# INTRA-WEEK AND INTER-MARKET VOLATILITY SPILLOVER IN KENYA'S FINANCIAL MARKETS

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## DECLARATION

I declare that this research paper is my original work and has never been presented to any other institution or examinations body for examination.

Sign: …… Date: ……

Kiplangat Josea Cheruiyot

## APPROVAL

This research paper has been submitted for examination with my approval as University supervisor:

Sign: …… Date: ……

Dr. Peter Muriu

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## ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| **ADF** | Augmented Dickey-Fuller |
| **ARCH** | Autoregressive Conditional Heteroscedastic |
| **DGP** | Data Generating Process |
| **EGARCH** | Exponential Generalized Autoregressive Conditional Heteroscedastic |
| **GARCH** | Generalized Autoregressive Conditional Heteroscedastic |
| **GED** | Generalized Error Distribution |
| **NSE** | Nairobi Securities Exchange |
| **OLS** | Ordinary Least Squares |
| **PP** | Phillips-Peron |
| **USD** | United States Dollar |
| **VAR** | Vector Autoregressive |

## ABSTRACT

Using weekly data, we document asymmetry in return and volatility spillover in Kenya's equity and currency market weekly returns during the period January 2000-April 2017 using an exponential GARCH modeling approach. Our findings suggest that that albeit the depreciation of the exchange rate, its volatility is two times less volatility than the stock market with the equity returns innovations being significant and positive and except during the crisis period while currency returns innovations are insignificant and positive except during the pre-crisis period. Secondly, we fail to find evidence for equity market intra-week volatility spillover except for pre-crisis period. On the contrary, currency market inter-week volatility spillover exists for the full period and the pre-crisis sample period but not for the crisis and post-crisis period. Lastly, our results reveal existence of volatility spillover from the equity to the currency market except for crisis period and volatility spillover from the currency to the equity market in the pre-crisis period and not in the other periods, which reinforces the importance of closely monitoring the evolution of financial markets. These findings have important policy implications for portfolio managers in enhancing their informational efficacy and efficiency in order to predict financial market interdependence.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 Background

The financial sector plays an indispensable role in any economy; first, it promotes real sector technological innovation and growth (Levine, 1991; King and Levine, 1993; Bencivenga, Smith and Star, 1996) by allocating resources between alternative technologies (Van der Vooren, Alkemade, and Hekkert, 2012). Secondly, the financial sector mobilizes and channels funds from liquidity surplus entities to liquidity deficient entities (Levine, 1991; Levine, Loayza and Beck, 2000) while also providing an avenue for portfolio diversification (Levine, 1991).

The sector' role is best exemplified by the words of the former British Prime Minister of Britain William Gladstone in his 1958 speech in which he stated that "Finance is, as it were, the stomach of the country, from which all the other organs take their tone." Despite the sector's role, its efficient functioning is not automatic; it may be weakened by market turbulence and aggravated further by the negative effects of increasing global financial market interconnectedness (Mishra, Swain, and Malhotra, 2007; Emenike, 2014; Jebran and Iqbal, 2016).

Asset price variation in the recent decades has become of great concern and a problem of the financial economics discipline. This is largely attributed to the fact that asset prices volatility persistence diminishes the asset prices and hence heightening investor uncertainty (Adrangi, Chatrath & Raffiee, 2014). This risk component should thus be paramount in investment decision making especially in a world of seamless financial asset trading with investors speculating with a view to making profitable trading.

Undertaking the trade in financial assets requires a deep understanding of the interlinkages between the stock and currency market and as a result enabling investors have an optimal portfolio that minimizes their risk exposure effectively (Andersen & Bollerslev, 1997; Caporale, Hunter & Ali, 2014). To appreciate the stock market and currency market interdependence, we infer from two theoretical propositions of the flow-oriented and the stock-oriented theory advanced in literature. Whereas the former postulates that the financial market interdependence is from the currency market to the equity market and the channel of transmission is such that an exchange rate depreciation dampens a country's currency competitiveness dwindling equity market's performance (Dornbusch & Fisher, 1983).

The later postulating that the interlinkages moves from the equity to the currency market. It posits that if there is a negative shock in the equity market there would be a disequilibrium[1] in the currency market and as a result investor's asset holding preferences changes such that they get more inclined to hold assets in the currency markets (Branson, 1983). According to the postulation of the two theories the interdependence between these markets is therefore not invariant and would depend on nature of financial market development in the regions or countries being examined.

Kenya's financial market offer an interesting case to study volatility transmission. First, the country's financial market is considered the most developed not only in East Africa but also within the Sub-Saharan region and has become the destination for global portfolio investments with market capitalization increasing almost five-fold from 9.88% of GDP in 2000 to 44% in 2006 before the global financial crisis, but has declined to 24% in 2011which is still higher compared to 9.5% of Nigeria's listed companies in 2011[2]. Secondly, the limited investigation of the interaction between the two segments of the financial system is relatively

[1] Because of the stock market asset price disequilibrium there is eventually an almost automatic portfolio reallocation process in search of a new equilibrium to correct the anomaly in the financial market

[2] These statistics are extracted from the world development indicators of the world Bank and can be accessed on: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators#

thus hedging, portfolio allocation and risk management strategies fail to take into account the idiosyncratic and systematic risks when making decisions which might lead to distress in case of a shock.

### 1.1.1 Foreign and Stock Market Volatility Clustering

Kenya's financial markets have experienced tremendous changes since the 1960s. Among the changes experienced includes the adoption of the floating exchange rate and financial liberalization in the 1990s and the global financial crisis in 2000s. As indicated in Figure 1 and 2 Kenya's financial markets have exhibited patterns of volatility clustering. In Figure 1.1 volatility clustering in the currency market was relatively low before and after the 2007-2008 crisis compared with the crisis period. Figure 1.2 also shows a similar pattern for the equity market although other events also affected the stock market volatility other than the global financial crisis as indicated in Figure 2.

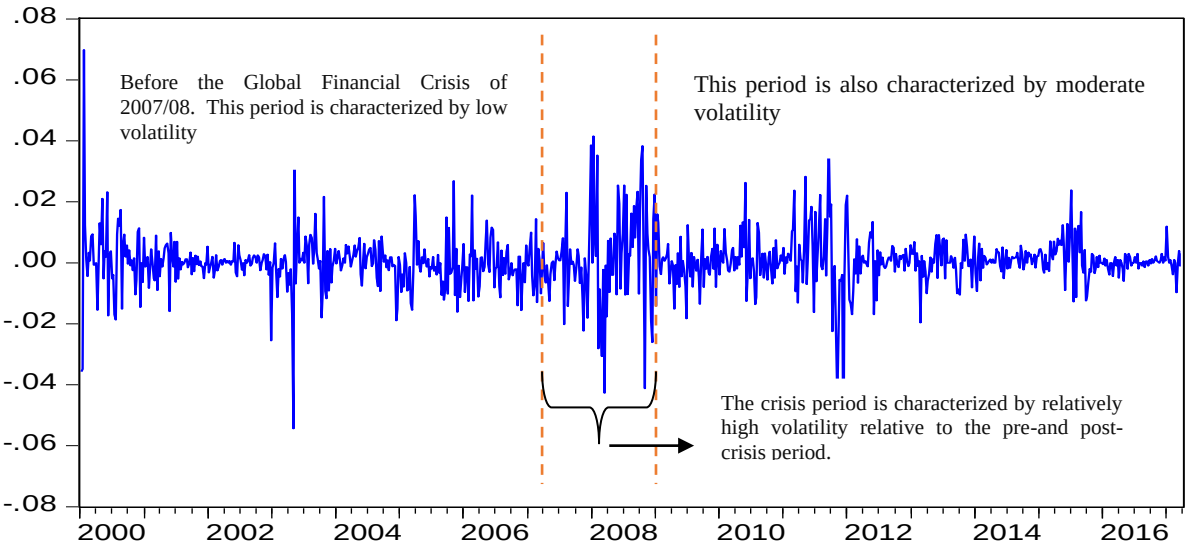


**Figure 1.1: Monthly Foreign Exchange (USD/KES) Return from Jan 2000-Apr 2017**

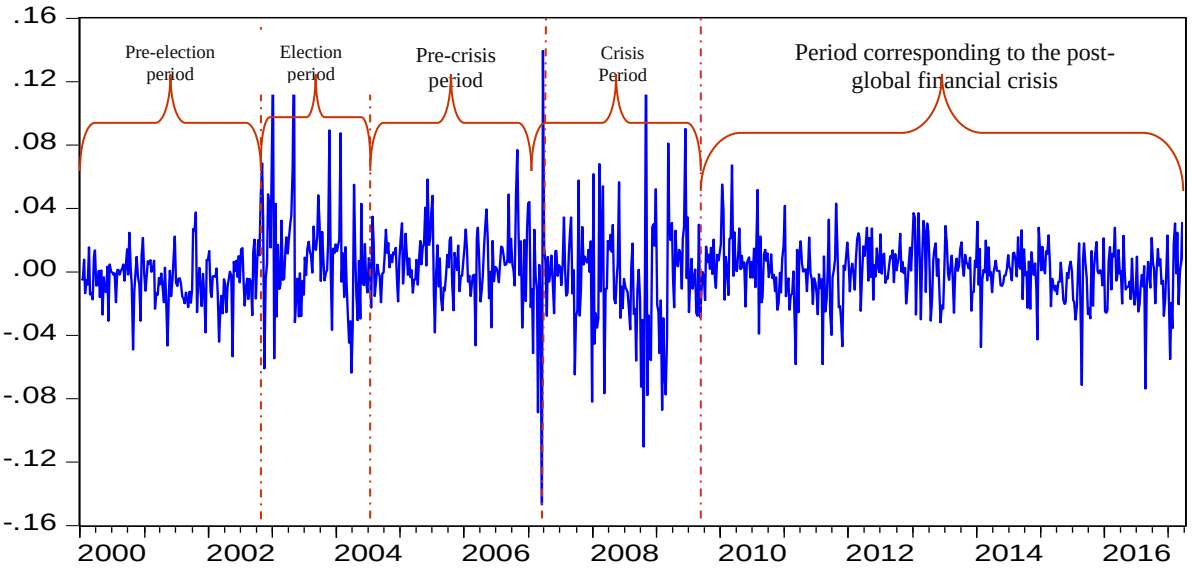


**Figure 1.2: Full Sample Monthly Stock Market Return (Jan 2000- April 2017)**

## 1.2 Statement of the Problem

Although there is unanimity of financial market interconnectedness and volatility, little is known about its nature as well as the direction of volatility, more so in frontier financial markets even in the wake of unprecedented growth in international equity investments[3] (Jebran and Iqbal, 2016). In addition, both the existing theoretical and empirical evidence on this area is mixed and inconclusive. The theoretical evidence points out that the interdependence can go in either way while the empirical literature on the other side suggests that it can be non-existent or can run from either market.

A wide range of studies have explored volatility transmission between the equity and the currency markets and evidence is mixed. For instance, Choi, Fang, and Fu (2010) in New Zealand; Andrikopoulos, Samitas, and Kougepsakis (2014) in the markets of Greece, Italy,

[3] For instance, Kenya's international equity investment has increased almost three-fold (CMA, 2017) and thus these developments within the financial system creates a strong pitch to understand the interlinkages between the financial markets not only from a policy perspective but also from an empirical standpoint. Such an analysis is important given that sometimes policy initiatives aimed at remedying financial system anomalies are ineffective sometimes leading to sub-optimal resource allocation (Adrangi, Chatrath & Raffiee, 2014).

Ireland, Portugal and Spain and Morales (2008) in the East Asian economies finds evidence for equity to currency market volatility spillover. On the contrary, Pan Fok and Liu (2007) while also looking at East Asian financial markets documents a case of volatility spillover from currency to the equity market. On the other hand, Caporale, Hunter, and Ali (2014) in examining countries in the European region and five other countries established the existence of a bi-directional volatility spillover analysis. Nieh and Lee (2002) and Morales and O'Donnell (2006) while examining volatility spillover in G-7's and five East Asian economies respectively established that volatility spillover is non-existent. While majority of the studies mentioned are within developed and emerging financial markets, studies in frontier markets are scant. In Nigeria and South Africa, volatility spillover is established to be bi-directional (Emenike, 2014; Maredza and Sibanda, 2013; Bonga 2013). In Kenya, Kisaka and Mwasaru (2013) only show that the markets are interdependent but fail to show how shocks would affect the interdependence of the markets.

Even with the limited research interrogating the existence and nature of volatility spillover, majority of the existing studies have focused on developed and emerging markets. The gap thus remains in literature regarding the existence of financial market volatility spillover especially in frontier markets with respect to the global financial crisis[4]. In particular, empirical investigation volatility spillover seems to have eluded the attention of portfolio managers, investors and policy makers resulting in their limited understanding and appreciation of the importance of volatility spillover issues. As limited as the extant empirical studies in this field, the findings are far from conclusive and seems to exhibit contextual and time differences. Nonetheless, for portfolio managers, investors and policy makers in frontier financial markets, gaining insight into the existence of volatility spillover is fundamental for risk management strategies especially in the wake of unprecedented international equity

[4] Although Burns *et. al.* (2012) shows that not only did the global financial crisis affect market participants but also ordinary citizens, the much needed evidence that would have important policy implications for frontier financial markets is clearly lacking.

flows[5]. This study is therefore, an effort towards understanding financial market asset dynamics with a view to improving our understanding of the mechanics of optimal portfolio design. It thus raises the following research questions; do we observe market interdependence, bi-directional or non-existent spillover effects for the Kenyan financial market?

### 1.3 Objectives of the Study

This study seeks to examine the intra-week and intra-market dynamics of volatility spillover and asymmetry in Kenya's financial markets. More specifically we set out to;

i. To analyze whether intra-week volatility exists in the stock and the currency markets of Kenya.
ii. To establish whether there exists inter-market volatility spillover between the stock and currency markets of Kenya.

### 1.4 Justification of the Study

This study contributes to existing literature and policy four-fold. First, the study adds to the frontier literature on the risk-return relationship by analyzing volatility trend of Kenya's equity and currency market concurrently an aspect largely ignored by previous research. Second, by exploring the intra-week and Intermarket volatility spillover across financial markets and especially the of impact exchange rate uncertainty on equity price fluctuations, this study allows for additional insights to the theoretical asset pricing models. Third, by examining the extent to which equity volatility explains currency volatility, this study

[5] For instance, Kenya's international equity investment has increased almost three-fold between 2000 to 2013 (CMA, 2017) and thus these developments within the financial system creates a strong pitch to understand the interlinkages between the financial markets not only from a policy perspective but also from an empirical standpoint. Such an analysis is important given that sometimes policy initiatives aimed at remedying financial system anomalies are ineffective sometimes leading to sub-optimal resource allocation (Adrangi, Chatrath & Raffiee, 2014).

complements evidence on the importance of order-flow[6] in exchange rate determination especially in the Kenya context where its understanding is little or rather unknown.

Fourthly, the period of analysis covers three different important periods in the evolution of Kenya's financial markets. These periods relates to the 2008/09 Global Financial Crisis (i.e. pre-crisis, crisis and the post-crisis period). The adoption of such a disaggregated framework for analyzing volatility spillover is crucial unearthing the impact new information arrival has on volatility spillover in Kenya's financial markets; an aspect also overlooked in previous work. Lastly, the study enhances policymakers and investor's intuitive understanding of volatility transmission thus enabling them to develop and implement appropriate financial market regulations and hedging strategies.

## 1.5 Organization of the Study

The rest of the study is organized as follows. Chapter 2 presents the theoretical and empirical literature and concludes with an overview of the literature. Section 3 presents the empirical model, the data source, and its measurement. Chapter 4 presents the description of data and summary statistics, results and discussions. Lastly, chapter 5 presents the conclusions, policy implications and areas for future research.

[6] According to Evan and Lyon (2002) the order-flow is an importance concept in exchange rate determination and is a measure of the pressure in either buying or selling of equity on the currency market.

# CHAPTER TWO

## LITERATURE REVIEW

### 2.1 Theoretical Literature

The analysis of equity and currency market's volatility spillover is anchored on two theories; the flow-oriented theory of Dornbusch and Fischer (1980) and the stock-oriented theory also referred to as the portfolio balance theory of Branson (1983).

Dornbusch and Fisher (1980) model assumes a small open economy trading goods and services with the rest of the world and therefore according to it any fluctuations in the currency would consequently reduce its competitiveness and trade balance positions. In turn, the economy's real output will contract and as a result current and expected future cash flows as well as asset prices of the stock market will shrink. The transmission mechanism in which the currency market affects the stock market is through currency depreciation or appreciations, for instance, if an economy's currency appreciates, its international competitiveness reduces and thus a decline in firm's equity prices and profitability.

On the other hand, the portfolio balance theory of Branson (1983) also known as the stock-flow oriented provides a contrasting view to theory of Dornbusch and Fisher (1980). This theory also assumes a small open economy where agents' portfolio holding comprises of domestic and foreign assets. It also assumes that domestic agents[7] besides holding domestic assets also hold domestic bonds. In addition, it also assumes that there is no market segmentation[8] thus; exchange rate equilibrates the supply and demand of domestic and foreign assets. As a result, this theory postulates that if the price of domestic assets increases its demands increases and due to its attractiveness investors sell foreign assets now deemed

[7] Foreign investors are considered not interested in small open economy and therefore the domestic bonds are only held by the domestic investors.

[8] The stock-oriented model assumes that markets are not distinguished as being domestic or foreign due to international barriers and as such the local and transcontinental bonds are not perfect substitutes.

unattractive to hold domestic assets consequently leading to an appreciation of the domestic currency.

## 2.2 Empirical Literature

Earlier empirical studies on financial market interdependence modeled asset returns movements in their first moments. For instance, using Cointegration analysis Nieh and Lee (2002) examines the relationship between G-7's financial markets where they establish that a bidirectional short-run relationship existed between them but not in the long-run. On the other hand, Kisaka and Mwasaru (2012) using monthly data for the period November 1993 and May 1999 examined Kenya's financial market interlinkages by applying Cointegration analysis and found the markets to be cointegrated though the direction of the relationship was from the currency market to the equity market.

Whereas the two studies by Nieh and Lee (2002) and Kisaka and Mwasaru (2012) examined financial markets interlinkages they, however, failed to investigate the existence of volatility spillover. Their approach to investigating the issue is criticized as being too simplistic to unearth the existence of volatility spillover and asymmetry which has eventually led to the adoption of models that consider the autoregressive nature of the data generating process of asset prices.

Using an AR-GARCH and AR-EGARCH model Mishra, Swain, and Malhotra (2007) examined volatility spillover in India and found it to be bi-directional. Pan Fok and Liu (2007) on the other hand, used AR-GARCH to examine volatility spillover in East Asian financial markets where they found evidence of unilateral spillover in Singapore, Hong Kong, and Korea before and after the Asian crisis which moved from the equity market to the currency market. However, during the crisis period volatility spillover was non-existent. Similar results are documented in a study by Morales and O'Donnell (2006) using an EGARCH model for five East Asian economies except for Taiwan where they found volatility spillover after the crisis. A study conducted in the same setting as that of Morales

and O'Donnell (2006) using a vector autoregressive BEKK model Chung, Lu and Tswei (2007) found that volatility was high during the Asian crisis with Japan having a stronger and influential effect on volatility transmission compared to other Asian equity markets.

Aloui (2007) examines the interlinkages between the financial markets in the United States and other European countries using an EGARCH model where they established that volatility within the financial markets was asymmetric and persistent. On the other hand, Morales (2008) established that for Latin America countries volatility was unidirectional and run from the equity to the currency market. In New Zealand, a study conducted by Choi, Fang, and Fu (2010) finds that financial market volatility spillover existed though in different directions depending on the period. Their findings indicated that during the full sample period, before, during and after the crisis spillover was unidirectional for the foreign exchange market but was bidirectional between its currency and equity markets.

Examining the Japanese financial markets volatility spillover using a trivariate BEKK-GARCH model with the USA's stock market returns as control, Yong, Holmes, and Choi (2011) established that the currency market drives volatility while also finding that asymmetry existed in Japan's financial markets volatility spillover. Using a similar approach as Yong, Holmes, and Choi (2011) Caporale, Hunter, and Ali (2014) in examining the interaction between the equity and currency market of the Euro region, United States, Switzerland, United Kingdom, Canada, and Japan, shows the existece of unidirectional volatility spillover in Japan's, UK and US financial markets running from the equity market to the currency market. However, in Canada's the spillover moved from currency market to the equity market while it was bidirectional for the Euro region and Switzerland.

Valls and Chulia (2014) in their study analyzed volatility spillover in ASEAN[9] economies financial markets using a VAR-GARCH model. Their results suggested that own past market volatilities affected the subsequent period's volatility. They also established that the cross-markets volatility was bidirectional contrary to the findings reported in the studies of Pan Morales and O'Donnell (2006) and Fok and Liu (2007) who examined volatility spillover among select Asian Economies. The difference in these studies can be attributed to the different country combinations adopted in the analysis as well as the approaches used.

Using an EGARCH model to model monthly data from August 2007 to July 2011 Andrikopoulos, Samitas, and Kougepsakis (2014) examined financial markets volatility in Greece, Italy, Ireland, Portugal and Spain. Their study finds that volatility is highly persistent. In addition, they established spillover of volatility to be unidirectional and spilled from the equity market to the currency market. Using a similar framework to Andrikopoulos, Samitas, and Kougepsakis (2014), Mozumder, De-Vita, Kyaw and Larkin (2015) examined volatility spillover across financial markets of three developed and emerging economies. They established that volatility was asymmetric and unidirectional for both the developed and emerging countries while also establish that the volatility run from the equity to the currency market for developed countries financial markets as was also the case in the study by Andrikopoulos, Samitas, and Kougepsakis (2014) however, Mozumder, De-Vita, Kyaw and Larkin (2015) established that for the emerging countries' markets it moved from the currency market to the equity market except for Brazil where it was bidirectional.

Jebran and Iqbal (2016) in their study of volatility spillover in six financial markets of China, India, Hong Kong, Japan Sri Lanka and Pakistan used an EGARCH model where they established asymmetry in volatility. They also found the existence of spillover in volatility though being bidirectional in nature for Pakistan, China, and Hong Kong. However, for India,

[9] The ASEAN economies under examination were China, Indonesia, Japan, Hong-Kong, Malaysia, Philippines, South Korea, Singapore, Taiwan and Thailand

it was unidirectional while for Japan, volatility spillover was non-existent. This is in contrast with the findings by Pan Fok and Liu (2007) who found that volatility spillover in Hong Kong's financial market to be unidirectional before and after the Asian crisis period. During this periods volatility spilled from the equity market to the currency market but non-existent during the crisis period.

Most of the previous studies highlighted so far have been conducted either in developing or emerging financial markets with a few in the developing countries. Among the few notable studies in SSA include those of Mlambo, Maredza, and Sibanda (2013), Bonga (2013) and Eminike (2014). In South Africa Mlambo, Maredza, and Sibanda (2013) shows using a GARCH model that volatility spillover is bidirectional. Their findings are in tandem with those of Bonga (2013) who also established the existence of a bidirectional volatility spillover in South African financial markets using a bivariate VAR model. Evidence from Nigeria's financial markets by Emenike (2014) using a BEKK-GARCH model for the period 1996 to 2013 also indicated the existence of a bidirectional volatility spillover.

## 2.3 Overview of Literature

Investigation of volatility spillage between volatility markets are premised on the theoretical propositions as advanced by Dornbusch and Fisher (1985) and Branson (1983) theoretical frameworks with the empirical literature suggesting diverse directions on the interlinkages. The diversity in evidence either indicating unidirectionalism, bidirectionalism on no linkage and this differs from country to country as well as the methodological approach adopted. Looking at the literature we discern two main widely adopted approaches. Some studies have adopted the first moments approach which is without limitations while other studies have adopted the second moments approach to modelling conditional variance of asset returns. Of the studies that adopted the first moments modelling majority of the reviewed studies indicate that the direction of the relationship can go either way just as was also established from the reviewed studies that modeled the relationship between the markets in their second moments.

Overall, we establish that there is scant of evidence using the second moments approach to investigating the relationship between financial markets in developing and emerging countries as most of the studies have been conducted in developed countries. Even in the context of emerging countries most of these studies have been outside Sub-Sahara Africa with the few focusing on South Africa and Nigeria.

# CHAPTER THREE

## METHODOLOGY

### 3.0 Introduction

Section 3.1 of this chapter presents the theoretical model. Section 3.2 presents the econometric model while Section 3.3, 3.4 and 3.5 presents a discussion of the variables, sources of the data and the robustness checks performed respectively.

### 3.1 Theoretical Model

Anchored on the flow-oriented and stock-oriented theory, we examine the intra-week and inter-market volatility spillover in Kenya's financial markets. According to the Branson's (1983) stock-oriented theory volatility spills from equity market to the currency market contrary to the view held by the flow-oriented theory of Dornbusch and Fisher (1985) that the spillover runs from the equity to the currency market. In the spirit of these models, Kenya's financial markets may either conform, partial conform or may not conform to either of the suppositions of these theories.

### 3.2 Empirical Model

In order to examine the intra-week and inter-market volatility spillover dynamics empirical previous empirical works have widely adopted the ARCH family models and especially the EGARCH family models (see Aloui 2007; Morales and O'Donnell, 2006; Morales, 2008; Andrikopoulos, Samitas, and Kougepsakis, 2014; Mozumder, De-Vita, Kyaw and Larkin, 2015, etc.). The ARCH models are usually preferred in such analyses as the data generating process (DGP) often follows an autoregressive process[10]. For instance, the opening stock price is determined by the previous day's closing stock price.

[10] This implies that the current values of either the stock and moment market are determined by its historical values such as the closing prices in the previous day and other market forces such as the arrival of new information.

The EGARCH model developed by Nelson (1991), is usually preferred because just like the other ARCH models allows for modeling financial series data that are usually leptokurtic and skewed in nature. Secondly, the EGARCH models, unlike the GARCH models, does not include a non-negativity constraint to be imposed of the conditional variance equation. EGARCH model overcomes this requirement by modeling conditional variance in logarithmic terms thus avoiding negative variance. The EGARCH model also allows for asymmetrical response of the conditional variance of asset returns to positive or negative innovations.

The EGARCH model mean and conditional variance equations are presented in equation ( 3.2) through equation (3.4). To examine intra-week and Intermarket volatility spillover we first compute the returns of the equity and the currency market as the natural logarithmic of the difference between two consecutive closing prices as indicated in equation (3.1).

$$R_t = \ln\left(P_t - P_{t-1}\right) \tag{3.1}$$

Where; $R_t$ represents the return to equity or currency market return, $P_t$ is the today day's stock or currency market price, $P_{t-1}$ is the previous day's stock or currency market closing price and $\ln$ is the natural logarithm.

Since the flow-oriented and the portfolio balance theory posits that the direction of the spillover is in either direction equation (3.2) and equation (3.3) presents an EGARCH model that in support of Branson's (1983) flow-oriented model and equation of Branson (1983) while equation (3.4) and equation (3.5) are in support of Dornbusch and Fisher's (1985) portfolio choice theory.

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_{t-1(ER)} + \varepsilon_t \tag{3.2}$$

$$h_{t(SP)} = \beta_0 + \beta_1 h_{t-1} + \beta_2 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \varphi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \delta_{(resid(ER))} \tag{3.3}$$

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \alpha_2 R_{t-1(SP)} + \varepsilon_t \quad (3.4)$$

$$h_{t(ER)} = \beta_0 + \beta_1 h_{t-1} + \beta_2 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| + \varphi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \delta_{(resid(SP))} \quad (3.5)$$

In equation (3.3) $h_{t(SP)}$ is the logarithm of the equity's market return conditional variance, $\beta_0$ is a volatility constant, $\beta_1 h_{t-1}$ represents volatility consistency, $\beta_2 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right|$ is a component of volatility change, $\varphi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ is a measure of the existence of asymmetry and $\delta$ is the parameter of interest in this study and capturing volatility spillover. While in equation (3.5)

$h_{t(ER)}$ is the logarithm of the conditional variance of currency market returns, $\beta_0$ is a volatility constant, $\beta_1 h_{t-1}$ represents volatility consistency, $\beta_2 \left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right|$ is a component of volatility change, $\varphi \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}}$ is a measure of the existence of asymmetry and $\delta$ is a volatility spillover parameter.

### 3.3 Variables Definition and Data Source

Table 3.1 presents the variables and their measurements and their source.

**Table 3.1: Variables Definition and Data Source**

| Variable | Definition and Measurement | Data Source | Frequency |
|---|---|---|---|
| Stock Market Returns | This represents the returns of the stock market index (NSE-20 Index). The stock market return will be measured both in daily and monthly frequency. | Nairobi Securities Exchange | Weekly data |
| Currency Market Returns | This represents the currency market return (i.e. Shs/USD). It is computed as the logarithm of the difference in today's currency market exchange rate and its previous day's closing exchange rate. The stock market return will be measured both in daily and monthly frequency. | Central Bank of Kenya | Weekly data |

### 3.4 Diagnostic Tests

Application of the ARCH models in analysis requires that the data follow an autoregressive process. To ascertain that this condition is met this study examines whether heteroscedastic and autocorrelation in both the absolute and squared returns exists. Besides these two tests the study also undertakes an examination of the existence of unit root test as most financial time series data are non-stationary. We employ the Augmented Dickey-Fuller (1979), ADF test and the Phillips and Perron (1988) PP test. Both tests assume that the data follows an autoregressive process of order one i.e. AR (1) and thus estimates the model in equation (3.6) in testing for the unit root. The test applied in equation (3.6) is therefore synonymous to establishing that the parameter $\phi \leq |1|$ is satisfied or no and we finally test for the ARCH effect using Engle (1982) test.

$$y_t = \phi y_{t-1} + \varepsilon_t \text{ and } \phi \geq |1| \qquad (3.6)$$

# CHAPTER FOUR

## EMPIRICAL FINDINGS

### 4.0 Introduction

This section presents a comprehensive analysis of the statistical, distributional, and time series properties of the data adopted for the analysis to establish the appropriateness of the model that is parsimonious. In section 4.1 we examine the financial asset prices and returns evolution trajectory for the period for which the analysis is carried out. Section 4.2 is the summary statistics and in section 4.3 we perform some diagnostic tests for robustness while section 4.4 and 4.5 delves in the examination of the existence of volatility spillover within and across the financial market.

### 4.1 Financial Market Prices and Returns Trends

We use weekly data of the NSE-25index and the foreign exchange rate (USD/KShs) for the period January 2000 to April 2017[11] and therefore accommodating the major developments in the global financial system yielding a sample 1,741 observations. As a result, we divide the sample in three periods. The first period, relating to the pre-crisis period, the second being the crisis period and the last relating to the post-crisis period. Figure 4.1 and Figure 4.2 indicates that before the financial crisis the stock prices were on an upward trend while the nominal foreign exchange rates dipped. These changes in financial asset prices clearly suggests the existence of asset volatility.

[11]These excludes all public days and all weekends as the stock and currency markets are usually not open and therefore no trading takes place.

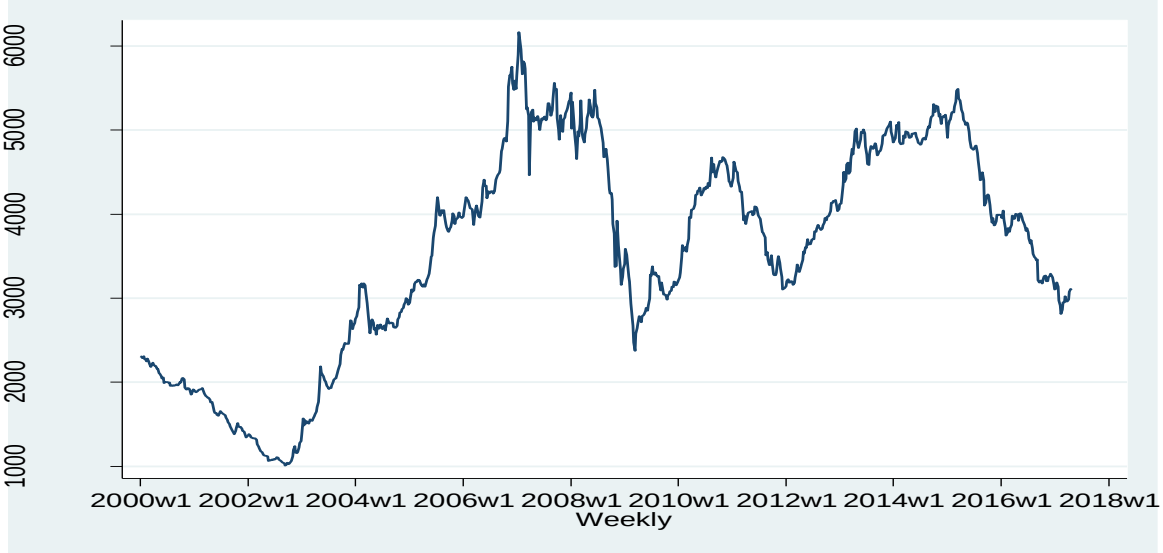


**Figure 4.1: Stock Market Price Index (Jan 2000 – April 2017)**

Figure 4.2 similarly indicates that the currency prices have been subject to sharp fluctuations. Strikingly the period corresponding to the global financial crisis of 2007/08 saw an appreciation of the Kenyan shilling relative to the US Dollar and also corresponded to an increase in the stock market prices as indicated in Figure 4.1. However, after 2008 the Kenyan currency depreciated along the declining stock market prices, implying that that the stock market prices and currency value tend to move together.

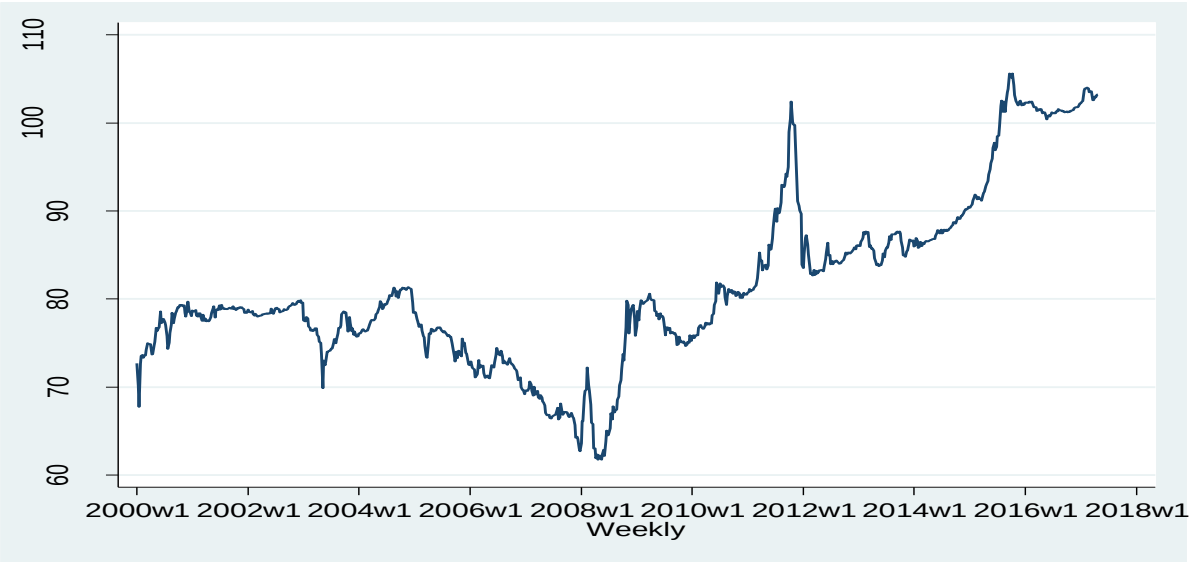


**Figure 4.2: USD/Kshs. Exchange Rates (Jan 2000 – April 2017)**

Figures 4.3 and 4.4 in addition show that the financial markets returns are volatile with low returns being followed by high returns and vice versa. Strikingly, the period corresponding to the global financial crisis of 2007/08 for both the stock market and the currency markets experienced high volatility in returns. Figure 4.3 and Figure 4.4 further shows that period of elections also appear to experience more volatility in returns than others.

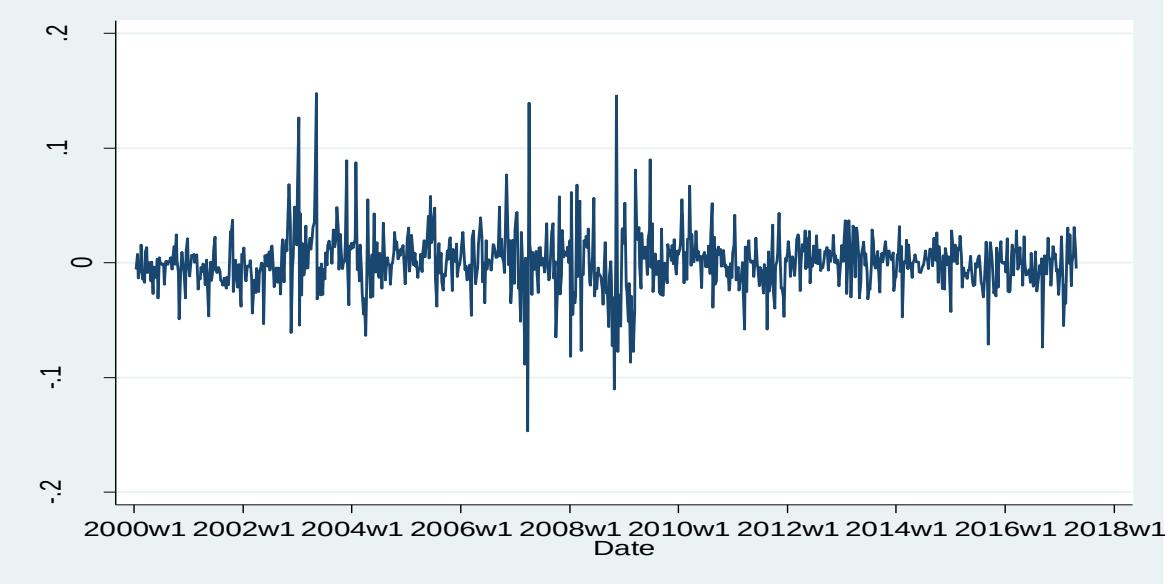


**Figure 4.3: Stock Market Returns (Jan 2000 – April 2017)**

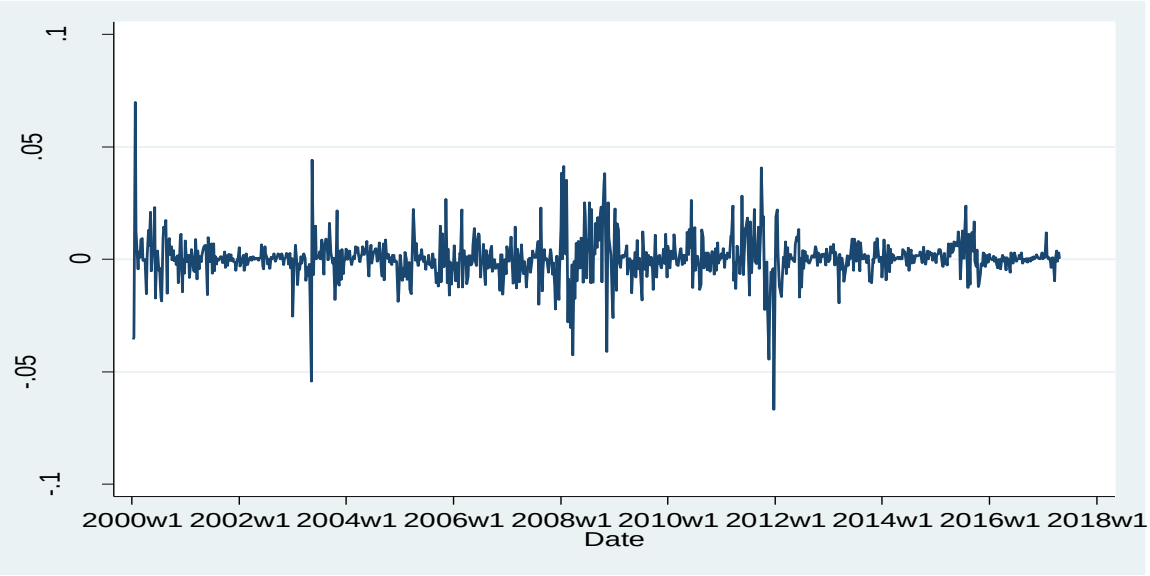


**Figure 4.4: Currency Market Returns (Jan 2000 – April 2017)**

## 4.2 Stock and Currency Market Summary Statistics

Table 4.1 shows the average weekly equity and currency market returns. The equity returns are highest for the pre-crisis period (0.2%), followed by the full sample period (0.03%) and negative for the crisis (-0.3%) and post-crisis period (-0.1%). This implies that after the financial crisis, the Kenyan stock market has on average been performing negatively. Similarly, the weekly average foreign exchange rate returns were highest during both the crisis and post crisis period (0.1%), followed by full period (0.04%) and negative during the pre-crisis period (-0.02%). Albeit the high exchange rate depreciation, it's volatility is two times less than the stock market volatility. The results in Table 1 further show that both market returns are volatile, skewed and leptokurtic with the Jargue-Bera statistic being statistically significant, therefore deviating from normal distribution[12].

During the pre-crisis period equity market returns were positive while negative for the currency market returns suggesting that during the crisis period the foreign exchange saw an appreciation and was less volatile compared to equity market asset returns which was three times more volatile compared to the foreign exchange market asset prices. On the other hand, the equity returns were negative while that of the foreign exchange market was positive during the crisis period. During this period equity returns were two times more volatile than the foreign exchange market.

Similarly, returns of the currency market was positive while that of the equity market on the other hand were negative during the post-crisis period and three times more volatile than the currency market asset returns. Overall, these results indicate that the returns of both markets are volatile, skewed and leptokurtic and therefore their distribution deviates from normal. This implies, therefore, that ordinary least squares technique cannot be estimated to fit the

[12] We test for normality using the Jarque-Bera Statistic whose null-hypothesis states that the distribution is not normal with a significant Jarque-Bera test p-value indicating that the distribution of the data deviates from normal. Therefore, that ordinary least squares technique cannot be estimated to fit the data and thus the need to use techniques that take into account the skewed and leptokurtic nature of the data.

data and thus the need to use techniques that take into account the skewed and leptokurtic nature of the data.

**Table 4.1: Summary Statistics of Stock and Currency Market Returns**

| | Full-Sample Estimates (N=900) | | Pre-Crisis Estimates (N=396) | | Crisis Estimates (N=57) | | Post-Crisis Estimates (N=445) | |
|---|---|---|---|---|---|---|---|---|
| Statistics | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return |
| Mean | 0.0003 | 0.0004 | 0.002 | -0.0002 | -0.003 | 0.001 | -0.001 | 0.001 |
| Maximum | 0.148 | 0.070 | 0.148 | 0.070 | 0.068 | 0.041 | 0.146 | 0.041 |
| Minimum | -0.147 | -0.067 | -0.147 | -0.054 | -0.082 | -0.043 | -0.110 | -0.067 |
| Std. Dev. | 0.025 | 0.010 | 0.026 | 0.009 | 0.032 | 0.016 | 0.023 | 0.009 |
| Skewness | 0.395 | -0.036 | 0.780 | 0.700 | 0.0114 | 0.127 | 0.022 | -0.908 |
| Kurtosis | 9.779 | 12.92 | 11.37 | 17.56 | 3.214 | 3.68 | 9.298 | 14.47 |
| JB | 1746.5 | 3690.6 | 1196.1 | 3528.3 | 0.110 | 1.245 | 735.5 | 2501.3 |
| (P-value) | (0.00) | (0.00) | (0.00) | (0.00) | (0.95) | (0.54) | (0.00) | (0.00) |

## 4.3 Robustness Checks

### 4.3.1 Testing for Autocorrelation in Absolute and Squared Returns

Empirical investigation of volatility clustering requires that returns are auto correlated (Zivot, 2009). We thus in this section examine the existence of autocorrelation in both absolute and squared returns where we establish that the absolute and squared returns of the financial assets during the full period were indeed auto correlated (Table 4.1). The autocorrelation in the returns are established to persistence for almost thirty-six weeks. Similar evidence is also found for financial asset returns during the pre-crisis period except for the currency market return; however, the squared returns in both markets are significant and persistent up to the $36^{th}$ week indicating the presence of autocorrelation in the returns of these markets in this period.

**Table 4.2: Autocorrelation in Absolute Equity and Currency Returns**

| Full-Sample Estimates (N=900) | | | Pre-Crisis Estimates (N=396) | | Crisis Estimates (N=57) | | Post-Crisis Estimates (N=445) | |
|---|---|---|---|---|---|---|---|---|
| Statistics | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return |
| AC1 | 0.047 | 0.087 | 0.134 | -0.076 | -0.135 | 0.101 | 0.171 | 0.163 |
| | (0.157) | (0.009) | (0.007) | (0.128) | (0.294) | (0.435) | (0.000) | (0.001) |
| AC12 | 0.056 | -0.028 | 0.025 | 0.030 | 0.032 | -0.018 | 0.104 | -0.057 |
| | (0.013) | (0.009) | (0.086) | (0.773) | (0.701) | (0.005) | (0.001) | (0.007) |
| AC24 | 0.006 | -0.016 | -0.026 | 0.005 | 0.161 | 0.005 | 0.003 | -0.006 |
| | (0.066) | (0.014) | (0.010) | (0.573) | (0.565) | (0.101) | (0.004) | (0.021) |
| AC36 | 0.003 | -0.016 | -0.004 | 0.008 | -0.034 | 0.000 | -0.019 | -0.056 |
| | (0.027) | (0.013) | (0.014) | (0.359) | (0.743) | (0.328) | (0.027) | (0.003) |

The p-values are in parentheses

The crisis period's returns, however, does not exhibit any autocorrelation in both the absolute and squared deviations except for currency return which is established to have autocorrelation which persists up to the 24th week. Lastly, the post-crisis returns in the equity and currency market are auto correlated and persist up to the 36th week for both the absolute and squared returns.

**Table 4.3: Autocorrelation in Squared Equity and Currency Returns**

| Full-Sample Estimates (N=900) | | | Pre-Crisis Estimates (N=396) | | Crisis Estimates (N=57) | | Post-Crisis Estimates (N=445) | |
|---|---|---|---|---|---|---|---|---|
| Statistics | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return | Equity Return | Currency Return |
| AC1 | 0.357 | 0.202 | 0.321 | 0.337 | 0.161 | -0.086 | 0.170 | 0.157 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.213) | (0.506) | (0.000) | (0.001) |
| AC12 | 0.062 | 0.180 | -0.024 | -0.001 | -0.017 | -0.126 | 0.068 | 0.236 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.945) | (0.010) | (0.000) | (0.000) |
| AC24 | 0.038 | 0.022 | 0.020 | 0.010 | 0.002 | -0.057 | 0.009 | 0.030 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.985) | (0.014) | (0.000) | (0.000) |
| AC36 | 0.045 | 0.018 | -0.037 | -0.021 | 0.171 | 0.004 | 0.038 | 0.002 |
| | (0.000) | (0.000) | (0.000) | (0.004) | (0.963) | (0.141) | (0.000) | (0.000) |

The p-values are in parentheses

### 4.3.2 Testing for Unit Roots

In performing the unit root tests we look at four different scenarios; first we apply the test to the full sample period. We then for robustness also examine whether the asset returns have a unit root by adopting disaggregated framework in light of the global financial crisis. Using the Augmented Dickey-Fuller (1979) ADF test and the Phillips and Perron (1988) PP test we establish that the financial market's asset returns are time invariant or rather stationary.

**Table 4.4: Unit Root Test**

| | ADF Test | | PP Test | |
|---|---|---|---|---|
| | Intercept | Intercept and Trend | Intercept | Intercept and Trend |
| Full Sample Period (1st Jan 2000 – 4th April 2017) | | | | |
| Equity Return | -9.27*** | -9.29*** | -26.98*** | -26.97*** |
| Currency Market Return | -10.59*** | -10.61*** | -28.69*** | -28.68*** |
| Pre-Crisis Sample Period (1st Jan 2000 – 9th Aug 2007) | | | | |
| Equity Return | -17.31*** | -17.49*** | -17.58*** | -17.65*** |
| Currency Market Return | -21.83*** | -22.06*** | -21.96*** | -22.23*** |
| Crisis Sample Period (7th Aug 2007 – 15th Sept 2008) | | | | |
| Equity Return | -8.43*** | -8.56*** | -8.45*** | -8.57*** |
| Currency Market Return | -3.14** | -3.41* | -7.02*** | -7.12*** |
| Post-Crisis Sample Period (15th Sept 2008 – 4th Apr 2017) | | | | |
| Equity Return | -4.85*** | -4.98*** | -17.70*** | -17.69*** |
| Currency Market Return | -17.867*** | -17.85*** | -17.97*** | -17.97*** |

Notes: ***, ** & * indicates 1%, 5% and 10% significance level respectively. 1%, 5% and 10% critical values for unit root test are −3.43, −2.86 and −2.56 respectively for intercept only while for Intercept and trend is 3.99, 3.41 and 3.13 respectively.

### 4.3.3 Testing for ARCH Effects

Besides examining the existence of autocorrelation in the asset returns we also examined for the presence of ARCH effects using Engle's (1982) ARCH Test under the null hypothesis of no ARCH effect. As indicated by the results presented in Table 4.5 we reject the null-hypothesis and affirm that there are ARCH effects and as a result the ARCH models are appropriate in this context as opposed to the OLS models.

**Table 4.5: Engle ARCH Effect Tests**

| | Constant | AR (1) | ARCH Test |
|---|---|---|---|
| Full Sample Period (1st Jan 2000 – 4th April 2017) | | | |
| Stock Prices | 0.8423<br>(0.79) | 0.047<br>(0.16) | 122.23***<br>(0.00) |
| Exchange Rates | 0.034<br>(0.17) | 0.087<br>(0.01) | 29.93***<br>(0.00) |
| Pre-Crisis Sample Period (1st Jan 2000 – 9th Aug 2007) | | | |
| Stock Prices | 0.002<br>(0.17) | 0.13***<br>(0.01) | 56.37***<br>(0.00) |
| Exchange Rates | -0.0001<br>(0.73) | -0.08<br>(0.123) | 50.56***<br>(0.00) |
| Crisis Sample Period (7th Aug 2007 – 15th Sept 2008) | | | |
| Stock Prices | -0.001<br>(0.79) | -0.613***<br>(0.00) | 0.118<br>(0.73) |
| Exchange Rates | 0.001<br>(0.57) | 0.103<br>(0.46) | 7.702**<br>(0.02) |
| Post-Crisis Sample Period (15th Sept 2008 – 4th Apr 2017) | | | |
| Stock Prices | -0.001<br>(0.61) | 0.171***<br>(0.00) | 25.980***<br>(0.00) |
| Exchange Rates | 0.001<br>(0.12) | 0.163***<br>(0.00) | 10.257***<br>(0.00) |

The p-values are in parentheses

## 4.4 Intra-Week Volatility Spill Over in Kenya's Financial Markets

Section 4.4.1 and 4.4.2 presents empirical evidence for the intra-week volatility spillover in Kenya's financial markets. We section 4.4.1 we investigate the existence of intra-week volatility spillover in Kenya's equity market while in section 4.4.2 we present the evidence of intra-week volatility spillover in the currency or foreign exchange market. The analysis of the intra-week volatility is disaggregated into three sub-samples relating to the pre-global financial crisis, the crisis period and the post-crisis period.

### 4.4.1 Intra-Week Volatility Spill Over in Kenya's Equity Market

We first examine the intra-week volatility spillover in the equity market using an Exponential Generalized Autoregressive Heteroscedastic model (EGARCH [1, 1]). Maximum likelihood estimates of the EGARCH model for the intra-week volatility spillover are reported in Table 4.6 where we make the following observations. First, from the conditional mean equation, the history of the equity market's returns has a positive sign and is significant except during the

crisis period where it is negative and insignificant. Similarly, we also note that equity returns' history influencing the current period's returns is highest during the pre-crisis period (27%), followed by full-sample period (18%), post-crisis period (16%) and lastly the crisis period (-1%). This implies that investors in this segment of the market can exploit on informational content to gain as this segment of the market is inefficient in the strong-form sense as encapsulated by the efficient market hypothesis.

The conditional variance equation reveals that for the full period no intra-week volatility spillover exist so is the case with the crisis and the post-crisis period. However, the pre-crisis period shows evidence of intra-week volatility spillover as indicated by a positive and significant coefficient on the spillover parameter. Evidence also indicated that the volatility that existed during the full period, pre-crisis, crisis and the post-global financial crisis was consistent and positive except for the crisis period where the volatility consistence was negative. The significant volatility spillover thus implies that the conditional variance is influenced by its history of innovations.

During the period crisis, crisis and post-crisis period, the asymmetry term ($\phi$) is positive as theoretically expected though insignificant and therefore negative shocks are likely to increase future volatility or uncertainty while a positive shock will ease the effect on future uncertainty. On the contrary the full period analysis shows that volatility was asymmetric with its parameter being positive and significant implying that the variance rises more after positive returns than after negative returns and thus positive shocks have more impact on volatility than negative shocks of the same magnitude. On the other hand, the volatility consistence term is positive and significant except for the crisis period which is negative. Its coefficient is also close to unity and thus implying that current innovations are an important predictor of future conditional variance.

**Table 4.6: Intra-Week Volatility Spill Over in the Equity Market in Kenya**

| | Full Period | Pre-Crisis Period | Crisis Period | Post-Crisis Period |
|---|---|---|---|---|
| **EGARCH (1,1) Mean Equation** | | | | |
| Constant | -1.84 | -0.0004 | -0.007** | -0.0003 |
| | (1.96) | (0.001) | (0.003) | (0.001) |
| Equity Return (-1) | 0.18*** | 0.27*** | -0.100 | 0.16*** |
| | (0.03) | (0.06) | (0.096) | (0.04) |
| **Conditional Variance Equation** | | | | |
| $\beta_0$ (Constant) | -0.03 | -1.25*** | -12.54*** | -0.13*** |
| | (0.04) | (0.32) | (0.00) | (0.01) |
| $\beta_2$ (Volatility Change) | 0.31*** | 0.38*** | 1.48*** | -0.07*** |
| | (0.03) | (0.06) | (0.45) | (0.01) |
| $\phi$ (Asymmetry) | 0.06*** | 0.02 | 0.03 | -0.01 |
| | (0.02) | (0.05) | (0.44) | (0.02) |
| $\beta_1$ (Volatility consistency) | 0.98*** | 0.87*** | -0.65*** | 0.98*** |
| | (0.98) | (0.04) | (0.004) | (0.00) |
| $\delta$ (Spillover Parameter) | -0.0001 | 2.33*** | -4.79 | -0.47 |
| | (0.0001) | (0.79) | (7.27) | (0.94) |
| No. Observations | 899 | 395 | 56 | 444 |
| Durbin-Watson Test | 2.27 | 2.28 | 2.00 | 1.98 |

The standard errors are in parentheses

### 4.4.2 Intra-Week Volatility Spill Over in Kenya's Currency Market

Table 4.7 presents the results of (in) existence of intra-week volatility spillover of Kenya's currency market between the periods of January 2000 to April 2017. From the mean equation, we establish that the currency market is efficient at 5 percent level of significance as the history of the currency returns does not influence the returns in the current period for all the periods considered in the analysis. From the conditional variance equation, we establish that intra-week volatility spillover existed for the full period sample as well as the pre-crisis period however, during the crisis and post-crisis period we do not find evidence of intra-week

volatility spillover as indicated by $\delta$, the volatility spillover parameter. Evidence also shows that volatility is only consistent for the full and pre-crisis period and not for the crisis and post-crisis period while we not existence of volatility asymmetry during the full sample period analysis we fail to find evidence of asymmetry for the disaggregated period analysis and more particularly during the pre-crisis, crisis and the post-crisis period.

**Table 4.7: Intra-Week Volatility Spill Over in the Currency Market in Kenya**

| | Full Period | Pre-Crisis Period | Crisis Period | Post-Crisis Period |
|---|---|---|---|---|
| **EGARCH (1,1) Mean Equation** | | | | |
| Constant | 0.06*** (0.01) | 0.001 (0.0003) | -0.002 (0.003) | 0.001*** (0.0003) |
| Currency Return (-1) | 0.01 (0.04) | -0.09* (0.05) | 0.05 (0.10) | 0.08 (0.05) |
| **Conditional Variance Equation** | | | | |
| $\beta_0$ (Constant) | -0.48*** (0.03) | -1.13*** (0.19) | -10.37** (4.24) | -0.78*** (0.11) |
| $\beta_2$ (Volatility Change) | 0.52*** (0.03) | 0.36*** (0.05) | -0.51 (0.37) | 0.29*** (0.05) |
| $\phi$ (Asymmetry) | 0.09*** (0.03) | 0.01 (0.04) | 0.26 (0.26) | 0.20 (0.03) |
| $\beta_1$ (Volatility consistency) | 0.90*** (0.01) | 0.91*** (0.02) | -0.29 (-0.29) | 0.94 (0.01) |
| $\delta$ (Spillover Parameter) | -0.09*** (0.02) | -18.14*** (3.09) | 7.92 (7.92) | -10.49 (1.84) |
| No. Observations | 899 | 395 | 56 | 444 |
| Durbin-Watson Test | 2.02 | 1.92 | 1.86 | 1.80 |

The standard errors are in parentheses

## 4.5 Inter-Market Volatility Spill Over in Kenya's Financial Markets

In Table 4.6 and Table 4.7 we present the results of volatility spillover in Kenya's financial markets in Kenya using monthly time series data for the period January 2000 to April 2017. Table 4.6 presents the empirical examination of volatility spillover from the currency market to the equity market while Table 4.7 presents the results of the empirical analysis of volatility spillover from the equity market to the currency market.

### 4.5.1 Currency to Equity Market Volatility Spill Over in Kenya

We present in Table 4.6 an EGARCH (1, 1) model of volatility from the currency to the equity market during the full period, pre-crisis, crisis and post-crisis sample period. The mean equation results reveal that stock market fluctuations have significant positive effect across all the three periods of analysis (i.e. the full period, pre-crisis, crisis period and the post-crisis period). The effect of past foreign exchange market fluctuations have a significant negative effect for the full period sample but positive and insignificant during the pre-crisis, crisis and post-crisis periods separately. The positive effect of stock market fluctuations on currency market returns indicates that this is in support of the portfolio balance theory.

From the variance equation, the volatility spillover from the currency to the equity market coefficient $\delta$ is positive for the full sample period and the post-crisis period indicating that increased currency market volatility increases the stock market volatility. In contrast, the pre-crisis period volatility spillover from the currency to the equity market is negative indicating that the foreign exchange market volatility decreases the stock market volatility. This is in tandem with the evidence from emerging markets by Pan, et. al. (2007) who finds that the spillover is from the currency to the equity market. It is also in line with the evidence with the study by Caporale, et. al. (2014), Valls and Chulia (2014), Mozumder, et. al. (2015) and Jebran and Iqbal (2016) who also established that the volatility spilled over from the currency to the equity market. On the theoretical front our evidence also supports the flow-oriented theory of Dornbusch and Fisher (1985) that the spillover runs from the equity to the currency

market. In addition, the results also indicate the existence of volatility consistency for the full period, crisis and post-crisis period which is significant at 5 percent level for significant except for the pre-crisis period where we find that volatility is not consistent. Finally, the results reveal that volatility is asymmetric only for the full period analysis and not for the other periods including the pre-crisis, crisis ad post-crisis period.

**Table 4.8: Currency to Equity Market Volatility Spill Over in Kenya**

| | Full Period | Pre-Crisis Period | Crisis Period | Post-Crisis Period |
|---|---|---|---|---|
| **EGARCH (1,1) Mean Equation** | | | | |
| Constant | -1.84<br>(-1.20) | 0.001<br>(0.89) | -0.01***<br>(0.001) | 0.001<br>(0.55) |
| Equity Return (-1) | 0.17***<br>(4.22) | 0.15**<br>(2.31) | -0.14** (0.06) | 0.159***<br>(3.14) |
| Forex return (-1) | -4.84***<br>(-2.63) | -0.02<br>(-0.14) | 0.13<br>(0.12) | -0.123<br>(-1.20) |
| **Conditional Variance Equation** | | | | |
| $\beta_0$ (Constant) | -0.04<br>(-0.56) | -8.37***<br>(-5.33) | -12.37***<br>(0.00) | -0.212<br>(-4.49) |
| $\beta_2$ (Volatility Change) | 0.25*** (4.58) | 0.81***<br>(6.26) | 1.41*** (0.54) | -0.003<br>(-0.11) |
| $\phi$ (Asymmetry) | 0.07*<br>(1.71) | 0.04<br>(0.32) | 0.18<br>(0.13) | -0.005<br>(-0.28) |
| $\beta_1$ (Volatility consistency) | 0.98***<br>(136.2) | -0.02<br>(-0.097) | -0.61***<br>(0.003) | 0.97***<br>(195.5) |
| $\delta$ (Spillover Parameter) | 0.07*<br>(1.69) | -21.31**<br>(-1.98) | -7.81<br>(6.75) | 5.848***<br>(2.60) |
| No. Observations | 899 | 395 | 56 | 444 |
| ARCH Test | 10.76<br>(0.06) | 0.08<br>(0.78) | 0.08<br>(0.78) | 1.39<br>(0.24) |
| Durbin-Watson Test | 2.27 | 2.05 | 1.84 | 1.99 |

The standard errors are in parentheses

### 4.5.2 Equity to Currency Market Volatility Spill Over in Kenya

We present in Table 4.9 also presents the results of an EGARCH (1, 1) model of volatility from the equity to the currency market during the full period, pre-crisis, crisis and post-crisis sample period. The mean equation results reveal that stock market fluctuations have significant positive effect across all the three periods of analysis while the effect of past foreign exchange market fluctuations have a significant negative effect for the full period sample but positive and insignificant during the pre-crisis, crisis and post-crisis periods separately. The asymmetry parameter on the other hand for all the periods considered is significant and therefore we do not find evidence for asymmetry in volatility whereas volatility consistency parameter is positive and significant and close to unity during the different periods of examination insinuating that history of innovations have a predictive power in influencing future volatility.

The volatility spillover parameter $\delta$ is positive for the full sample period, pre-crisis and the post-crisis period while negative during the crisis period. The positive and significant coefficient volatility spillover term implies that currency market volatility increases the stock market volatility while the negative parameter during the crisis period reveals that during this period implies that the foreign exchange market volatility decreased the level of volatility in the stock market. Our finding is thus in line with the evidence from emerging markets by Choi, et. al., (2010), Andrikopoulos, et. al., (2014), Morales (2008) who found out that volatility spills from the equity to the currency market. On the theoretical front our finding is in support of Branson's (1983) stock-oriented theory that volatility spills from equity market to the currency market.

**Table 4.9: Equity to Currency Market Volatility Spillover in Kenya**

| | Full Period | Pre-Crisis Period | Crisis Period | Post-Crisis Period |
|---|---|---|---|---|
| **EGARCH (1,1) Mean Equation** | | | | |
| Constant | 0.031*** (2.09) | 0.00003 (0.14) | 0.00 (0.001) | 0.001*** (4.80) |
| Equity Return (-1) | 0.0003 (1.37) | 0.005 (0.46) | 0.07* (0.03) | 0.018 (0.87) |
| Forex return (-1) | -0.026 (-0.47) | -0.089 (-1.43) | 0.21** (0.08) | 0.035 (0.44) |
| **Conditional Variance Equation** | | | | |
| $\beta_0$ (Constant) | -0.455*** (-5.44) | -1.231*** (-3.47) | -1.07*** (0.27) | -0.656** (-2.09) |
| $\beta_2$ (Volatility Change) | 0.504*** (6.60) | 0.345*** (3.96) | 0.28 (0.56) | 0.344*** (6.15) |
| $\phi$ (Asymmetry) | 0.028 (0.48) | -0.034 (-0.588) | 0.05 (0.22) | 0.111 (1.22) |
| $\beta_1$ (Volatility consistency) | 0.909*** (24.19) | 0.903*** (27.24) | 0.89*** (0.06) | 0.960*** (30.76) |
| $\delta$ (Spillover Parameter) | 0.001 (0.61) | 7.295* (1.60) | -0.76 (5.31) | 0.710 (0.79) |
| No. Observations | 899 | 395 | 56 | 444 |
| ARCH Test | 1.77 (0.90) | 0.742 (0.39) | 0.36 (0.55) | 0.315 (0.57) |
| D-W Test | 1.77 | 2.02 | 2.17 | 1.71 |

The standard errors are in parentheses

# CHAPTER FIVE

## CONCLUSIONS

### 5.0 Introduction

The main objective of the study was to examine the contagion between foreign exchange and the stock market in Kenya- an area which is relatively under-researched in a vast literature of financial spillovers. Specifically, we set out to model and test for volatility spillovers in the inter-market as well as the intra-market. This chapter first begins with a summary of the findings and conclusions in section 5.1 and moves to section 5.2 where the policy implications are put forth and section 5.3 highlights the areas of further research.

### 5.1 Summary of Findings

In this paper financial market volatility spillover and in particular intra-week and inter-market volatility analysis are examined using an Exponential Generalized Autoregressive Heteroscedastic Model for the period January 2000 to April 2017. We first establish that albeit the depreciation of the exchange rate, its volatility is two times less volatility than the stock market with the equity returns innovations being significant and positive and except during the crisis period while currency returns innovations are insignificant and positive except during the pre-crisis period. Secondly, we fail to find evidence for equity market intra-week volatility spillover except for pre-crisis period. On the contrary, currency market inter-week volatility spillover exists for the full period and the pre-crisis sample period but not for the crisis and post-crisis period. Lastly, our results reveal existence of volatility spillover from the equity to the currency market except for crisis period and volatility spillover from the currency to the equity market in the pre-crisis period and not in the other periods.

## 5.2 Conclusion

Based on our findings we, therefore conclude that Kenya's financial market is intertwined and that shocks in one market get propagated to another. In light of this observation we therefore find that the financial markets are interconnected and therefore the choice of investment opportunities in either segment of the financial market should minimize portfolio allocation in assets that are likely to be affected by systemic risks and should therefore focus on a portfolio of assets with unique idiosyncratic risks and thus mitigating the loses that would accrue to their investment in case of a systemic crises that affects the both financial segments in the economy.

## 5.3 Policy Implications

In light of this observation we therefore infer that the choice of investment opportunities in either segment of the financial market should minimize portfolio allocation in assets that are likely to be affected by systemic risks and should, therefore, focus on a portfolio of assets with unique idiosyncratic risks and thus mitigating the loses that would accrue to their investment in case of a systemic crises that affect both financial segments in the economy. The findings from the study are insightful and have several financial implications on the nature of markets. From our findings we infer that not only did the global financial crisis of 2007/08 have repercussions on the developed and emerging capital markets but also on the frontier capital markets and thus this analysis, which is a move to accurately characterise the volatility spillover in Kenya's financial market will have a direct bearing on financial decisions especially financial hedging, portfolio management, and asset allocation, and, most important, in designing policies to mitigate the effects of adverse market shocks. This knowledge thus helps in guiding the design an optimal portfolio to minimises its risk exposure and therefore creating value to their wealth. More so for international portfolio managers and hedge fund managers, an explicit understanding of volatility spillover between financial markets helps in predicting the behaviour of one market by having information about the other market which can thus help in formulating effective hedging strategies that

minimises their exposure to much risk and thus enhancing their informational efficiency of financial markets.

## 5.4 Areas for Further Research

The scope of the current study was to examine the intra-week and inter-market volatility spillover of Kenya's frontier financial markets. The analysis was carried out purely within the context of the global financial crisis of 2008/09. It is in this spirit that future empirical studies should examine the effect of coming into force of the interest rate capping law on volatility spillover between the financial markets. In addition, it is also suggested that future efforts to examine financial market volatility spillover should encompass a cross-country analysis especially within the east African region. Such an approach would serve to increasing the investors and policy maker's knowledge base and evidence on the nature of the regions financial markets especially with the advent of cross-border listings.

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