-0.0504	1.4589	11.4400	0.0757
	0.0250	0.0384	4.9649	0.0259	-0.0560	1.3309	8.6518	0.1941
	0.0100	0.0243	11.5660	0.0007	-0.0663	1.2445	32.4400	0.0000
	0.0050	0.0179	15.6920	0.0001	-0.0666	1.1817	43.7860	0.0000
	0.0025	0.0090	7.8130	0.0052	-0.0754	1.2110	14.2640	0.0268
JPYTND	0.0500	0.0512	0.0241	0.8765	-0.0229	1.3730	2.2577	0.8945
	0.0250	0.0307	0.9815	0.3218	-0.0277	1.3020	6.7292	0.3466
	0.0100	0.0179	4.0120	0.0452	-0.0339	1.2257	21.8580	0.0013
	0.0050	0.0141	8.6590	0.0033	-0.0345	1.1399	50.3520	0.0000
	0.0025	0.0064	3.3202	0.0684	-0.0362	1.1535	5.1943	0.5191

Note: The Table shows the long postion in-sample backtesting results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B19: Out of Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

				Gaussian Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	1.0000	-	0.0000	-	-	3503.2	0.0000
	0.9750	1.0000	-	0.0000	-	-	7260.0	0.0000
	0.9900	1.0000	-	0.0000	-	-	18531.0	0.0000
	0.9950	1.0000	-	0.0000	-	-	37316.0	0.0000
	0.9975	1.0000	-	0.0000	-	-	74886.0	0.0000
JPYEGP	**0.9500**	0.9808	6.7012	0.0096	0.0332	1.6619	5.1822	0.0228
	0.9750	**0.9885**	**2.4090**	**0.1206**	0.0413	1.7246	1.9329	0.1644
	0.9900	0.9885	0.0592	0.8077	0.0413	1.4655	0.0622	0.8031
	0.9950	**0.9885**	**1.6287**	**0.2019**	0.0413	1.3297	2.2342	0.1350
	0.9975	0.9885	4.4977	0.0339	0.0413	1.2246	8.5174	0.0035
JPYGHS	**0.9500**	0.9385	0.6811	0.4092	0.0529	1.4111	0.7287	0.3933
	0.9750	0.9692	0.3311	0.5650	0.0617	1.4755	0.3550	0.5513
	0.9900	0.9846	0.6539	0.4187	0.0803	1.5671	0.7615	0.3829
	0.9950	0.9885	1.6287	0.2019	0.0729	1.5649	2.2342	0.1350
	0.9975	0.9885	4.4977	0.0339	0.0729	1.4451	8.5174	0.0035
JPYMAD	**0.9500**	0.9539	0.0830	0.7733	0.0303	1.4451	0.0810	0.7760
	0.9750	0.9654	0.8823	0.3476	0.0332	1.3281	0.9862	0.3207
	0.9900	0.9885	0.0592	0.8077	0.0421	1.5116	0.0622	0.8031
	0.9950	0.9885	1.6287	0.2019	0.0421	1.3731	2.2342	0.1350
	0.9975	0.9923	1.8028	0.1794	0.0484	1.4323	2.8109	0.0936
JPYNGN	**0.9500**	-	-	-	-	-	-	-
	0.9750	-	-	-	-	-	-	-
	0.9900	-	-	-	-	-	-	-
	0.9950	-	-	-	-	-	-	-
	0.9975	-	-	-	-	-	-	-
JPYZAR	**0.9500**	0.9808	6.7012	0.0096	0.0417	1.3242	5.1822	0.0228
	0.9750	0.9962	7.3749	0.0066	0.0758	2.1088	4.7732	0.0289
	0.9900	0.9962	1.2989	0.2544	0.0758	1.8038	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0758	1.6420	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0758	1.5160	0.1889	0.6638
JPYTND	**0.9500**	0.9500	0.0000	1.0000	0.0266	1.3543	0.7287	0.3933
	0.9750	0.9615	1.6642	0.1970	0.0284	1.2359	0.3550	0.5513
	0.9900	0.9885	0.0592	0.8077	0.0395	1.3965	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	0.0443	1.4369	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	0.0443	1.3257	0.1889	0.6638

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B20: Out of Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

Gaussian Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.0500**	0.0000	-	0.0000	-	-	13.6840	0.0002
	0.0250	0.0000	-	0.0000	-	-	6.6667	0.0098
	0.0100	0.0000	-	0.0000	-	-	2.6263	0.1051
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYEGP	**0.0500**	0.0192	6.7012	0.0096	-0.0230	1.2558	5.1822	0.0228
	0.0250	**0.0115**	**2.4090**	**0.1206**	-0.0261	1.1700	1.9329	0.1644
	0.0100	0.0038	1.2989	0.2544	-0.0282	1.0815	0.9946	0.3186
	0.0050	**0.0000**	-	**0.0000**	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYGHS	**0.0500**	0.0615	0.6811	0.4092	-0.0337	1.3643	0.7287	0.3933
	0.0250	0.0423	2.6544	0.1033	-0.0384	1.2289	3.1953	0.0739
	0.0100	0.0231	3.2801	0.0701	-0.0382	1.1360	4.4911	0.0341
	0.0050	0.0115	1.6287	0.2019	-0.0446	1.0623	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-0.0556	1.0237	0.1889	0.6638
JPYMAD	**0.0500**	0.0385	0.7890	0.3744	-0.0216	1.2815	0.7287	0.3933
	0.0250	0.0192	0.3852	0.5348	-0.0222	1.2351	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0348	1.4480	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0348	1.3015	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0348	1.1899	0.1889	0.6638
JPYNGN	**0.0500**	-	-	-	-	-	-	-
	0.0250	-	-	-	-	-	-	-
	0.0100	-	-	-	-	-	-	-
	0.0050	-	-	-	-	-	-	-
	0.0025	-	-	-	-	-	-	-
JPYZAR	**0.0500**	0.0385	0.7890	0.3744	-0.0463	1.4741	0.7287	0.3933
	0.0250	0.0308	0.3311	0.5650	-0.0490	1.3129	0.3550	0.5513
	0.0100	0.0231	3.2801	0.0701	-0.0524	1.1543	4.4911	0.0341
	0.0050	0.0192	6.1239	0.0133	-0.0554	1.0572	10.5840	0.0011
	0.0025	0.0077	1.8028	0.1794	-0.0725	1.0125	2.8109	0.0936
JPYTND	**0.0500**	0.0385	0.7890	0.3744	-0.0189	1.3066	0.0000	1.0000
	0.0250	0.0192	0.3852	0.5348	-0.0220	1.2555	1.9329	0.1644
	0.0100	0.0115	0.0592	0.8077	-0.0241	1.1811	0.0622	0.8031
	0.0050	0.0077	0.3250	0.5686	-0.0275	1.1435	0.3788	0.5382
	0.0025	0.0038	0.1620	0.6873	-0.0301	1.1310	2.8109	0.0936

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B21: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	0.9693	7.0374	0.0080	0.1862	1.2979	18.0470	0.0061
	0.9750	0.9885	7.2543	0.0071	0.4305	1.1824	16.6570	0.0106
	0.9900	0.9987	9.5690	0.0020	0.0669	1.0247	5.9989	0.4233
	0.9950	1.0000	-	0.0000	-	-	3.9246	0.6869
	0.9975	**1.0000**	-	0.0000	-	-	1.9574	0.9236
JPYEGP	**0.9500**	0.9629	2.9778	0.0844	0.0249	1.2792	6.0455	0.4181
	0.9750	0.9885	7.2543	0.0071	0.0330	1.3249	6.0836	0.4139
	0.9900	0.9949	2.2859	0.1306	0.0397	1.3197	1.9326	0.9258
	0.9950	0.9962	0.2292	0.6321	0.0413	1.1969	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	0.0471	1.1013	0.0280	1.0000
JPYGHS	**0.9500**	0.9565	0.7175	0.3970	0.0372	1.3816	1.5258	0.9578
	0.9750	0.9782	0.3500	0.5541	0.0487	1.3335	2.6197	0.8548
	0.9900	0.9923	0.4605	0.4974	0.0708	1.4030	0.6116	0.9962
	0.9950	0.9962	0.2292	0.6321	0.0797	1.4953	0.2566	0.9997
	0.9975	0.9962	0.4834	0.4869	0.0797	1.3070	0.6543	0.9954
JPYMAD	**0.9500**	0.9578	1.0391	0.3080	0.0250	1.2935	7.1424	0.3079
	0.9750	0.9795	0.6949	0.4045	0.0305	1.2354	2.9047	0.8207
	0.9900	0.9949	2.2859	0.1306	0.0376	1.3279	1.9326	0.9258
	0.9950	0.9974	1.1382	0.2860	0.0484	1.4117	0.9476	0.9875
	0.9975	0.9974	0.0011	0.9730	0.0484	1.2648	0.0280	1.0000
JPYNGN	**0.9500**	0.9714	8.2597	0.0041	0.2011	1.3208	8.7953	0.1854
	0.9750	0.9918	11.4630	0.0007	0.0573	1.4032	8.5902	0.1980
	0.9900	0.9973	5.5037	0.0190	0.0681	1.3546	3.9227	0.6871
	0.9950	0.9986	2.7421	0.0977	0.0860	1.3146	1.9495	0.9243
	0.9975	0.9986	0.4546	0.5002	0.0860	1.0495	0.3830	0.9990
JPYZAR	**0.9500**	0.9706	8.0947	0.0044	0.0416	1.2255	8.8543	0.1819
	0.9750	0.9910	10.8940	0.0010	0.0489	1.2609	8.3640	0.2126
	0.9900	0.9987	9.5690	0.0020	0.0758	1.7260	5.9989	0.4233
	0.9950	0.9987	3.0963	0.0785	0.0758	1.5076	2.1737	0.9031
	0.9975	0.9987	0.5679	0.4511	0.0758	1.3327	0.4692	0.9982
JPYTND	**0.9500**	0.9603	1.8740	0.1710	0.0235	1.2763	9.0419	0.1712
	0.9750	0.9782	0.3500	0.5541	0.0280	1.1927	2.6208	0.8547
	0.9900	0.9962	3.9091	0.0480	0.0368	1.3541	3.0155	0.8069
	0.9950	0.9974	1.1382	0.2860	0.0443	1.3306	0.9476	0.9875
	0.9975	0.9974	0.0011	0.9730	0.0443	1.1926	0.0280	1.0000

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B22: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by Japanese Yen

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.0500**	0.0615	2.0188	0.1554	-0.1175	3.9827	12.9940	0.0431
	0.0250	0.0333	1.9981	0.1575	-0.1885	4.6706	21.2900	0.0016
	0.0100	0.0154	1.9508	0.1625	-0.3533	6.1285	40.8760	0.0000
	0.0050	0.0077	0.9697	0.3248	-0.6464	8.7392	33.3530	0.0000
	0.0025	0.0038	0.4834	0.4869	-1.2103	12.9770	0.6543	0.9954
JPYEGP	**0.0500**	0.0448	0.4574	0.4988	-0.0292	1.6910	2.5058	0.8678
	0.0250	0.0256	0.0118	0.9137	-0.0355	1.5981	2.7420	0.8405
	0.0100	0.0115	0.1746	0.6761	-0.0486	1.6057	9.9742	0.1257
	0.0050	0.0077	0.9697	0.3248	-0.0590	1.5678	33.3130	0.0000
	0.0025	0.0064	3.3202	0.0684	-0.0639	1.4222	84.6300	0.0000
JPYGHS	**0.0500**	0.0538	0.2292	0.6321	-0.0308	1.4076	5.0215	0.5411
	0.0250	0.0282	0.3093	0.5781	-0.0361	1.2910	2.5311	0.8650
	0.0100	0.0102	0.0046	0.9457	-0.0410	1.2153	0.4550	0.9983
	0.0050	0.0038	0.2292	0.6321	-0.0484	1.2572	0.2566	0.9997
	0.0025	0.0026	0.0011	0.9730	-0.0578	1.1603	0.0280	1.0000
JPYMAD	**0.0500**	0.0551	0.4078	0.5231	-0.0251	1.3938	2.4347	0.8757
	0.0250	0.0307	0.9815	0.3218	-0.0294	1.2856	12.9260	0.0442
	0.0100	0.0115	0.1746	0.6761	-0.0363	1.2390	25.1240	0.0003
	0.0050	0.0064	0.2833	0.5945	-0.0419	1.1617	40.3390	0.0000
	0.0025	0.0038	0.4834	0.4869	-0.0317	1.0769	0.6543	0.9954
JPYNGN	**0.0500**	0.0532	0.1555	0.6933	-0.1371	5.1531	2.6922	0.8464
	0.0250	0.0259	0.0252	0.8739	-0.2480	6.9406	11.3040	0.0794
	0.0100	0.0123	0.3583	0.5494	-0.4726	9.4365	16.9510	0.0095
	0.0050	0.0055	0.0299	0.8628	-0.9973	15.5830	0.1548	0.9999
	0.0025	0.0041	0.6245	0.4294	-1.3038	16.1570	0.8491	0.9907
JPYZAR	**0.0500**	0.0589	1.2348	0.2665	-0.0489	1.4651	11.9910	0.0622
	0.0250	0.0371	4.1132	0.0426	-0.0564	1.3290	7.5838	0.2702
	0.0100	0.0205	6.6569	0.0099	-0.0673	1.2021	29.5770	0.0000
	0.0050	0.0090	1.9935	0.1580	-0.0754	1.1917	3.0596	0.8013
	0.0025	0.0026	0.0011	0.9730	-0.0961	1.3512	0.0280	1.0000
JPYTND	**0.0500**	0.0551	0.4078	0.5231	-0.0223	1.3711	2.8614	0.8260
	0.0250	0.0282	0.3093	0.5781	-0.0289	1.3157	7.8222	0.2514
	0.0100	0.0166	2.9031	0.0884	-0.0350	1.1846	22.9460	0.0008
	0.0050	0.0064	0.2833	0.5945	-0.0362	1.1658	0.5227	0.9976
	0.0025	0.0038	0.4834	0.4869	-0.0428	1.0991	0.6543	0.9954

Note: The Table shows thelong position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest Yen. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B23: Out of Sample Value-at-Risk of African Carry Trade Funded by Japanese Yen

Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.9500**	0.9769	4.9183	0.0266	0.0291	1.1897	3.9676	0.0464
	0.9750	0.9962	7.3749	0.0066	0.0499	1.0095	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
JPYEGP	**0.9500**	0.9731	3.4780	0.0622	0.0290	1.5532	2.9150	0.0878
	0.9750	**0.9885**	2.4090	**0.1206**	0.0413	1.7426	1.9329	0.1644
	0.9900	0.9885	0.0592	0.8077	0.0413	1.3712	0.0622	0.8031
	0.9950	**0.9923**	**0.3250**	**0.5686**	0.0471	1.2661	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	0.0471	1.0940	2.8109	0.0936
JPYGHS	**0.9500**	0.9423	0.3093	0.5781	0.0552	1.4537	0.3239	0.5693
	0.9750	0.9654	0.8823	0.3476	0.0606	1.3846	0.9862	0.3207
	0.9900	0.9846	0.6539	0.4187	0.0803	1.4321	0.7615	0.3829
	0.9950	0.9923	0.3250	0.5686	0.0870	1.5762	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	0.0870	1.4042	2.8109	0.0936
JPYMAD	**0.9500**	0.9539	0.0830	0.7733	0.0303	1.4464	0.0810	0.7760
	0.9750	0.9692	0.3311	0.5650	0.0345	1.3423	0.3550	0.5513
	0.9900	0.9885	0.0592	0.8077	0.0421	1.4314	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	0.0484	1.4452	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	0.0484	1.3037	2.8109	0.0936
JPYNGN	**0.9500**	-	-	-	-	-	-	-
	0.9750	-	-	-	-	-	-	-
	0.9900	-	-	-	-	-	-	-
	0.9950	-	-	-	-	-	-	-
	0.9975	-	-	-	-	-	-	-
JPYZAR	**0.9500**	0.9808	6.7012	0.0096	0.0417	1.3285	5.1822	0.0228
	0.9750	0.9962	7.3749	0.0066	0.0758	2.0256	4.7732	0.0289
	0.9900	0.9962	1.2989	0.2544	0.0758	1.6472	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	0.0758	1.4387	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	0.0758	1.2716	0.1889	0.6638
JPYTND	**0.9500**	0.9539	0.0830	0.7733	0.0273	1.3873	0.0810	0.7760
	0.9750	0.9692	0.3311	0.5650	0.0308	1.2752	0.3550	0.5513
	0.9900	0.9923	0.1519	0.6967	0.0443	1.5126	0.1399	0.7084
	0.9950	0.9923	0.3250	0.5686	0.0443	1.3454	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	0.0443	1.2127	2.8109	0.0936

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest Yen. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B24: Out of Sample Value-at-Risk of African Carry Trade Funded by Japanese Yen

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
JPYBWP	**0.0500**	0.0462	0.0830	0.7733	-0.0357	1.4977	0.0810	0.7760
	0.0250	0.0115	2.4090	0.1206	-0.0596	1.6432	1.9329	0.1644
	0.0100	0.0077	0.1519	0.6967	-0.0665	1.2138	0.1399	0.7084
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYEGP	**0.0500**	0.0385	0.7890	0.3744	-0.0198	1.2576	0.7287	0.3933
	0.0250	0.0115	**2.4090**	**0.1206**	-0.0261	1.2346	1.9329	0.1644
	0.0100	0.0038	1.2989	0.2544	-0.0282	1.0056	0.9946	0.3186
	0.0050	0.0000	-	**0.0000**	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
JPYGHS	**0.0500**	0.0615	0.6811	0.4092	-0.0337	1.3931	0.7287	0.3933
	0.0250	0.0423	2.6544	0.1033	-0.0384	1.2106	3.1953	0.0739
	0.0100	0.0231	3.2801	0.0701	-0.0382	1.0605	4.4911	0.0341
	0.0050	0.0038	0.0756	0.7833	-0.0556	1.0016	0.0696	0.7920
	0.0025	0.0000		0.0000			0.6516	0.4195
JPYMAD	**0.0500**	0.0385	0.7890	0.3744	-0.0216	1.2991	0.7287	0.3933
	0.0250	0.0192	0.3852	0.5348	-0.0222	1.2200	0.3550	0.5513
	0.0100	0.0038	1.2989	0.2544	-0.0348	1.3740	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-0.0348	1.2042	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0348	1.0732	0.1889	0.6638
JPYNGN	**0.0500**	-	-	-	-	-	-	-
	0.0250	-	-	-	-	-	-	-
	0.0100	-	-	-	-	-	-	-
	0.0050	-	-	-	-	-	-	-
	0.0025	-	-	-	-	-	-	-
JPYZAR	**0.0500**	0.0423	0.3410	0.5593	-0.0457	1.4753	0.3239	0.5693
	0.0250	0.0308	0.3311	0.5650	-0.0490	1.2939	0.3550	0.5513
	0.0100	0.0192	1.7617	0.1844	-0.0554	1.0876	2.2378	0.1347
	0.0050	0.0038	0.0756	0.7833	-0.0801	1.0030	0.0696	0.7920
	0.0025	0.0000		0.0000			0.6516	0.4195
JPYTND	**0.0500**	0.0385	0.7890	0.3744	-0.0189	1.3292	0.7287	0.3933
	0.0250	0.0192	0.3852	0.5348	-0.0220	1.2414	0.3550	0.5513
	0.0100	0.0077	0.1519	0.6967	-0.0275	1.2070	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-0.0301	1.1419	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-0.0301	1.0141	0.1889	0.6638

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest JPY. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B25: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

				Gaussian Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9629	2.9778	0.0844	3.4376	1.2954	6.1534	0.4062
	0.9750	0.9782	0.3500	0.5541	3.8129	1.2357	2.2065	0.8998
	0.9900	0.9885	0.1746	0.6761	4.2801	1.1683	0.8281	0.9913
	0.9950	0.9923	0.9697	0.3248	4.4762	1.1051	1.5016	0.9594
	0.9975	**0.9962**	**0.4834**	**0.4869**	4.3690	1.0749	0.6543	0.9954
GBPEGP	**0.9500**	0.9565	0.7175	0.3970	2.5765	1.2560	22.4110	0.0010
	0.9750	**0.9808**	**1.1675**	**0.2799**	3.2701	1.2505	35.7060	0.0000
	0.9900	0.9923	0.4605	0.4974	4.3344	1.3061	65.2300	0.0000
	0.9950	**0.9923**	**0.9697**	**0.3248**	4.3344	1.1821	130.1000	0.0000
	0.9975	0.9936	3.3202	0.0684	4.0202	1.1059	80.5770	0.0000
GBPGHS	**0.9500**	0.9565	0.7175	0.3970	3.8062	1.3622	2.8430	0.8283
	0.9750	0.9744	0.0118	0.9137	4.6165	1.3157	12.2460	0.0567
	0.9900	0.9859	1.1680	0.2798	5.4873	1.2821	8.9227	0.1780
	0.9950	0.9885	4.8729	0.0273	5.8261	1.2068	7.9601	0.2410
	0.9975	0.9936	3.3202	0.0684	7.5389	1.2285	5.1943	0.5191
GBPMAD	**0.9500**	0.9462	0.2292	0.6321	1.6055	1.2981	5.4191	0.4913
	0.9750	0.9731	0.1116	0.7384	1.8402	1.2739	6.9676	0.3239
	0.9900	0.9834	2.9031	0.0884	2.0518	1.1874	9.6065	0.1422
	0.9950	0.9923	0.9697	0.3248	2.3387	1.2194	32.0200	0.0000
	0.9975	0.9949	1.6479	0.1993	2.5945	1.2048	2.3692	0.8828
GBPNGN	**0.9500**	0.9539	0.2572	0.6121	3.3246	1.2155	6.9512	0.3254
	0.9750	0.9821	1.7761	0.1826	4.1177	1.2060	3.9403	0.6848
	0.9900	0.9923	0.4605	0.4974	5.3408	1.1606	0.6116	0.9962
	0.9950	0.9949	0.0023	0.9617	6.4086	1.0938	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	8.1456	1.1352	0.4692	0.9982
GBPZAR	**0.9500**	0.9654	4.3683	0.0366	3.5537	1.3162	9.1280	0.1665
	0.9750	0.9808	1.1675	0.2799	4.0915	1.2463	2.3445	0.8855
	0.9900	0.9898	0.0046	0.9457	4.5195	1.1663	0.4550	0.9983
	0.9950	0.9936	0.2833	0.5945	5.3065	1.1268	0.5227	0.9976
	0.9975	0.9962	0.4834	0.4869	6.0741	1.1056	0.6543	0.9954
GBPTND	**0.9500**	0.9513	0.0300	0.8626	1.6130	1.3428	8.7900	0.1857
	0.9750	0.9744	0.0118	0.9137	1.8799	1.3143	2.6275	0.8539
	0.9900	0.9885	0.1746	0.6761	2.4211	1.3585	9.6670	0.1394
	0.9950	0.9898	3.3066	0.0690	2.5111	1.2610	26.1930	0.0002
	0.9975	0.9936	3.3202	0.0684	2.6489	1.2732	5.1943	0.5191

Note:The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B26: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

Gaussian Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.0500**	0.0461	0.2572	0.6121	-4.0774	1.5302	2.2345	0.8969
	0.0250	0.0294	0.6006	0.4383	-4.7022	1.4834	2.9017	0.8211
	0.0100	0.0205	6.6569	0.0099	-5.3237	1.3923	14.5440	0.0241
	0.0050	0.0115	4.8729	0.0273	-6.3748	1.4953	28.3410	0.0001
	0.0025	**0.0102**	**10.5170**	**0.0012**	-6.5664	1.4148	62.4890	0.0000
GBPEGP	**0.0500**	0.0346	4.3683	0.0366	-3.0528	1.6096	6.1671	0.4047
	0.0250	**0.0205**	**0.6949**	**0.4045**	-3.9401	1.6482	9.4952	0.1476
	0.0100	0.0154	1.9508	0.1625	-4.3978	1.5624	9.1337	0.1662
	0.0050	**0.0115**	**4.8729**	**0.0273**	-4.8986	1.5634	26.1640	0.0002
	0.0025	0.0102	10.5170	0.0012	-5.1573	1.4926	63.8800	0.0000
GBPGHS	**0.0500**	0.0474	0.1152	0.7343	-3.1173	1.3729	3.0637	0.8008
	0.0250	0.0256	0.0118	0.9137	-3.9039	1.3571	6.7763	0.3420
	0.0100	0.0166	2.9031	0.0884	-3.9922	1.2561	9.6065	0.1422
	0.0050	0.0115	4.8729	0.0273	-4.2296	1.2139	25.5580	0.0003
	0.0025	0.0064	3.3202	0.0684	-4.7081	1.2423	80.5770	0.0000
GBPMAD	**0.0500**	0.0410	1.4239	0.2328	-1.5961	1.3359	5.3251	0.5028
	0.0250	0.0243	0.0146	0.9038	-1.7821	1.2541	2.6632	0.8498
	0.0100	0.0051	2.2859	0.1306	-3.2801	1.5832	1.9326	0.9258
	0.0050	0.0038	0.2292	0.6321	-3.8708	1.5745	0.2566	0.9997
	0.0025	0.0038	0.4834	0.4869	-3.8708	1.4354	0.6543	0.9954
GBPNGN	**0.0500**	0.0551	0.4078	0.5231	-3.4750	1.3671	10.8420	0.0934
	0.0250	0.0294	0.6006	0.4383	-4.4250	1.3401	24.5980	0.0004
	0.0100	0.0205	6.6569	0.0099	-5.1490	1.2044	51.5320	0.0000
	0.0050	0.0128	6.6645	0.0098	-5.7220	1.1731	26.1370	0.0002
	0.0025	0.0090	7.8130	0.0052	-6.0768	1.1259	14.2640	0.0268
GBPZAR	**0.0500**	0.0563	0.6356	0.4253	-3.9187	1.3365	3.4517	0.7504
	0.0250	0.0320	1.4485	0.2288	-4.6958	1.2995	8.0177	0.2368
	0.0100	0.0218	8.1752	0.0042	-5.0573	1.1822	16.4760	0.0114
	0.0050	0.0102	3.3066	0.0690	-5.6464	1.2017	5.1384	0.5262
	0.0025	0.0064	3.3202	0.0684	-6.5639	1.2006	5.1943	0.5191
GBPTND	**0.0500**	0.0346	4.3683	0.0366	-1.6870	1.3493	6.1584	0.4057
	0.0250	0.0154	3.4412	0.0636	-2.0418	1.3971	3.6122	0.7290
	0.0100	0.0090	0.0879	0.7668	-2.4986	1.3700	0.3848	0.9990
	0.0050	0.0064	0.2833	0.5945	-2.8884	1.3490	0.5227	0.9976
	0.0025	0.0064	3.3202	0.0684	-2.8884	1.2319	5.1943	0.5191

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B27: Out of Sample Value-at-Risk of African Carry Trade Funded by British Pounds

				Gaussian Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9885	11.6010	0.0007	3.4080	1.0828	8.0972	0.0044
	0.9750	0.9962	7.3749	0.0066	3.1202	1.0080	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	**1.0000**	-	**0.0000**	-	-	0.6516	0.4195
GBPEGP	**0.9500**	0.9923	**14.9960**	0.0001	2.3381	1.3495	9.7976	0.0017
	0.9750	**0.9962**	**7.3749**	**0.0066**	2.9036	1.4096	4.7732	0.0289
	0.9900	0.9962	**1.2989**	0.2544	2.9036	1.2092	0.9946	0.3186
	0.9950	**0.9962**	**0.0756**	**0.7833**	2.9036	1.1025	0.0696	0.7920
	0.9975	0.9962	**0.1620**	0.6873	2.9036	1.0192	0.1889	0.6638
GBPGHS	**0.9500**	0.9692	2.3324	0.1267	6.2926	1.5168	2.0243	0.1548
	0.9750	0.9769	0.0405	0.8406	7.6700	1.4088	0.0394	0.8426
	0.9900	0.9846	0.6539	0.4187	9.4205	1.3518	0.7615	0.3829
	0.9950	0.9923	0.3250	0.5686	13.0100	1.4955	0.3788	0.5382
	0.9975	0.9923	1.8028	0.1794	13.0100	1.3811	2.8109	0.0936
GBPMAD	**0.9500**	0.9615	0.7890	0.3744	1.4009	1.2408	0.7287	0.3933
	0.9750	0.9846	1.1405	0.2855	1.6717	1.1710	0.9862	0.3207
	0.9900	0.9923	0.1519	0.6967	1.7867	1.0657	0.1399	0.7084
	0.9950	1.0000	-	0.0000	-	1.3065	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	0.6516	0.6516	0.4195
GBPNGN	**0.9500**	0.9731	3.4780	0.0622	2.5552	1.1347	2.9150	0.0878
	0.9750	0.9923	4.3648	0.0367	2.4795	1.0640	3.1953	0.0739
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPZAR	**0.9500**	0.9885	11.6010	0.0007	2.5620	1.1491	8.0972	0.0044
	0.9750	0.9962	7.3749	0.0066	3.0279	1.1003	4.7732	0.0289
	0.9900	1.0000	-	-	-	-	2.6263	0.1051
	0.9950	1.0000	-	-	-	-	1.3065	0.2530
	0.9975	1.0000	-	-	-	-	0.6516	0.4195
GBPTND	**0.9500**	0.9692	2.3324	0.1267	1.5722	1.3859	2.0243	0.1548
	0.9750	0.9731	0.0385	0.8445	1.6717	1.2185	0.0394	0.8426
	0.9900	0.9923	0.1519	0.6967	2.0198	1.2978	0.1399	0.7084
	0.9950	0.9962	0.0756	0.7833	2.6550	1.4110	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	2.6550	1.3011	0.1889	0.6638

Note: The Table shows the short position out-of-sample results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B28: Out of Sample Value-at-Risk of African Carry Trade Funded by British Pounds

				Gaussian Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.0500**	0.0308	2.3324	0.1267	-3.3645	1.3396	2.0243	0.1548
	0.0250	0.0231	0.0405	0.8406	-3.6252	1.2056	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-4.6621	1.2466	0.1399	0.7084
	0.0050	0.0077	0.3250	0.5686	-4.6621	1.1182	0.3788	0.5382
	0.0025	**0.0038**	**0.1620**	**0.6873**	-4.4820	1.0501	0.1889	0.6638
GBPEGP	**0.0500**	0.0154	8.8948	0.0029	-2.6024	1.6493	6.5587	0.0104
	0.0250	**0.0077**	**4.3648**	**0.0367**	-3.4637	1.8359	3.1953	0.0739
	0.0100	0.0077	4.3648	0.6967	-3.4637	1.5181	0.1399	0.7084
	0.0050	**0.0077**	**0.3250**	**0.5686**	-3.4637	1.3580	0.3788	0.5382
	0.0025	0.0077	1.8028	0.1794	-3.4637	1.2371	2.8109	0.0936
GBPGHS	**0.0500**	0.0731	2.5675	0.1091	-3.4192	1.4813	2.9150	0.0878
	0.0250	0.0462	3.8347	0.0502	-4.0535	1.4241	4.7732	0.0289
	0.0100	0.0346	9.7113	0.0018	-3.6768	1.2949	15.9130	0.0001
	0.0050	0.0269	12.2960	0.0005	-3.9980	1.2382	25.1180	0.0000
	0.0025	0.0192	11.7760	0.0006	-4.3954	1.2058	29.1840	0.0000
GBPMAD	**0.0500**	0.0462	0.0830	0.7733	-1.4085	1.3295	0.0810	0.7760
	0.0250	0.0308	0.3311	0.5650	-1.5215	1.1871	0.3550	0.5513
	0.0100	0.0077	0.1519	0.6967	-2.0044	1.3055	0.1399	0.7084
	0.0050	0.0038	0.0756	0.7833	-2.6194	1.4333	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-2.6194	1.3018	0.1889	0.6638
GBPNGN	**0.0500**	0.0308	2.3324	0.1267	-3.0691	1.4654	2.0243	0.1548
	0.0250	0.0192	0.3852	0.5348	-3.7166	1.4082	0.3550	0.5513
	0.0100	0.0154	0.6539	0.4187	-4.0263	1.2308	0.7615	0.3829
	0.0050	0.0115	1.6287	0.2019	-3.4866	1.1570	2.2342	0.1350
	0.0025	0.0038	0.1620	0.6873	-4.2293	1.2406	0.1889	0.6638
GBPZAR	**0.0500**	0.0615	0.6811	0.4092	-3.0639	1.2256	0.7287	0.3933
	0.0250	0.0231	0.0405	0.8406	-4.0415	1.2406	0.0394	0.8426
	0.0100	0.0154	0.6539	0.4187	-4.4345	1.1106	0.7615	0.3829
	0.0050	0.0077	0.3250	0.5686	-5.0457	1.0757	0.3788	0.5382
	0.0025	0.0038	0.1620	0.6873	-5.9033	1.0114	0.1889	0.6638
GBPTND	**0.0500**	0.0462	0.0830	0.7733	-1.5404	1.3788	0.0810	0.7760
	0.0250	0.0231	0.0405	0.8406	-1.7659	1.3621	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-2.5742	1.6079	0.1399	0.7084
	0.0050	0.0077	0.3250	0.5686	-2.5742	1.4329	0.3788	0.5382
	0.0025	0.0077	1.8028	0.1794	-2.5742	1.3017	2.8109	0.0936

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Gaussian (normal) distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B29: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

Student t Distribution								
Short Position								
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9565	0.7175	0.3970	3.4446	1.3159	4.9270	0.5532
	0.9750	0.9808	1.1675	0.2799	3.8339	1.2532	2.3445	0.8855
	0.9900	0.9923	0.4605	0.4974	4.3222	1.1216	0.6116	0.9962
	0.9950	0.9974	1.1382	0.2860	4.0909	1.0466	0.9476	0.9875
	0.9975	1.0000	-	0.0000	-	-	1.9574	0.9236
GBPEGP	**0.9500**	0.9526	0.1152	0.7343	2.4885	1.2928	20.6270	0.0021
	0.9750	**0.9821**	**1.7761**	**0.1826**	3.1797	1.2899	39.4920	0.0000
	0.9900	0.9923	0.4605	0.4974	4.3344	1.2113	65.2300	0.0000
	0.9950	**0.9949**	**0.0023**	**0.9617**	4.0744	1.0860	0.1114	1.0000
	0.9975	0.9987	0.5679	0.4511	3.6747	1.0208	0.4692	0.9982
GBPGHS	**0.9500**	0.9501	0.0001	0.9935	3.6450	1.3647	4.0788	0.6660
	0.9750	0.9757	0.0146	0.9038	4.8224	1.3255	13.3370	0.0380
	0.9900	0.9885	0.1746	0.6761	5.8261	1.2311	0.8281	0.9913
	0.9950	0.9962	0.2292	0.6321	10.0790	1.3125	0.2566	0.9997
	0.9975	0.9974	0.0011	0.9730	9.2468	1.2200	0.0280	1.0000
GBPMAD	**0.9500**	0.9488	0.0241	0.8765	1.6389	1.3256	5.9747	0.4260
	0.9750	0.9757	0.0146	0.9038	1.8961	1.2833	2.8538	0.8270
	0.9900	0.9872	0.5698	0.4503	2.1706	1.1794	8.9218	0.1780
	0.9950	0.9949	0.0023	0.9617	2.5945	1.2052	0.1114	1.0000
	0.9975	0.9974	0.0011	0.9730	3.0494	1.1540	0.0280	1.0000
GBPNGN	**0.9500**	0.9539	0.2572	0.6121	3.3246	1.2231	6.9512	0.3254
	0.9750	0.9834	2.5303	0.1117	4.2573	1.2049	4.7233	0.5798
	0.9900	0.9936	1.1705	0.2793	5.8500	1.1382	1.1295	0.9802
	0.9950	0.9974	1.1382	0.2860	9.6902	1.0901	0.9476	0.9875
	0.9975	0.9987	0.5679	0.4511	8.1456	1.0454	0.4692	0.9982
GBPZAR	**0.9500**	0.9616	2.3912	0.1220	3.6920	1.2946	7.2045	0.3024
	0.9750	0.9834	2.5303	0.1117	4.2549	1.2489	3.0521	0.8023
	0.9900	0.9936	1.1705	0.2793	5.3065	1.1759	1.1295	0.9802
	0.9950	0.9962	0.2292	0.6321	6.0741	1.0969	0.2566	0.9997
	0.9975	0.9987	0.5679	0.4511	5.1442	1.0105	0.4692	0.9982
GBPTND	**0.9500**	0.9488	0.0241	0.8765	1.6455	1.3453	10.6110	0.1012
	0.9750	0.9770	0.1254	0.7233	1.9483	1.3307	3.3062	0.7696
	0.9900	0.9885	0.1746	0.6761	2.4211	1.2902	9.6670	0.1394
	0.9950	0.9936	0.2833	0.5945	2.6489	1.2702	0.5227	0.9976
	0.9975	0.9962	0.4834	0.4869	2.9658	1.2185	0.6543	0.9954

Note: The Table shows the short position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B30: In Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

				Student t Distribution				
				Long Position				
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.0500**	0.0576	0.9116	0.3397	-3.7354	1.5147	5.8709	0.4378
	0.0250	0.0320	1.4485	0.2288	-4.5824	1.4432	6.3637	0.3837
	0.0100	0.0141	1.1680	0.2798	-5.7951	1.4140	9.6023	0.1424
	0.0050	0.0064	0.2833	0.5945	-7.5605	1.5235	0.5227	0.9976
	0.0025	**0.0026**	**0.0011**	**0.9730**	-10.5200	1.8573	0.0280	1.0000
GBPEGP	**0.0500**	0.0435	0.7175	0.3970	-2.7936	1.5893	5.0295	0.5400
	0.0250	0.0218	0.3500	0.5541	-3.8416	1.6291	8.4332	0.2081
	0.0100	0.0115	0.1746	0.6761	-4.8986	1.6234	9.9742	0.1257
	0.0050	0.0077	0.9697	0.3248	-5.7726	1.5918	33.3130	0.0000
	0.0025	0.0051	1.6479	0.1993	-6.9437	1.5929	106.5900	0.0000
GBPGHS	**0.0500**	0.0461	0.2572	0.6121	-3.1646	1.4187	2.3608	0.8837
	0.0250	0.0243	0.0146	0.9038	-4.0196	1.3477	7.1847	0.3041
	0.0100	0.0115	0.1746	0.6761	-4.4558	1.2323	9.6670	0.1394
	0.0050	0.0051	0.0023	0.9617	-5.1151	1.2265	0.1114	1.0000
	0.0025	0.0038	0.4834	0.4869	-5.0475	1.0841	0.6543	0.9954
GBPMAD	**0.0500**	0.0423	1.0391	0.3080	-1.5833	0.6626	4.1038	0.6626
	0.0250	0.0205	0.6949	0.4045	-1.8547	0.9001	2.2027	0.9001
	0.0100	0.0038	3.9091	0.0480	-3.8708	0.8069	3.0155	0.8069
	0.0050	0.0038	0.2292	0.6321	-3.8708	0.9997	0.2566	0.9997
	0.0025	0.0038	0.4834	0.4869	-3.8708	0.9954	0.6543	0.9954
GBPNGN	**0.0500**	0.0551	0.4078	0.5231	-3.4789	1.3880	10.8420	0.0934
	0.0250	0.0307	0.9815	0.3218	-4.4358	1.3189	23.2340	0.0007
	0.0100	0.0179	4.0120	0.0452	-5.4243	1.1899	35.6220	0.0000
	0.0050	0.0090	1.9935	0.1580	-6.0768	1.1560	3.0596	0.8013
	0.0025	0.0064	3.3202	0.0684	-6.0264	1.0689	5.1943	0.5191
GBPZAR	**0.0500**	0.0589	1.2348	0.2665	-3.9134	1.3514	5.4936	0.4822
	0.0250	0.0320	1.4485	0.2288	-4.6958	1.2892	8.0177	0.2368
	0.0100	0.0166	2.9031	0.0884	-5.5040	1.1711	9.7670	0.1348
	0.0050	0.0064	0.2833	0.5945	-6.5639	1.2028	0.5227	0.9976
	0.0025	0.0051	1.6479	0.1993	-6.7290	1.1058	2.3692	0.8828
GBPTND	**0.0500**	0.0359	3.6360	0.0565	-1.7639	1.3671	5.5900	0.4707
	0.0250	0.0166	2.5303	0.1117	-1.9834	1.3594	3.0521	0.8023
	0.0100	0.0064	1.1705	0.2793	-2.8884	1.4429	1.1295	0.9802
	0.0050	0.0051	0.0023	0.9617	-3.1845	1.3147	0.1114	1.0000
	0.0025	0.0026	0.0011	0.9730	-4.4261	1.3777	0.0280	1.0000

Note: The Table shows the long position in-sample backtesting results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Table B31: Out of Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

				Student t Distribution				
				Short Position				
Carry Trade	***Quan-tile***	**Success Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.9500**	0.9846	8.8948	0.0029	3.0791	1.2275	6.5587	0.0104
	0.9750	0.9962	7.3749	0.0066	3.1202	1.1076	4.7732	0.0289
	0.9900	1.0000	-	-	-	-	2.6263	0.1051
	0.9950	1.0000	-	-	-	-	1.3065	0.2530
	0.9975	**1.0000**	-	-	-	-	0.6516	0.4195
GBPEGP	**0.9500**	0.9885	11.6010	0.0007	2.0312	1.3417	8.0972	0.0044
	0.9750	**0.9962**	**7.3749**	**0.0066**	2.9036	1.5197	4.7732	0.0289
	0.9900	0.9962	1.2989	0.2544	2.9036	1.1983	0.9946	0.3186
	0.9950	**0.9962**	**0.0756**	**0.7833**	2.9036	1.0189	0.0696	0.7920
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPGHS	**0.9500**	0.9692	2.3324	0.1267	6.2926	1.5788	2.0243	0.1548
	0.9750	0.9769	0.0405	0.8406	7.6700	1.4277	0.0394	0.8426
	0.9900	0.9885	0.0592	0.8077	10.3060	1.3954	0.0622	0.8031
	0.9950	0.9923	0.3250	0.5686	13.0100	1.3672	0.3788	0.5382
	0.9975	0.9962	0.1620	0.6873	14.2750	1.4678	0.1889	0.6638
GBPMAD	**0.9500**	0.9615	0.7890	0.3744	1.4009	1.2635	0.7287	0.3933
	0.9750	0.9808	0.3852	0.5348	1.6840	1.1256	0.3550	0.5513
	0.9900	0.9962	1.2989	0.2544	1.6938	1.0570	0.9946	0.3186
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPNGN	**0.9500**	0.9731	3.4780	0.0622	2.5552	1.1200	2.9150	0.0878
	0.9750	0.9923	4.3648	0.0367	2.4795	1.0300	3.1953	0.0739
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPZAR	**0.9500**	0.9846	8.8948	0.0029	2.7293	1.0934	6.5587	0.0104
	0.9750	0.9962	7.3749	0.0066	3.0279	1.0259	4.7732	0.0289
	0.9900	1.0000	-	0.0000	-	-	2.6263	0.1051
	0.9950	1.0000	-	0.0000	-	-	1.3065	0.2530
	0.9975	1.0000	-	0.0000	-	-	0.6516	0.4195
GBPTND	**0.9500**	0.9654	1.4454	0.2293	1.5394	1.3609	1.2955	0.2550
	0.9750	0.9731	0.0385	0.8445	1.6717	1.2021	0.0394	0.8426
	0.9900	0.9962	1.2989	0.2544	2.6550	1.4854	0.9946	0.3186
	0.9950	0.9962	0.0756	0.7833	2.6550	1.3157	0.0696	0.7920
	0.9975	0.9962	0.1620	0.6873	2.6550	1.1810	0.1889	0.6638

Note: The Table shows the short postion out-of-sample results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

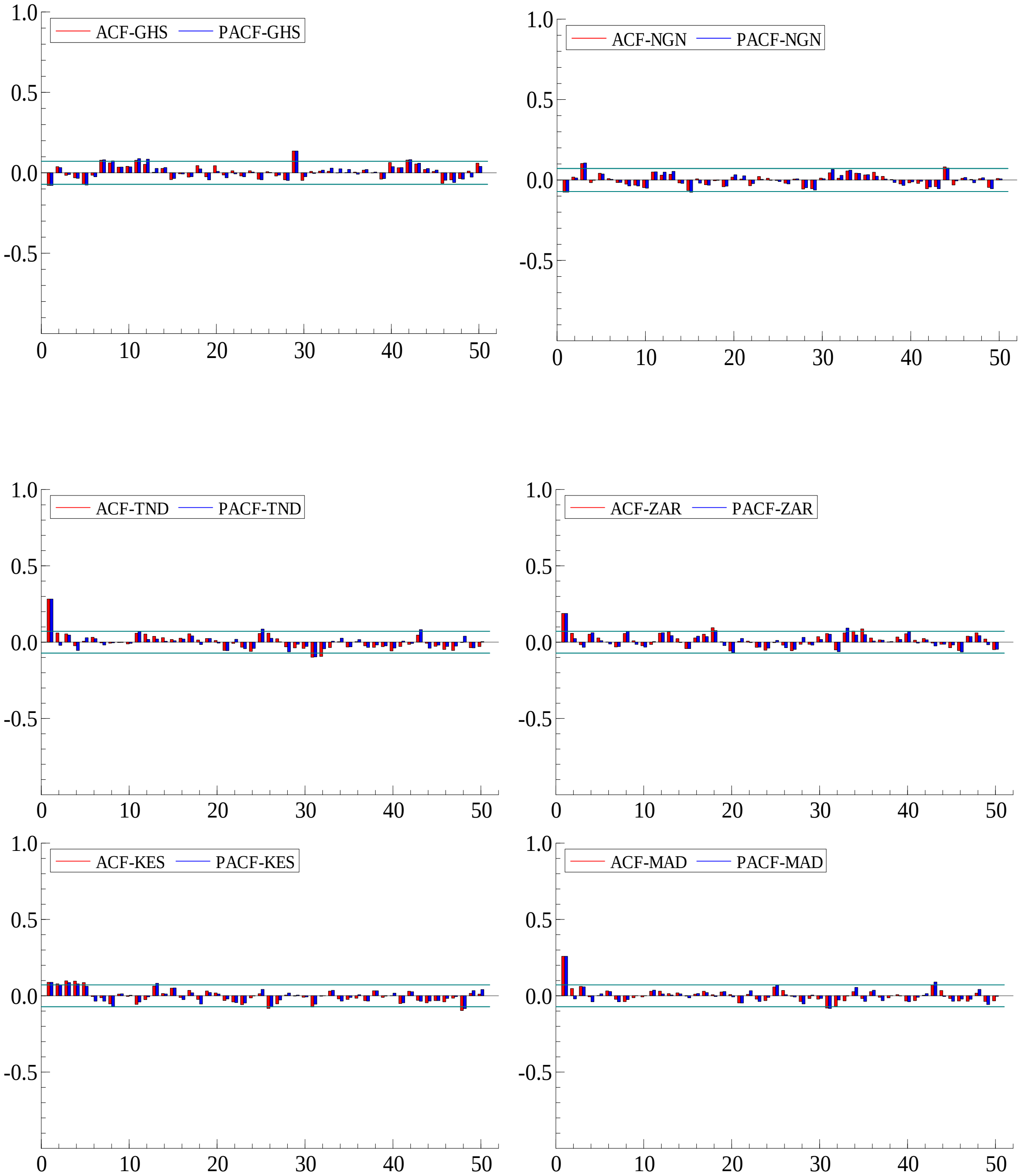
Table B32: Out of Sample Value-at-Risk Backtesting of African Carry Trade Funded by British Pounds

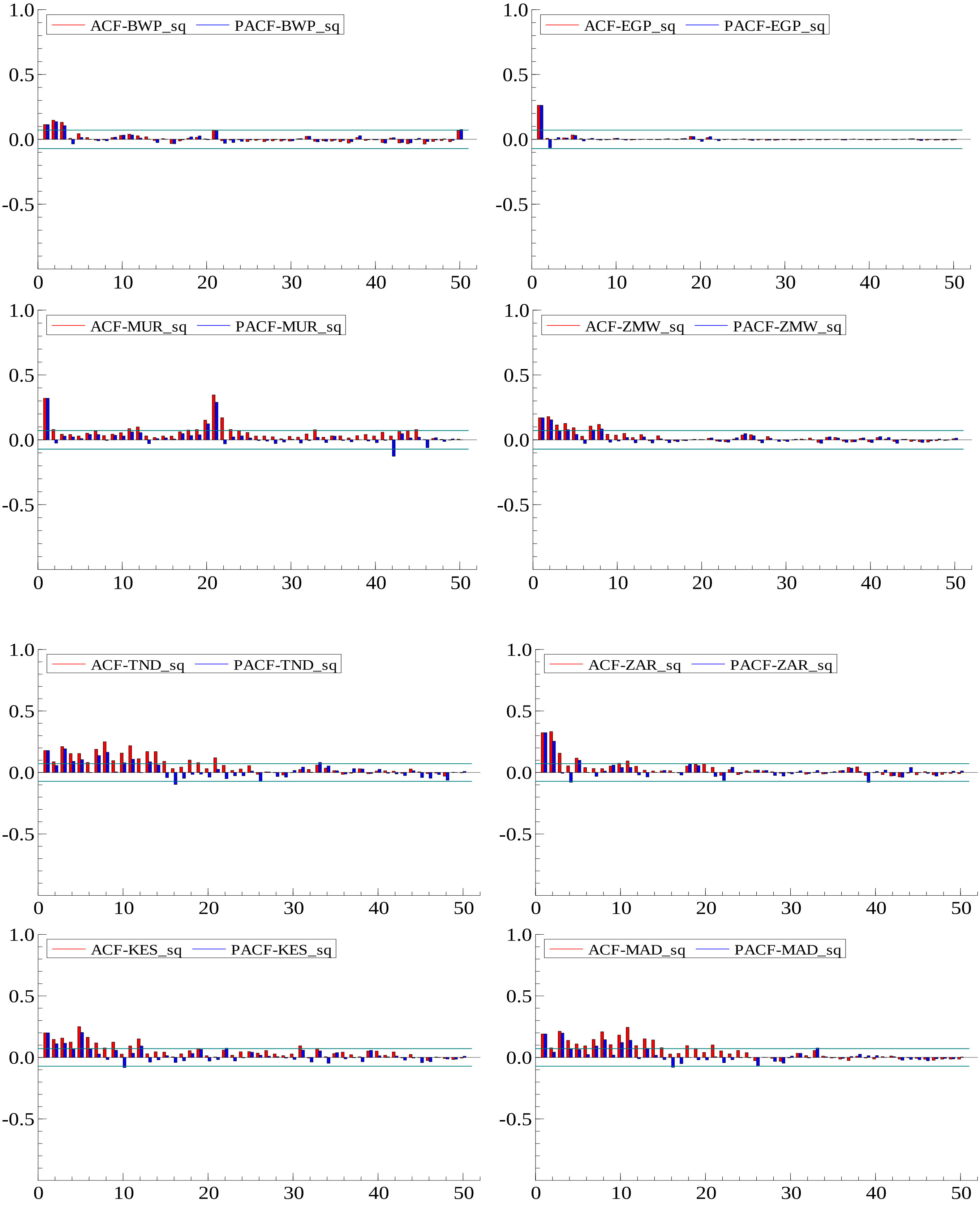
Student t Distribution								
Long Position								
Carry Trade	***Quan-tile***	**Failure Rate**	**Kupiec LRT**	**Kupiec P-Value**	**Expected Shortfall 1**	**Expected Shortfall 2**	**Dynamic Q Statistics**	**Dynamic Q P-Value**
GBPBWP	**0.0500**	0.0385	0.7890	0.3744	-3.1322	1.4114	0.7287	0.3933
	0.0250	0.0231	0.0405	0.8406	-3.6252	1.2595	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-4.6621	1.1525	0.1399	0.7084
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	**0.0000**	-	**0.0000**	-	-	0.6516	0.4195
GBPEGP	**0.0500**	0.0385	0.7890	0.3744	-2.0775	1.3819	0.7287	0.3933
	0.0250	**0.0077**	**4.3648**	**0.0367**	-3.4637	1.9145	3.1953	0.0739
	0.0100	0.0077	0.1519	0.6967	-3.4637	1.4314	0.1399	0.7084
	0.0050	**0.0038**	**0.0756**	**0.7833**	-3.5717	1.3676	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-3.5717	1.1460	0.1889	0.6638
GBPGHS	**0.0500**	0.0731	2.5675	0.1091	-3.4192	1.4972	2.9150	0.0878
	0.0250	0.0423	2.6544	0.1033	-4.2522	1.4282	3.1953	0.0739
	0.0100	0.0269	5.1412	0.0234	-3.9980	1.2748	7.5214	0.0061
	0.0050	0.0192	6.1239	0.0133	-4.3954	1.1805	10.5840	0.0011
	0.0025	0.0115	4.4977	0.0339	-4.6253	1.1278	8.5174	0.0035
GBPMAD	**0.0500**	0.0500	0.0000	1.0000	-1.3822	1.3365	0.0000	1.0000
	0.0250	0.0269	0.0385	0.8445	-1.5407	1.1951	0.0394	0.8426
	0.0100	0.0038	1.2989	0.2544	-2.6194	1.5561	0.9946	0.3186
	0.0050	0.0038	0.0756	0.7833	-2.6194	1.3372	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-2.6194	1.1708	0.1889	0.6638
GBPNGN	**0.0500**	0.0308	2.3324	0.1267	-3.0691	1.4605	2.0243	0.1548
	0.0250	0.0192	0.3852	0.5348	-3.7166	1.3798	0.3550	0.5513
	0.0100	0.0154	0.6539	0.4187	-4.0263	1.1766	0.7615	0.3829
	0.0050	0.0038	0.0756	0.7833	-4.2293	1.2622	0.0696	0.7920
	0.0025	0.0038	0.1620	0.6873	-4.2293	1.1272	0.1889	0.6638
GBPZAR	**0.0500**	0.0615	0.6811	0.4092	-3.0639	1.2421	0.7287	0.3933
	0.0250	0.0231	0.0405	0.8406	-4.0415	1.2107	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-5.0457	1.1047	0.1399	0.7084
	0.0050	0.0000	-	0.0000	-	-	1.3065	0.2530
	0.0025	0.0000	-	0.0000	-	-	0.6516	0.4195
GBPTND	**0.0500**	0.0462	0.0830	0.7733	-1.5404	1.4039	0.0810	0.7760
	0.0250	0.0231	0.0405	0.8406	-1.7659	1.3509	0.0394	0.8426
	0.0100	0.0077	0.1519	0.6967	-2.5742	1.5299	0.1399	0.7084
	0.0050	0.0077	0.3250	0.5686	-2.5742	1.3153	0.3788	0.5382
	0.0025	0.0038	0.1620	0.6873	-3.1878	1.4025	0.1889	0.6638

Note: The Table shows the long position out-of-sample results of the African currency carry trade financed by borrowing the low interest GBP. The value at risk estimations were done through the ARIMA (1, 0)-GARCH (1, 1) with Student t distribution of the error term. ESF1 and ESF2 represent the expected shortfall 1 & 2, DQ is dynamic quantile test and LRT is log-likelihood test.

Appendix C: Autocorrelation and Partial Autocorrelation Graphs of African Currency Carry Trade Returns Series Figure

C1: ACF and PACF of Returns of African Carry Trade Funded by USD




ACF-BWP_sq
PACF-BWP_sq
ACF-EGP_sq
PACF-EGP_sq
ACF-MUR_sq
PACF-MUR_sq
ACF-ZMW_sq
PACF-ZMW_sq
ACF-TND_sq
PACF-TND_sq
ACF-ZAR_sq
PACF-ZAR_sq
ACF-KES_sq
PACF-KES_sq
ACF-MAD_sq
PACF-MAD_sq
1.0
0.5
0.0
-0.5
0
10
20
30
40
50

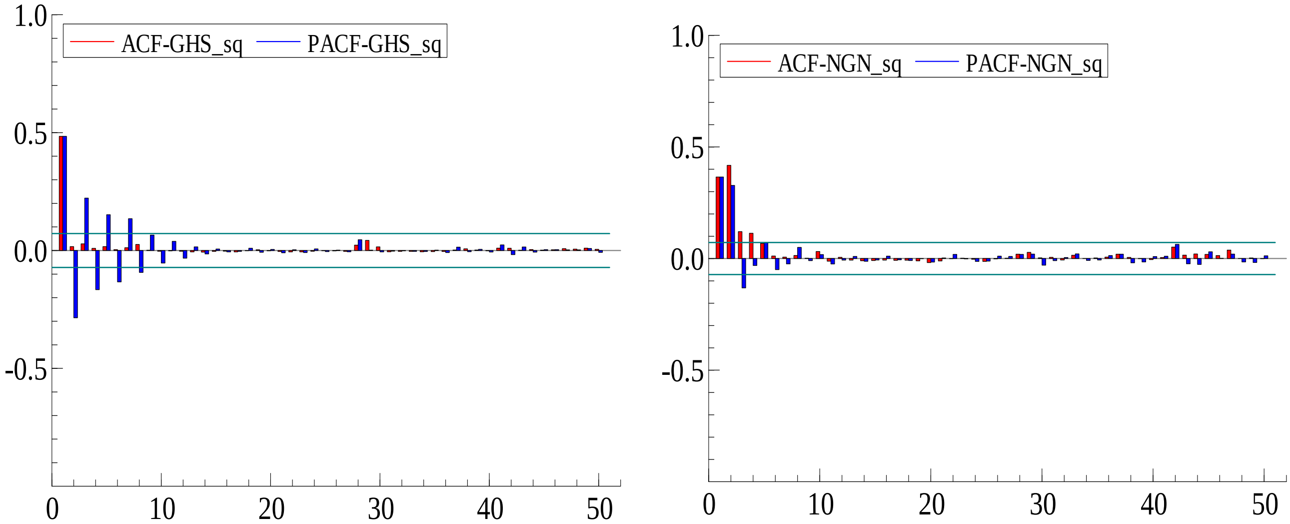
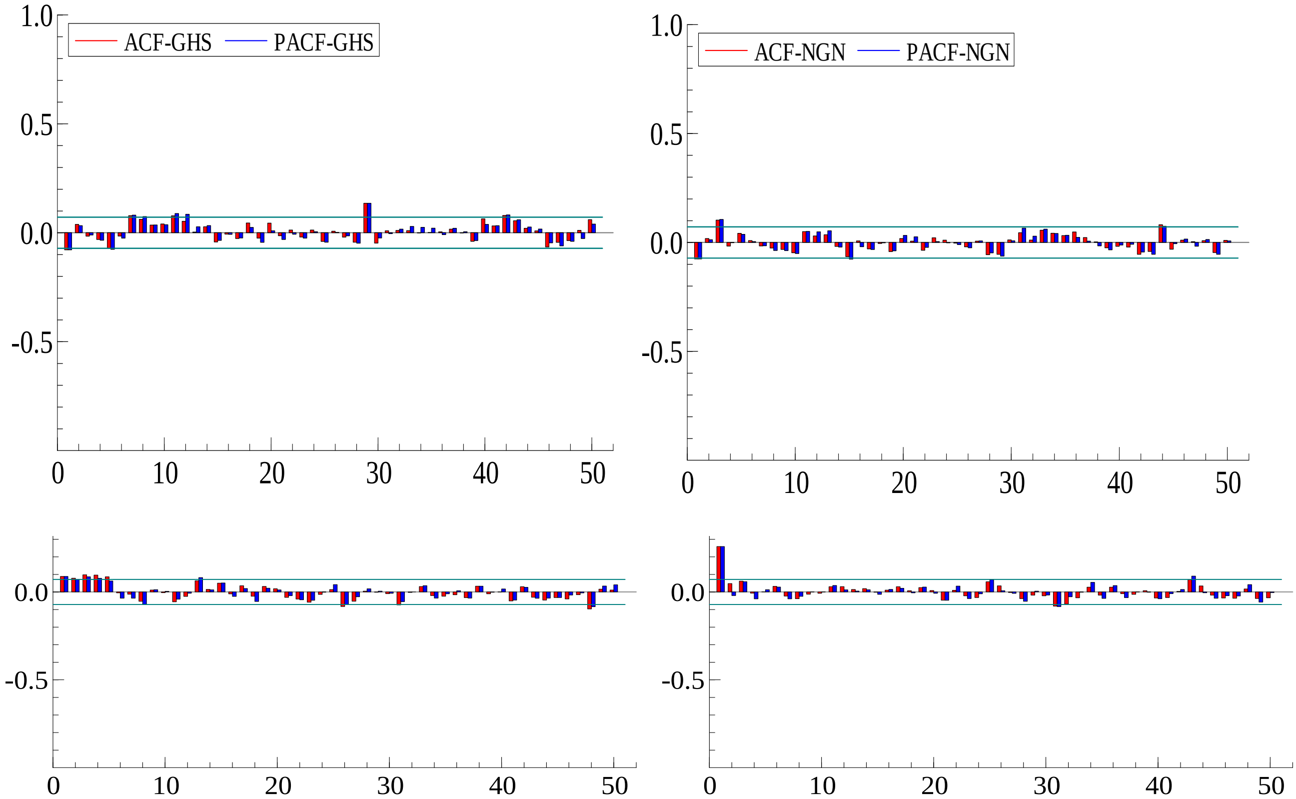
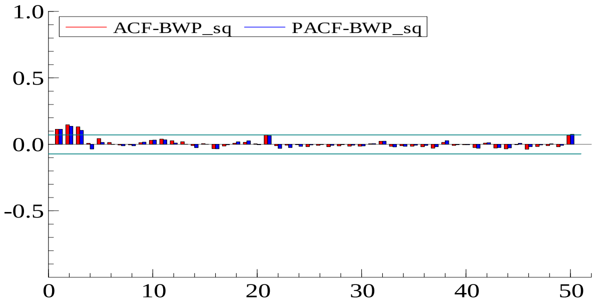
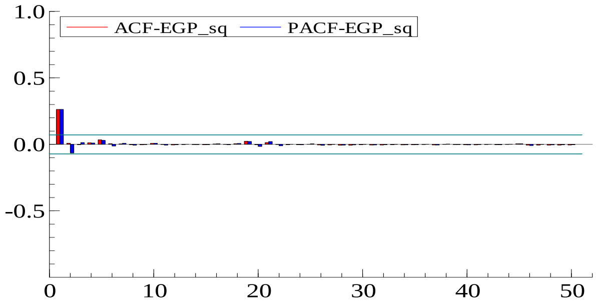
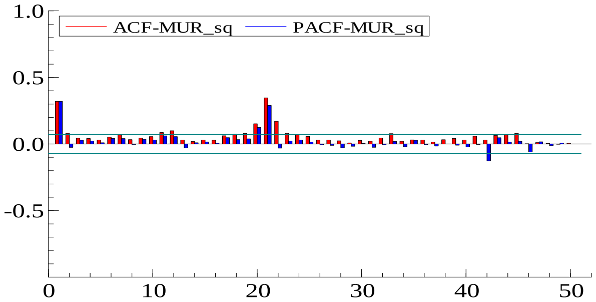


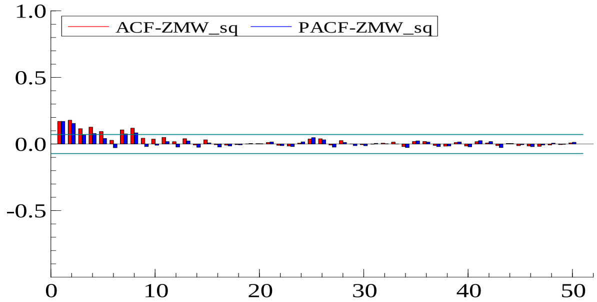
Figure C2: ACF and PACF of Returns of African Carry Trade Funded by EUR

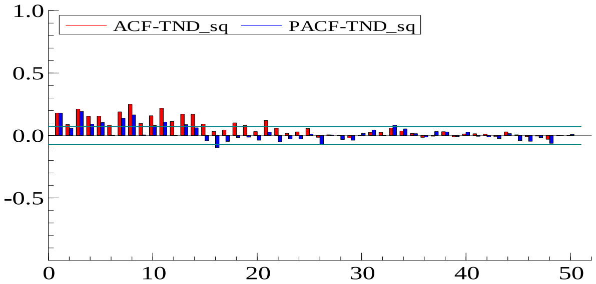


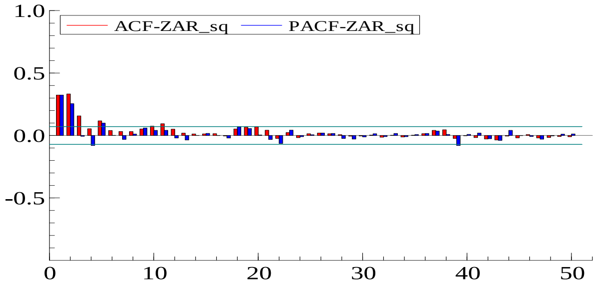

ACF-BWP_sq
PACF-BWP_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50

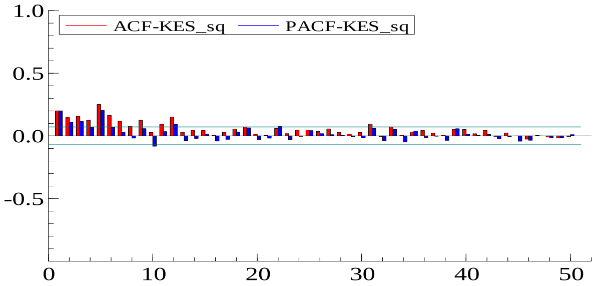

ACF-EGP_sq
PACF-EGP_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50

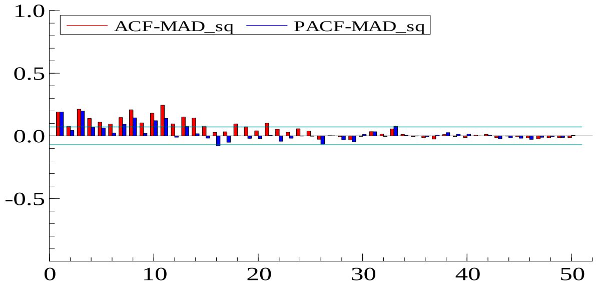

ACF-MUR_sq
PACF-MUR_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-ZMW_sq
PACF-ZMW_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-TND_sq
PACF-TND_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-ZAR_sq
PACF-ZAR_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-KES_sq
PACF-KES_sq
1.0
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-MAD_sq
PACF-MAD_sq
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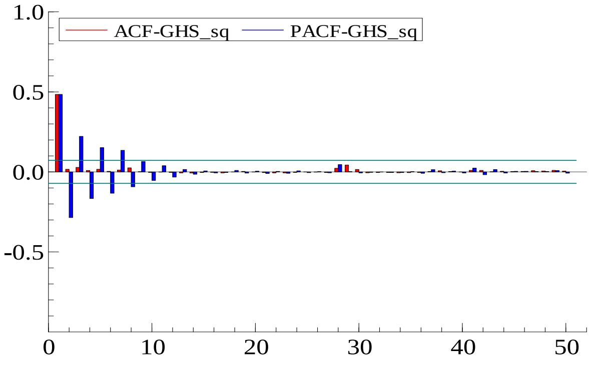
0.0
-0.5
0 10 20 30 40 50


ACF-GHS_sq
PACF-GHS_sq
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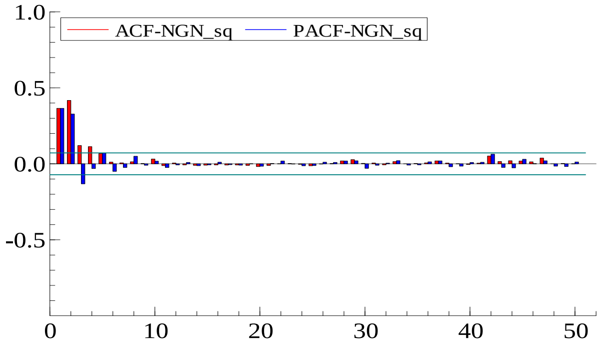
0.5
0.0
-0.5
0 10 20 30 40 50


ACF-NGN_sq
PACF-NGN_sq
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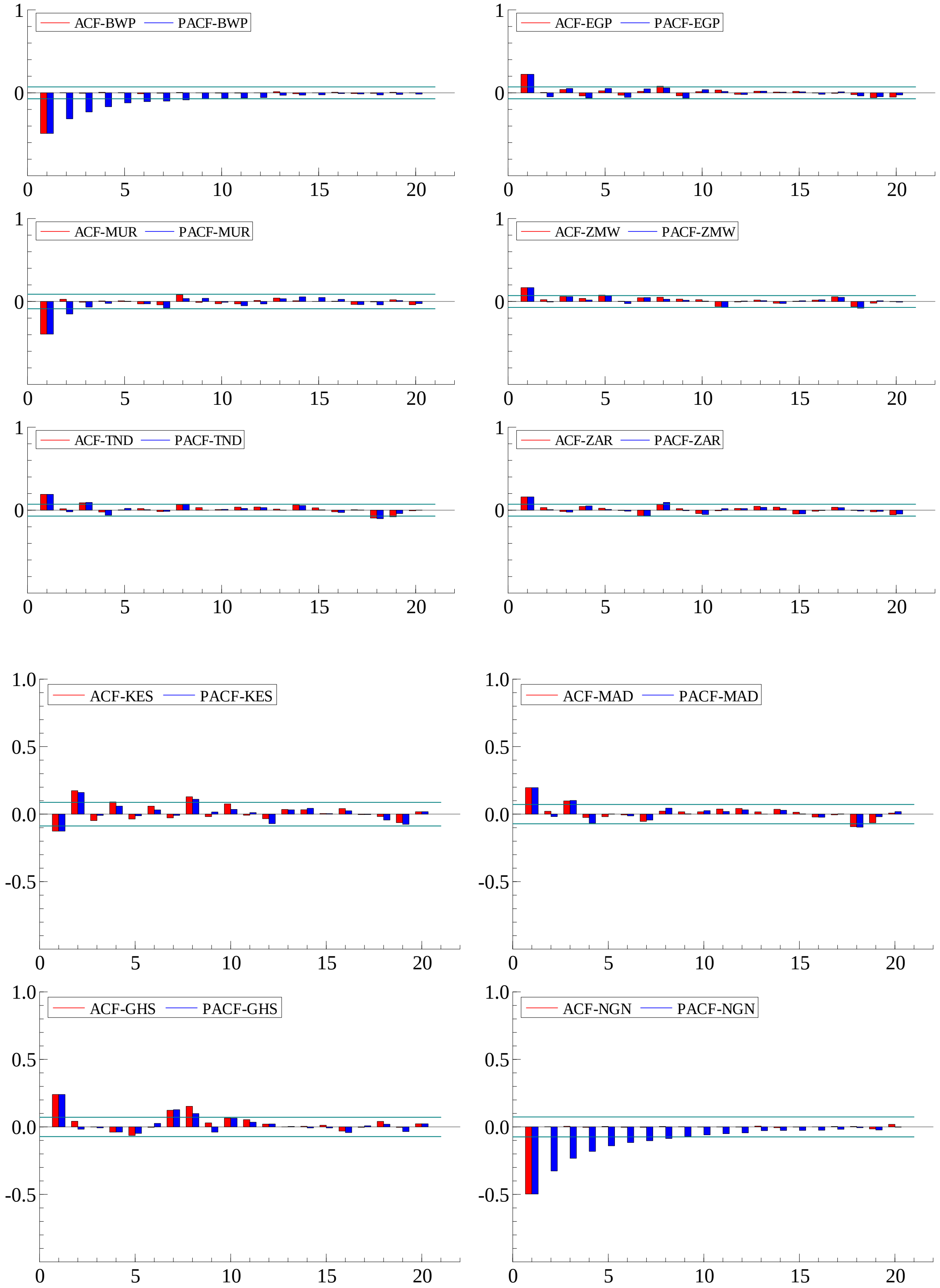
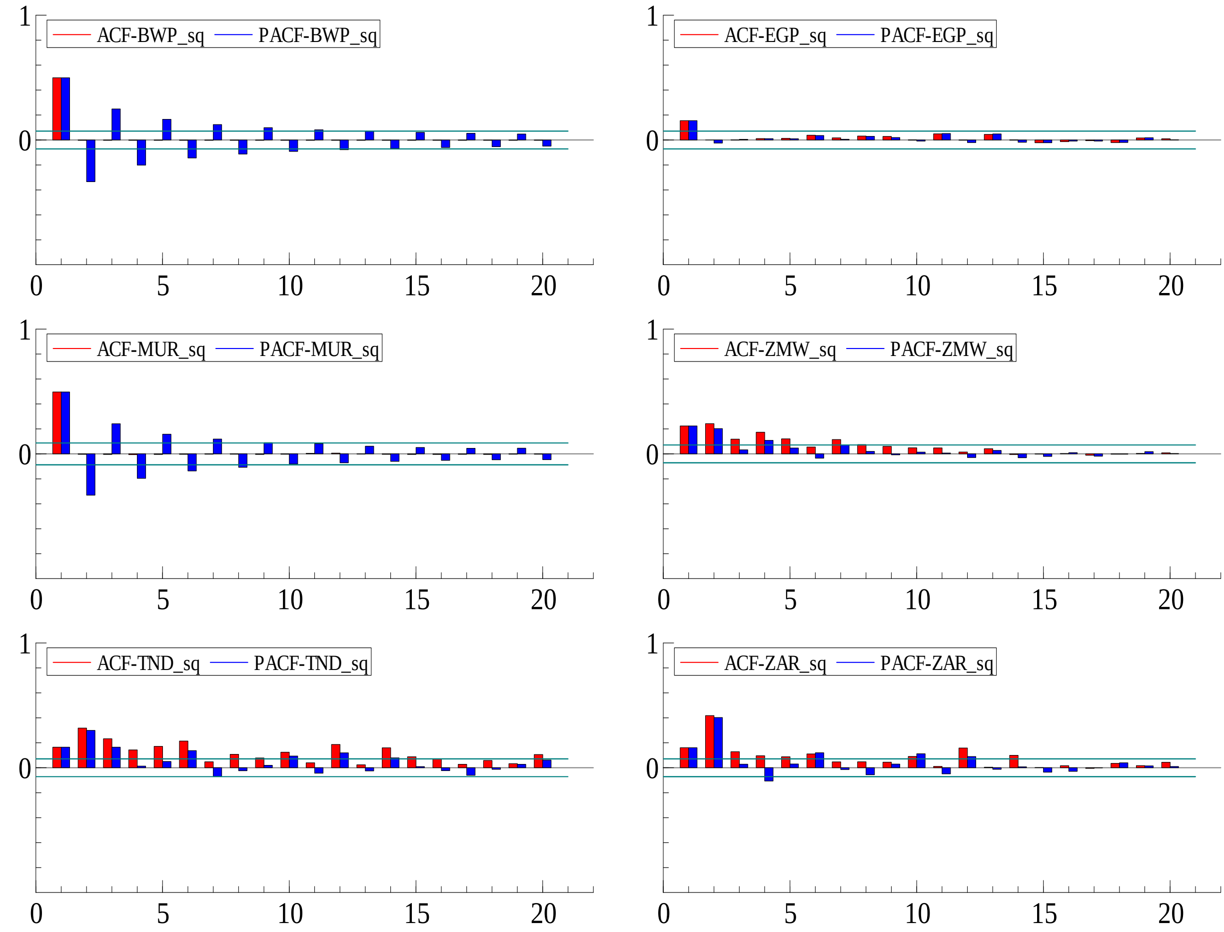
0.0
-0.5
0 10 20 30 40 50

Figure C3: ACF and PACF of Returns of African Carry Trade Funded by JPY




ACF-BWP_sq PACF-BWP_sq
ACF-EGP_sq PACF-EGP_sq
ACF-MUR_sq PACF-MUR_sq
ACF-ZMW_sq PACF-ZMW_sq
ACF-TND_sq PACF-TND_sq
ACF-ZAR_sq PACF-ZAR_sq

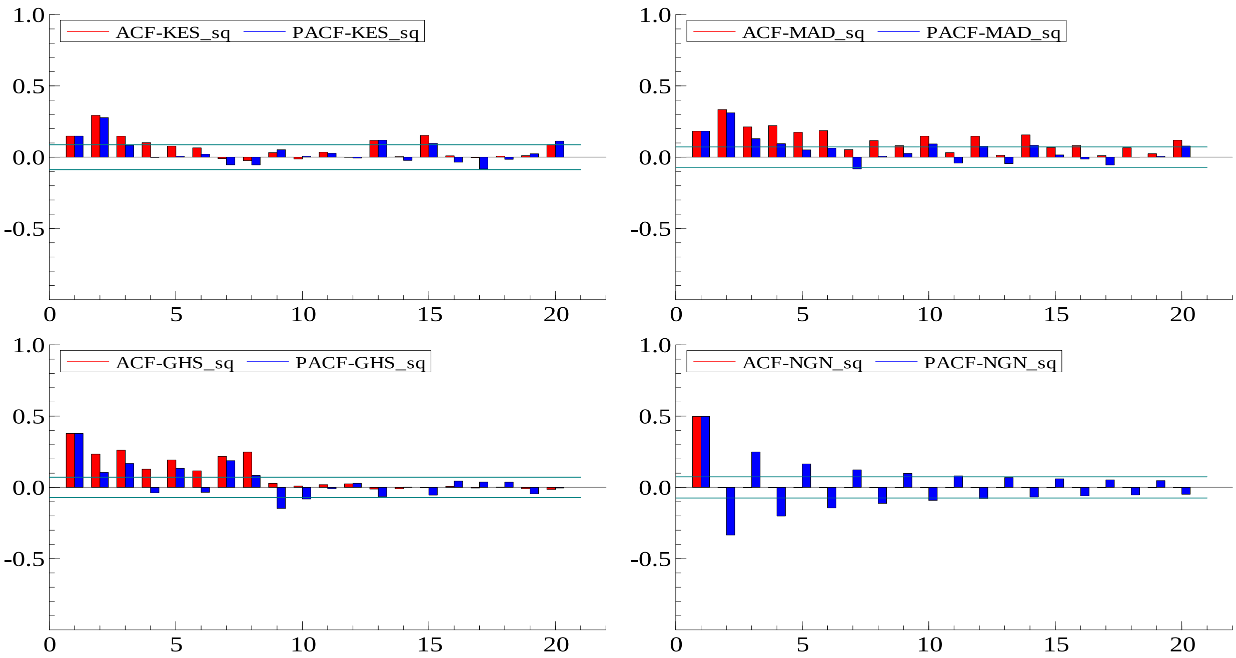
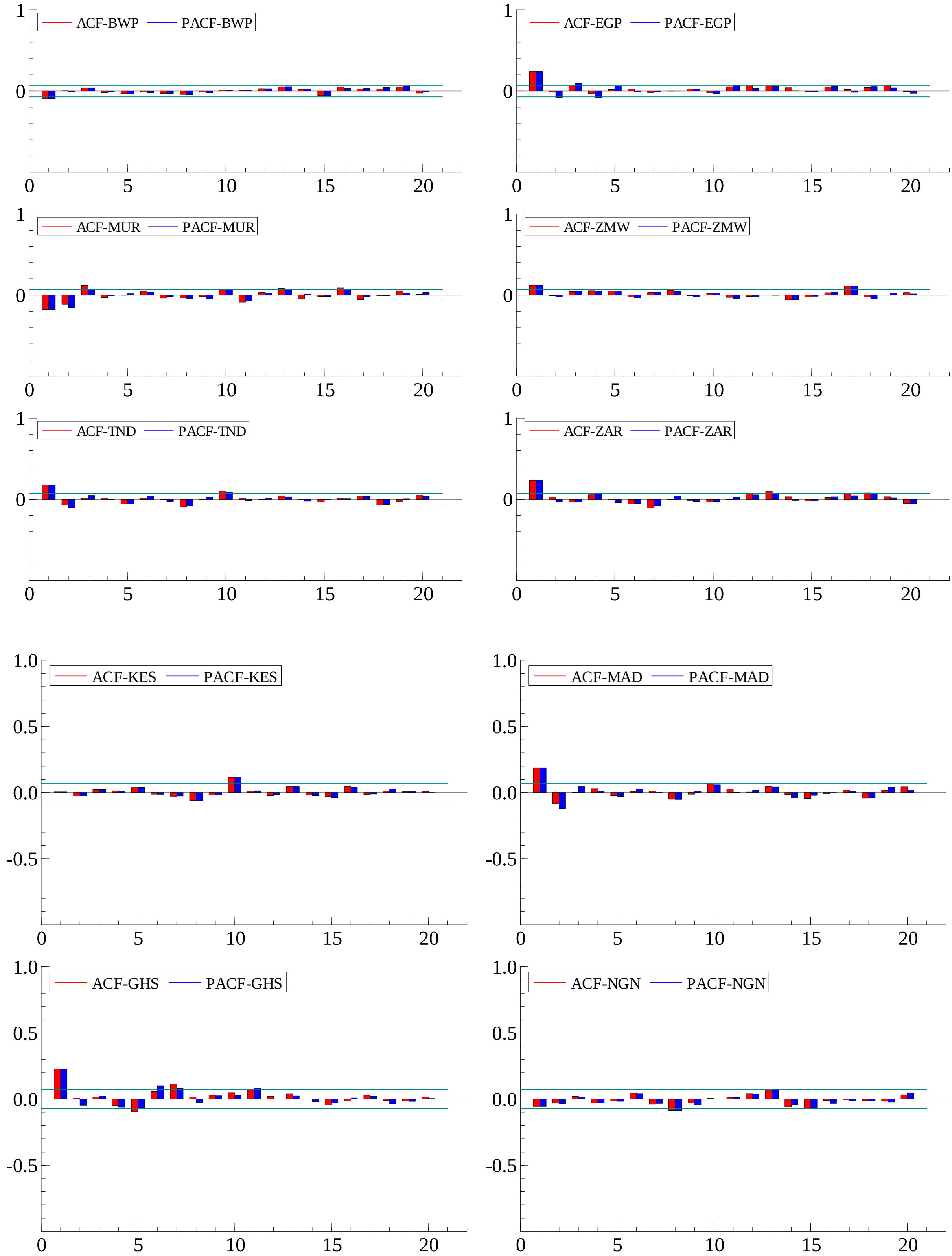
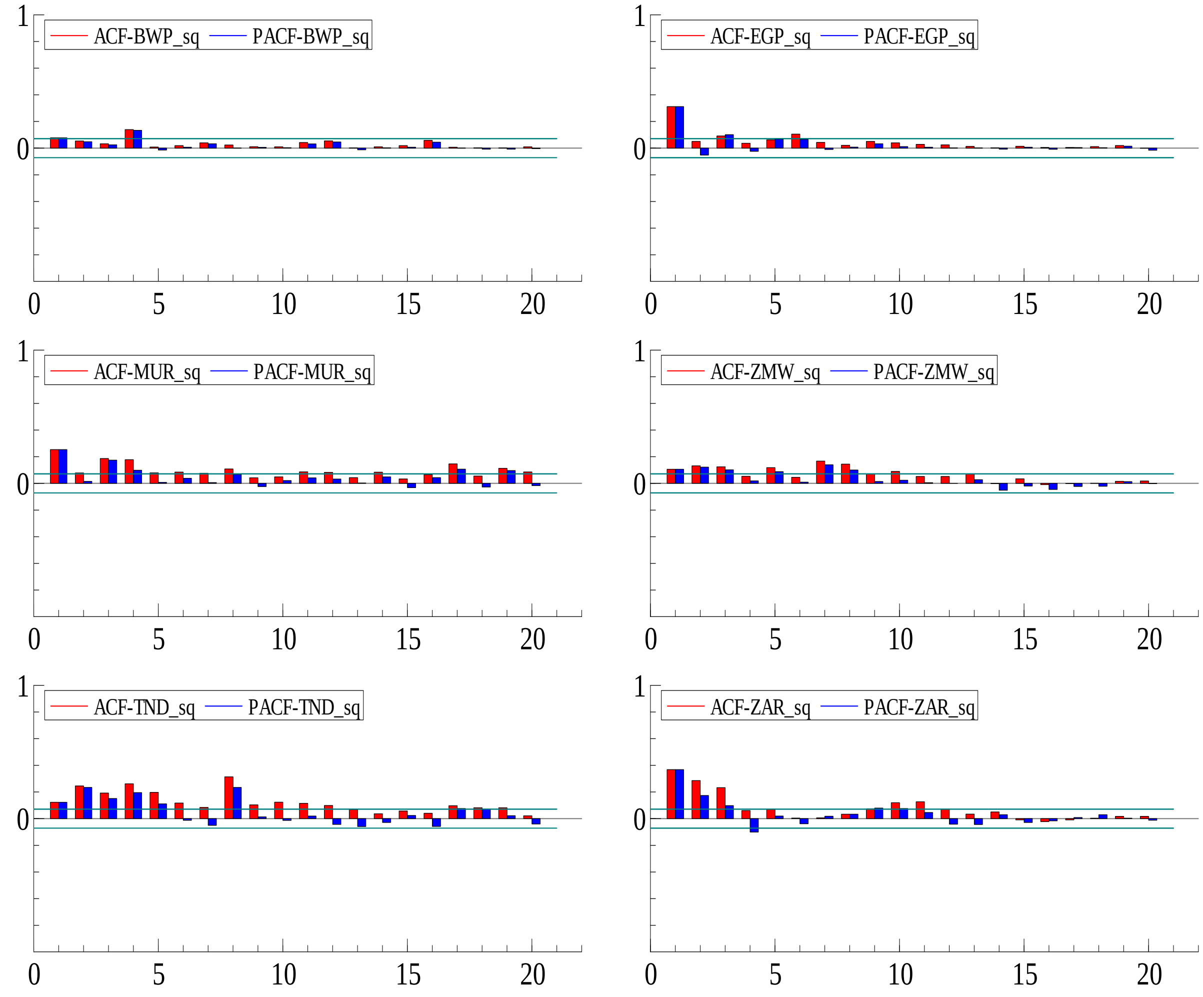
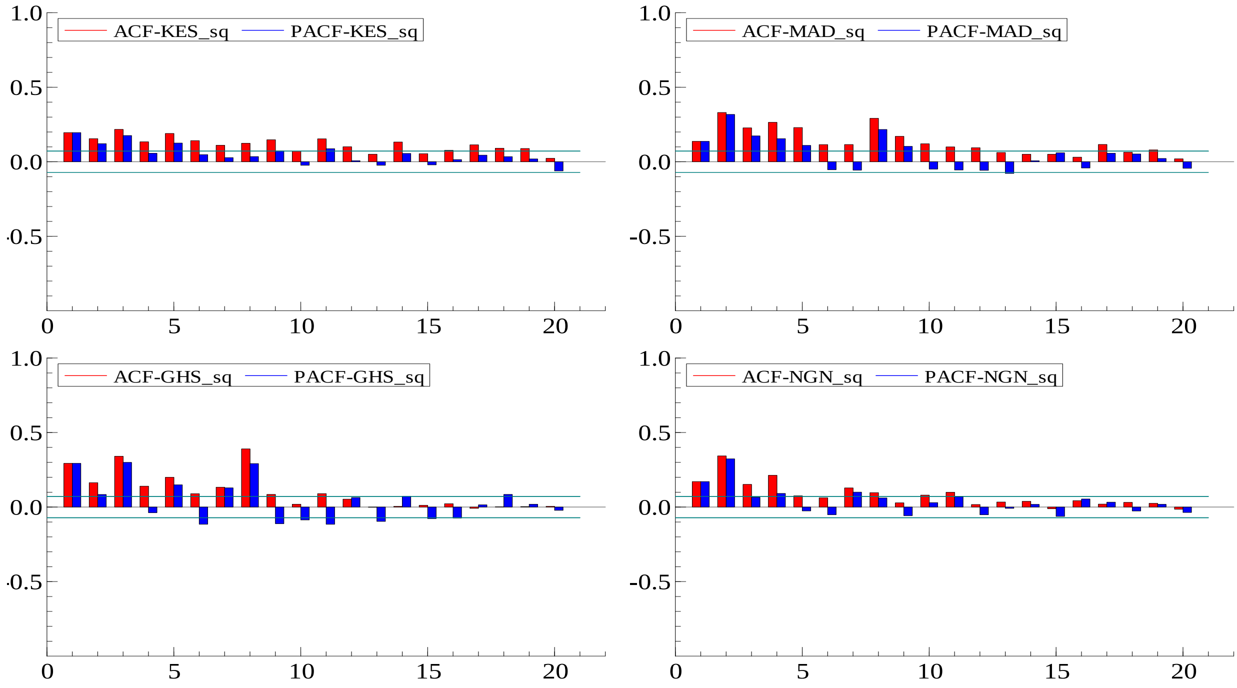
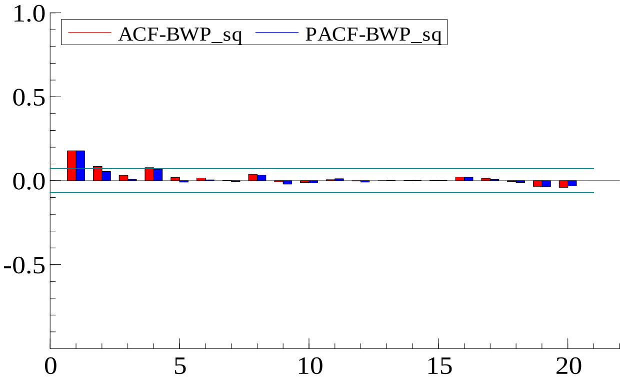

ACF-KES_sq PACF-KES_sq
ACF-MAD_sq PACF-MAD_sq
ACF-GHS_sq PACF-GHS_sq
ACF-NGN_sq PACF-NGN_sq

Figure C4: ACF and PACF of Returns of African Carry Trade Funded by GBP




ACF-BWP_sq
PACF-BWP_sq
ACF-EGP_sq
PACF-EGP_sq
ACF-MUR_sq
PACF-MUR_sq
ACF-ZMW_sq
PACF-ZMW_sq
ACF-TND_sq
PACF-TND_sq
ACF-ZAR_sq
PACF-ZAR_sq


ACF-KES_sq
PACF-KES_sq
ACF-MAD_sq
PACF-MAD_sq
ACF-GHS_sq
PACF-GHS_sq
ACF-NGN_sq
PACF-NGN_sq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PACF-BWP_sq
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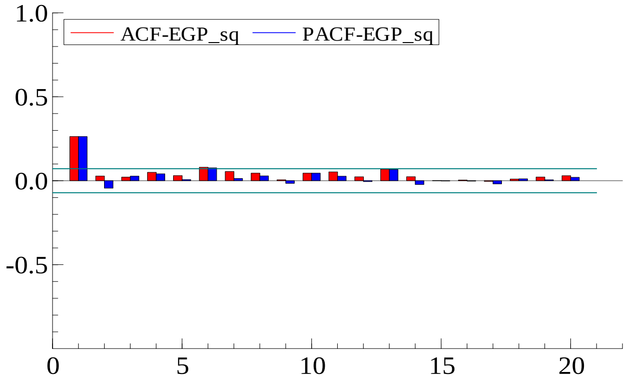
0.5
0.0
-0.5
0
5
10
15
20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PACF-EGP_sq
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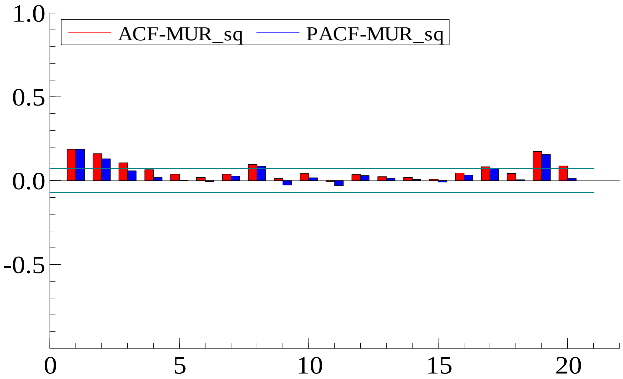
-0.5
0
5
10
15
20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PACF-MUR_sq
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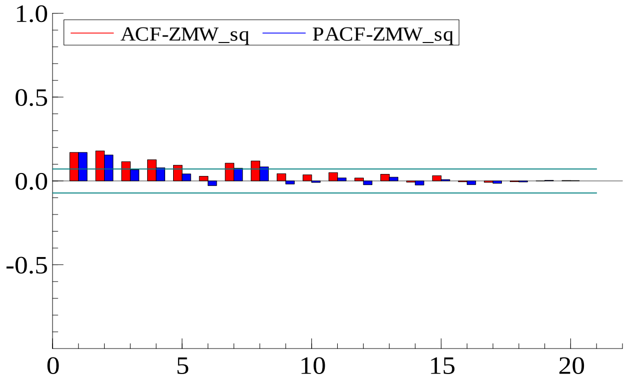
0.5
0.0
-0.5
0
5
10
15
20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PACF-ZMW_sq
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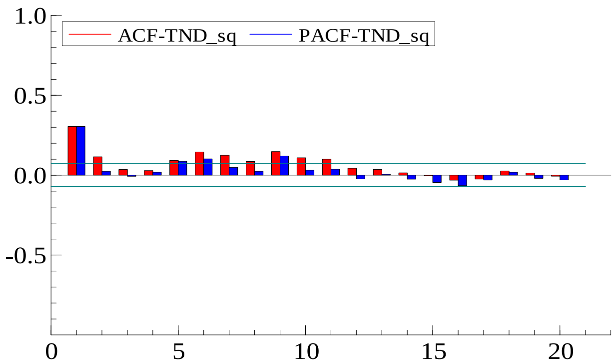
0
5
10
15
20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PACF-TND_sq
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0
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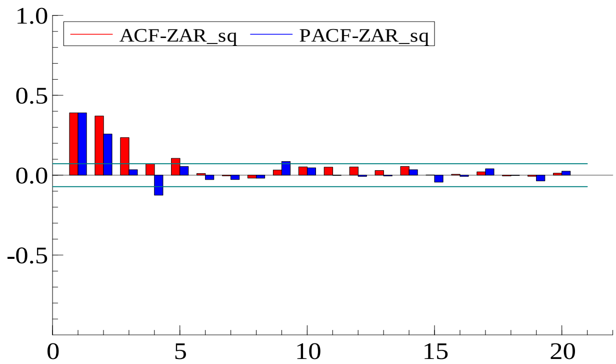
10
15
20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PACF-ZAR_sq
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0.0
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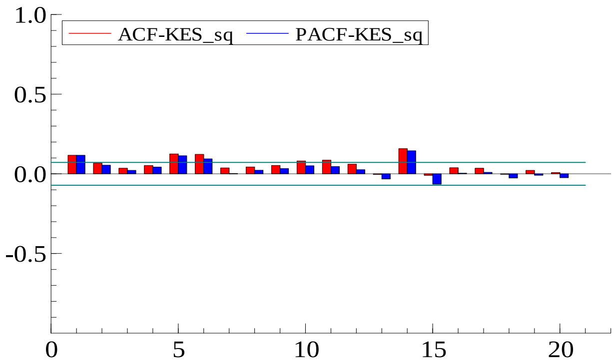
0
5
10
15
20


ACF-KES_sq
PACF-KES_sq
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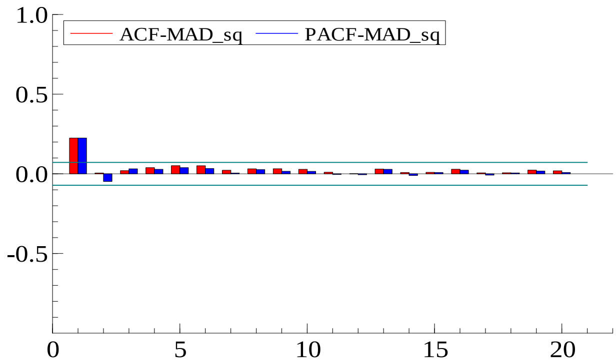
0.5
0.0
-0.5
0
5
10
15
20


ACF-MAD_sq
PACF-MAD_sq
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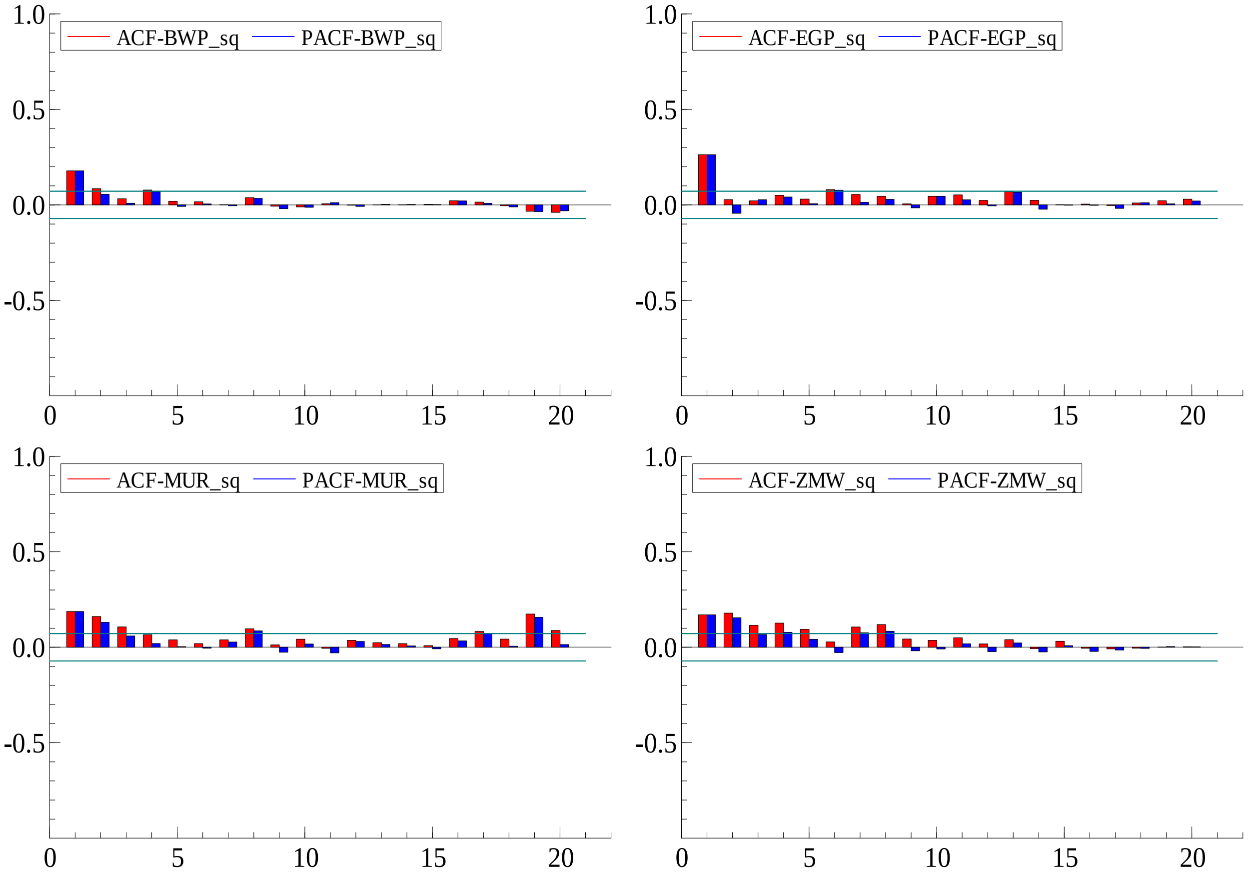
0.5
0.0
-0.5
0
5
10
15
20


ACF-BWP_sq
PACF-BWP_sq
ACF-EGP_sq
PACF-EGP_sq
ACF-MUR_sq
PACF-MUR_sq
ACF-ZMW_sq
PACF-ZMW_sq

Appendix D: ARMA (1, 0)-GARCH (1, 1) with Skewed t Distribution of Innovation Estimation Diagnostics for the Currencies Pairs Studied

Figure D1: USDBWP Carry Trade Returns

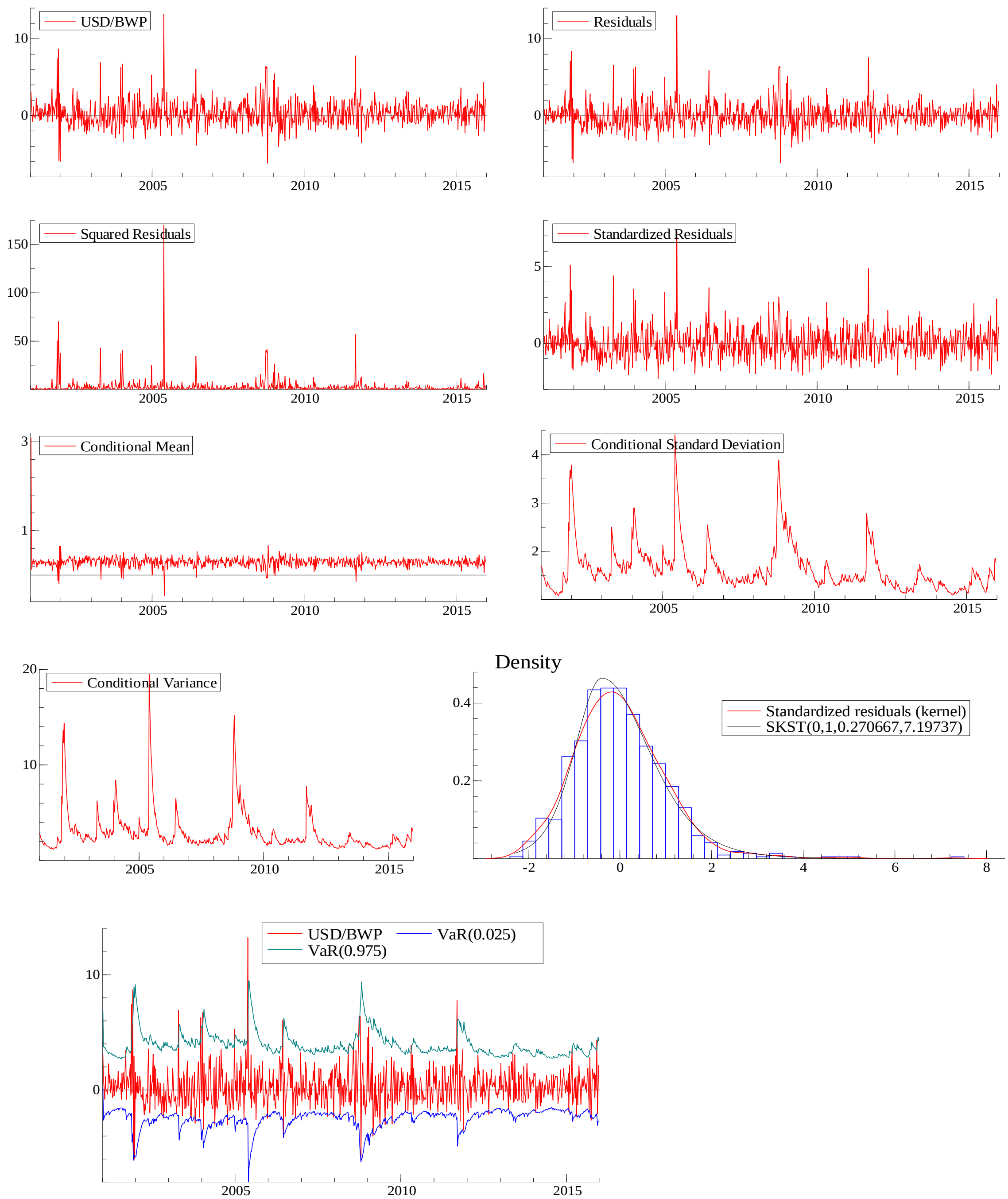


Figure D2: EURBWP Carry Trade Returns

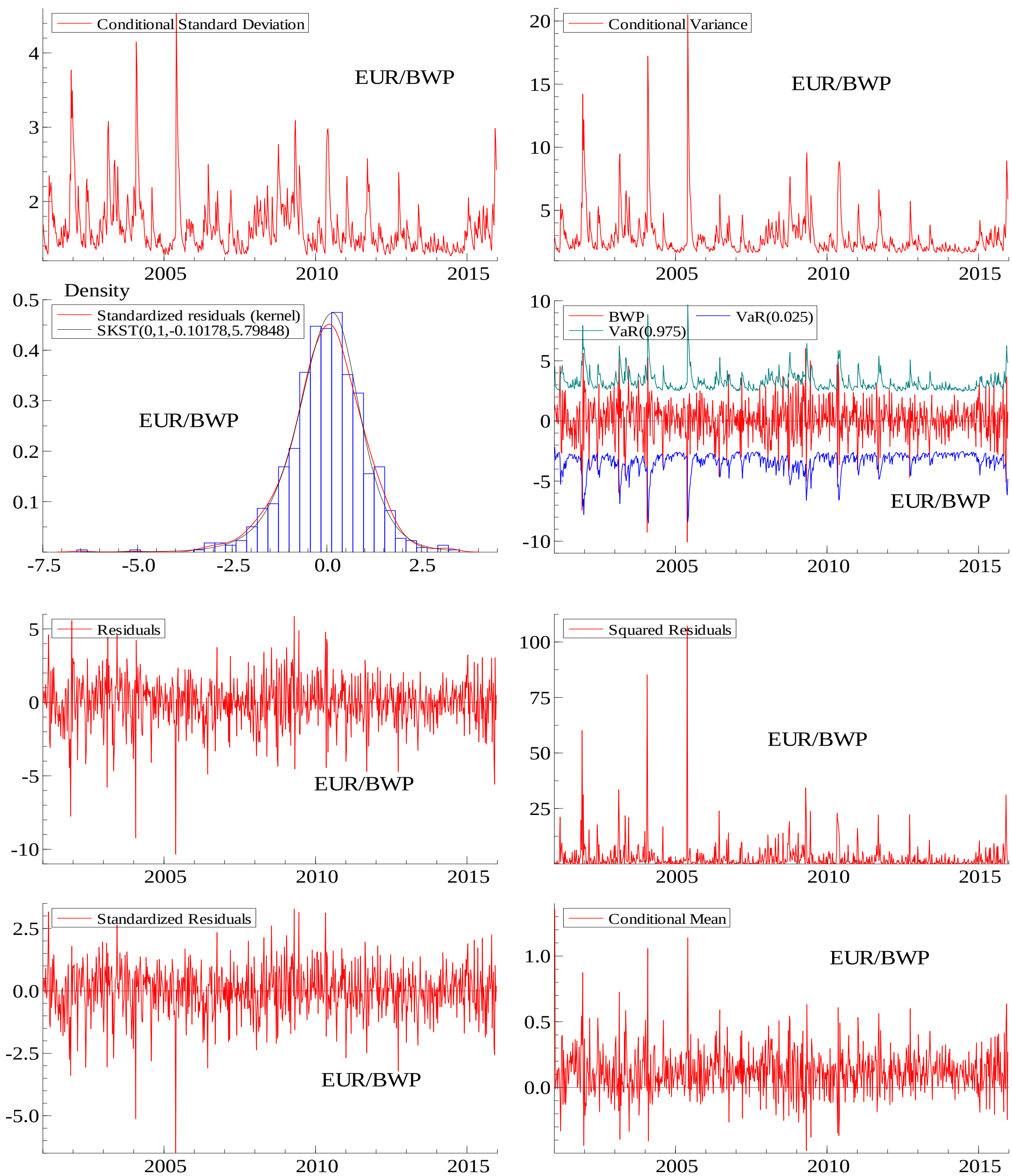


Figure D3: GBPBWP Carry Trade Returns

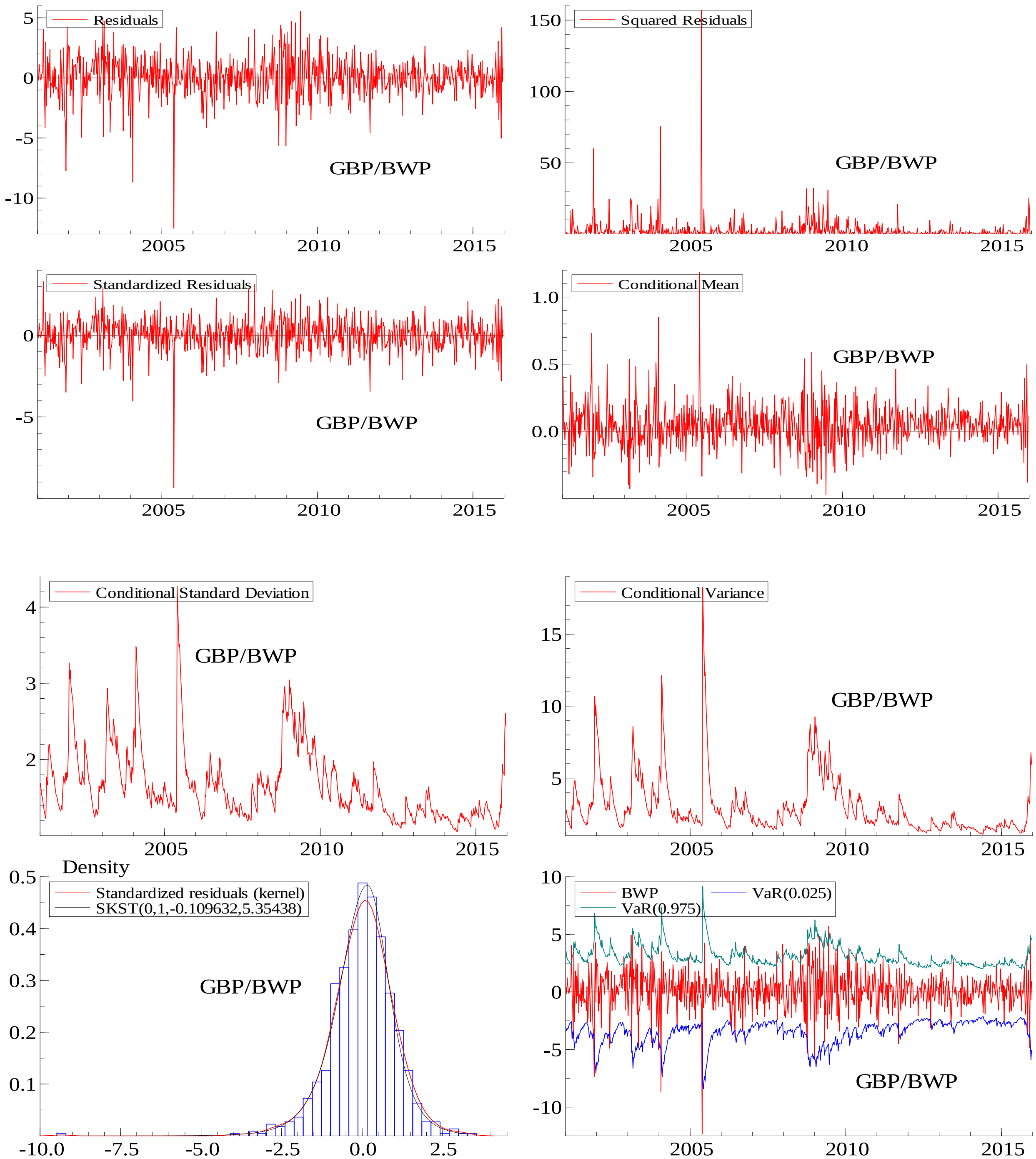


Figure D4: JPYBWP Carry Trade Returns

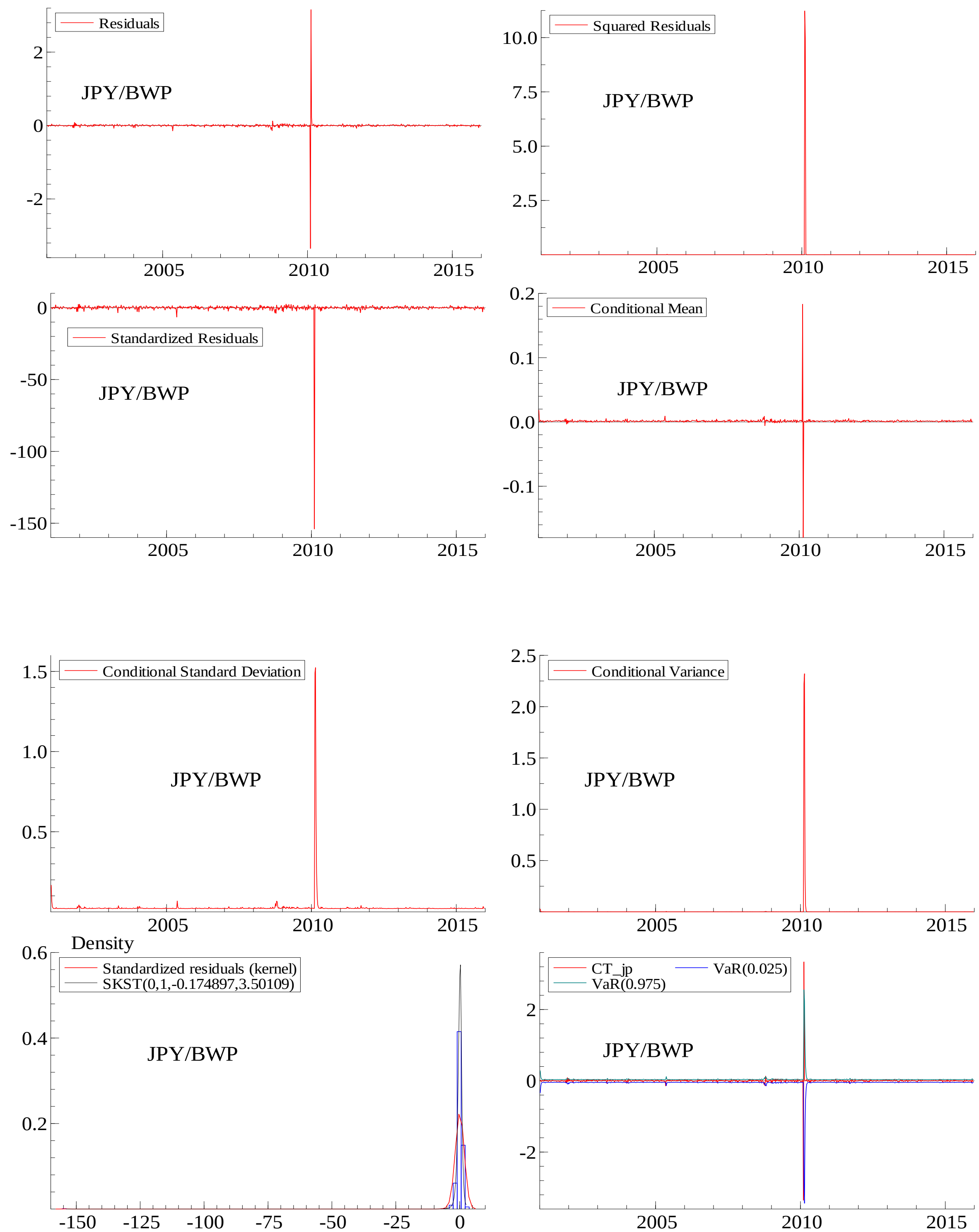


Figure D5: USDEGP Carry Trade Returns

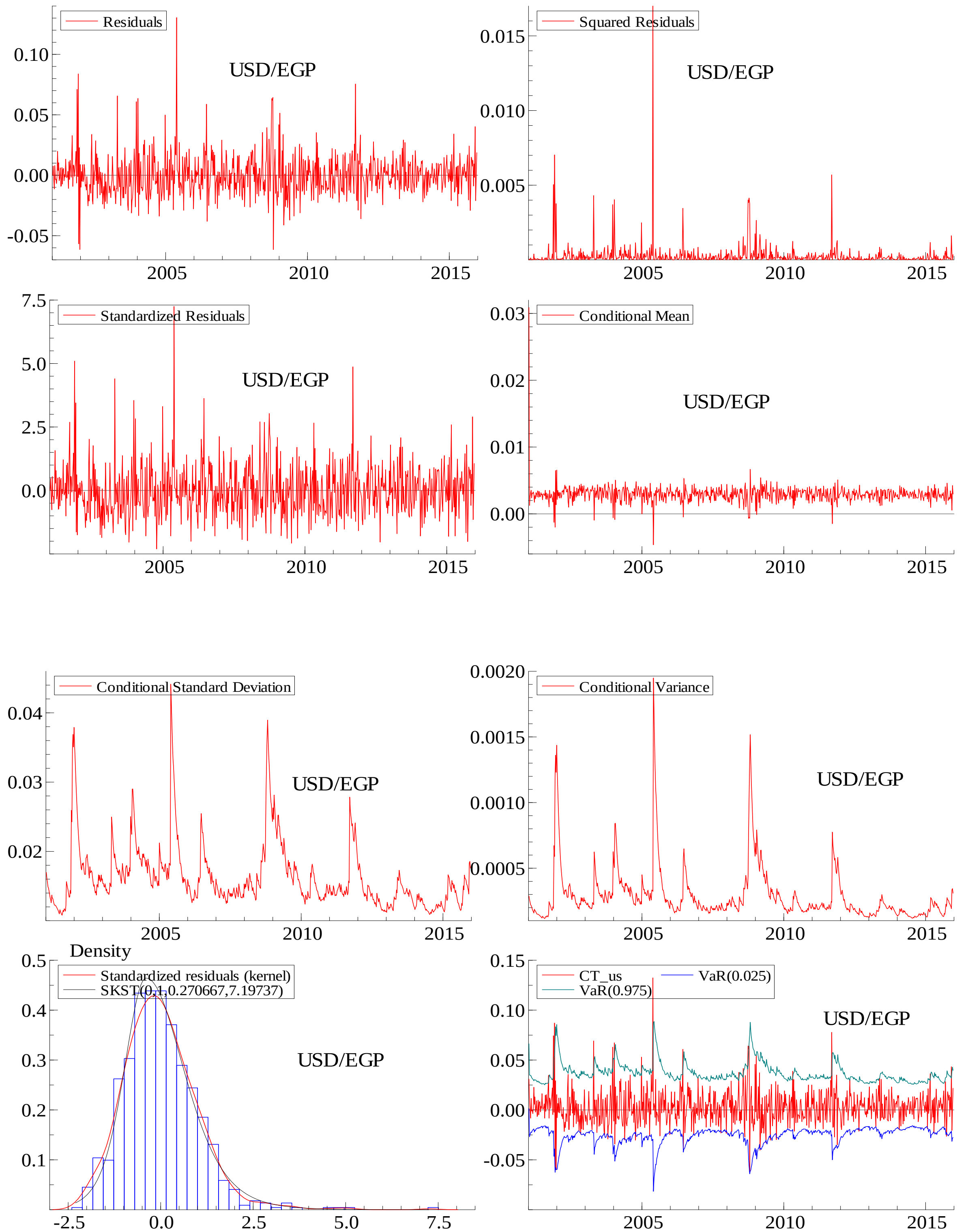


Figure D6: EUREGP Carry Trade Returns

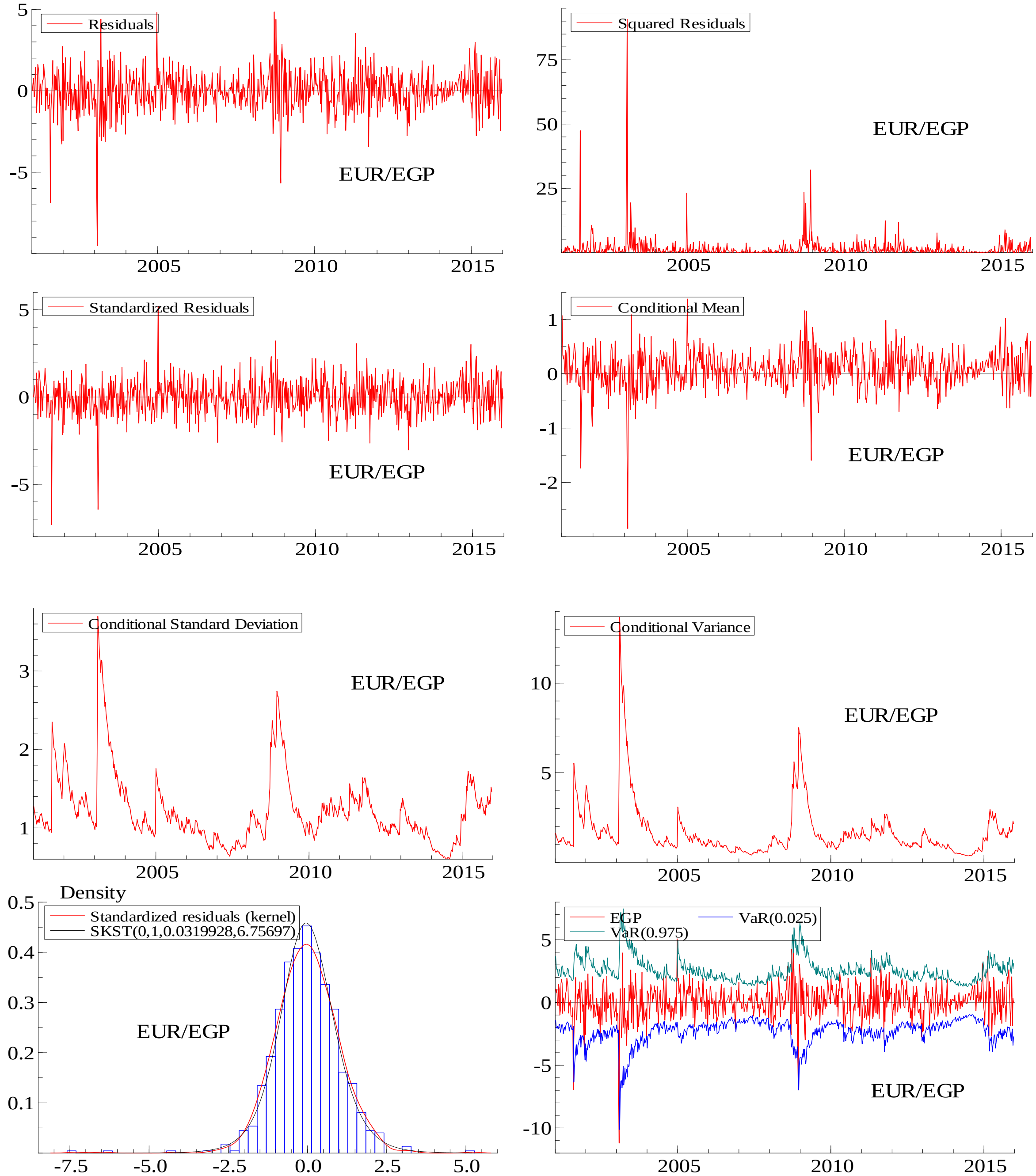


Figure D7: GBPEGP Carry Trade Returns

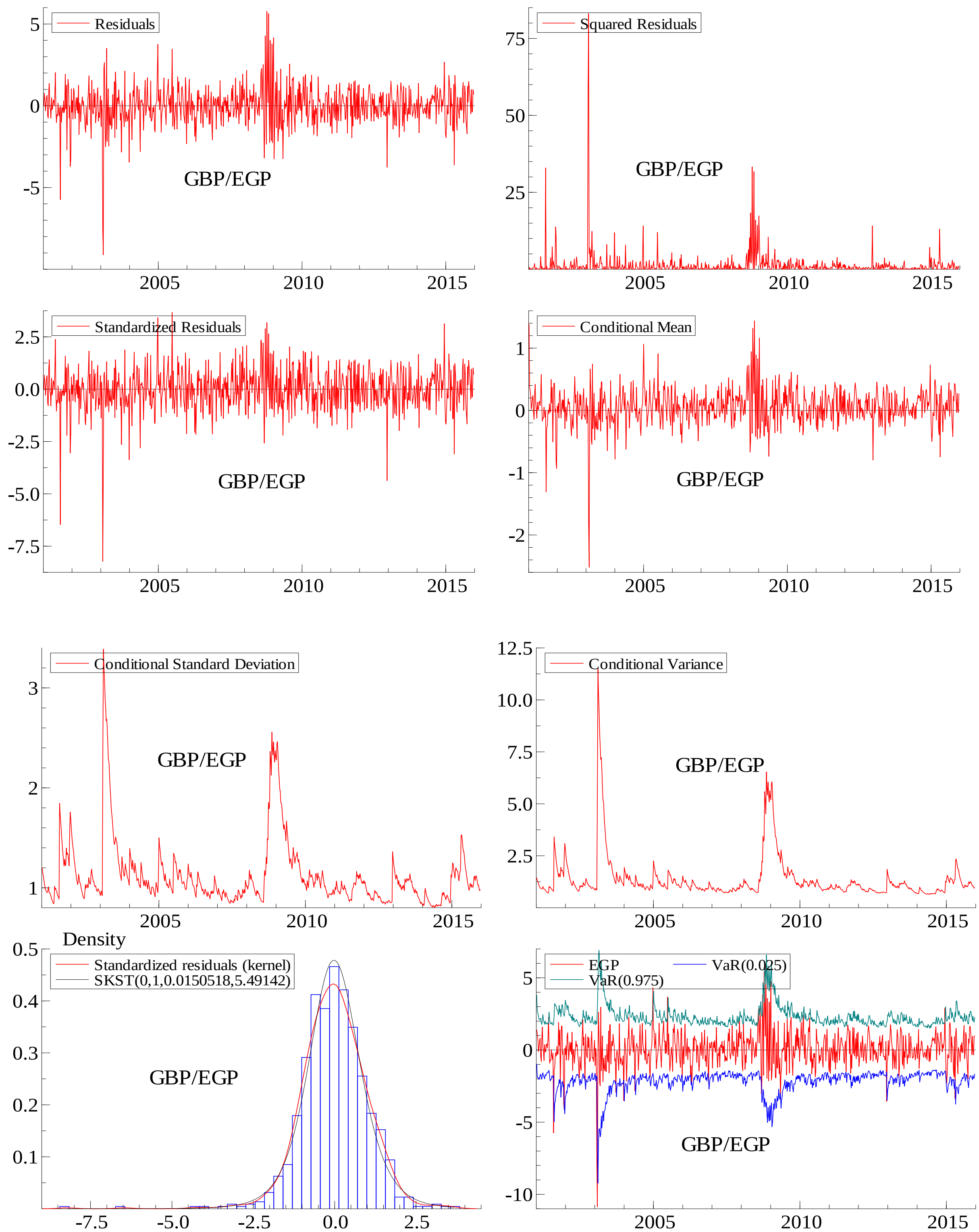


Figure D8: JPYEGP Carry Trade Returns

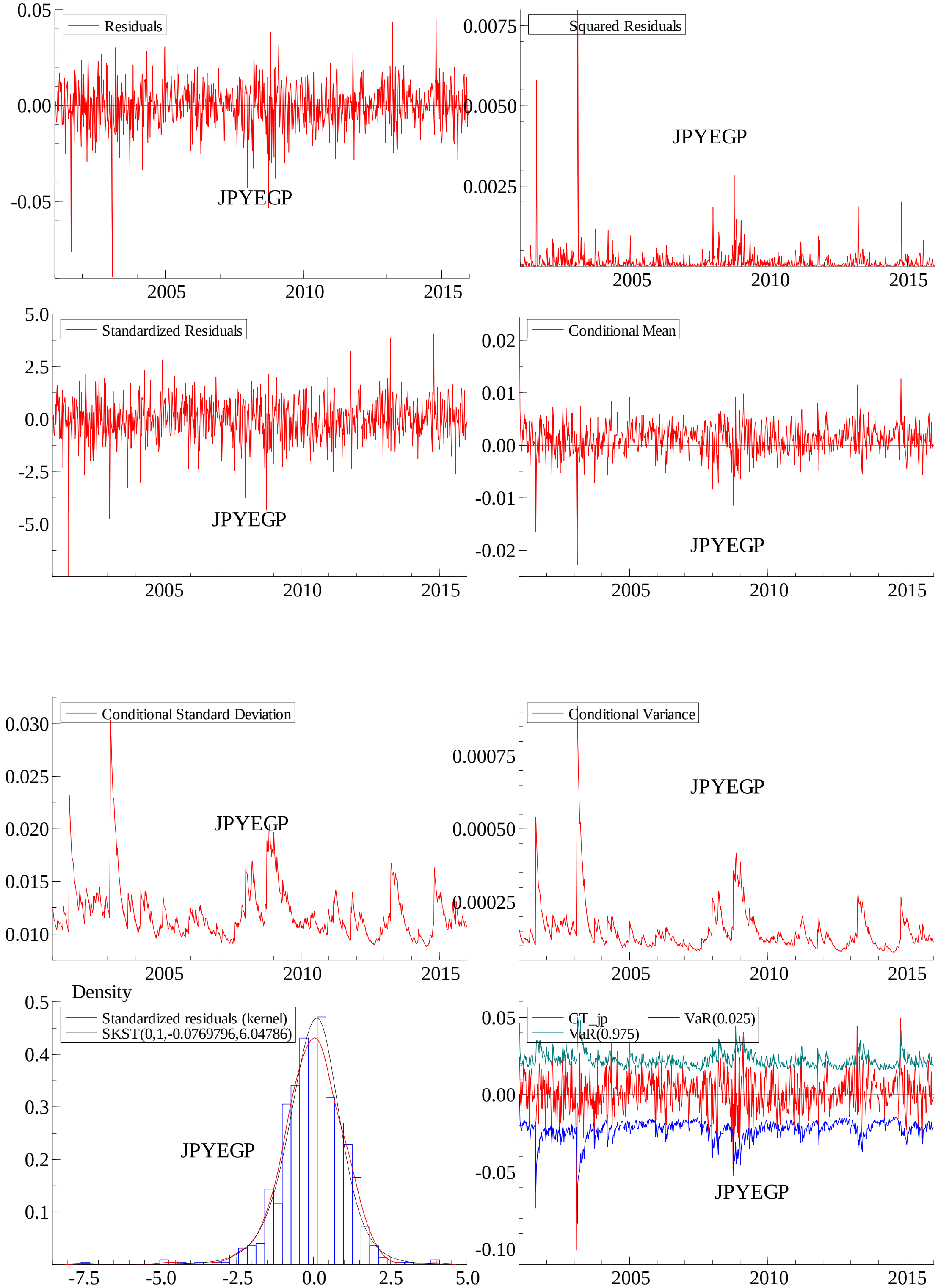


Figure D9: EURTND Carry Trade Returns

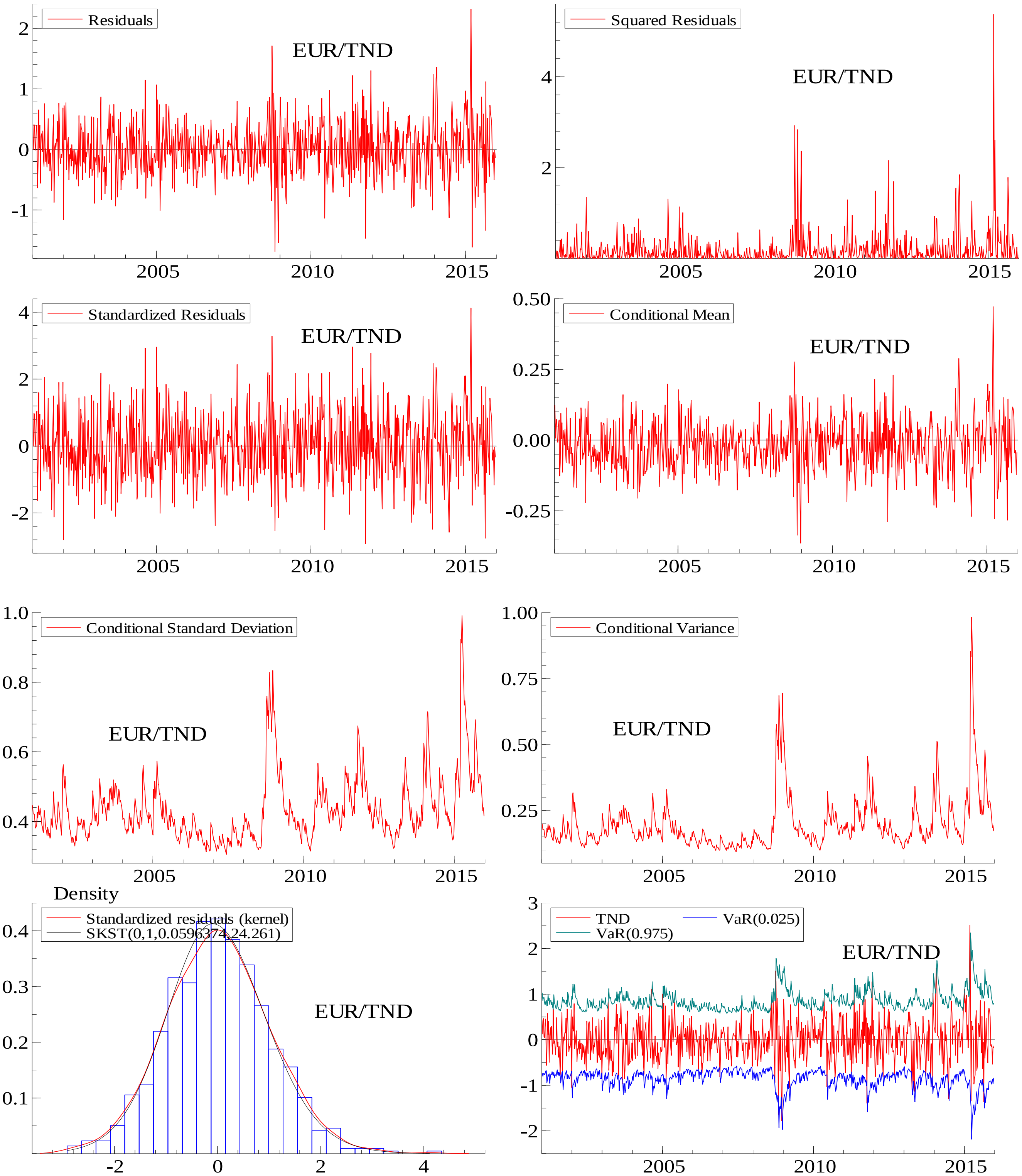


Figure D10: GBPTND Carry Trade Returns

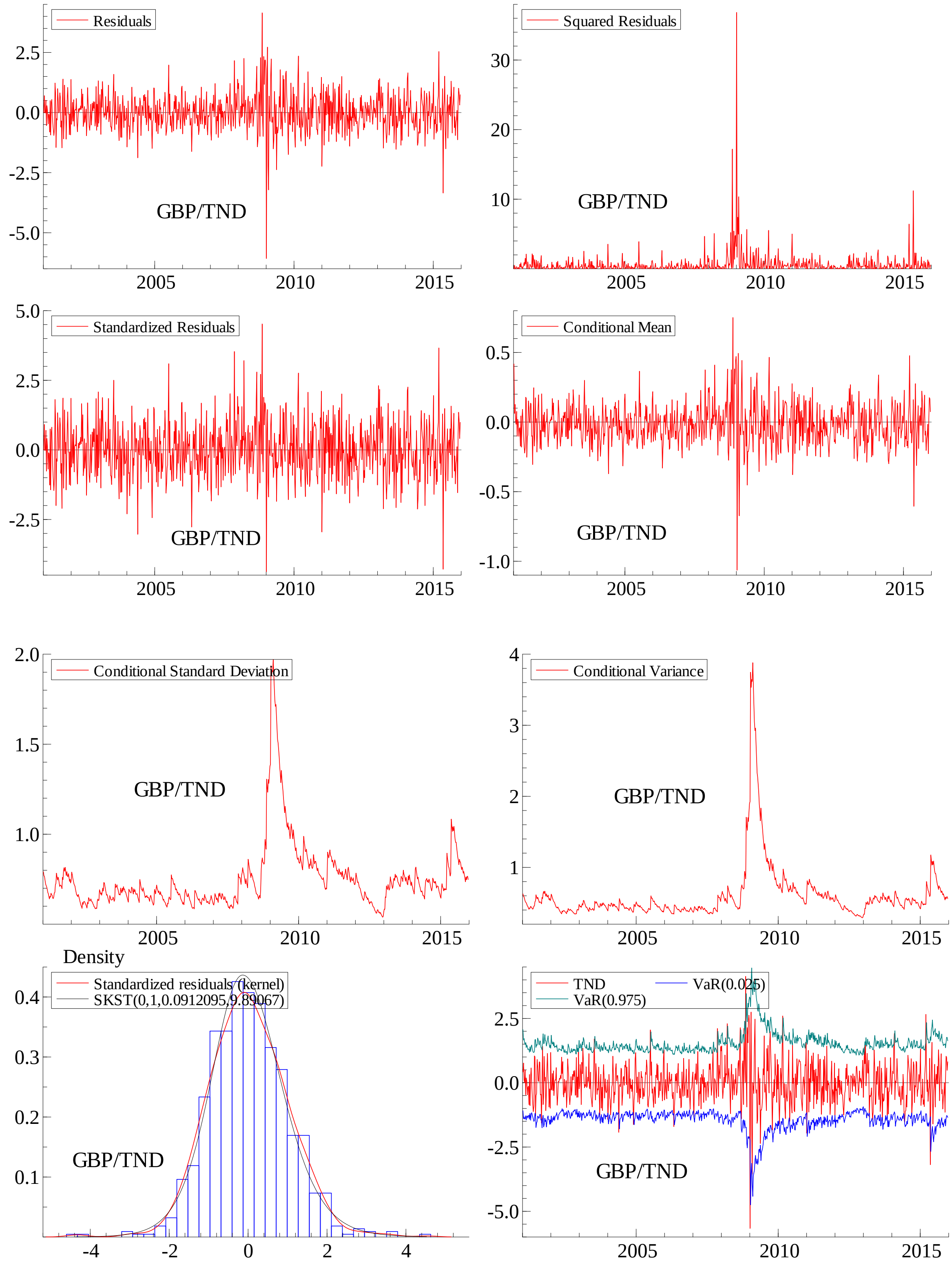


Figure D11: JPYTND Carry Trade Returns

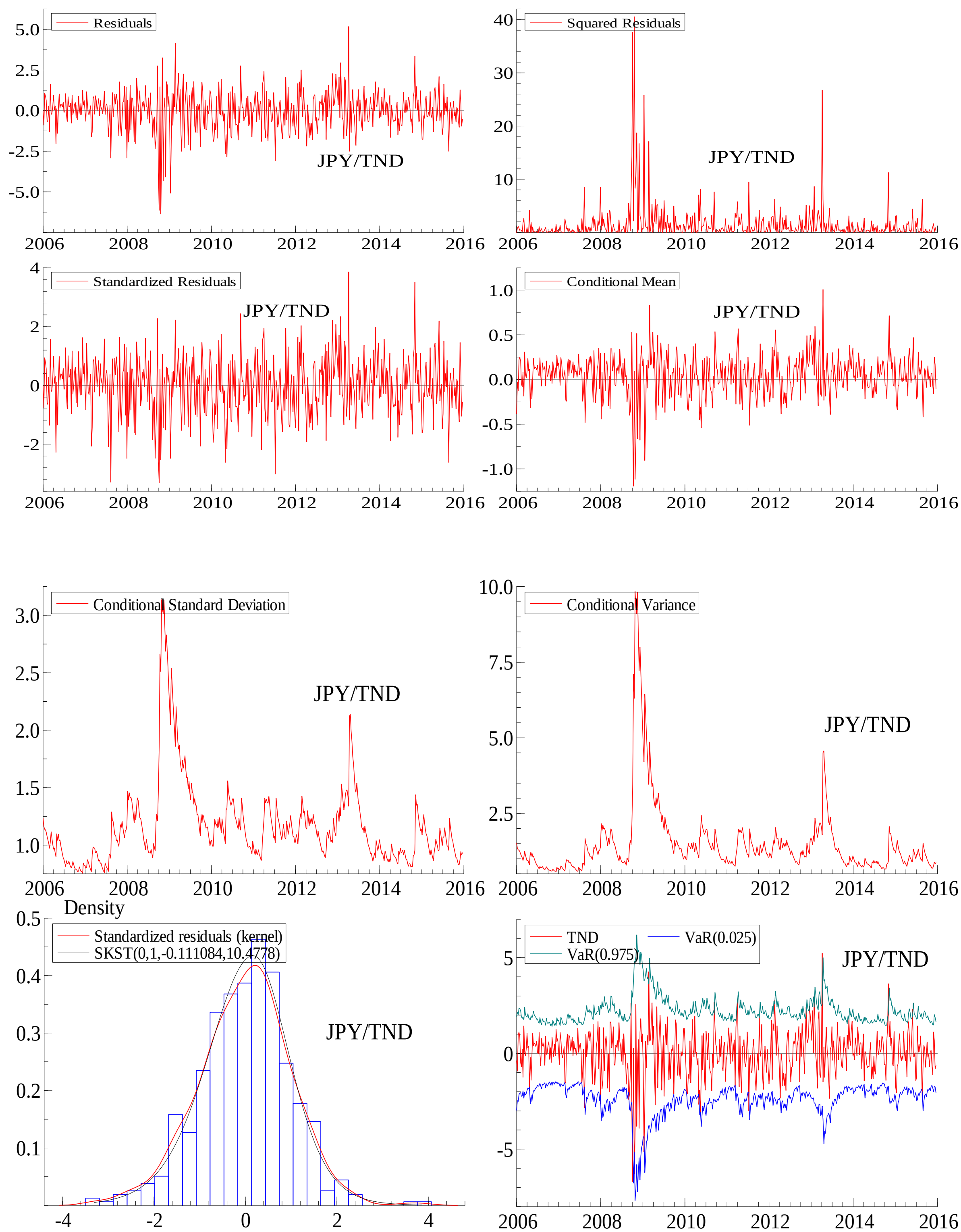


Figure D12: USDTND Carry Trade Returns

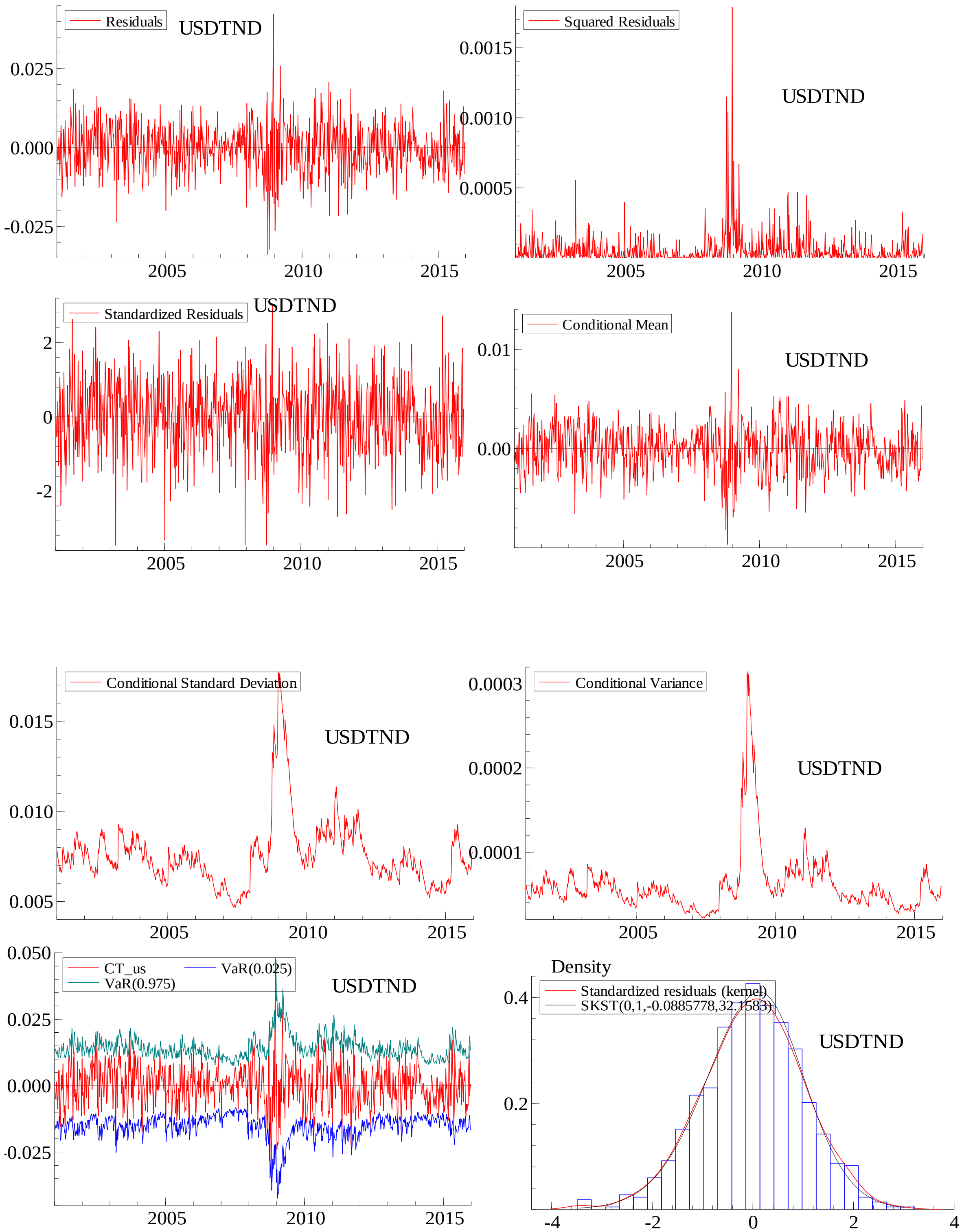


Figure D13: EURZAR Carry Trade Returns

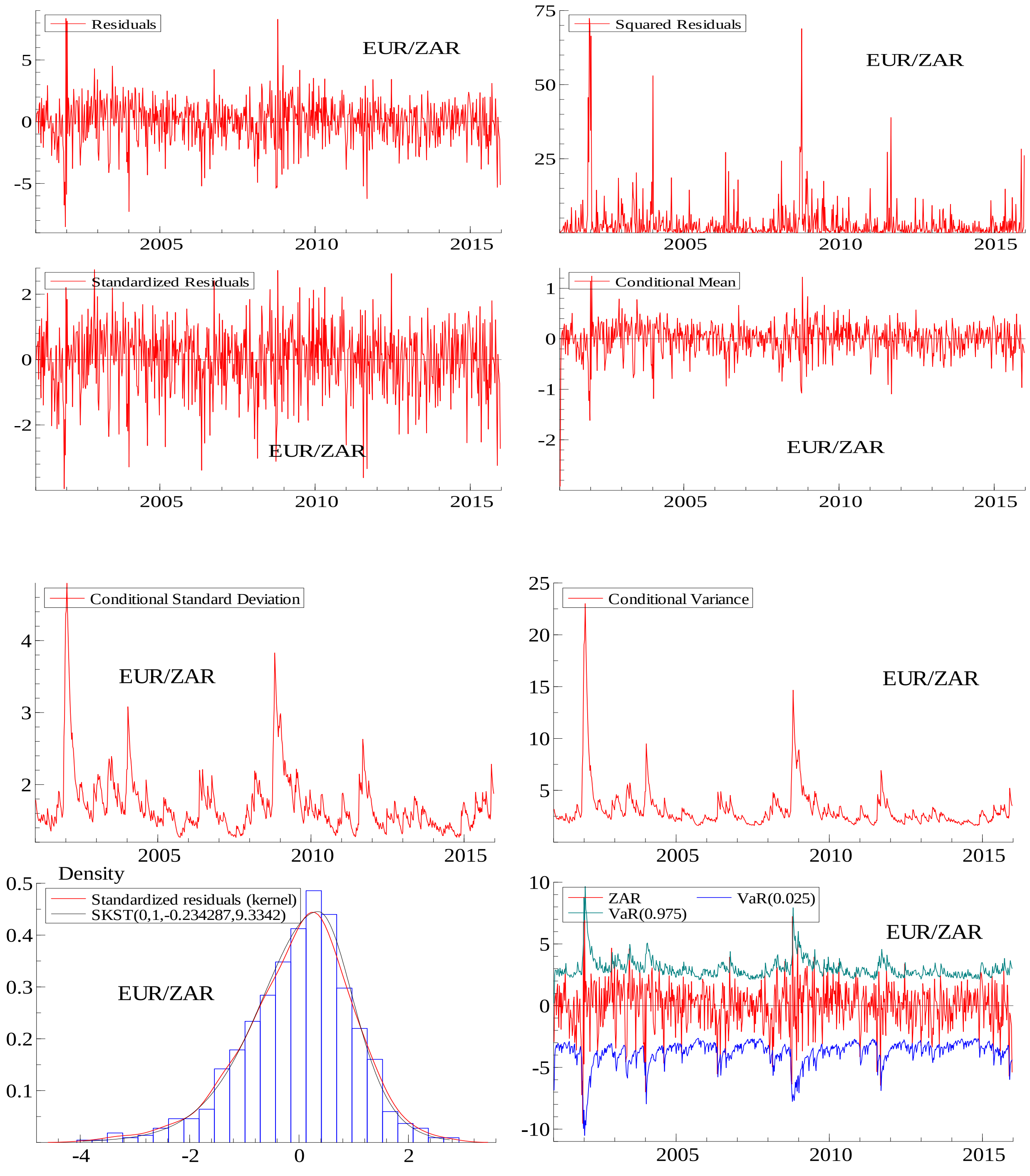


Figure D14: JPYZAR Carry Trade Returns

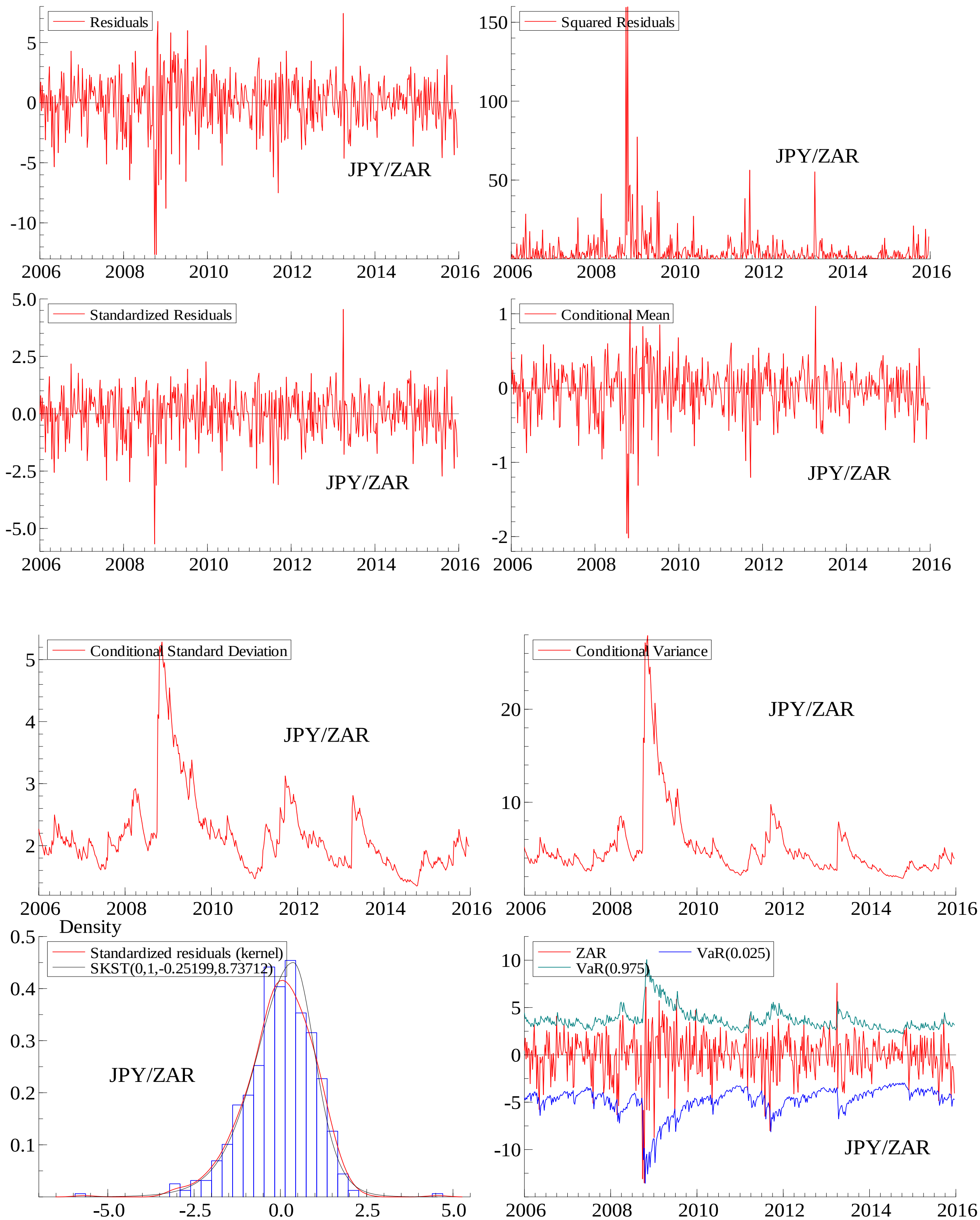


Figure D15: GBPZAR Carry Trade Returns

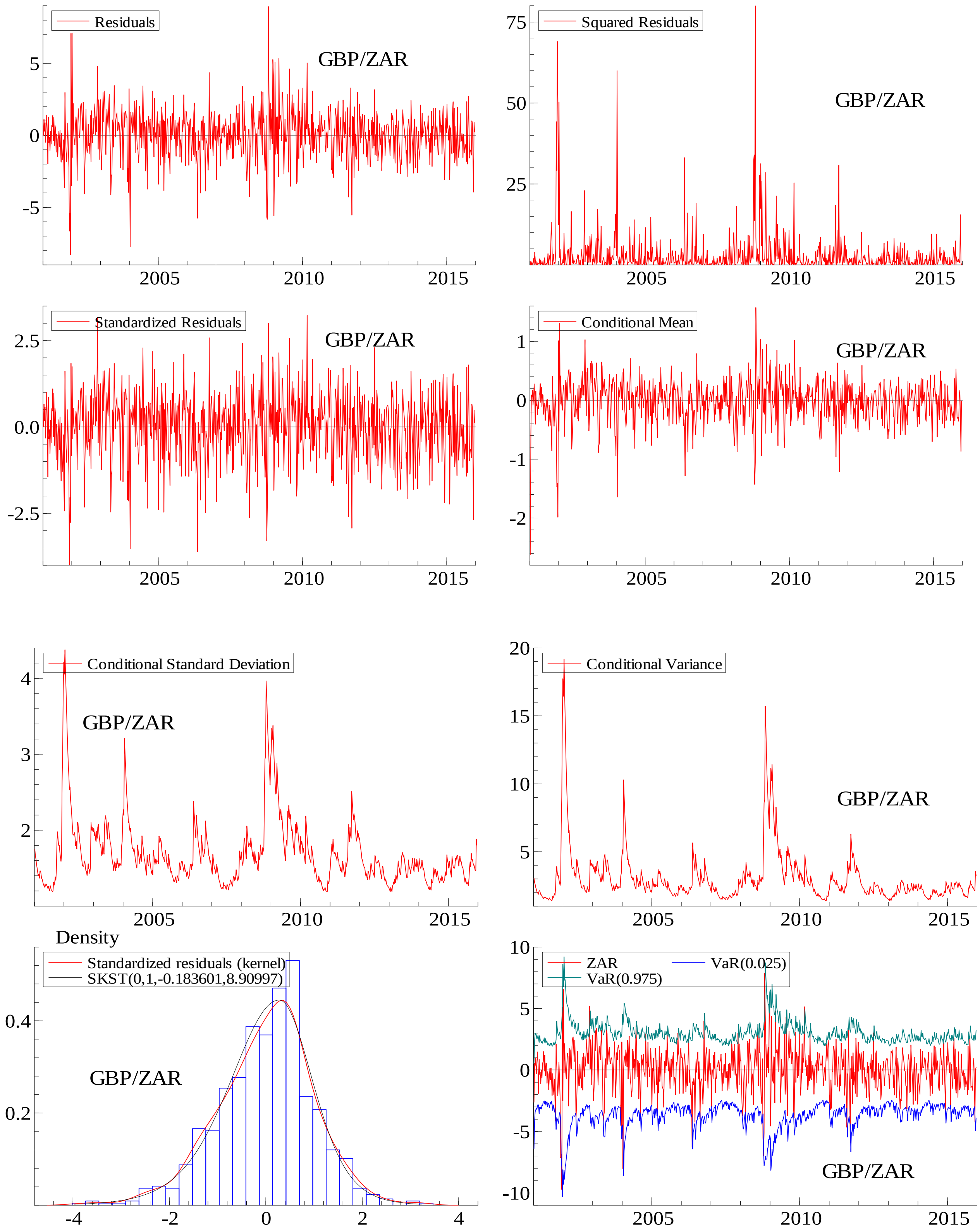


Figure D16: USDZAR Carry Trade Returns

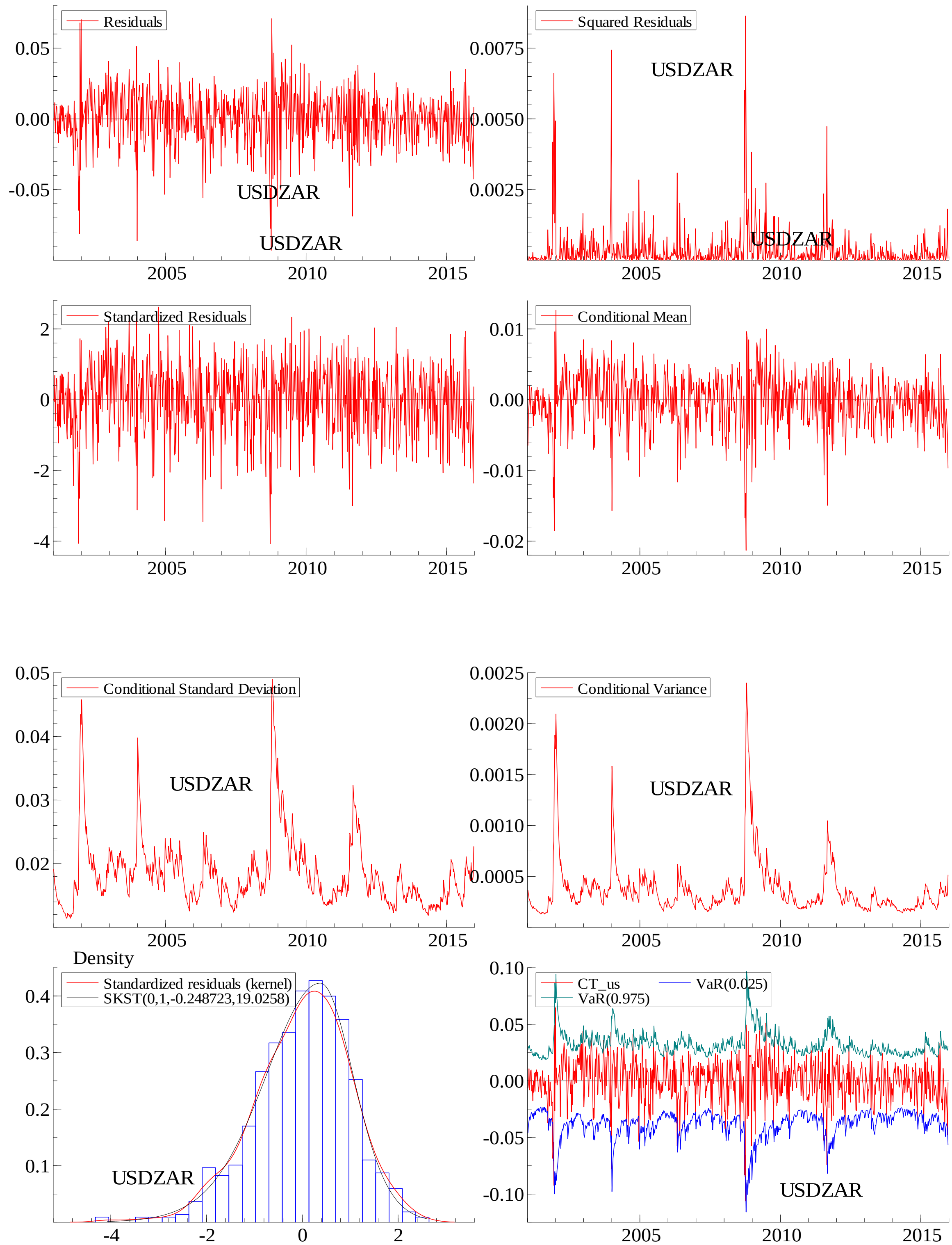


Figure D17: EURMAD Carry Trade Returns

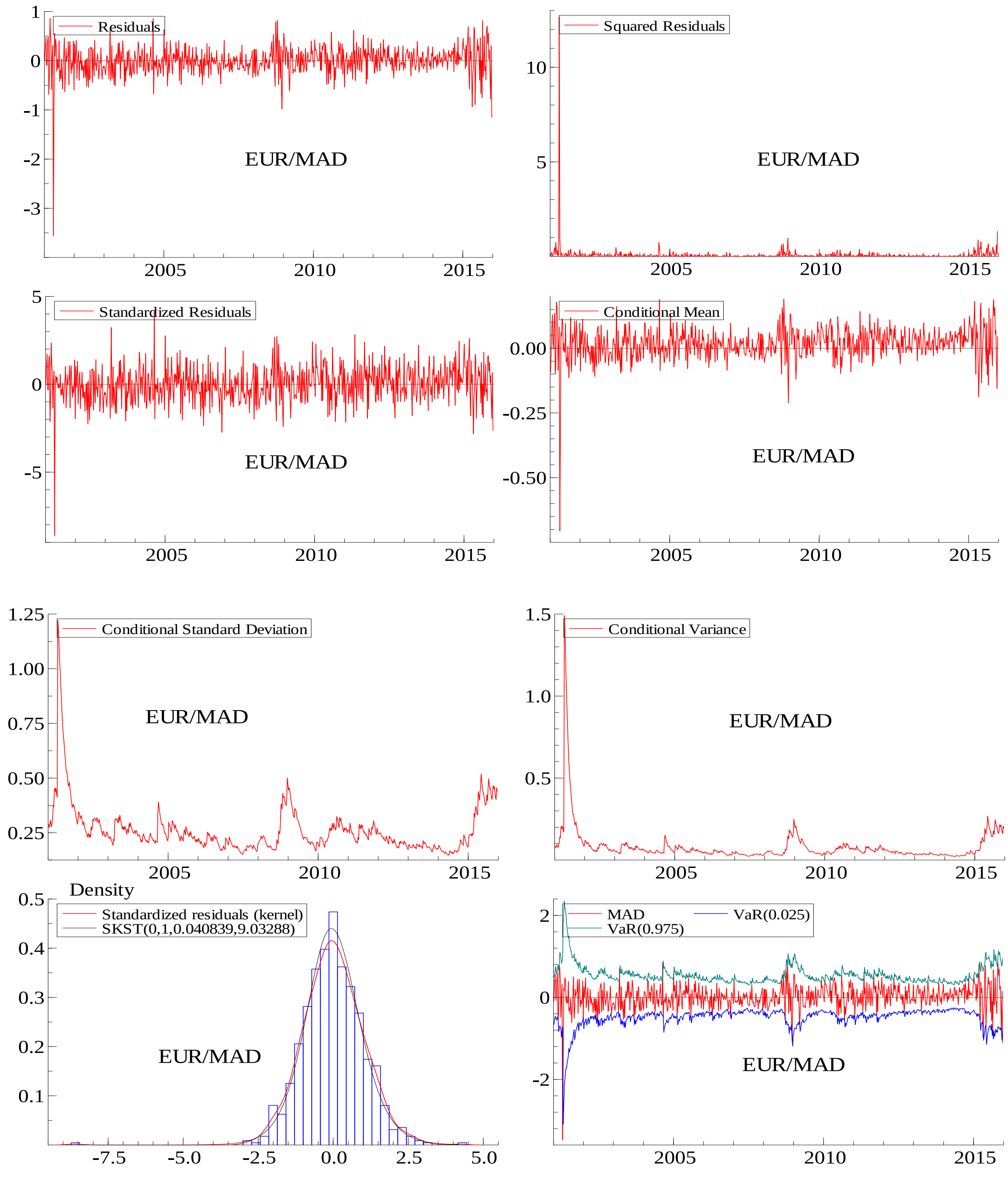


Figure D18: JPYMAD Carry Trade Returns

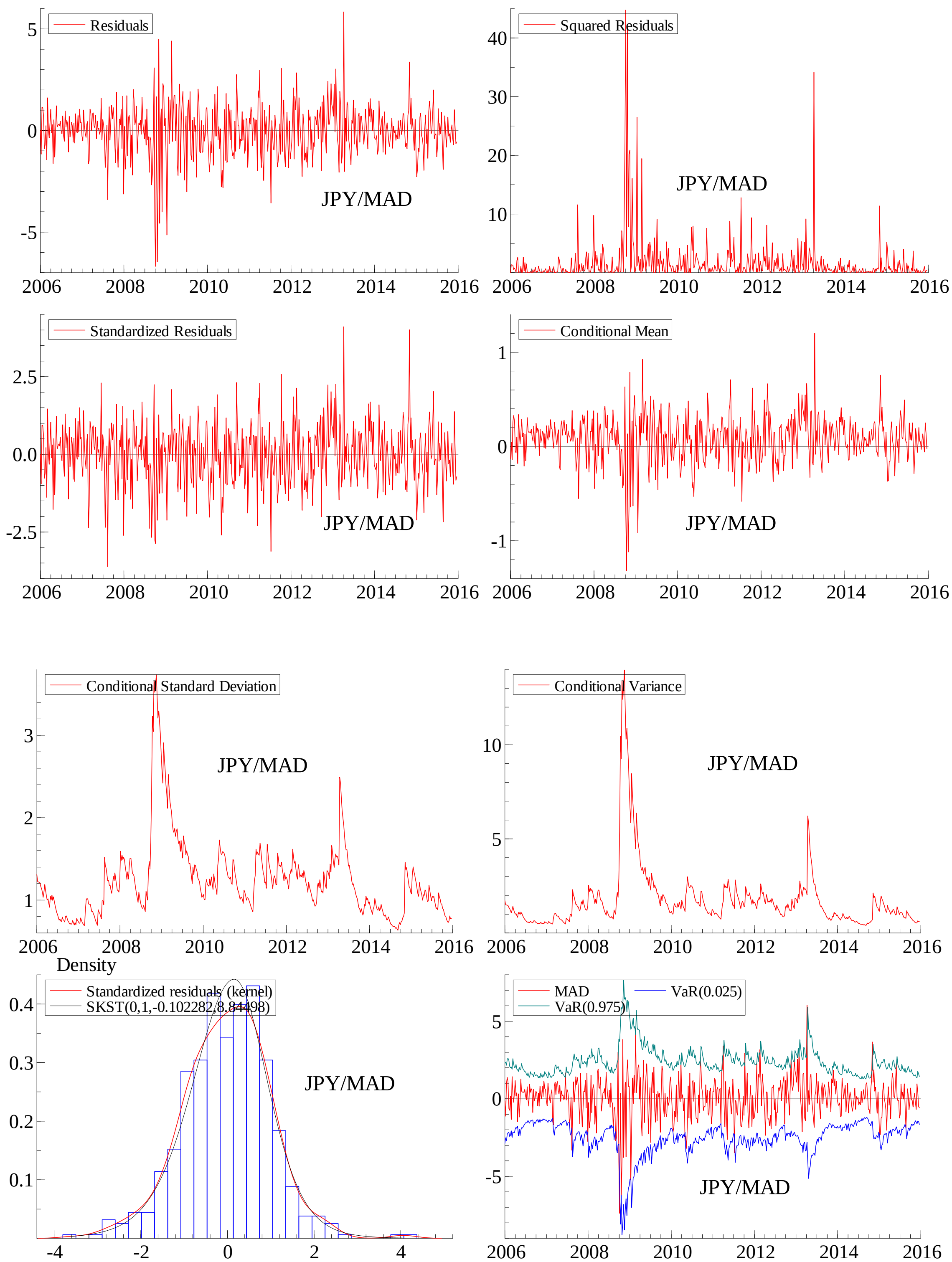


Figure D19: GBPMAD Carry Trade Returns

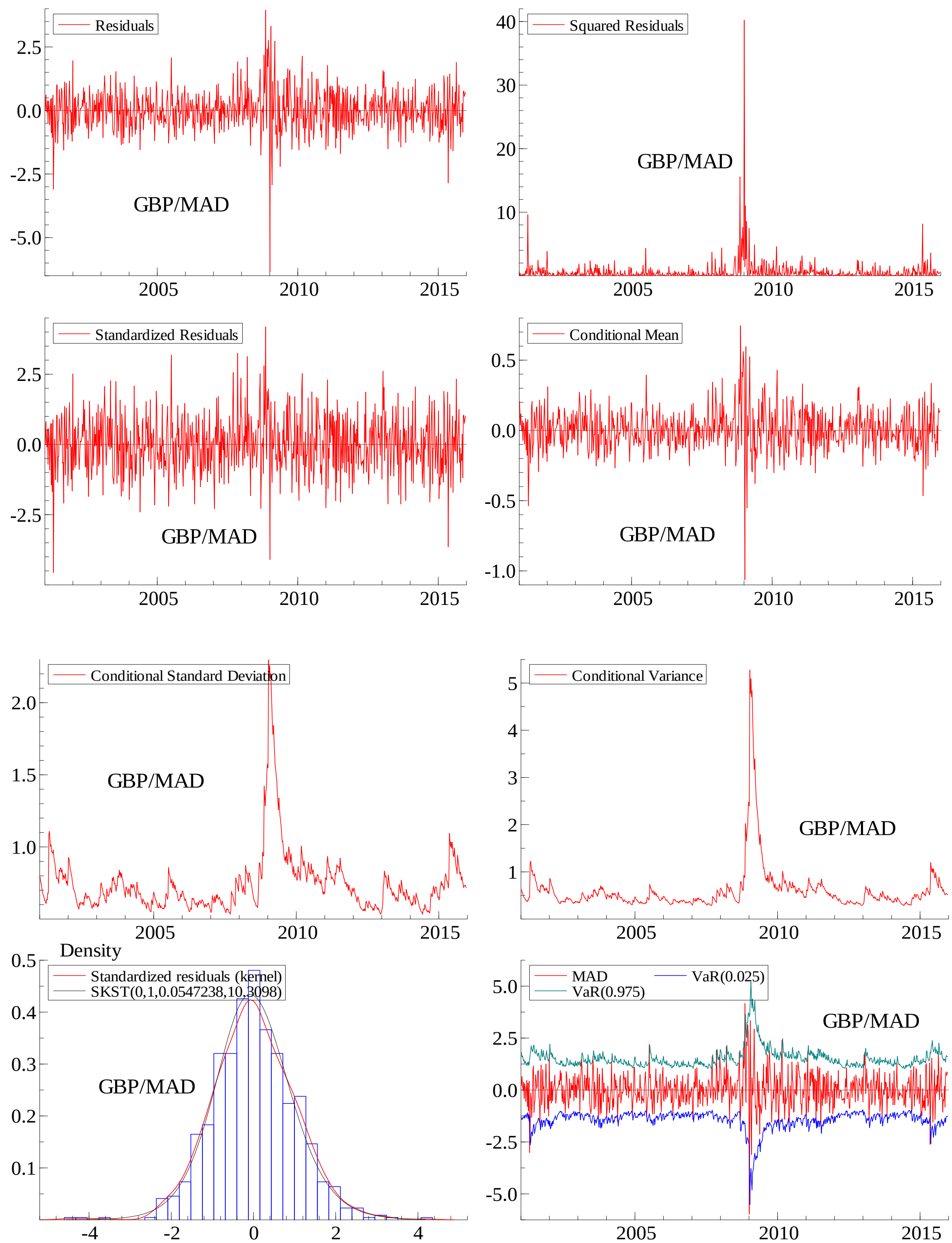


Figure D20: USDMAD Carry Trade Returns

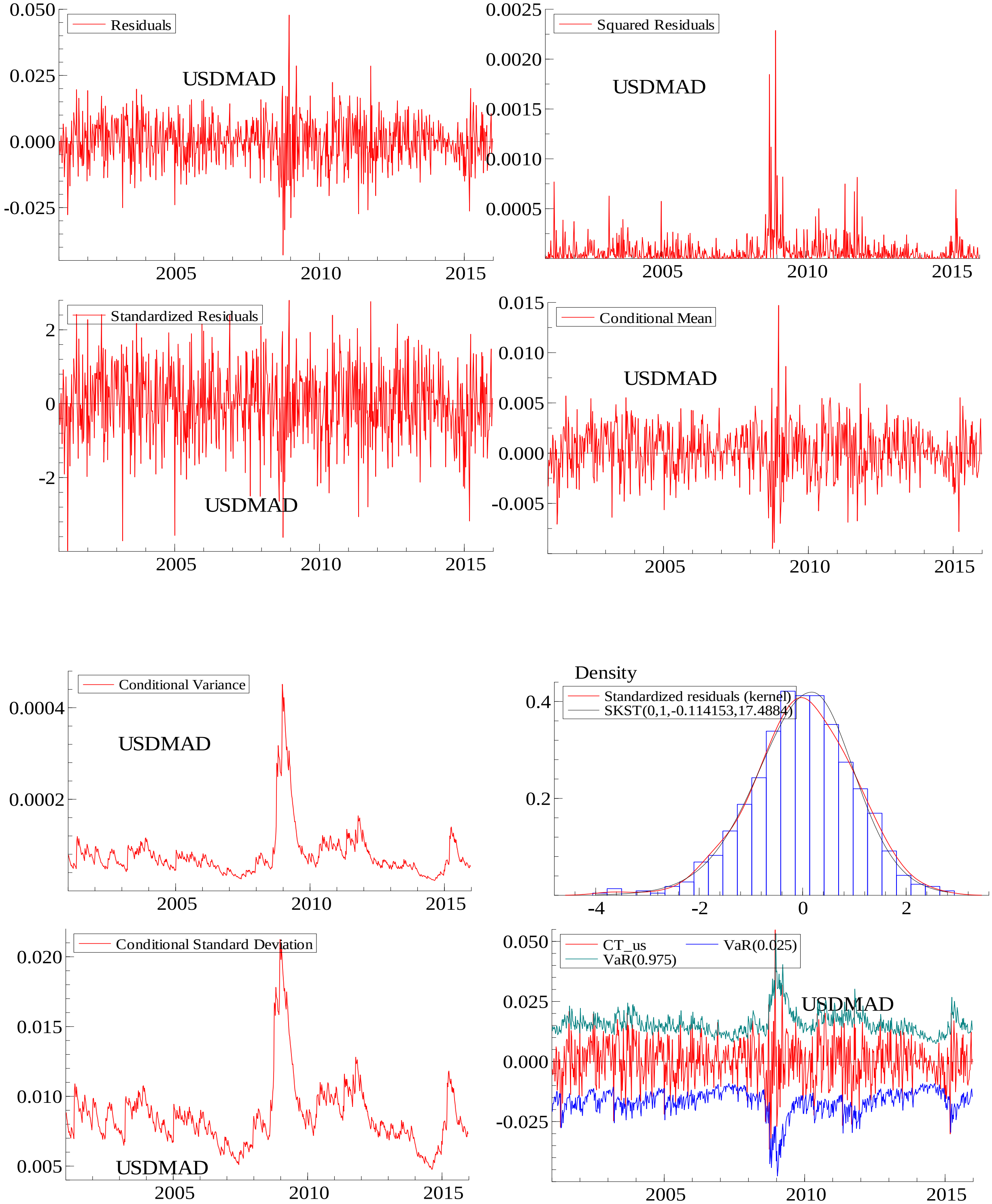


Figure D21: EURGHS Carry Trade Returns

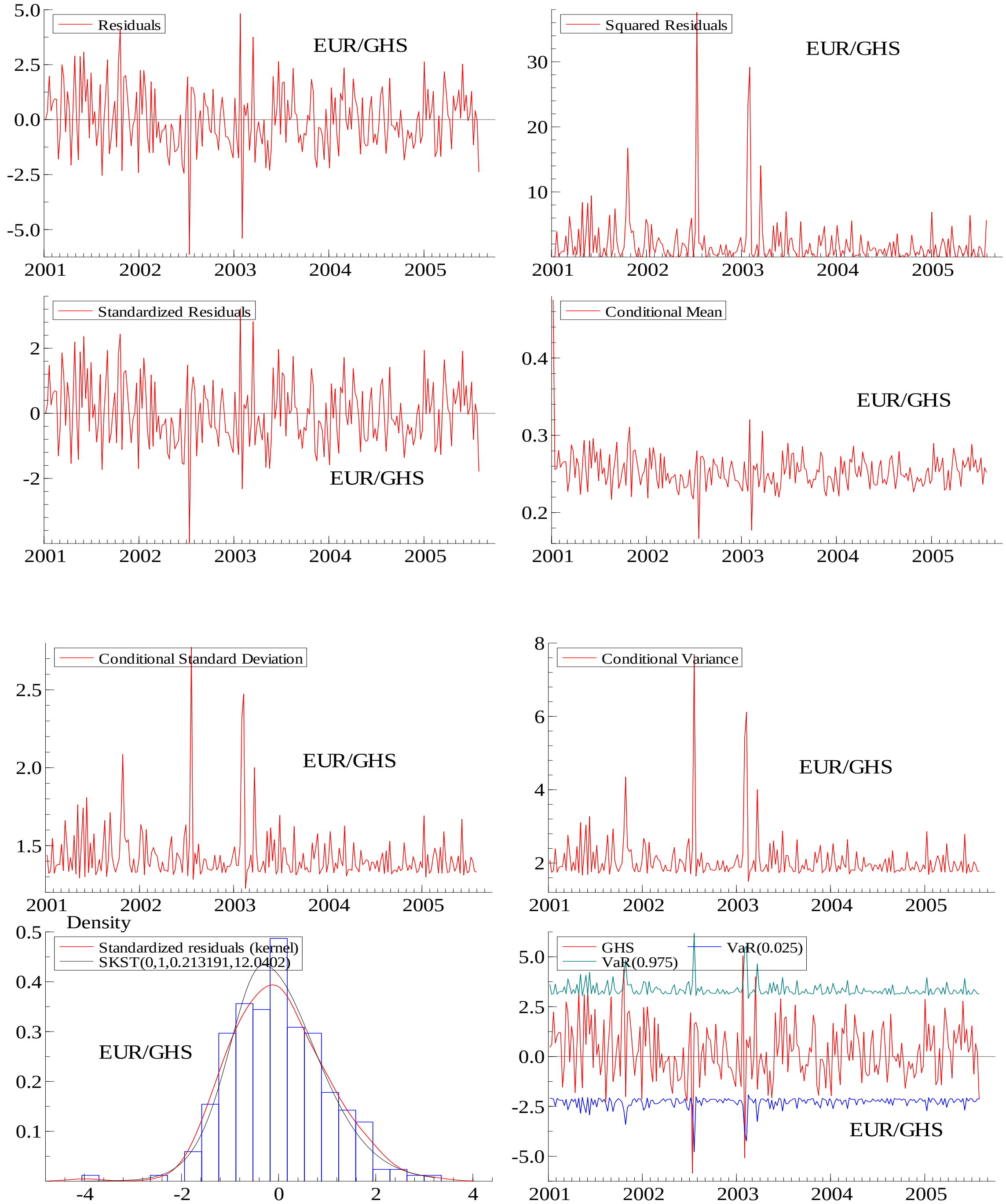


Figure D22: JPYGHS Carry Trade Returns

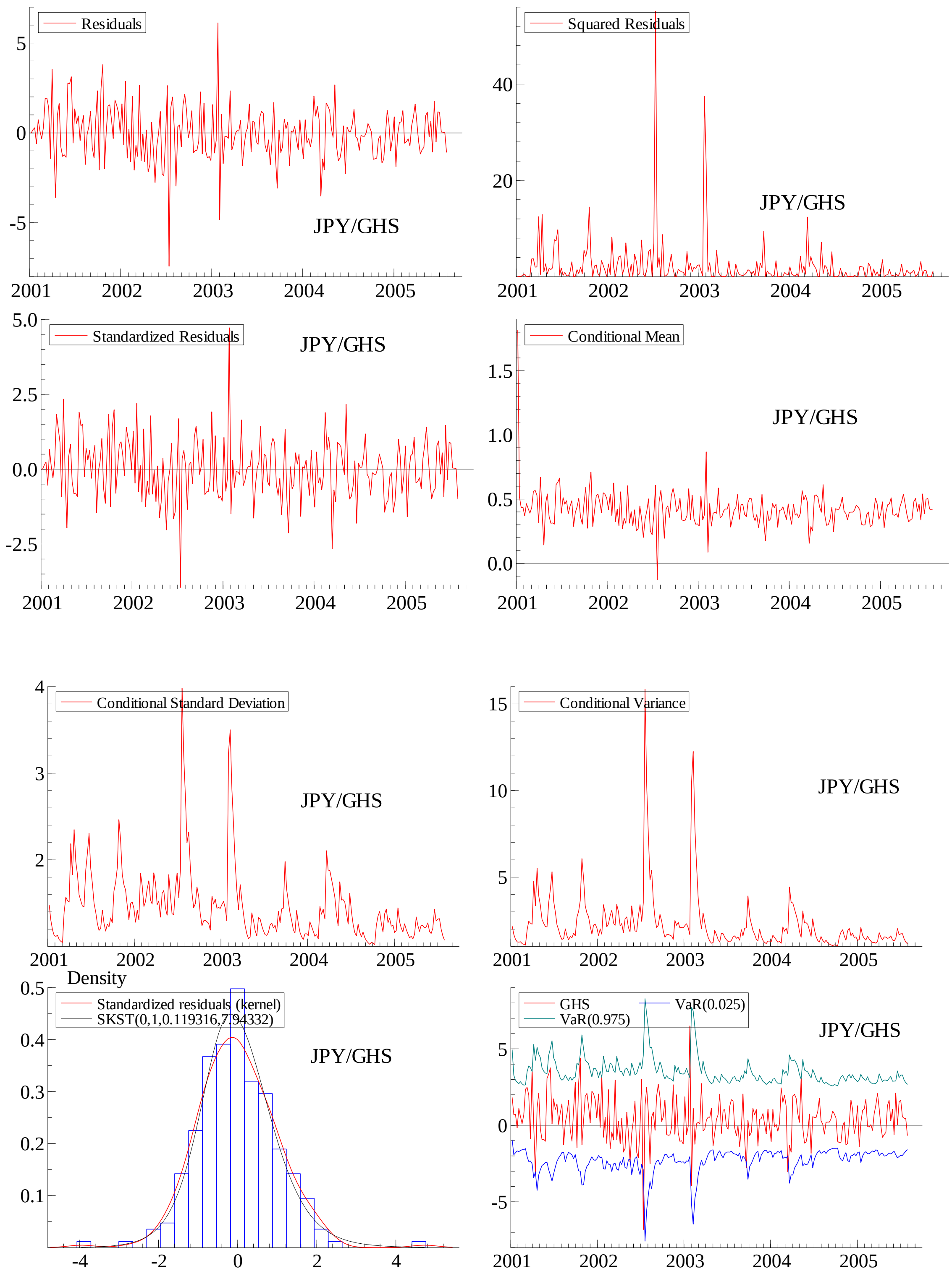


Figure D23: GBPGHS Carry Trade Returns

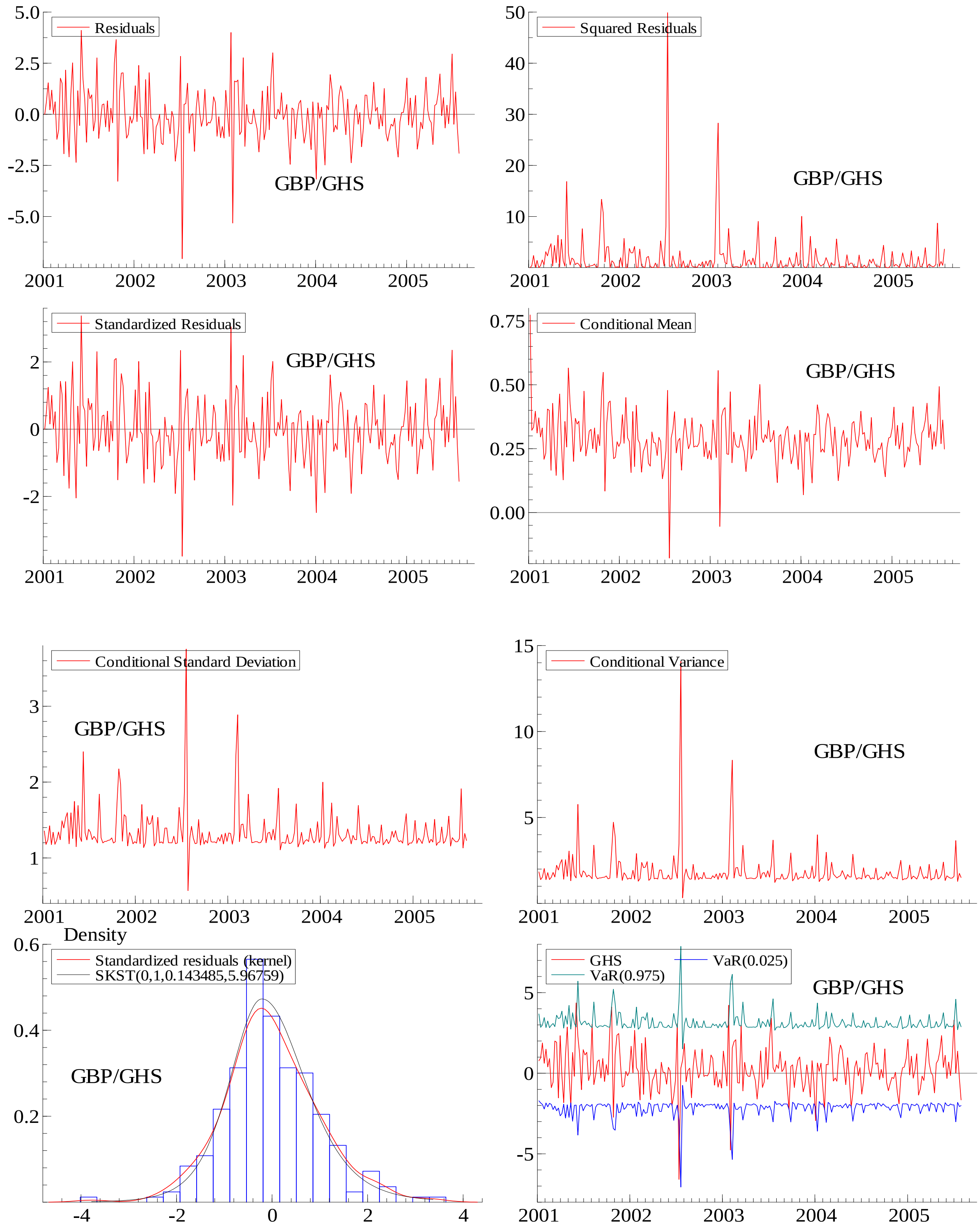


Figure D24: GARCH Estimation Diagnostics of USDGHS Carry Trade

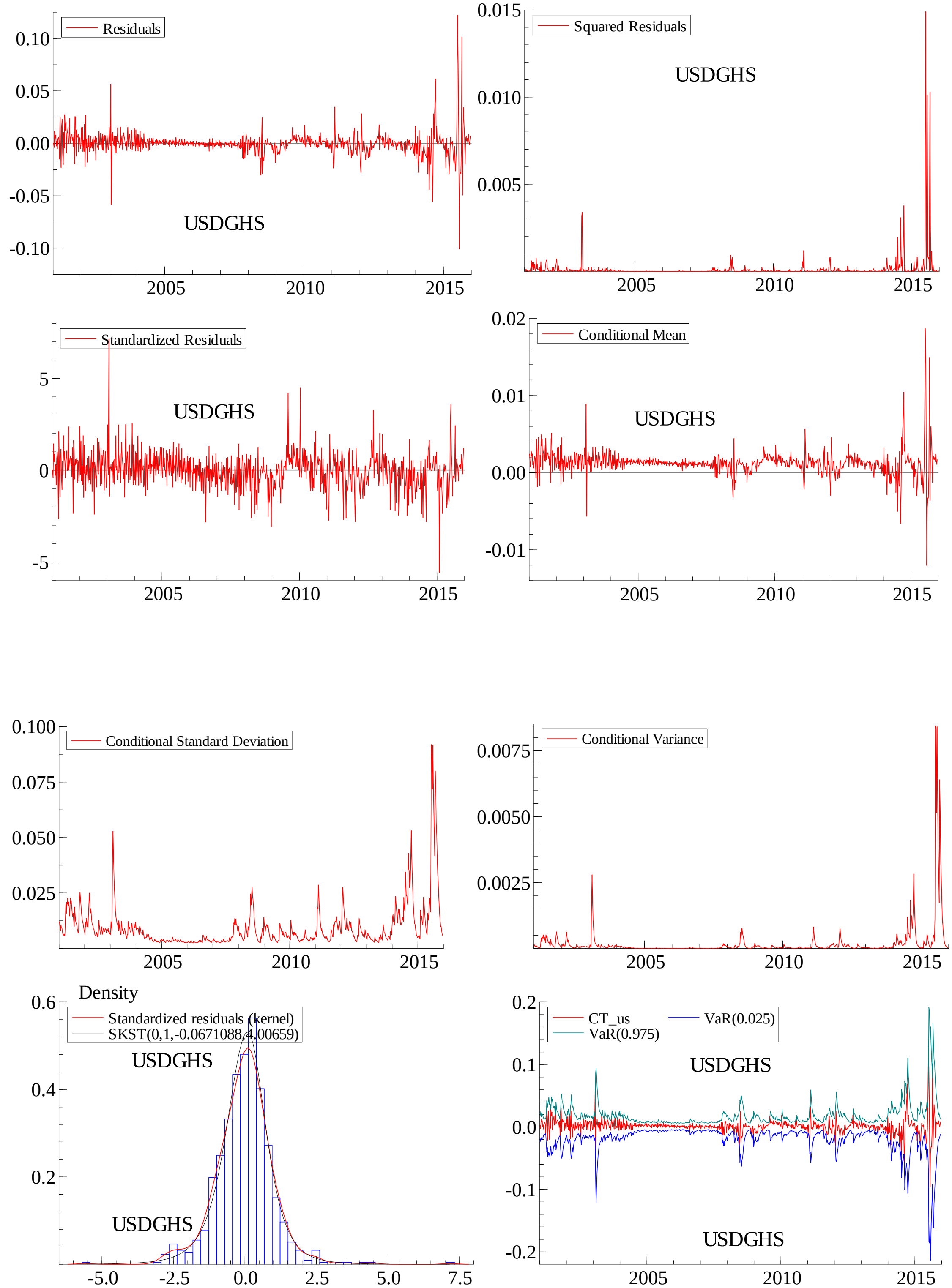


Figure D25: GBPNGN Carry Trade Returns

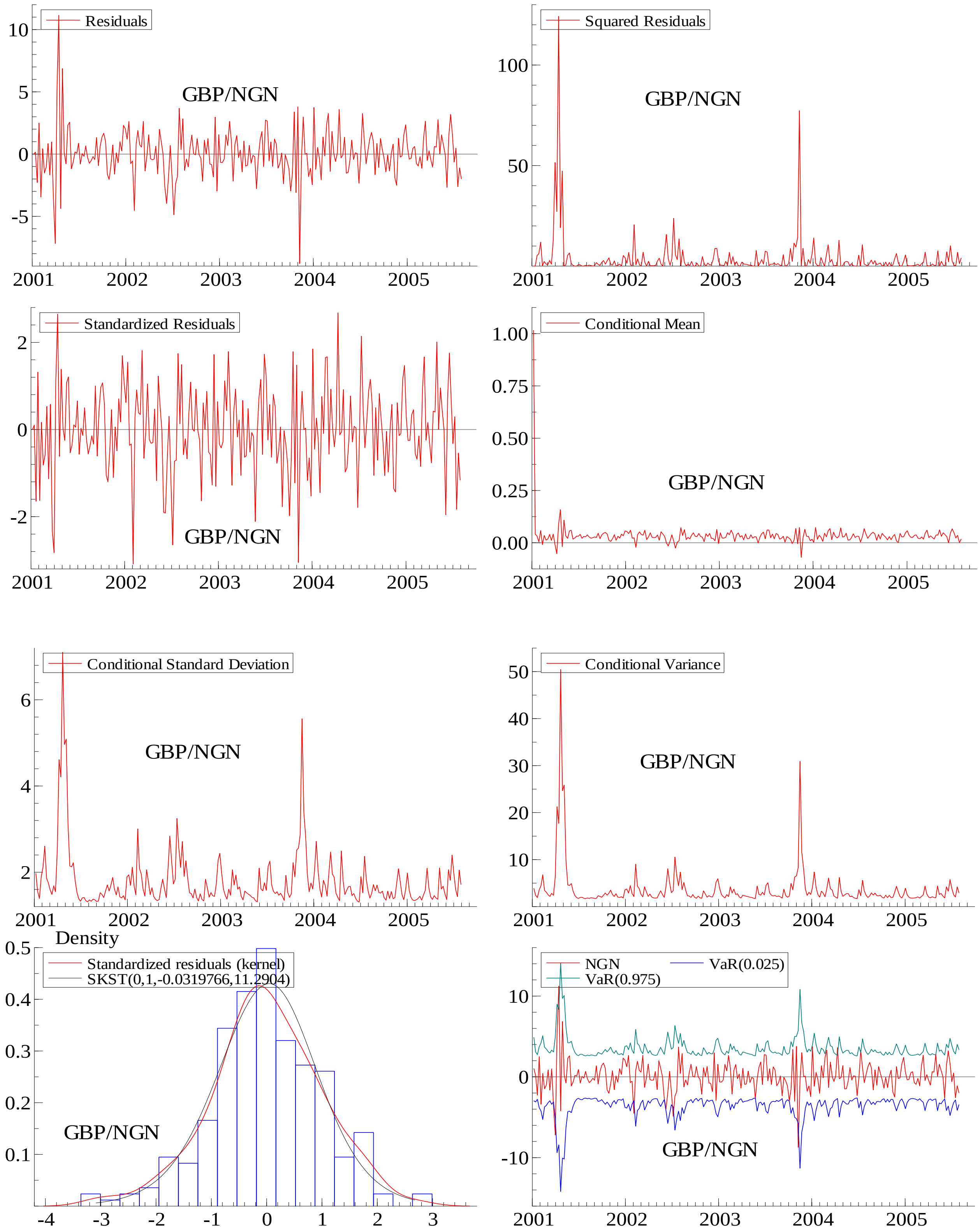


Figure D26: USDNGN Carry Trade Returns

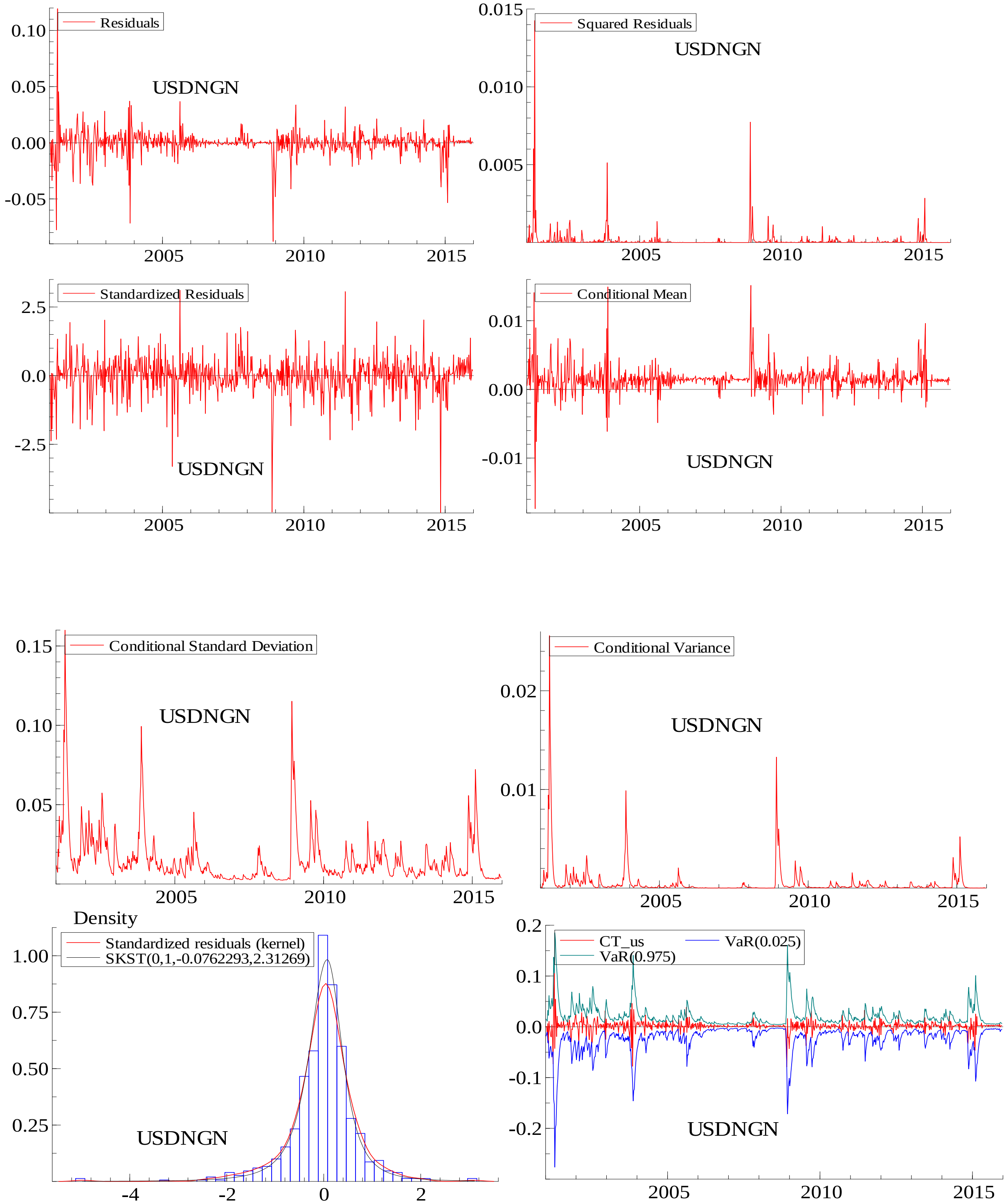


Figure D27: JPYNGN Carry Trade Returns

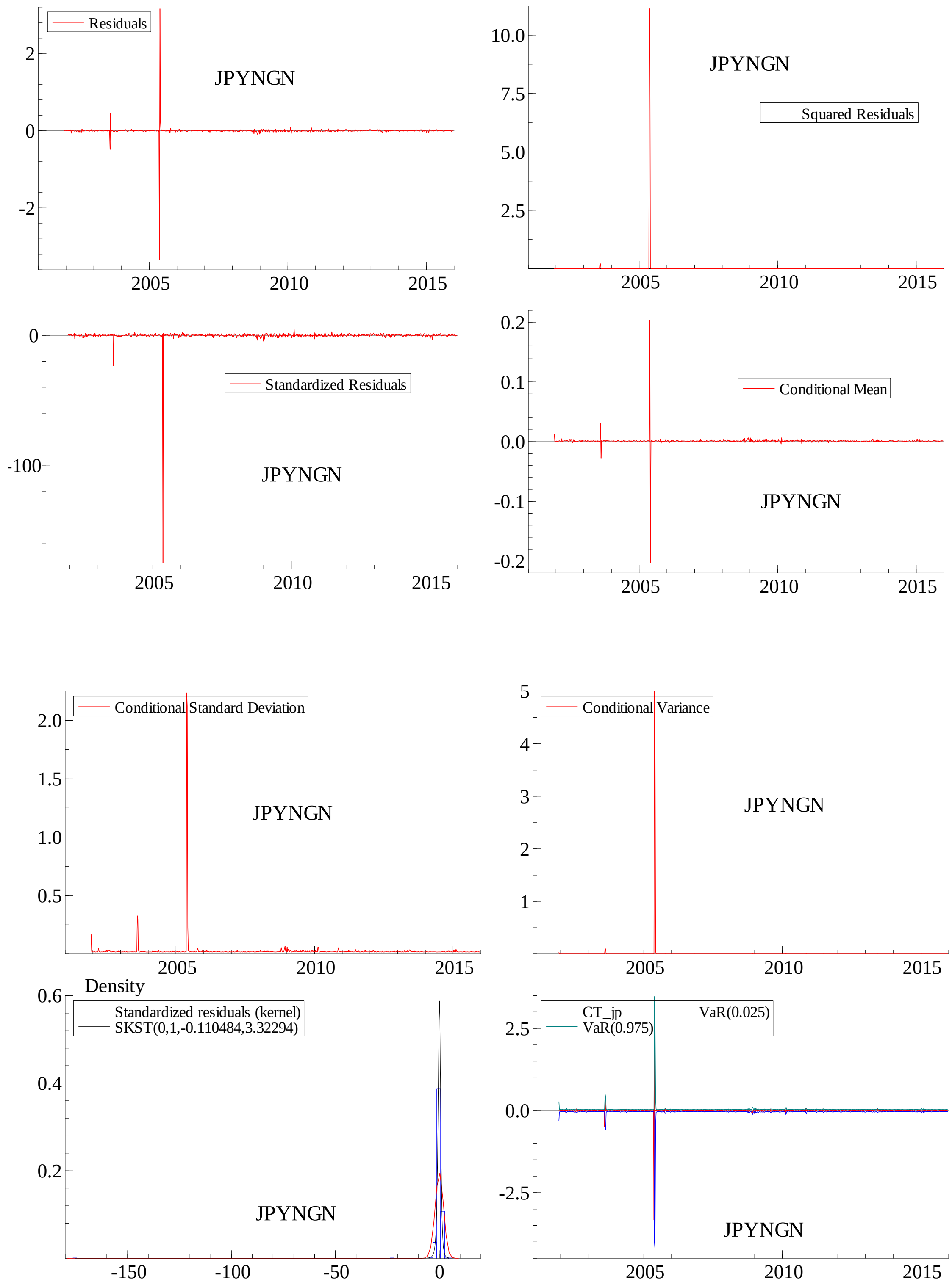
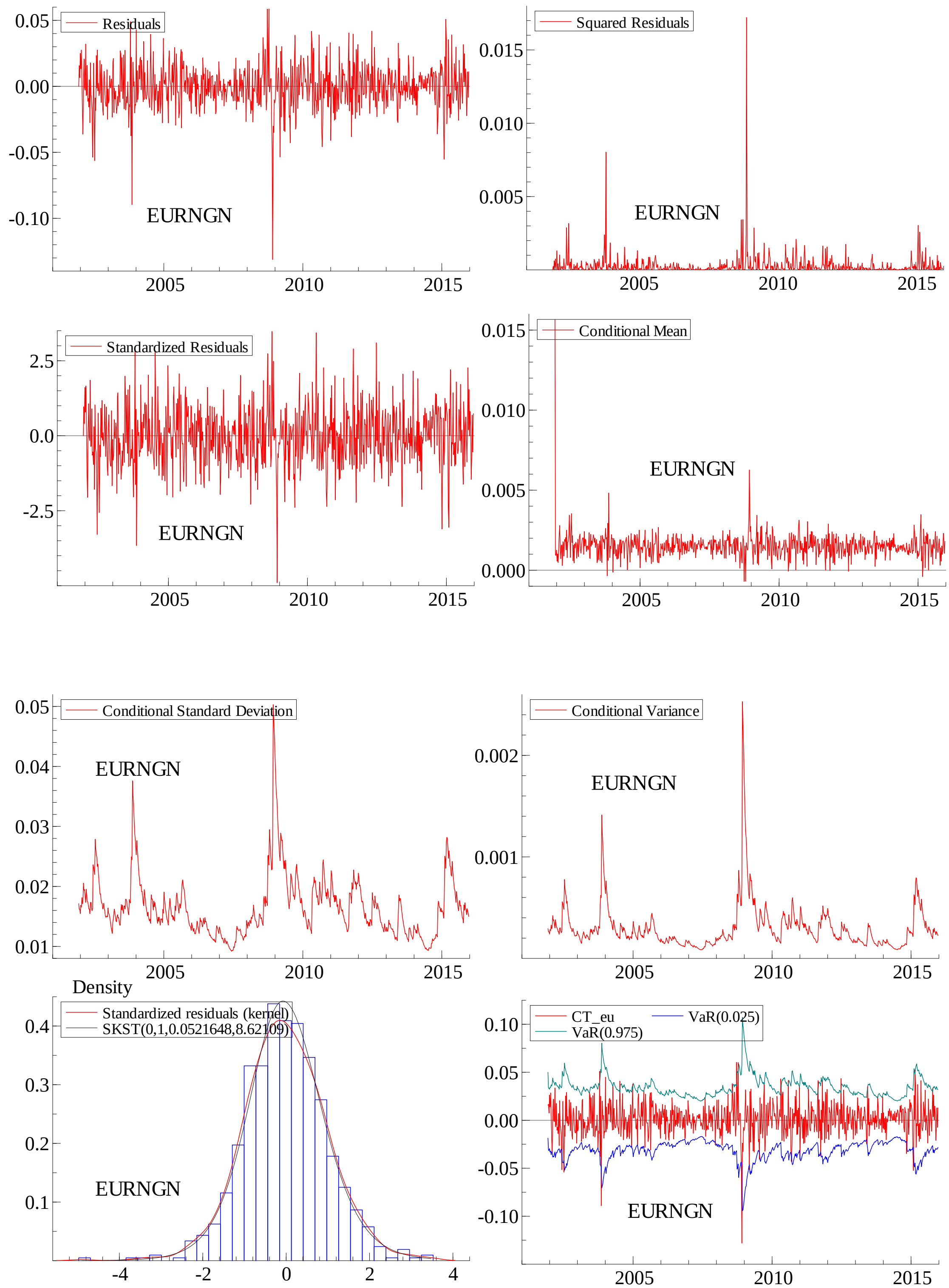


Figure D28: EURNGN Carry Trade Returns



Appendix E: Unit Root Test for Weekly Currency Carry Trade and Stock Market Returns used for Modeling ARMA(1, 0)-GARCH(1, 1), VAR-Granger Causality and the DCC-GARCH

Table E1: Unit Root Test Currency Carry Trade Returns Financed by EUR and USD

Variable	Test Equation	Carry Trade [EUR Funded]		Carry Trade [USD Funded]	
		ADF Test	PP Test	ADF Test	PP Test
South Africa	*None*	-22.051***	-22.080***	-22.298***	-22.37203
	Intercept only	-22.041***	-22.069***	-22.296***	-22.34025
	Intercept & Trend	-22.025***	-22.054***	-22.328***	-22.36605
Morocco	*None*	-21.322***	-21.710***	-19.935***	-19.88810
	Intercept only	-21.381***	-21.714***	-19.974***	-19.98377
	Intercept & Trend	-22.062***	-22.066***	-20.048***	-19.99850
Egypt	*None*	-20.433***	-20.560***	-16.654***	-18.74249
	Intercept only	-20.427***	-20.552***	-16.736***	-18.74452
	Intercept & Trend	-20.580***	-20.578***	-16.780***	-18.73455
Nigeria	*None*	-19.250***	-28.650***	-19.250***	-28.65075
	Intercept only	-19.607***	-28.910***	-19.607***	-28.91007
	Intercept & Trend	-19.652***	-28.935***	-19.652***	-28.93545
Tunisia	*None*	-22.111***	-22.169***	-20.124***	-20.16211
	Intercept only	-22.136***	-22.187***	-20.112***	-20.14976
	Intercept & Trend	-22.170***	-22.175***	-20.180***	-20.21007
Botswana	*None*	-29.839***	-30.019***	-17.320***	-27.80829
	Intercept only	-29.921***	-30.209***	-28.388***	-28.35798
	Intercept & Trend	-29.900***	-30.187***	-28.380***	-28.34995
Ghana	*None*	-22.109***	-22.718***	-34.560***	-33.71024
	Intercept only	-22.173***	-22.743***	-34.843***	-33.77649
	Intercept & Trend	-22.218***	-22.743***	-35.381***	-34.14807

Table E2: Unit Root Test Currency Carry Trade Returns Financed by GBP and JPY

Variable	***Test Equation***	**Carry Trade [GBP Funded]**		**Carry Trade [JPY Funded]**	
		ADF Test	**PP Test**	**ADF Test**	**PP Test**
South Africa	*None*	-21.083***	-21.012***	-22.943***	-22.970***
	Intercept only	-21.073***	-21.002***	-22.959***	-22.979***
	Intercept & Trend	-21.066***	-20.994***	-22.954***	-22.956***
Morocco	*None*	-18.662***	-20.925***	-21.767***	-21.832***
	Intercept only	-18.686***	-20.932***	-21.817***	-21.785***
	Intercept & Trend	-18.676***	-20.916***	-21.806***	-21.774***
Egypt	*None*	-13.353***	-20.984***	-21.352***	-21.352***
	Intercept only	-13.360***	-20.978***	-21.418***	-21.368***
	Intercept & Trend	-21.134***	-21.011***	-21.477***	-21.407***
Nigeria	*None*	-28.352***	-28.355***	-15.932***	-115.385***
	Intercept only	-28.449***	-28.479***	-15.965***	-131.903***
	Intercept & Trend	-28.434***	-28.465***	-15.960***	-132.480***
Tunisia	*None*	-19.195***	-22.465***	-22.263***	-22.408***
	Intercept only	-19.186***	-22.451***	-22.280***	-22.415***
	Intercept & Trend	-19.173***	-22.435***	-22.266***	-22.401***
Botswana	*None*	-29.137***	-29.103***	-16.073***	-137.354***
	Intercept only	-29.237***	-29.228***	-16.123***	-178.064***
	Intercept & Trend	-29.220***	-29.213***	-16.115***	-184.031***
Ghana	*None*	-12.314***	-23.763***	-21.645***	-22.730***
	Intercept only	-12.403***	-23.771***	-21.845***	-22.635***
	Intercept & Trend	-12.476***	-23.768***	-21.937***	-22.515***

Table E3: Unit Root Tests for Stock Market Returns

Variable	*Test Equation*	ADF Unit Root Test	PP Unit Root Test
		Levels	***Levels***
South Africa	*None*	-28.596***	-28.552***
	Intercept only	-28.648***	-28.650***
	Intercept & Trend	-28.646***	-28.610***
Morocco	*None*	-24.411***	-24.597***
	Intercept only	-24.523***	-24.639***
	Intercept & Trend	-24.707***	-24.765***
Egypt	*None*	-25.823***	-26.348***
	Intercept only	-25.897***	-26.312***
	Intercept & Trend	-25.894***	-26.302***
Nigeria	*None*	-16.474***	-25.790***
	Intercept only	-16.483***	-25.773***
	Intercept & Trend	-16.532***	-25.767***
Tunisia	*None*	-25.248***	-25.565***
	Intercept only	-25.367***	-25.611***
	Intercept & Trend	-25.362***	-25.600***
Botswana	*None*	-10.601***	-27.859***
	Intercept only	-10.771***	-27.891***
	Intercept & Trend	-10.960***	-27.970***
Ghana	*None*	-16.474***	-25.790***
	Intercept only	-16.483***	-25.773***
	Intercept & Trend	-16.532***	-25.767***

Appendix F: Correlation Matrix of Asset Classes

	S&P 500	*MSCI*	*JALSH*	*CT PORT*	*BOND*	*CMMTY*	*US CT*	*JPY CT*	*EUR CT*	*GBP CT*	*PORT1*	*PORT2*	*PORT3*	*PORT 4*	*PORT 5*	*PORT 6*	*PORT 7*	*PORT 8*	*PORT 9*	*PORT 10*	*PORT 11*
S&P 500	1.0000																				
MSCI	0.0741	1.0000																			
JALSH	0.0391	0.2763	1.0000																		
CT PORT	0.0765	0.3870	0.1226	1.0000																	
BOND	-0.0357	-0.0068	0.0983	0.0079	1.0000																
CMMTY	0.0354	0.2713	0.5105	0.1953	0.2143	1.0000															
US CT	0.0697	0.5739	0.2903	0.6010	0.1738	0.4043	1.0000														
JPY CT	0.0624	0.4947	0.2041	0.8393	-0.0206	0.3171	0.4979	1.0000													
EUR CT	0.0103	-0.2377	-0.1175	0.4970	-0.0521	-0.1981	-0.1430	0.1194	1.0000												
GBP CT	-0.0597	-0.1235	-0.3147	0.4567	-0.0509	-0.3631	0.0783	0.0861	0.5030	1.0000											
PORT1	0.9179	0.3325	0.3922	0.1762	0.0003	0.2382	0.2561	0.2081	-0.0702	-0.1724	1.0000										
PORT2	0.0686	0.6851	0.8852	0.3499	0.0793	0.5224	0.5260	0.4449	-0.1517	-0.2525	0.4575	1.0000									
PORT3	0.9144	0.3437	0.3939	0.2098	0.0006	0.2434	0.2752	0.2359	-0.0524	-0.1553	0.9994	0.4666	1.0000								
PORT 4	0.9093	0.3549	0.4007	0.2019	0.0084	0.2539	0.2993	0.2286	-0.0759	-0.1665	0.9990	0.4761	0.9993	1.0000							
PORT 5	0.9043	0.3664	0.4011	0.2417	-0.0014	0.2595	0.2919	0.2862	-0.0589	-0.1618	0.9967	0.4848	0.9985	0.9974	1.0000						
PORT 6	0.9207	0.3198	0.3865	0.2047	-0.0027	0.2276	0.2486	0.2154	-0.0138	-0.1443	0.9984	0.4500	0.9988	0.9971	0.9958	1.0000					
PORT 7	0.9221	0.3281	0.3774	0.2039	-0.0026	0.2193	0.2627	0.2148	-0.0418	-0.1163	0.9984	0.4468	0.9988	0.9977	0.9957	0.9984	1.0000				
PORT 8	0.0677	0.6943	0.8779	0.3224	0.0954	0.5339	0.5703	0.4161	-0.2038	-0.2731	0.4562	0.9963	0.4644	0.4768	0.4812	0.4458	0.4443	1.0000			
PORT 9	0.0700	0.7050	0.8573	0.4086	0.0696	0.5340	0.5396	0.5414	-0.1588	-0.2562	0.4538	0.9928	0.4650	0.4731	0.4891	0.4459	0.4428	0.9861	1.0000		
PORT 10	0.0664	0.6480	0.8985	0.3484	0.0748	0.5007	0.4760	0.4077	-0.0588	-0.2325	0.4529	0.9934	0.4620	0.4692	0.4773	0.4507	0.4433	0.9845	0.9796	1.0000	
PORT 11	0.0571	0.6746	0.8828	0.3485	0.0760	0.4835	0.5159	0.4092	-0.1319	-0.1615	0.4446	0.9934	0.4537	0.4628	0.4692	0.4382	0.4390	0.9889	0.9799	0.9894	1.0000

Appendix G: Panel VAR Results

Panel (LSDV) vector autoregression	Number of obs = 1071
Group variable: CountryID	Number of groups = 7
	Obs per group = 153

Equation	Parms	RMSE	R-sq	F	P > F
USDCT	11	.086447	0.3045	28.81231	0.0000
STOCK	11	.070629	0.0412	10.64188	0.0000

F statistic for F(4,1060)

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
USDCT						
l1_USDCT	.2962441	.0306938	9.65	0.000	.2360166	.3564716
l1_STOCK	-.0146115	.037573	-0.39	0.697	-.0883375	.0591144
l2_USDCT	.0465906	.0308603	1.51	0.131	-.0139637	.1071449
l2_STOCK	-.0050091	.0375498	-0.13	0.894	-.0786895	.0686712
STOCK						
l1_USDCT	.0436243	.0250775	1.74	0.082	-.0055829	.0928315
l1_STOCK	.1650563	.030698	5.38	0.000	.1048206	.2252921
l2_USDCT	.0326696	.0252136	1.30	0.195	-.0168046	.0821438
l2_STOCK	.0400819	.030679	1.31	0.192	-.0201166	.1002804

Contemporary coefficients

	USDCT	STOCK
USDCT	1	0
STOCK	-.00080801	1

Response of USDCT to shock in USDCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0864469	.0823019	.0896757	0	0	0
1	.0256104	.0202841	.0312837	1	1	1
2	.01156	.0061058	.0172087	.999869	.9949553	.999998
3	.0045323	.0011744	.0080496	.9997878	.9917827	.999877
4	.0018256	.0001469	.0042772	.9997669	.9903738	.999874
5	.0007243	-.0000954	.0021799	.999762	.9898238	.9998736
6	.0002866	-.0001015	.001129	.999761	.9896939	.9998736
7	.0001129	-.0000433	.0005792	.9997608	.9896606	.9998736
8	.0000443	-.0000272	.0003002	.9997608	.9896526	.9998736

Response of STOCK to shock in USDCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	-.0000698	-.0041356	.0032074	0	0	0
1	.0037597	-.0006534	.0081695	9.78e-07	2.49e-06	.0036593
2	.0045592	.000323	.0089635	.0027518	.0002205	.0131221
3	.0022442	.0003027	.0045683	.0067405	.001261	.0221722
4	.0011285	.0001039	.0024344	.007703	.0014028	.0259673
5	.0005039	.0000379	.001131	.0079464	.0014461	.0272018
6	.0002196	5.64e-06	.0005768	.0079949	.0014563	.0275036
7	.0000926	1.93e-06	.0002863	.0080041	.0014587	.0275798
8	.0000384	-1.93e-08	.0001358	.0080058	.0014593	.0275973

Response of USDCT to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	-.001032	-.0064267	.0043468	0	0	0
2	-.0008299	-.0065161	.0047254	.000131	2.02e-06	.0050447
3	-.0004211	-.0031435	.0021178	.0002122	.000123	.0082173
4	-.0002042	-.0018792	.0012888	.0002331	.000126	.0096262
5	-.0000909	-.0008499	.0005911	.000238	.0001264	.0101762
6	-.0000393	-.0004273	.0002974	.000239	.0001264	.0103061
7	-.0000165	-.0001882	.0001448	.0002392	.0001264	.0103394
8	-6.82e-06	-.0000831	.0000751	.0002392	.0001264	.0103473

Response of STOCK to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.070629	.0680598	.0733575	0	0	0
1	.0116578	.0077367	.0157779	.999999	.9963407	.9999975
2	.0047101	.0010718	.0086602	.9972482	.9868779	.9997795
3	.0011748	-.0001456	.0027383	.9932594	.9778278	.998739
4	.0003372	-.0002872	.0012555	.992297	.9740326	.9985973
5	.0000801	-.0002223	.0005182	.9920536	.9727982	.9985539
6	.0000161	-.0001451	.0002291	.9920051	.9724964	.9985437
7	1.18e-06	-.0000765	.0001067	.9919959	.9724202	.9985412
8	-1.16e-06	-.0000432	.0000445	.9919942	.9724027	.9985407

95% lower and upper bounds reported; percentile ci

```
Panel (LSDV) vector autoregression              Number of obs      =     1071
Group variable: CountryID                       Number of groups   =        7

                                                Obs per group      =      153
```

Equation	Parms	RMSE	R-sq	F	P > F
EURCT	11	.054713	0.5010	27.52863	0.0000
STOCK	11	.070785	0.0370	9.425397	0.0000

F statistic for F(4,1060)

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
EURCT						
l1_EURCT	.3027062	.0307426	9.85	0.000	.2423828	.3630295
l1_STOCK	.0123547	.0237593	0.52	0.603	-.0342658	.0589753
l2_EURCT	.0134528	.0309288	0.43	0.664	-.0472358	.0741414
l2_STOCK	-.0144609	.0237837	-0.61	0.543	-.0611294	.0322077
STOCK						
l1_EURCT	.0453035	.0397732	1.14	0.255	-.0327398	.1233467
l1_STOCK	.1670733	.0307385	5.44	0.000	.1067581	.2273886
l2_EURCT	.0188613	.0400141	0.47	0.637	-.0596545	.0973771
l2_STOCK	.0389654	.0307702	1.27	0.206	-.021412	.0993428

Contemporary coefficients

	EURCT	STOCK
EURCT	1	0
STOCK	.02602515	1

Response of **EURCT** to shock in **EURCT**

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0547135	.052387	.0574964	0	0	0
1	.0165797	.0131846	.0204384	1	1	1
2	.0057678	.0029445	.0088632	.9997662	.9938072	.9999975
3	.001958	.0001467	.0038222	.9996549	.9923552	.9999617
4	.0006503	-.0000865	.0017656	.9996306	.9919119	.9999574
5	.0002136	-.0000513	.0008023	.999624	.9916817	.9999561
6	.000069	-.0000319	.0003679	.9996228	.991634	.9999558
7	.0000219	-.0000209	.000161	.9996226	.9916296	.9999558
8	6.87e-06	-1.00e-05	.000071	.9996226	.991629	.9999558

Response of STOCK to shock in EURCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0014239	-.0022123	.0053933	0	0	0
1	.0027166	-.0017624	.0073236	.0004047	5.87e-06	.0059554
2	.0022924	-.0015682	.0061569	.001824	.0001547	.0129296
3	.0010629	-.0008961	.0028255	.0028275	.0002935	.0175405
4	.0004644	-.0004462	.0014476	.0030438	.0003103	.0189124
5	.0001854	-.0001635	.0006574	.0030851	.0003135	.0191324
6	.000071	-.0000637	.0003041	.0030917	.0003136	.0191657
7	.0000262	-.0000248	.0001432	.0030927	.0003136	.0191707
8	9.45e-06	-.0000103	.0000664	.0030928	.0003136	.0191714

Response of EURCT to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	.0008744	-.0028869	.0046022	0	0	0
2	-.0006127	-.0040646	.0028893	.0002338	2.48e-06	.0061928
3	-.0002857	-.0019757	.0013341	.0003451	.0000383	.0076448
4	-.0001483	-.0010256	.0005988	.0003694	.0000425	.0080881
5	-.0000622	-.0004655	.0002613	.000376	.0000439	.0083183
6	-.000025	-.000215	.0001165	.0003772	.0000442	.008366
7	-9.50e-06	-.0000946	.0000515	.0003773	.0000442	.0083704
8	-3.51e-06	-.0000443	.0000229	.0003774	.0000443	.008371

Response of STOCK to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0707711	.0682014	.0731877	0	0	0
1	.011824	.0076854	.0158716	.9995953	.9940446	.9999942
2	.0047727	.0004375	.0094708	.998176	.9870704	.9998453
3	.0012469	-.0002738	.0027581	.9971725	.9824595	.9997065
4	.0003698	-.0001095	.0014398	.9969562	.9810876	.9996897
5	.0000983	-.0000861	.0005149	.9969149	.9808676	.9996865
6	.0000252	-.0000421	.0002282	.9969083	.9808342	.9996865
7	5.74e-06	-.0000252	.000089	.9969073	.9808294	.9996865
8	1.04e-06	-.0000111	.0000378	.9969072	.9808286	.9996865

95% lower and upper bounds reported; percentile ci

```
Panel (LSDV) vector autoregression              Number of obs      =      1071
Group variable: CountryID                       Number of groups   =         7

                                                Obs per group      =       153
```

Equation	Parms	RMSE	R-sq	F	P > F
JPYCT	11	.111312	0.2721	34.08015	0.0000
STOCK	11	.070754	0.0378	9.671491	0.0000

F statistic for F(4,1060)

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
JPYCT						
l1_JPYCT	.3387949	.0307322	11.02	0.000	.2784919	.3990978
l1_STOCK	.0042443	.0483301	0.09	0.930	-.0905893	.0990778
l2_JPYCT	-.0035523	.0308338	-0.12	0.908	-.0640545	.0569499
l2_STOCK	-.0024685	.0483544	-0.05	0.959	-.0973497	.0924126
STOCK						
l1_JPYCT	.0222861	.0195345	1.14	0.254	-.0160446	.0606167
l1_STOCK	.1669064	.0307203	5.43	0.000	.106627	.2271859
l2_JPYCT	.0162611	.019599	0.83	0.407	-.0221961	.0547184
l2_STOCK	.0396132	.0307357	1.29	0.198	-.0206965	.0999229

Contemporary coefficients

	JPYCT	STOCK
JPYCT	1	0
STOCK	.00553417	1

Response of JPYCT to shock in JPYCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.111312	.1071601	.1154091	0	0	0
1	.0377146	.0308602	.0443445	1	1	1
2	.0123915	.0060313	.0186983	.9999934	.9951717	.9999993
3	.004071	-.000141	.0084223	.9999935	.9929682	.9999444
4	.001334	-.0003996	.0037561	.9999935	.9920462	.9999413
5	.0004366	-.0002508	.0016635	.9999935	.9917649	.9999408
6	.0001427	-.0000913	.00075	.9999935	.9917263	.9999408
7	.0000466	-.0000389	.0003495	.9999935	.9917182	.9999407
8	.0000152	-.0000206	.0001649	.9999935	.9917165	.9999407

Response of STOCK to shock in JPYCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.000616	-.0034937	.0053732	0	0	0
1	.0025835	-.0015486	.0067977	.0000758	5.02e-07	.0058377
2	.0031062	-.0014926	.0076197	.0013691	.0001845	.0112347
3	.0015102	-.0007307	.003843	.0032215	.0007351	.01677
4	.0006673	-.0004079	.0018611	.0036586	.0008105	.018473
5	.0002671	-.0001644	.0008367	.003744	.0008254	.0186855
6	.0001024	-.0000611	.0003716	.0037577	.0008289	.0187093
7	.000038	-.0000293	.0001656	.0037597	.0008298	.0187133
8	.0000138	-.0000111	.0000735	.00376	.0008299	.0187142

Response of JPYCT to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	.0003003	-.0067734	.0073696	0	0	0
2	-.0000228	-.0068397	.0064593	6.53e-06	6.61e-07	.0048283
3	-.0000177	-.003506	.0032333	6.49e-06	.0000556	.0070318
4	-.0000123	-.0016273	.0015903	6.51e-06	.0000586	.0079538
5	-5.54e-06	-.0007108	.0007393	6.52e-06	.0000592	.0082351
6	-2.33e-06	-.0003108	.0003538	6.52e-06	.0000593	.0082737
7	-9.08e-07	-.0001164	.0001681	6.52e-06	.0000593	.0082818
8	-3.42e-07	-.0000477	.0000796	6.52e-06	.0000593	.0082835

Response of STOCK to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.070751	.067897	.0739832	0	0	0
1	.0118088	.0077861	.0163007	.9999242	.9941623	.9999995
2	.0047803	.0007479	.0089778	.9986309	.9887652	.9998155
3	.00127	-.0001626	.0028347	.9967785	.98323	.9992648
4	.0004006	-.0001522	.0013912	.9963413	.981527	.9991895
5	.0001166	-.0000983	.0005254	.996256	.9813144	.9991746
6	.000035	-.0000577	.0002363	.9962423	.9812907	.999171
7	.0000103	-.0000272	.0001022	.9962403	.9812866	.9991702
8	3.05e-06	-.0000135	.000047	.99624	.9812858	.9991701

95% lower and upper bounds reported; percentile ci

Panel (LSDV) vector autoregression	Number of obs	=	1071
Group variable: CountryID	Number of groups	=	7
	Obs per group	=	153

Equation	Parms	RMSE	R-sq	F	P > F
GBPCT	11	.079695	0.3032	17.03084	0.0000
STOCK	11	.070822	0.0359	9.139432	0.0000

F statistic for F(4,1060)

	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GBPCT						
l1_GBPCT	.2485942	.0307703	8.08	0.000	.1882165	.3089719
l1_STOCK	.0074156	.0345964	0.21	0.830	-.0604696	.0753008
l2_GBPCT	-.0101795	.030788	-0.33	0.741	-.0705919	.0502328
l2_STOCK	-.0050681	.0346419	-0.15	0.884	-.0730426	.0629064
STOCK						
l1_GBPCT	.004384	.0273447	0.16	0.873	-.049272	.0580399
l1_STOCK	.1689702	.0307448	5.50	0.000	.1086426	.2292979
l2_GBPCT	.0238465	.0273604	0.87	0.384	-.0298403	.0775332
l2_STOCK	.0414861	.0307853	1.35	0.178	-.0189209	.1018932

Contemporary coefficients

	GBPCT	STOCK
GBPCT	1	0
STOCK	-.04190228	1

Response of GBPCT to shock in GBPCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0796946	.0763086	.0827721	0	0	0
1	.0197869	.0135858	.0258854	1	1	1
2	.004123	-.0005315	.0092416	.9999592	.9954227	.9999987
3	.0008381	-.001266	.0033318	.9999564	.9924969	.9999433
4	.000163	-.00041	.0012661	.9999558	.9919914	.9999405
5	.0000303	-.0001436	.0004909	.9999557	.991889	.9999402
6	5.09e-06	-.0000612	.0002005	.9999557	.9918777	.9999402
7	6.78e-07	-.0000274	.0000818	.9999557	.9918768	.9999402
8	2.21e-08	-.0000104	.0000333	.9999557	.9918768	.9999402

Response of STOCK to shock in GBPCT

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	-.0033394	-.0069974	.0012872	0	0	0
1	-.0002149	-.0044475	.0040166	.0022233	.0000117	.0095249
2	.0018123	-.0018982	.0053185	.0021706	.0000769	.0121373
3	.0007872	-.0008585	.0023825	.0027922	.0005462	.0138719
4	.0003102	-.0002514	.0010314	.0029104	.0005692	.0141446
5	.0001058	-.0000799	.0003769	.0029288	.0005719	.0141887
6	.0000348	-.00003	.00015	.0029309	.0005722	.0141956
7	.000011	-.0000114	.0000644	.0029311	.0005723	.0141964
8	3.43e-06	-4.89e-06	.0000272	.0029311	.0005723	.0141965

Response of GBPCT to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	0	0	0	0	0	0
1	.0005246	-.0045544	.0056102	0	0	0
2	-.0001395	-.0054527	.0050834	.0000408	1.35e-06	.0045772
3	-.0000638	-.0022834	.0021141	.0000436	.0000567	.0075031
4	-.0000296	-.0009625	.0009313	.0000442	.0000595	.0080086
5	-.0000103	-.0003682	.0003532	.0000443	.0000598	.008111
6	-3.51e-06	-.0001353	.0001491	.0000443	.0000598	.0081223
7	-1.12e-06	-.0000473	.0000577	.0000443	.0000598	.0081232
8	-3.53e-07	-.0000165	.0000232	.0000443	.0000598	.0081232

Response of STOCK to shock in STOCK

step	IRF	Lower	Upper	FEVD	Lower	Upper
0	.0707436	.0673246	.073146	0	0	0
1	.0119536	.0080846	.015941	.9977767	.9904751	.9999883
2	.004957	.0005388	.0096036	.9978294	.9878627	.9999231
3	.0013454	-.0001146	.0031347	.9972078	.9861281	.9994538
4	.0004294	-.0000594	.001571	.9970896	.9858554	.9994309
5	.0001267	-.0000632	.0006045	.9970713	.9858112	.9994282
6	.0000385	-.0000256	.0002739	.9970691	.9858044	.9994278
7	.0000115	-.0000117	.0001212	.9970689	.9858036	.9994277
8	3.45e-06	-5.04e-06	.0000555	.9970689	.9858035	.9994277

95% lower and upper bounds reported; percentile ci