

**THE EFFECT OF TRIANGULAR ARBITRAGE ON THE FINANCIAL
PERFORMANCE OF FOREX MARKET IN KENYA**

BY

MUTUA SARAH MWENDE

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DECLARATION

I, the undersigned, declare that this is my original work and has not been presented to any institution or university other than the University of Nairobi for examination.

Signed: _____ Date: _____

MUTUA SARAH MWENDE

D63/84295/2015

This Research Project has been submitted for examination with my approval as the University Supervisor.

Signed: _____ Date: _____

MR. JOSEPH BARASA

Lecturer, Department of Finance and Accounting

School of Business, University of Nairobi

DEDICATION

To

My dear father Daniel Mutua

(Your prayers have always sustained me and your sacrifices to finance my education
is incomparable)

And

My loving and caring mother

Jacinta Mutua

(This wouldn't have been possible without your encouragement and prayers)

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ABSTRACT

The objective of this study was to investigate the existence of triangular arbitrage in the forex market in Kenya and the effect thereof on the financial performance of the forex market in Kenya.

From the literature review many authors have argued that short term triangular arbitrage opportunities exist in the forex market among the most traded currencies inviting traders to exploit them quickly hence eliminating mispricing in the forex market. Previous studies have been done concerning arbitrage opportunities in the forex market, but they have not dealt with the impact of the arbitrage opportunities on the performance of the forex market, this research has filled the gap by determining the effect of the triangular arbitrage on the forex market performance.

Descriptive cross-sectional design was adopted in this study. Secondary data was obtained from central bank of Kenya. Findings of the study confirmed the existence of triangular arbitrage in the forex market. Kenya shilling was observed to have depreciated against the USD over the period in consideration. The level of volatility in the first half of the period of study was found to be lower than the volatility in the second half of the period of study. In general, the study revealed that the performance of the forex market in Kenya can be predicted using arbitrage pricing theory multifactor model if triangular arbitrage is known. The study confirmed the existence of weak form market efficiency hence the existence of arbitrage opportunities.

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LIST OF ABBREVIATIONS

APT	Arbitrage Pricing Theory
ARS	Argentine Peso
CAPM	Capital Asset Pricing Model
CBK	Central Bank of Kenya
EMH	Efficient Market Hypothesis
FX	Forex Market
GBP	British Pound Sterling
HFT	High Frequency Trading
JPY	Japanese Yen
KES	Kenya Shillings
KNBS	Kenya National Bureau of Statistics
LOP	Law of One Price
OLS	Ordinary Least Squares

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Triangular arbitrage results from inefficiency in the pricing of currency rates in the forex market. It exploits those efficiencies by offering a methodology for a less time duration propelling a profit which is less risky. More so, it is the exchanging of the currency, the primary currency for the second currency, then for a third, and then for the original. The arbitrageur in the course of the second trade pays attention to a zero-risk profit from all the inconsistency existing as a result of failing to align cross exchange rate of the market with implicit cross exchange rates. Triangular arbitrage transaction can be given to promptly allowing three component trades through electronic trading systems. On the other hand, there is a delay between identifying such opportunities, the commencement of trades, and onset of trading between the parties citing the discrepancies in pricing (Gradojevic & Gencay, 2010).

Though the finance theory hypothesizes that no-arbitrage circumstances grip in uninterrupted time in well-functioning markets, Akram (2005) discovers that arbitrage chances do happen though they vanish instantaneously. Through his research, he expounded on the impact of market place alongside with that one of arbitrage and directed, creating a conclusion through referencing FX that the lesser arbitrage opportunities can be observed when there is more market that are liquid and active hence reduced amount of profit gains and extra short-lasting arbitrage.

The country's market especially in trading forex has played a very key role facilitating ICT trades hence transforming the country in telecommunication sector.

Incredible progress, innovations and development in the in Kenya's ICT segment has been felt in the county spreading through the past 10 years with the main propeller of growth in economy in the country being ICT. This segment's development has outpaced all other sectors resulting to 23 % expansion yearly in the past ten years and has performed better than the beginning of the former 10 years facilitating it been 6 times larger. In terms of communication costs analyzed in the continent, the currently lowest communication costs are in Kenya. The new innovative ICT platforms have impressively boosted performance thus the financial sector has greatly scooped benefits arising from this innovation. These innovations have made it easier for firms to take advantage of triangular arbitrage but they have also reduced the time span for existence of those opportunities (World Bank, 2016).

1.1.1 Triangular Arbitrage

Arbitrage is Triangular involved in benefits taking arising from inequity state between two or more markets in finance world's arbitrage. An arbitrageur is someone who engages in arbitrage process and is well conversant in it. The arbitrageur make a couple of matching deals in different markets aiming to make profit though using different prices in market prices, this is made possible by exploiting the imbalance that is present in the market. Triangular arbitrage on the other hand, is the way of fully exploiting an arbitrage opportunity in three unlike currencies in market for the foreign exchange ensuing from a pricing discrepancy. A triangular arbitrage approach that is typical entails three trades: swapping the initial currency for a second, trading second currency for a third and the third currency for the initial. The arbitrageur looks for a profit that has no risk in the discrepancy occurring in the second trade, when the

market cross exchange rate is not lined up with the implicit cross exchange rate (Lyons, 2001).

Some of the essential pillars of financial economics are derived from arbitrage. Risk-free arbitrage chances are not offered in financial markets, when transaction costs have made possibility for making it seems normally accepted. This perception is unswervingly connected to the law of one price (LOP) suggesting that undistinguishable securities need to have the same price regardless of how they are formed in well-functioning efficient financial markets. For example, if using two different sets of underlying securities a derivative instrument can be created, then the derivative instrument total price must be similar or else there would exist an arbitrage opportunity. Lyons (2001) states that arbitrage is the instrument that is in line in ensuring the legitimacy of the LOP.

It is clear that if all the market contestants' on one hand post arbitrage-free tradable quotes in financial markets, then opportunities in arbitrage cannot be in existence. However, though the notion of no arbitrage is prospectively sensibly effective in a number of finance contexts, the damages can be streamlined severally. The nonexistence of opportunities in arbitrage simple terms contributes to the rise of the paradox arbitrage principally stated by Grossman and Stiglitz (1980). This research conclude that if one doesn't observe arbitrage where arbitrage opportunities arise, then participants in market may be limited in having enough incentives for the market observation. O'Hara (1995) says that a likely determination to this absurdity for short duration arbitrage opportunities welcome traders exploitation to them hence they are quickly transacted.

1.1.2 Financial Performance

Financial performance entails the magnitude in which objectives of the firm and in this case financial objectives were met or have been met (Yahaya & Lamidi, 2015). A company's financial performance is subject to how effectively a firm uses its assets from its principal role of conducting business and its subsequent generation of revenues. Financial performance can also refer to the general well-being of a firm as far as finance is concerned in a certain duration of time. Financial performance as well can be useful in gauging or measuring organizations from identical industry or across different industries for comparison purposes. Financial performance is, in summary, is a crucial objective that firms especially the profit oriented firms desire or aim at to achieve (Kajirwa, 2015).

Financial performance focuses more items that affect the financial statements or reports of a firm directly. The financial performance analysis can deal with items such as dividend growth, sales turnover, capital employed, asset base among others about the firm (Omondi & Muturi, 2013). The financial performance is a crucial indicator or measure of some economic units' success for example on achievement of set goals and objectives (Xu & Wanrapee, 2014). Firms stakeholders are mostly interested in the firm's performance as far as finance is concerned (Nyamita, 2014).

Financial performance in terms of measurement normally examines firms' financial ratios (which are derivative of financial statements). These ratios are liquidity, activity, profitability and debt ratios (Bouba, 2011). Financial outcome in performance can be measured from various perspectives including: solvency, profitability, and liquidity (Mwangi & Angima, 2016). Financial performance in a firm is weighed by using accounting-based measures which is calculated from firm's

financial statements such as Return on Equity (ROE), Return on Assets (ROA), and Gross profit margin (Mwangi & Murigu, 2015).

1.1.3 Triangular Arbitrage and Financial Performance

Efficient market hypothesis (EMH) is termed as a report reflecting fully all existing market information for security prices (Fama, 1965). In this market there is active competition between big amounts of rational and optimizers in profit with all working hard to bring about imminent prediction of market place values of different securities in which up-to-date information of at most importance is almost obtainable at will to all members. Grossman and Stigz (1980) emphasized that for complete efficiency to be realized the information should be ultimately zero and incrementally less expensive. The one price law concludes that undistinguishable product should be sold in similar prices in different markets (Baffes, 1999). However, it overlooks exemption of trade obstacles and transaction cost differentials. Assuming markets are efficient, then triangular arbitrage will not lead to an increase in financial performance.

It can be an effectual approach using triangular arbitrage to take profits when the conditions in market consent, and integrating it into one's playbook of strategies hence this might be boost probabilities for gains. Dealers, nevertheless, should be alert in regard to competition in-built in the market for forex that inclines to spot-on price discrepancies very promptly as they perform. The occurrence of such opportunities may results to fleeting even as short as seconds or milliseconds. As of this, somebody concerned in embracing an arbitrage approach will require to be having a scheme in place to screen the market thoroughly throughout lengthy times in order to possibly and potentially receipt advantage of this chances in advance before prices interchange to find equilibrium (Akram, 2005).

Short-term arbitrage prospects have not been able to be detected through empirical studies in a financial market that is a multiplicity one. This short-lived opportunities in arbitrage are sufficiently examined through on spot quotations across all prices of asset involvement in a given financial markets that have high activity level. However, obtaining such data is extremely challenging. Moreover, individual need to take into justification all pertinent features of the small formations in the marketplaces so as to seizure the prospects and operation expenses that the participants' encounters (Lyons, 2001).

1.1.4 Forex Market in Kenya

Foreign exchange transaction in the former periods required huge amounts of money to start and was only for the 'big boys', however in 1980 rules changed and individuals could trade forex profitability. During the year of liberalization in 1990, and in the middle 1992 the certificates for foreign exchange bearer were dispensed thus providing a noteworthy reprieve to the market in line to foreign exchange prices since ownership allowed the holder to a given level of foreign exchange reducing the challenges of the licensing practice that was elongated and delaying. Few handicaps were felt as liberalization progression of the foreign exchange market continued taking up shape. Toward the end of first quarter in 1993, Kenya was by then in a severe risk of a flight from the shilling as prices were progressively being referred to in dollars and there were uncertainty for those who were importing on trade credit since the calling of credit letters of the entitlement in terms of price to pay for foreign exchange.

Cash increase seasonally exerted additional burden on the domestic prices as it coincided with the 1992 elections. Instability in prices had stretched to a point that all liberalization in regards to financial measures were supposed to halt at the end of March 1993 in order to let time for working out more well-ordered process. A new strategy was put in to place the encompassed stepping up Treasury bill auctions weekly from KES 1 billion to KES 5 billion. Arbitrage correspond foreign exchange rates in the forex market out of having capability by enabling the transfer of foreign exchange from the lower exchange rate market to those having higher exchange rate market. Triangular arbitrage use fully inadequacy in the market where some market are hyped in terms of value and another one is belittled in value and this is realized by using variances in prices between exchange rates which are merely portions of a cent. In order for this arbitrage method to be cost-effective one is obligated to trade investment in large amount. After a thorough research in previous studies, would like the gap filled through using authentic statistics arising from the banks regulator in Kenya through displaying the consequence of triangular arbitrage gains on the performance of the forex market in Kenya.

1.2 Research Problem

Performance of the forex market depends on how fast the market adjusts to new information. Participants in one location of the market might be not be perfectly by having knowledge of purchases opportunities and undistinguishable selling of assets in different place noticing asset variation in prices in the market places from various places(Grossman & Stiglitz, 1980). Currency market is not efficient due to existence of arbitrage opportunities. If more players participated in the forex market the short term arbitrage opportunities would be exploited (Arnott& Pham, 1993).Muhoro

(2005) argued that carrying out locational arbitrage transaction could result to huge profit rather than the one made in both bureaus and banks.

The forex market has experienced rapid growth since it was first established and amount of operating bureaus have raised from 48 in 1998 to 149 as at December 2016. This rapid growth has to do with units in the market and also the volume of their trading. Despite the upsurge of commercial banks and foreign exchange bureaus in Kenya volatility of the exchange rate has increased. Thus, transaction and information costs have increased hence the liquidity of the foreign exchange markets has significantly declined. Commercial banks have also recorded abnormal profits from currency trade in Kenya and thus there is need to carry a study on the effect of triangular arbitrage on financial performance of forex market in Kenya.

Kurgat (1998) analyzed the spot markets efficiency using data from the foreign exchange bureaus in Kenya. The results were that significant arbitrage profits existed in this market consequently the market is inefficient. Ndunda (2002) studied the forward exchange markets efficiency in Kenya. She tested the forward unbiased hypothesis in the major foreign currency markets in Kenya. She found the forward rate is not unbiased predictor of the future spot rate. Kimani (2007) re-examined the effectiveness in forward market but focusing on irrational behavior of market participants. After performing a battery of tests on several major currencies against the Kenya shilling, she concluded that the forward exchange market is inefficient. She attributed this to the irrationality of key players in Kenya markets for the foreign exchange. The focus of Muhoro (2005) study was on triangular arbitrage using two key currencies - the US dollar and the Euro against the Kenya shilling, and a large

sample (57 bureaus). The results showed that the respective foreign exchange markets are inefficient due to the existence of significant arbitrage profits.

Sifunjo (2011) analyzed the efficiency of the KES/USD exchange rate. The study covered the period from January 1, 1994 to June 31, 2007. He focused on both the spot and forward markets. Applying a battery of tests, he concluded that the market is inefficient. The causes of inefficiency were irrational behavior of market participants and speculation in the market. Muga (2012) investigated whether arbitrage in exchange rate functioned spot market located in Mombasa. This research involved population of the functioning banks and forex bureaus in Mombasa in 2010. The findings showed that both triangular and locational arbitrage was in existent where spot market existed though statistics that is descriptive specified a relative deterioration against former findings resulting to all arithmetic means of comparative largely decreasing. Most researchers investigated the existence of opportunities in arbitrage of forex market but they did not research effects of the arbitrage on the financial performance of the forex market. Upon tallying, foreign exchange market has accomplished more vibrancy in Kenya as compared to 2012 when arbitrage opportunities study locally was prepared in the currency market. This gap in the research of the current study pursues to address by answering the research question: What is the effect of triangular arbitrage on the performance of forex market in Kenya?

1.3 Research Objectives

The objective of the study is to determine the effect of triangular arbitrage on the financial performance of the forex market in Kenya.

1.4 The Value of the Study

The finding of the study forms a future reference to researchers, scholars and students who may aspire to take out research on the same or correlated field. The study may also be helpful to scholars and researchers in identification of further areas of research on other related studies by highlighting related topics that require further research and reviewing the empirical literature to establish study gaps.

Findings in this study can be useful to the government and other policy making bodies as a recommendation in origination and policies development that are concerned with the economy sector. The central bank being the regulator benefits with the findings of this study as it was enlightened on the effects of triangular arbitrage in the progress of forex market in Kenya.

The study benefits participants in the foreign exchange market by advising them on whether or not they can take advantage of the inefficiency in the foreign exchange market to make arbitrage profits, this so because this research will determine if the arbitrage opportunities exist in the forex market and how the arbitrage opportunities affect performance of the forex market. It's also useful to traders and other market participants in knowing the performance of the forex market as a result of triangular arbitrage existence in the forex market, this is important because if triangular arbitrage has a positive impact on forex performance then it will act as a motivator to potential investors to invest more on the currency trading.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter presents the theoretical framework applied in the study and reviews previous studies done on triangular arbitrage and financial performance of forex market. It contains the theoretical review, determinants of firms' financial performance, empirical review, summary of literature review and conceptual framework.

2.2 Theoretical Review

This section highlights on the fundamental forex trading theories and how they inform on the proposed study. These theories include arbitrage pricing theory, law of one price theory and efficient market hypothesis theory.

2.2.1 Arbitrage Pricing Theory

Arbitrage pricing theory advanced by Ross (1976), argued that APT occurs when simultaneous trading of currencies in markets that are different is done aiming in taking advantage of differing prices. Ross argued that stock price on foreign exchange is undervalued has been equated to local exchange price, therefore a trader uses this difference to make profit from this without incurring any risk. He asserted that arbitrage opportunities need rapid identification and should involve low transaction costs because in highly competitive markets mispricing is quickly corrected.

The theory assumed that the investors of the forex market are risk averse utility maximizers although it is presumed not to prevail if there is no opportunity of

arbitrage. This theory predicts the relationship between the triangular arbitrage and the forex market performance through linear combination of many independent macroeconomic variables: interest rate, balance of payment and inflation rate. According to Azhar Bin Zakaria (2006) states that the APT model is used by arbitrageurs to gain yield by taking benefit of mispriced currency rates because the actual exchange rate will have a price which is different from the model prediction hypothetical currency rate. APT theory helps the arbitrageurs determine the overvalued and undervalued currencies and through this profit is gained. The theory is related to this study in that it explains the conditions necessary for triangular arbitrage to take place.

2.2.2 The Law of One Price Theory

The one price law argued that similar assets price should be the same in different markets if the transaction costs are taken into consideration. If the prices differ the arbitrageurs will stabilize the price by moving it toward equilibrium through buying in the market that are cheaper and selling in market of dealers to benefit from the arbitrage profits (Akram, Rime & Sarno, 2008). According to Parikh(2010),the LOP is based on assumptions that there aren't transactions costs association through trading of items/currencies in several markets hence assuming absence of mobility expenses related with the exportation and importation of goods in order for LOP to be valid.

According to Krugman and Obstfeld (2002) argues out that free conveyance costs and official barriers identical goods in competitive markets sold in different locations having their prices expressed in terms of the same currency need to sell for the same price. LOP theory doesn't always hold in practice because of the transaction costs

the different currency rates in the forex market. This theory is related to this study as it explains how triangular arbitrage is not feasible in an efficient market.

2.2.3 Efficient Market Hypothesis

Efficient market theory by Fama (1970), argued that in a market that is efficient, prices must reflect fully in entirety both significant and accessible information; thus exploiting all profit opportunities. The spot or forward exchange rates demonstrate all information having relevance if currency markets are efficient and they should not be able to forecast the spot or forward exchange rate as one another function. He asserted that in an efficient market, it's impossible for the participants or traders to use inside information, publicly available information or returns from financial assets to generate a trading rule that was at the market consistently over time. Diamandis(2007), examined the validity of the efficient market hypothesis and concluded that the efficient market hypothesis won't hold for certain markets, due to inaccurate information announced in the market leading to arbitrage opportunities which can be exploited by investors in the forex market. Forex market theories are relevant in this study as they explain the conditions necessary for triangular arbitrage to take place.

2.3 Determinants of Financial Performance

The performance of forex market can be influenced by either external or internal factors. External factors include; exchange rate volatility, Interest rates, Inflation, public debt, balance of payments among others. The internal factors include corporate governance, firm size, financial leverage, liquidity, management efficiency, capital, market power among others (Athanasoglou, Brissimis & Delis, 2005).

2.3.1 External Factors

The first external factor is exchange rate volatility, the demand and supply changes in the FOREX market currency results to fluctuations. This effect is caused by having more local currency to invest by foreign investors through getting more shillings for each dollar. Though, the effect in long term is anticipated to be undesirable as depreciation of local currency shows poor performance in economy. Barsky (2009) expounds the investors' risk prevalence in long term. The foreign investors request a risk premium for poor economic performance expectation while investors locally uphold more cautionary savings and shunning away assets that are risky. This reduces significantly the financial performance of the forex firms.

The second factor is inflation rate, inflation can be described as a continuous rise in the general price level of an economy's goods and services over a time period. The inflation effects can be both positive and negative (Biller, 2007). Thus during inflation the price of currency follow suit therefore inflations increase more likely cause a financial performance decrease of the forex market. Investors and traders in the forex market will factor therefore inflation into the selling prices.

The third factor is interest rate, it's a Monetary policy used to stimulate or stabilize the economy. From the perspective of the firm, borrowing money to finance working capital and/or for capital expenditure will drive up their cost of debt. This will likely hamper company profits and the dividends available for shareholders. As a result, it would be expected that the share price may drop. Higher interest rates reduce the present value of future dividend income, which should lower stock prices. From the investing side of things, high-yielding fixed income investments would tend to be more attractive and relatively safer to investors than equities (Barnor, 2014).

The fourth factor is public debt, Piet and Raman (1995) state that nations that participate in financing large-scale deficit to pay for projects in public sector and government domestic economy are less attractive to foreign and local investors leading to high inflation and thus loss in the value of local currency. A country's debt rating has impact on the exchange rate levels of that country as inflation is encouraged by large debt and on inflation been high, the debt was in future be serviced and ultimately paid off with cheaper real dollars . For the forex bureaus this would translate to low demand for their services and hence leading to low profitability.

The fifth factor is balance of payment ,Solnik (2000) states that the balance of payments approach for economic modeling of the exchange rate was the first approach used. This approach trails all of the financial flows through a certain period across borders country. All financial transactions are taken as credits and the final balance need to be zero. We have several types of international transactions which include: international trade, service payment, income receipt, direct foreign investment, portfolio investments, short term capital flow and long term capital flows and currency reserves sale by the central bank. A ratio equating import prices to export prices, the trade terms is related to current accounts and the balance of payments. If the country's export price increases by a higher rate as compared to that of its imports, its terms of trade will positively have to improve. Enlarging terms of trade directly demonstrates larger country's exports demand. This, results in rising revenues in turns from exports that offers better demand for the country's currency (and an increase in the currency's value). If there is rise by a smaller rate in the exports' price than that of its imports, the currency's value relative to its trading partners will decrease (Solnik 2000).

2.3.2 Internal Factors

The first factor is corporate governance, it is necessary for economies to develop efficient and forex market sectors and this need is particularly important in developing countries. Having recognized the need, many developing countries have initiated changes in the financial measures that aim at improving the efficiency of real forex markets. Corporate Governance is one of the institutional ways in which decision making in financial institutions is aligned with that of the best of their stakeholders (Arun & Turner, 2009).

In a study conducted in Bangladesh, Arun and Turner (2009) concluded that the entry of foreign firms in the banking industry enhance not only the competitive pressure but also introduce the relatively better functioning and more prudent governance mechanisms of western economies into developing economies. Therefore, policies regarding financial sector and corporate governance reform must ensure the participation of foreign firms as well as investors in the real estate sector.

The second factor is firm's size, the amount of assets owned by an organization determines its size (Amato & Burson, 2007). It is argued that large firms have adequate resources to undertake a number of large projects with better returns than firms with small amounts of total assets. In addition, firms with large amounts of total assets have adequate collateral which they can pledge to access credit and other debt facilities compared to their smaller counterparts (Njoroge, 2014). Lee (2009) established that the total assets controlled by a firm as measured by the total assets have an influence on the level of profitability recorded from one year to another.

The third factor is financial leverage the balance between debt and equity in financing firm operations has some level of influence on the level of returns on equity and Return on assets recorded in firms. As argued in the capital structure irrelevant theory, in perfect markets, it is assumed that there is perfect flow of information hence no room for arbitrage (Lee, 2009). This means that the net worthy of an organization is not affected in any way by the leverage.

However, in real world, taxes exist and affect the way organization operates in terms of their capital structure (Njoroge, 2014). Usage of debt comes with some agency costs like the existence of constraints put by the firm providing debt on how an organization is to run its affairs (Lee, 2009). This may bring about inflexibility in undertaking some projects even if they promise greater return on equity (Amato &Burson, 2007).

2.4 Empirical Review

Poole (1967) and Booth (1977) did an empirical study on the foreign exchange market efficiency, so they tested the null hypothesis under a regime of freely floating exchange rate. They concluded that there were several significant departures from the random behavior under floating exchange rates therefore the spot market was not efficient.

Poole (1967).Further analyzed the investment strategies that use filter rules as guides for picking speculative positions so as to take arbitrage opportunities benefit. A filter rule is a mathematical rule that can be applied mechanically in producing signals for buying and selling. An x per cent filter rule indicates that one to purchase a currency when it rises x per cent above its best latest trough and trade the currency whenever it

drops x percent lower to its most recent peak. This implied that the forex market is not efficient and participants of the market can take arbitrage opportunities advantage which exist in the market.

According to Pukthuanthong and Thomas (2008), they argued that from 2010-2015 period investment in the forex exchange market on major currencies didn't yield very good results compared to the early 1980's and 1990's where trading in the main currencies and their linked cross rates of exchange was very profitable, this implies that markets in years 2010-2015, are more efficient compared to past years although there is no a significant reason behind such behavior but one hypothesis in favor is that inefficiency is attributed to the early markets.

World Bank (2010) further added that the Kenya's foreign exchange market has attained more liveliness likened to 2006 as specifically shown by Mombasa, the previous year when arbitrage opportunities study locally was done in the currency market. Not only are there extra industry players but also the foreign currency volumes of trading have meaningfully increased.

Kristian Dukov and Eleni Kyriaki (2014) investigated by testing triangular arbitrage opportunities efficiency of the FX market into specific candidate currencies for 2011 and 2013. The major partakers of the study were divided into two groups either as the developed markets or the emerging ones. In one group JPY, CHF, GBP and AUD currencies were considered while in the in the other one HUF, CZK, PLN and TRY were studied in Euros and US dollars contrast correspondingly. The conclusions indicated arbitrage transpire into the FX market for all the triangular round trips and that arbitrage opportunities in emerging economies were much higher than in the developed economies.

Kurgat (1998) pointed out that foreign exchange in Kenyan market became alive in 1995 as a result of the Exchange Control Act repeal of licensing bureaus for foreign exchange. The foreign exchange bureaus introduction boosted the Kenya shilling convertibility in relative currencies from other countries. Spot markets empirical study of foreign exchange bureaus efficiency was done in Kenya where it stated that the Kenya's inefficiency in market for foreign exchange is brought by the arbitrage opportunities existence. He revealed chance was there to get returns which have no risk instantaneously by applying locational arbitrage. The analysis recognized inefficiency of the foreign exchange in Kenya markets.

Ndunda (2002) tested forward exchange rates in determining whether there are future financial transaction rates predictors in the market via model by Hansen and Hodrick (1980). She dedicated a lot to her study on the forex market prices as set by demand and supply law from October 1993 to December 2002 that is under foreign exchange market. The data used encompassed spot exchange rate weekly and the a quarter of an year forward exchange premium for the UK sterling pound, the US dollar, the Euro, the Swiss Franc and the Japanese Yen. Prediction regression faults in a particular rate of exchange was projected using a continuous two lagged errors through seven days statistics and a 13-week forward rate. The regression model tests used concluded that all the regression coefficients are equal to zero based on the joint hypothesis. The conclusions of the learning recognized strong evidence for backing hypothesis having simpler efficiency for not less than four out of five currencies. This proved inequality in rates used for foreign exchange since interest rates in the market is relatively high. Therefore the quoted current expectation for future rates having been higher than the financial transactional rates is assign that the current expectation for future rate is not

the best future spot rate predictor. She hence established that in Kenya, we have zero speculation due to inefficient foreign exchange market.

Muhoro (2005) did a comparable study of the same by use of locational arbitrage models and triangular arbitrage models. This was achieved by using already existing data in daily closing form in countering for foreign exchange rates in line graphs. This was aiming to find the possibility of an arbitrageur making proceeds by using this models. The verdicts recognized many cases of arbitrage opportunities happen in the market resulting to inefficiency of the FOREX market. Higher profits might be realized by completing transaction using a triangular arbitrage other than doing the transaction relying on locational arbitrage in trading market. This then proved currencies prices been inefficiently contrary to one another.

Mwangi and Duncan (2012) investigated the arbitrage opportunities existence in the Mombasa spot market. He concluded existence of arbitrage opportunities in the forex market resulting from the trade interplay between Kenyan Shilling, US Dollar and Euro. He concluded also that rarely traded currencies such as Australian Dollar, Japanese Yen and Canadian Dollar seems to create additional arbitrage opportunities meaning that they were priced relatively inefficiently. He said that analysis on arbitrage shows that cross rates shilling included generated many arbitrage opportunities hence attracting arbitrageurs.

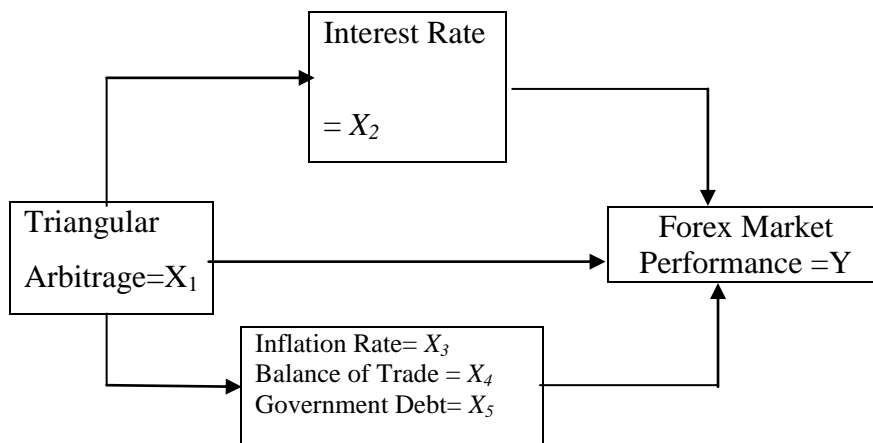
2.5 The Conceptual Framework of Study

This is the understanding of the relationship among conceptual different variables in a certain study. According to McGaghie (2001) he argued that the conceptual model sets the stage for the presentation of the particular research question that drives the

investigation being reported based on the problem statement. The problem statement of this research is: The effect of triangular arbitrage on the performance of the forex market in Kenya, The two main variables from the statement are, triangular arbitrage (Independent variable) and performance of forex market (Dependent variable).

Assuming other things are constant during the performance of the study, the below conceptual framework was used to show the effect of triangular arbitrage on the performance of the forex market. The independent variable is triangular arbitrage which was measured by interest rates, inflation rates, balance of payments and government debt. Forex market performance is the dependent variable which the study seeks to explain and it was measured by forex market performance in KES/USD.

2.1 The Conceptual Model



2.6 Summary of Literature Review

The forex market theories narrated in this study, that is, law of one price, purchasing power parity, balance of payment theory and efficient market hypothesis was analyzed and used in determining the outcome of triangular arbitrage of the forex market performance in Kenya. From the findings of the previous studies, it is apparent that there is a gap to fill. This is so because foreign exchange market efficiency was mostly carried out on local studies in Kenya, that is, Ndunda (2002), Kurgat (1998) and Muhoro (2005) they looked at efficiency from profitability basis of simple trading rules (arbitrage) and concluded that the market was not efficient due to existence of arbitrage opportunities. These studies didn't investigate how the arbitrage opportunities affect the performance of the forex market. This study filled this gap by looking at the outcome of triangular arbitrage on the performance of forex market in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

In this chapter the methodology used in delivering the study's objectives was addressed. This methodology will comprehensively discuss the data analysis method, methods of data collection, research design and the populations.

3.2 Research Design

Research design is defined as a blue print of those procedures, which are adopted by a researcher for finding out association of independent variables and dependent variables (Khan, 2008). Descriptive cross sectional design was adopted for the study. A descriptive study involves a description of all the elements of the population. It allows estimates of a part of a population that has these attributes. Cross-sectional study methods are done once and they represent summary at a given timeframe (Cooper & Schindler, 2008).

3.3 Target Population

Population refers to all observations of interest in an entire collection like people or events as described by a researcher (Burns & Burns, 2008). The population of the study will comprise of the 21 foreign currencies traded in Kenyan forex market from 1st January 2014 to 31st December 2016.

3.4 Sampling Design and Sample Size

The study will use systematic sampling method in selecting the most traded exchange rates in the forex to participate in the study for year 2014-2016. The researcher will select 3 currencies to participate in the study. The exchange rates were selected from the most traded exchange rate currencies in the FX market where the researcher will settle on US Dollar and the Euro against Kenya Shilling.

3.5 Data Collection

This research will involve secondary data collection from monthly Economic Reviews of the Central Bank of Kenya (CBK) and data from the Kenya National Bureau of Statistics (KNBS). The exchange rates for the various currencies to be used was the monthly averages, derived from taking the average of the daily rates for each month. All the exchange rates were expressed in Kenya Shillings (KES) per unit of foreign currency since this is the home currency. This research paper will employ actual data collected from CBK over a period of one month for year 2014, 2015 and 2016.

3.6 Diagnostics Test

Linearity show that two variables X and Y are related by a mathematical equation $Y=a+bX$ where a and b are constant numbers. The linearity test was obtained through the scatterplot testing or F-statistic in ANOVA. Stationarity test is a process where the statistical properties such as mean, variance and autocorrelation structure do not change with time. Stationarity was obtained from the run sequence plot. Normality is a test for the assumption that the residual of the response variable are normally distributed around the mean. This was determined by Shapiro-walk test or

Kolmogorov-Smirnov test. Autocorrelation is the measurement of the similarity between a certain time series and a lagged value of the same time series over successive time intervals. It was tested using Durbin-Watson statistic (Khan, 2008).

Multi collinearity is said to occur when there is a nearly exact or exact linear relation among two or more of the independent variables. This was tested by the determinant of the correlation matrices, which varies from zero to one. Orthogonal independent variable is an indication that the determinant is one while it is zero if there is a complete linear dependence between them and as it approaches to zero then the multi collinearity becomes more intense. Variance Inflation Factors (VIF) and tolerance levels will also be carried out to show the degree of multi collinearity (Burns & Burns, 2008).

3.7 Data Analysis

Data was analyzed using regression analysis, correlation and descriptive techniques on been uploaded into Statistical Package for Social Sciences (SPSS)(Borg and Gall 1989). The correlation coefficient from regression will show either negative or positive effect of the variables that are independent on the dependent ones. The importance of the association between the determinant factors and triangular arbitrage was shown by the t-tests. The relationships significance shall be tested at 95% confidence model. Regression analysis in statistics is used for finding out the relationships among variables using a statistical process. This process include various methods for evaluating a number of variables and modeling them, while emphasis is on the relationship of dependent variable with several independent variables.

3.7.1 Analytical Model

The below analytical model below was used in determining the triangular arbitrage impact on forex market performance. The model is synonymous with the multifactor APT model.

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 \dots \dots \dots \epsilon$$

Where :Y= Volatility and movements in KES/USD exchange rate; X_1 = Triangular arbitrage; X_2 = Interest rate; X_3 = Inflation Rate; X_4 = Balance of Payments; X_5 = Government Debt; α = Constant; β = Beta; ϵ = Error

Triangular arbitrage is computed using the cross rate formula as given by Shapiro (2009).

$$Y = f(\text{Currency A/KES}) * (\text{KES/Currency B})$$

Where” Y= Cross rate of Currency A to Currency B; Currency A/KES=Rate of exchanging one of currency A for a certain amount of the KES; KES/Currency B= Rate of exchanging one KES for a certain amount of currency B.

3.7.2 Test of Significance

The Pearson Correlation Analysis was used to analyze the significance of the data. Pearson correlation was used to test conceptual relationships between independent variable (effects of triangular arbitrage) and the dependent performance of the forex market. The relationship significance between the determinant factors and triangular arbitrage was shown using t-tests. The relationships significance shall be examined at 95% confidence level.

3.8 Chapter Summary

In summary, chapter three of the research focused on the research methodology. The chapter introduces the reader to the research methods considered for the completion of the research. In general, the APT model is considered to be of critical importance to the completion of the current research.

CHAPTER FOUR

DATA ANALYSIS, RESULTS, AND DISCUSSION OF FINDINGS

4.1 INTRODUCTION

Chapter four of the study focused on the analysis of data, presentation of results, and discussion of findings. This includes linking the findings of the available literature as presented in chapter two of the study. The chapter is organized into the three sections identified in the title of the chapter as well specific sections guided by the research objectives presented in chapter one of the research.

4.2 Results and Discussion of Findings

4.2.1 Test for Arbitrage Opportunities

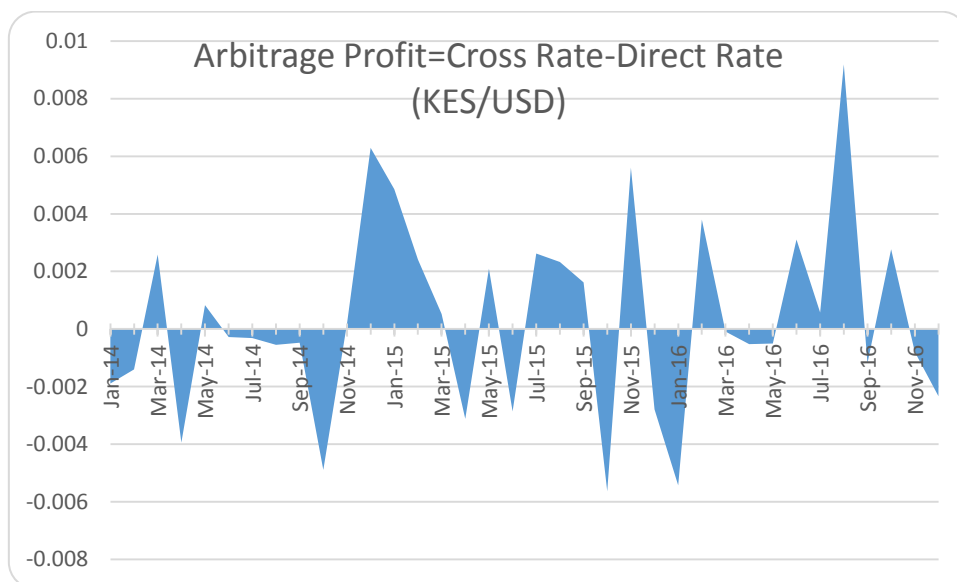
The first stage in the analysis of data was the test for arbitrage opportunities. The test focused on the conversion of Kenya Shillings (KES) to U.S. Dollar (USD) using both direct conversion and using cross rates. Direct conversion was considered as the direct purchase of USD using KES while the cross rate is considered as the purchase of EUR and then using the EUR to purchase the USD. The election to use both EUR and USD was informed first by the analytical model which requires only three currencies to compute a cross rate and hence test for arbitrage opportunities. Secondly, the election to use the two currencies was informed by the fact that they are the two most commonly traded currencies, in exchange for the home currency (KES).

The test for arbitrage opportunities was conducted using monthly data collected for the period between January 1, 2014 and December 31, 2016. The data was readily available both on Investing.com and on the website of Central Bank of Kenya. The

test was conducted by computing the cross rate before deducting the direct conversion rate hence revealing whether or not an investor would generate risk-free profit in the transactions. The data is as shown in appendix 1.

Using the data presented above, the analysis tested for arbitrage opportunities. The analysis revealed that there exists arbitrage opportunities in the forex markets such that an investor would make risk free profits by converting Kenya Shillings to Euro and then converting Euro to U.S. Dollar in place of converting directly from KES to USD. The importance of this finding informs the concern whether an investor would elect to use the cross rate instead of direct conversion in order to make a risk-free profit. Further, the finding is important in determining the level of market efficiency in Kenya’s forex markets. The findings of the analysis are as shown in figure 1 below.

Figure 1: Triangular Arbitrage Opportunities



From the chart in figure 1 above, the analysis of data indicate that the monthly cross rate for KES-EUR-USD has had various opportunities for risk-free profits. This is because the investor would make a risk-free profit by choosing to purchasing the euro

and then converting the euro to a U.S. dollar instead of converting the Kenya Shilling directly to dollars.

According to the law of one price, the exchange rate of Kenya shillings to one U.S dollar should be the same as the price of changing the Kenya shillings to one Euro then to One U.S dollar if the transaction costs are held constant in the two transactions. However, the analysis of data indicates that the law of one price does not hold in this instance thereby resulting in arbitrage opportunities.

The presence of arbitrage opportunities can be explained based on the efficient market hypothesis in which Eugene Fama (1976) posited that there are three levels of market efficiency. These levels include weak form market efficiency, semi-strong form efficiency, and strong form efficiency. Under strong form efficiency there is no information asymmetry hence no opportunity for an investor to make supernormal profits. Under semi-strong form efficiency some there is a level of information asymmetry whereby there is information not readily available in the market; that is insider information. This information can be used in making supernormal profits. Under the weak form efficiency there is a high level of information asymmetry leading to the existence of arbitrage opportunities. Historical information can be used to predict the future price levels of a financial security and at the same time be used in defining where arbitrage opportunities may exist.

From the analysis of data, Kenya's forex market is operating in the weak form market efficiency. Consequently, there is the existence of arbitrage opportunities allowing the investors make arbitrage profits by trading the USD, Euro, and KES. The weak form is the most preferred level of market efficiency wince it allows investors to make supernormal profits. However, the arbitrage opportunities should not be sustained for

long periods of time as the mispricing should be corrected by the market as soon as it is discovered and the investors start taking advantage of it. The observation that triangular arbitrage opportunities have been sustained for more than three years is an indication that there are other market inefficiencies in Kenya's forex markets.

4.2.2 Performance of Forex Markets in Kenya

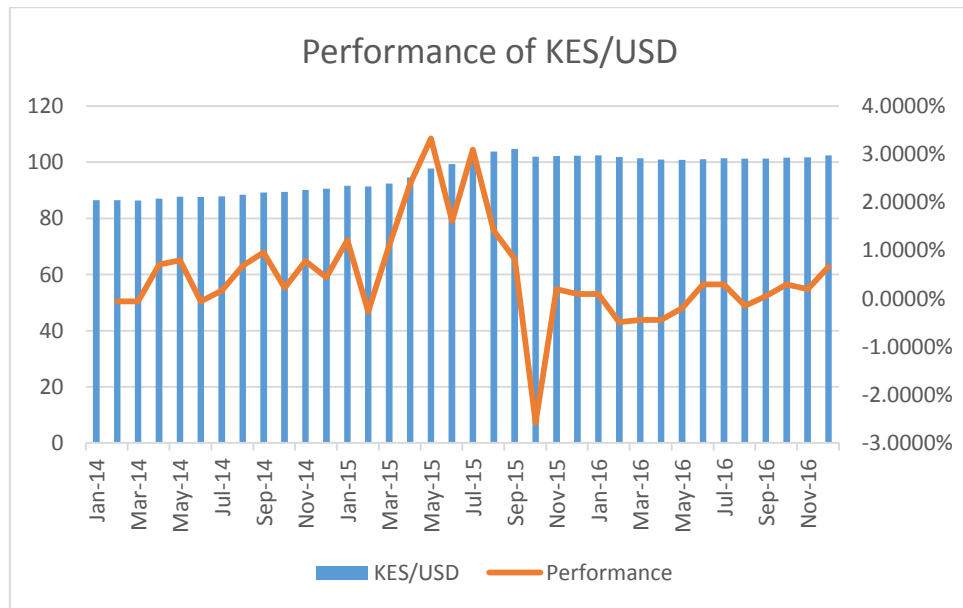
The study also focused on the performance of the forex markets in Kenya. This performance was considered as the appreciation or depreciation of the Kenya Shilling against the USD and the volatility in the exchange rate between the two currencies. The USD is the primary currency of valuing imports and exports in Kenya. Consequently, a snapshot of how this market is performing is always presented in the form of the exchange rate between the USD and the KES.

Performance of the forex markets in terms of the parameters spelt out above made use of data drawn from a period of 36 months starting January 2014 and ending in December of 2016. This data was readily available from the website of the Central Bank of Kenya as well as Investing.com. Notably, the CBK offers the indicative foreign exchange rates having factored in the economic environment and hence, this becomes the best indicator of the performance of the market. The data and computations on performance are as indicated in appendix 2.

From the analysis of the data, the research observed that that the KES has been depreciating against the USD for the period in consideration. In January 2014, the exchange rate closed at 86.5 while in December of 2016 the currency closed at 102.47 indicating the depreciation of the KES against the USD. Focusing on the volatility, the analysis of data indicated that the USD was more volatile in the period between

January 2014 and June 2015 as compared to the rest of the period where the market has been more stable. This is an indication of the movements in the macroeconomic variables. The findings are as presented in figure 2 below.

Figure 2: Performance of KES/USD



4.2.3 Effect of Triangular Arbitrage on Financial Performance of Forex Market

Having established the existence of triangular arbitrage in the three currencies and having studied the performance of the financial markets, the study focused on employing the arbitrage pricing theory multifactor model to the prediction of the performance of the financial market. This was important in order to help determine whether the existence of arbitrage opportunities in the market has significant impact on the direction of forex markets in Kenya.

The study elected to determine the impact of triangular arbitrage on both the exchange rate and on the volatility of the market on a monthly basis. In both cases, the APT multifactor model was employed. APT multifactor model is basically a multivariate

regression model that allows the investor to study the existence of arbitrage opportunities by using economic indicators. In this case, the economic indicators included interest rate, inflation rate, balance of payments, and fiscal deficit or public debt in addition to triangular arbitrage as computed above.

Beginning with the impact of triangular arbitrage on the absolute exchange rate between the KES and USD and using the APT model, the analysis found that an investor can actually predict the direction of the exchange rate by focusing on triangular arbitrage alongside the economic indicators identified in the paragraph above. This is because the results of regression analysis resulted in a predictive model as shown below.

$$Y = 60.34263 + 31.62X1 + 0.40X2 + 0.16X3 - 0.00001X4 + 0.0000194X5 + e$$

Where: X1=Triangular Arbitrage; X2=Interest Rate; X3=Inflation Rate; X4=Balance of Payments; X5=External Debt; E=Standard Error

With a P-value of 0.8286, the study revealed that triangular arbitrage has a major positive relationship with the direction of the KES/USD exchange rate. This indicates that an investor can predict the direction of exchange rate with near certainty if the triangular arbitrage is known. This is also embellished by the fact that triangular arbitrage bore the greatest weight in the APT model applied in the study. Summary statistics on the APT multifactor model as show in table 1 below.

Table 1: SUMMARY OUTPUT: Effect of Triangular Arbitrage on KES/USD Rate

SUMMARY OUTPUT: Effect of Triangular Arbitrage on KES/USD Rate									
<i>Regression Statistics</i>									
Multiple R	0.9293								
R Square	0.8635								
Adjusted R Square	0.8408								
Standard Error	2.6146								
Observations	36.000								
<i>ANOVA</i>									
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>				
Regression	5	1297.5380	259.5076	37.960	0.0000				
Residual	30	205.0893	6.8363						
Total	35	1502.6273							
		<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
	Intercept	60.3426	8.4013	7.1825	0.0000	43.1849	77.5004	43.1849	77.5004
Triangular Arbitrage	X1	31.6177	144.7329	0.2185	0.8286	263.966	327.201	263.9662	327.2017
Interest Rate	X2	0.4037	0.3468	1.1641	0.2536	-0.3046	1.1120	-0.3046	1.1120
Inflation Rate	X3	0.1587	0.6460	0.2457	0.8076	-1.1606	1.4780	-1.1606	1.4780
BOP	X4	0.0000	0.0000	-0.3514	0.7278	-0.0001	0.0000	-0.0001	0.0000
External Debt	X5	0.0000	0.0000	12.829	0.0000	0.0000	0.0000	0.0000	0.0000

The study also focused on the relationship between the volatility in the exchange rate and triangular arbitrage. The analysis resulted in a regression model in the form shown below.

$$Y = 0.0409 + 0.0809X1 - 0.0027X2 + 0.001X3 + 0.008X4 + 0.050X5 + e$$

Where: X1=Triangular Arbitrage; X2=Interest Rate; X3=Inflation Rate; X4=Change in Balance of Payments; X5=Change in External Debt; E=Standard Error

Like in the case above, the analysis revealed that it was possible to project the volatility in the KES/USD exchange rate, if the triangular arbitrage from the previous

period is known. This also revealed that triangular arbitrage had the single largest impact on the performance of the forex markets in Kenya, given the P-value of 0.89. The summary statistics from this analysis are as shown in table 2.

Table 2: SUMMARY OUTPUT: Effect of Triangular Arbitrage on KES/USD Rate

SUMMARY OUTPUT: Effect of Triangular Arbitrage on Volatility of KES/USD Rate									
<i>Regression Statistics</i>									
Multiple R	0.4243								
R Square	0.1800								
Adjusted R Square	0.0386								
Standard Error	0.0103								
Observations	35.0000								
<i>ANOVA</i>									
	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>Significance F</i>				
Regression	5	0.0007	0.0001	1.2733	0.3021				
Residual	29	0.0031	0.0001						
Total	34	0.0037							
		<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>	<i>Lower 95%</i>	<i>Upper 95%</i>	<i>Lower 95.0%</i>	<i>Upper 95.0%</i>
Triangular Arbitrage (X1)	Intercept	0.0409	0.0280	1.4593	0.1552	-0.0164	0.0982	-0.0164	0.0982
	X1	0.0809	0.5998	0.1348	0.8937	-1.1459	1.3076	-1.1459	1.3076
Interest Rate (X2)	X2	0.0027	0.0014	-2.0046	0.0544	-0.0055	0.0001	-0.0055	0.0001
Inflation rate (X3)	X3	0.0011	0.0025	0.4335	0.6678	-0.0041	0.0063	-0.0041	0.0063
Change in BOP	X4	0.0082	0.0074	1.1111	0.2757	-0.0069	0.0234	-0.0069	0.0234
Change in External Debt	X5	0.0507	0.0510	0.9952	0.3279	-0.0535	0.1550	-0.0535	0.1550

4.3 Chapter Summary

In summary, chapter four focused on the analysis of data, presentation of results, and discussion of findings. Three years of monthly data was considered in the analysis. The analysis indicates that there exists triangular arbitrage opportunities in the three currencies that include KES, USD, and EUR. The analysis also revealed that KES has depreciated against USD over the three years and that volatility in the first half of the period in analysis was higher than that in the second half. Further, the analysis revealed that if known, triangular arbitrage can be used in the projection of both the level of absolute KES/USD exchange rate and in the projection of the volatility of the exchange rate. The findings indicate that Kenya's forex market is operating under weak form efficiency hence the existence in the mispricing of financial securities and the resultant existence of arbitrage opportunities. Chapter five of the study focuses on the summary of findings, conclusions, and recommendations.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction to the Chapter

Chapter five is the last chapter of the current study. The chapter focuses on the presentation of a summary of the study, conclusions, and recommendations. The chapter is organized into the three sections identified in the title. In addition, the chapter includes a section of limitations of the study, which ought to be considered as areas of improvement in future research.

5.2 Summary

The objective of this study was to investigate the existence of triangular arbitrage in the forex market in Kenya and the effect thereof on the financial performance of the forex market in Kenya. In pursuing this objective the study intended to highlight three important areas. The first regards whether there exists arbitrage opportunities in the exchange rates of KES, USD, and EUR. Secondly, the study intended to measure the performance of the forex market in Kenya as indicated by the appreciation and depreciation of the KES against the USD. Thirdly, the study sought to project the effect of triangular arbitrage in the three currencies on the financial performance of the forex markets in Kenya.

A number of previous studies focused on the testing of triangular arbitrage in Kenya. From the literature review many authors have argued that short term triangular arbitrage opportunities exist in the forex market among the most traded currencies inviting traders to exploit them quickly hence eliminating mispricing in the forex market. Previous studies have been done concerning arbitrage opportunities in the

forex market, but they have not dealt with the impact of the arbitrage opportunities on the performance of the forex market, this research has filled the gap by determining the effect of the triangular arbitrage on the forex market performance.

In testing the effect of triangular arbitrage on the financial performance of forex markets the study employed the use of descriptive cross-sectional research in the study. Cross-sectional research focuses on the collection and analysis at a particular point in time and providing results that pertain to that particular moment in the economic environment. Secondary data was obtained from central bank of Kenya as the primary source of data. Some statistics were drawn from Invetsing.com. The data was characterized by monthly frequencies and covered a period of three years beginning from January 2014 and ending in December 2016.

Data was analyzed based on the arbitrage pricing theory multifactor model. The theory asserts that by studying the economic variables mainly affecting a particular financial security then it is possible to determine whether it is possible to predict the market and hence determine whether it is possible to obtain arbitrage profits in the market. The model included five factors that included triangular arbitrage (X1), interest rates (X2), inflation rates (X3), balance of payments (X4), and government public debt (X5). These are the factors considered to have the greatest impact on the USD/KES exchange rate.

Findings of the study confirmed the existence of triangular arbitrage in the forex market. This is particular to the case of KES, USD, and EUR which are the three most commonly traded securities in the country. The second major finding was on the performance of the forex markets and the Kenya shilling was observed to have depreciated against the USD over the period in consideration. In the first period the

exchange rate stood at 86 while in the last period the exchange rate stood at 102. The other major observation focused on the level of volatility which in the first half of the period of study was found to be lower than the volatility in the second half of the period of study. Lastly, the study revealed that the performance of the forex market in Kenya can be predicted using arbitrage pricing theory (APT) multifactor model if triangular arbitrage is known.

5.3 Conclusions

The study made a number of conclusions based on the results and findings of data analysis. Firstly, the study concluded that here exists short-term arbitrage opportunities in the forex markets. Consequently, an investor would make risk-free profits by trading the cross rate of the KES-EUR-USD instead of converting directly from KES to USD. The findings confound the observations of previous researchers who recorded similar findings.

The study also concluded that the forex market in Kenya is currently operating under weak form efficiency. The conclusion was based on the observation of arbitrage opportunities in the market and the confirmation of the fact that it is possible to predict the future returns in trading KES/USD. The weak form efficiency is consistent with Eugene Fama's efficient market hypothesis which underscores the impact of information asymmetry in the weak form efficiency markets. The conclusion is based on the view that in all the transactions the transaction costs are kept constant.

The study also concluded that if the triangular arbitrage is known and so long as the triangular arbitrage exists, then it is possible to project the returns and exchange rate for the KES/USD exchange rate. The observations are important to the current study

and future research as the can focus on how long the triangular arbitrage persists against the law of one price.

5.4 Recommendations

The study proposes a number of recommendations based on the findings of data analysis. First is a recommendation for further research. Future research should focus not only on measuring triangular arbitrage among the three currencies. Rather, it should also focus on determining the causes of the arbitrage opportunities in Kenya's forex markets. One area of consideration would a study testing weak form efficiency in the forex market. Another option would be conducting a study of the transaction costs in the forex markets in Kenya and how they influence the arbitrage opportunities and the ability to take advantage of such opportunities.

The other recommendation focuses on policy development. The findings of the current study would be important in influencing policies touching on the foreign exchange markets in Kenya. The analysis of data revealed the lack of strict policies and regulations guiding the practice in trading of currencies in the country. The analysis considers this to be one of the reasons for the recording of arbitrage opportunities in the markets.

The third recommendation focuses on the traders and investors. The study recommends that traders should take advantage of the arbitrage opportunities in the market. This would enable them to enjoy risk-free profits in the short-run and reduce mispricing in the long-run.

The study also recommends the decentralization of information in the forex market in Kenya. Increased information dispensation would result in increased market

efficiency thereby ridding the market of the weak form efficiency tag. Increased market efficiency would result in reduced volatility in Kenya's forex markets.

Lastly, the study recommends the application of the findings of this study in informing Kenya's policy on public debt by the Treasury. The rationale in this argument is that the government through the Treasury has engaged in external borrowing and this has had an impact on the forex markets and the existence of triangular arbitrage.

5.5 Limitations of the Study

The study's scope was limited to the study of triangular arbitrage and its impact on financial performance of the forex markets in Kenya. The study recommends the delimitation of scope in explaining this relationship for all future studies focusing on the same area of study.

The study was limited to the study of only three currencies which include KES, USD, and EUR based on the model for computing cross rates. Delimitation in this perspective would include studying different sets of currencies preferably including Tanzania Shilling, Uganda Shilling, and South African Rand among other major currencies.

The study focused only three years of data based on the understanding that arbitrage opportunities only exist in the short-run. However, the study revealed that arbitrage opportunities existed throughout the period of study. Delimitation of this study should focus on long-term data spreading between five and ten years.

The study was limited to the study of triangular arbitrage but did not include transaction costs. Data for transaction costs was not readily available. Delimitation of this study would include factoring in the transaction costs and testing for arbitrage opportunities.

The study was limited to triangular arbitrage. However, there are other forms of arbitrage including locational arbitrage. Delimitation of this factor would require considering other arbitrage opportunities.

REFERENCES

- Aiba, Y., Hatano, N., Takayasu, H., Marumo, K., & Shimizu, T. (2002). Triangular arbitrage as an interaction among foreign exchange rates, *PhysicaA* 310(3-4) 467–479.
- Akram, F., Rime, D., & Sarno, L. (2008). *Does the law of one price hold in international financial markets: Evidence from Tick Data*. Research department. Oslo, Norway: Norges Bank.
- Amato, L. & Burson, T. (2007). The effects of firm size on profit rates in the financial service, *Journal of Economic and Economic Research*, 8(1), 61- 81.
- Aroskar, R., Sarkar, S.K., & Swanson, P.E., (2004). European foreign exchange market efficiency: Evidence based on crisis and non-crisis periods. *International Review of Financial Analysis*, 13(3), 333-347.
- Barnor, C. (2014). *The Effect of macroeconomic variables on stock market returns in Ghana (2000-2013)*. Unpublished Project, Walden University. Available at <http://scholarworks.waldenu.edu/dissertations>.
- Bouba, I. (2011). *Financial performance measurement of manufacturing small and medium enterprises in Pretoria: A multiple exploratory case study*. Unpublished Project, University Of South Africa.
- Cooper, R., & Schindler, S. (2008). *Business research methods*. New York: McGrawhill.

- Fama, E F., & French R. K. (1988). Permanent and temporary components of stock prices. *Journal of Political Economy*(98),247-273.
- Fama, E. F., & Blume, M. E. (1966). Filter rules and stock-market trading. *The journal of Business*, 39.
- Fama, E. F., (1984). Forward and spot exchange rates. *Journal of Monetary Economics*,14 (3),319-338.
- Fama, E.F. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, 25(2), 383–417.
- Fama, E.F. (1991). Efficient capital markets: II. The *Journal of Finance*, 46(5), 1575-1617.
- Farroq, A., Dagfinn, R., & Luciosa, M. (2006). Arbitrage in the foreign exchange Foreign exchange markets. *Journal of Multinational Financial Management*.
- Frommel, M. (2006). Volatility regimes in central and eastern european countries' Exchange rates. *Czech Journal of Economics and Finance*, (60), 2010.
- Galati, D. (1978). Empirical tests of boundary conditions for CBOE Options. *Journal of Financial Economics* (6), 187-211.
- Galati, G., & Bank for International Settlements. (2000). *Trading volumes, volatility and spreads in foreign exchange markets: Evidence from emerging market countries*. Basel: Bank for International Settlements, Monetary and Economic Department.

- Grossman, S. J., & Stiglitz, J. E. (1980). On the impossibility of informationally efficient Markets. *American Economic Review* (70), 393 – 407.
- Eun, C. S., & Resnick, B. G. (2004). International financial management. Boston. *Journal of Portfolio Management*, 37, (2), 118-128.
- Kajirwa, H. I. (2015). Effects of debt on firm performance: A survey of commercial banks listed on Nairobi Securities Exchange. *Global Journal of Advanced Research*, 2(6), 1025-1029.
- Khan, J. A. (2008). *Research Methodology*. New Delhi. APH Publishing Corporation.
- Kimani, S.W. (2007). *Efficiency of foreign exchange market in Kenya*, Unpublished MBA Project, University of Nairobi.
- Kollias, C., & Metaxas, K. (2001). How efficient are FX markets? Empirical evidence of arbitrage opportunities using high-frequency data, Applied financial economics. *Journal of Emerging Market Finance*(11), 435-444.
- Kurgat, P. (1998). *An empirical study of spot market efficiency of Kenya's foreign exchange bureaus*, Unpublished MBA Project, University of Nairobi.
- Lee, J (2009). Does the size matter in firm performance? Evidence from US public firms, *Internal Journal of the Economic of Business*, 16(2), 199- 203.
- Lyons, R.K. (2001). *The Microstructure Approach to Exchange Rates*. Cambridge, USA: MIT Press.

- Mamabolo, D. (2012). *Research design and methodology*. Published by Longhorn publishers, Nairobi Kenya, 12, (56 –78).market: Turning on the Microscope. *A research report from the Swedish institute for financial research* (42).
- Mugenda, O. M. &Mugenda, A. G. (2003).*Research methods: Qualitative and quantitative approaches*. Nairobi acts press.
- Muhoro, J. (2005). *Determining the efficiency of the foreign exchange market in Kenya*.Unpublished MBA research project, University of Nairobi.
- Mwangi, C., & Duncan, M. (2012).An investigation into the existence of exchange rate arbitrage in the Mombasa spot market.*International Journal of Humanities and Social Science* (1 – 15).
- Mwangi, M.,&Angima, C. (2016). Actuarial risk management practices and financial performance of property and casualty insurance firms: Identification of a Moderating Variable. *International Journal of Humanities and Social Science*, 6(2), 126 – 132.
- Mwangi, M. &Murigu, J. (2015).The determinants of financial performance in general insurance companies in Kenya.*European Scientific Journal*, 11(1), 288 – 297.
- Ndunda, F., (2002).*Forward exchange rates as predictors of the future spot rates*, Unpublished MBA Project, University of Nairobi.
- Njoroge, A. (2014). *Relationship between capital structure and financial performance*. An Unpublished Masters Project from the University of Nairobi.

- Nyamita, M. O. (2014). *Factors influencing debt financing and its effects on financial performance of state corporations in Kenya*. Doctorate Thesis. Durban University of Technology.
- Omondi, O. M. & Muturi, W. (2013). Factors affecting the financial performance of listed companies at the Nairobi Securities Exchange in Kenya. *Research Journal of Finance and Accounting*, 4 (15), 99 – 104.
- Pukthuanthong, K., Thomas III, Lee R., & Institute CFA (2008). Weak-form efficiency in currency markets. *Financial Analysts Journal*, 64(3), 2008.
- Ross, K. (2012). Sample design for educative research survey. UNESCO International Institute of Educational Learning.
- Ryee, S. G. & Chang, R. P. (1992). Intra-day arbitrage opportunities in foreign exchange and Euro currency markets. *Journal of Finance*, (47), 363-379.
- Ryoo, H. H. (2006). Arbitrage opportunities in foreign exchange market, *Unpublished manuscript*. Economic and Finance Department La Frobe University.
- Sanford J and Joseph E (1980): *On the impossibility of informational efficient markets*, NBER Reprints 0121. National Bureau of Economic Research, inc.
- Shanken, J. (1982). The arbitrage pricing theory: Is it testable. *The Journal of Finance*, 1129 - 1140.
- Shapiro, A. (2010). *Multinational financial management*. New York: Wiley.

- Sifunjo, K. (2011). *Chaos and nonlinear dynamical approaches to predicting exchange rates in Kenya, Unpublished PhD Thesis*, School of Business, University of Nairobi.
- Takatoshi, I., Kenta, Y., Misako, T., & Hideki, T. (2012). *Free lunch: Arbitrage opportunities in foreign exchange*. Massachusetts: National Bureau of Economic Research.
- WeKESa, T. (2006). *A survey of arbitrage opportunities in the foreign exchange market: The case of forex bureaus. Unpublished MBA research project*, University of Nairobi.
- Wickremasinghe, B.G. & Kim, H.J. (2014). *Weak-form efficiency of foreign exchange markets of developing economies: Some Sri Lankan evidence*.
- Wickremasinghe, B.G. (2004). *Efficiency of foreign exchange markets: A developing country perspective*. Monash University. *Faculty of business and economics, Asian business and economics research unit, & Wickremasinghe*.
- World Bank, (2010 december). *Kenya economic update*. The World bank.
- World Bank, (2012 january). *Kenya economic update*. The world bank.
- World Bank Doing Business Report, (2016). *Annual Report*.
- Xu, M. & Wanrapee, B. (2014). *Factors affecting financial performance of firms listed on Shanghai Stock Exchange*. University of Thailand.

Yahaya, O. A.&Lamidi, Y. (2015). Empirical examination of the financial performance of islamic banking in Nigeria: A Case Study Approach. *International Journal of Accounting Research*, 2(7), 1 – 13.

Yassini, B. S. (2010). An analysis of ‘Triangle ordering’ in foreign exchange market (Forex) simultaneous ordering of three major currency pairs.*International Journal of Financial Accounting Economic Studies*, 1(2), 413-424.

APPENDICES

Appendix 1: Analysis of Arbitrage Opportunities

Analysis for Arbitrage Opportunities

Date	KES/USD	KES/EUR	EUR/USD	CROSS RATE (KES-EUR-USD)	Arbitrage Profit=Cross Rate-Direct Rate (KES/USD)
Dec-16	102.47	107.755	1.0516	102.4677	-0.00233
Nov-16	101.8	107.785	1.0588	101.7992	-0.00079
Oct-16	101.6	111.57	1.0981	101.6028	0.002768
Sep-16	101.3	113.87	1.1241	101.2988	-0.00118
Aug-16	101.25	112.985	1.1158	101.2592	0.009186
Jul-16	101.4	113.305	1.1174	101.4006	0.000573
Jun-16	101.1	112.275	1.1105	101.1031	0.003107
May-16	100.8	112.21	1.1132	100.7995	-0.0005
Apr-16	101	115.705	1.1456	100.9995	-0.00052
Mar-16	101.45	115.45	1.138	101.4499	-8.8E-05
Feb-16	101.9	110.8	1.0873	101.9038	0.003798
Jan-16	102.4	110.965	1.0837	102.3946	-0.00543
Dec-15	102.3	111.105	1.0861	102.2972	-0.00279
Nov-15	102.2	107.97	1.0564	102.2056	0.005604
Oct-15	102	112.255	1.1006	101.9944	-0.00563
Sep-15	104.7	117.025	1.1177	104.7016	0.001619
Aug-15	103.85	116.46	1.1214	103.8523	0.002327
Jul-15	102.4	112.52	1.0988	102.4026	0.002621
Jun-15	99.325	110.625	1.1138	99.32214	-0.00286
May-15	97.75	107.41	1.0988	97.75209	0.002093
Apr-15	94.6	106.185	1.1225	94.59688	-0.00312
Mar-15	92.4	99.155	1.0731	92.40052	0.000522
Feb-15	91.4	102.325	1.1195	91.40241	0.002412
Jan-15	91.65	103.46	1.1288	91.65485	0.004855
Dec-14	90.55	109.555	1.2098	90.55629	0.00629
Nov-14	90.15	112.255	1.2452	90.15018	0.000177
Oct-14	89.45	112.03	1.2525	89.44511	-0.00489
Sep-14	89.25	112.74	1.2632	89.24953	-0.00047
Aug-14	88.4	116.095	1.3133	88.39945	-0.00055
Jul-14	87.8	117.555	1.3389	87.79969	-0.00031
Jun-14	87.65	120.01	1.3692	87.64972	-0.00028
May-14	87.7	119.545	1.3631	87.70083	0.000829
Apr-14	87.01	120.66	1.3868	87.00606	-0.00394
Mar-14	86.4	118.985	1.3771	86.40259	0.002585
Feb-14	86.45	119.325	1.3803	86.4486	-0.0014
Jan-14	86.5	116.66	1.3487	86.49811	-0.00189

Appendix 2: Performance of KES/USD

Appendix 2:Performance of KES/USD

Performance of KES/USD

Date	KES/USD	Performance
Jan-14	86.5	
Feb-14	86.45	-0.0578%
Mar-14	86.4	-0.0578%
Apr-14	87.01	0.7060%
May-14	87.7	0.7930%
Jun-14	87.65	-0.0570%
Jul-14	87.8	0.1711%
Aug-14	88.4	0.6834%
Sep-14	89.25	0.9615%
Oct-14	89.45	0.2241%
Nov-14	90.15	0.7826%
Dec-14	90.55	0.4437%
Jan-15	91.65	1.2148%
Feb-15	91.4	-0.2728%
Mar-15	92.4	1.0941%
Apr-15	94.6	2.3810%
May-15	97.75	3.3298%
Jun-15	99.325	1.6113%
Jul-15	102.4	3.0959%
Aug-15	103.85	1.4160%
Sep-15	104.7	0.8185%
Oct-15	102	-2.5788%
Nov-15	102.2	0.1961%
Dec-15	102.3	0.0978%
Jan-16	102.4	0.0978%
Feb-16	101.9	-0.4883%
Mar-16	101.45	-0.4416%
Apr-16	101	-0.4436%
May-16	100.8	-0.1980%
Jun-16	101.1	0.2976%
Jul-16	101.4	0.2967%
Aug-16	101.25	-0.1479%
Sep-16	101.3	0.0494%
Oct-16	101.6	0.2962%
Nov-16	101.8	0.1969%
Dec-16	102.47	0.6582%

Appendix 3: Dataset used in Predicting Performance

Predicting the Exchange Rate KES/USD							
Date	KES/USD	Performance (Y)	Triangular Arbitrage (X1)	Interest Rate (X2)	Inflation rate (X3)	BOP (X4)	External Debt (X5)
	Y		X1	X2	X3	X4	X5
Jan-14	86.5		-0.00233	17.03	7.21	(87,053.98)	920,500.71
Feb-14	86.45	-0.0578%	-0.00079	17.06	6.86	(64,424.44)	937,328.35
Mar-14	86.4	-0.0578%	0.002768	16.91	6.27	(59,157.56)	940,402.99
Apr-14	87.01	0.7060%	-0.00118	16.7	6.41	(90,289.20)	950,981.15
May-14	87.7	0.7930%	0.009186	16.97	7.30	(102,611.63)	957,893.23
Jun-14	87.65	-0.0570%	0.000573	16.36	7.39	(69,529.95)	1,085,928.57
Jul-14	87.8	0.1711%	0.003107	16.91	7.67	(105,738.50)	1,089,655.77
Aug-14	88.4	0.6834%	-0.0005	16.26	8.36	(100,000.72)	1,090,984.32
Sep-14	89.25	0.9615%	-0.00052	16.04	6.60	(119,462.74)	1,087,827.67
Oct-14	89.45	0.2241%	-8.8E-05	16	6.43	(113,262.07)	1,088,832.15
Nov-14	90.15	0.7826%	0.003798	15.94	6.09	(78,706.79)	1,088,951.54
Dec-14	90.55	0.4437%	-0.00543	15.99	6.02	(97,025.61)	1,170,696.28
Jan-15	91.65	1.2148%	-0.00279	15.93	5.53	(86,484.43)	1,163,350.79
Feb-15	91.4	-0.2728%	0.005604	15.47	5.61	(70,497.51)	1,296,748.46
Mar-15	92.4	1.0941%	-0.00563	15.46	6.31	(67,155.56)	1,278,107.87
Apr-15	94.6	2.3810%	0.001619	15.4	7.08	(89,961.29)	1,326,835.19
May-15	97.75	3.3298%	0.002327	15.26	6.87	(98,073.38)	1,381,156.98
Jun-15	99.325	1.6113%	0.002621	16.06	7.03	(80,638.12)	1,408,613.59
Jul-15	102.4	3.0959%	-0.00286	15.75	6.62	(84,747.99)	1,473,143.70
Aug-15	103.85	1.4160%	0.002093	15.68	5.84	(70,620.75)	1,530,678.61
Sep-15	104.7	0.8185%	-0.00312	16.82	5.97	(88,802.51)	1,550,232.74
Oct-15	102	-2.5788%	0.000522	16.58	6.72	(74,513.20)	1,490,713.76
Nov-15	102.2	0.1961%	0.002412	17.16	7.32	(114,283.34)	1,562,515.56
Dec-15	102.3	0.0978%	0.004855	18.3	8.01	(73,552.32)	1,615,184.20
Jan-16	102.4	0.0978%	0.00629	18	7.78	(58,459.59)	1,654,744.49
Feb-16	101.9	-0.4883%	0.000177	17.91	7.09	(49,073.67)	1,646,555.21
Mar-16	101.45	-0.4416%	-0.00489	17.87	6.45	(60,391.09)	1,665,578.04
Apr-16	101	-0.4436%	-0.00047	18.04	5.27	(78,318.83)	1,685,269.16
May-16	100.8	-0.1980%	-0.00055	18.22	5.00	(66,288.77)	1,680,631.83

Jun-16	101.1	0.2976%	-0.00031	18.18	5.80	(79,104.30)	1,803,256.30
Jul-16	101.4	0.2967%	-0.00028	18.1	6.39	(69,274.54)	1,797,696.38
Aug-16	101.25	-0.1479%	0.000829	17.66	6.26	(85,972.51)	1,803,260.48
Sep-16	101.3	0.0494%	-0.00394	13.86	6.34	(78,222.84)	1,849,019.87
Oct-16	101.6	0.2962%	0.002585	13.73	6.47	(73,088.41)	1,844,474.96
Nov-16	101.8	0.1969%	-0.0014	13.67	6.68	(79,842.69)	1,834,914.33
Dec-16	102.47	0.6582%	-0.00189	13.66	6.35	(76,470.31)	1,896,443.05
			0.012377				
	Highest:106.700						

Appendix 4: Dataset used in predicting performance (volatility)

Predicting Variability in KES/USD							
Date	KES/USD	Performance (Y)	Triangular Arbitrage (X1)	Interest Rate (X2)	Inflation rate (X3)	Change in BOP	Change in External Debt
			X1	X2	X3	X4	X5
Jan-14	86.5	Y					
Feb-14	86.45	-0.0578%	-0.0007934	17.06	6.86	(0.26)	0.02
Mar-14	86.4	-0.0578%	0.0027684	16.91	6.27	(0.08)	0.00
Apr-14	87.01	0.7060%	-0.0011832	16.7	6.41	0.53	0.01
May-14	87.7	0.7930%	0.0091862	16.97	7.30	0.14	0.01
Jun-14	87.65	-0.0570%	0.0005728	16.36	7.39	(0.32)	0.13
Jul-14	87.8	0.1711%	0.0031067	16.91	7.67	0.52	0.00
Aug-14	88.4	0.6834%	-0.0005031	16.26	8.36	(0.05)	0.00
Sep-14	89.25	0.9615%	-0.0005237	16.04	6.60	0.19	(0.00)
Oct-14	89.45	0.2241%	-8.787E-05	16	6.43	(0.05)	0.00
Nov-14	90.15	0.7826%	0.0037984	15.94	6.09	(0.31)	0.00
Dec-14	90.55	0.4437%	-0.0054259	15.99	6.02	0.23	0.08
Jan-15	91.65	1.2148%	-0.0027898	15.93	5.53	(0.11)	(0.01)
Feb-15	91.4	-0.2728%	0.0056039	15.47	5.61	(0.18)	0.11
Mar-15	92.4	1.0941%	-0.0056333	15.46	6.31	(0.05)	(0.01)
Apr-15	94.6	2.3810%	0.0016194	15.4	7.08	0.34	0.04
May-15	97.75	3.3298%	0.0023274	15.26	6.87	0.09	0.04
Jun-15	99.32						
Jul-15	102.4	1.6113%	0.002621	16.06	7.03	(0.18)	0.02
Aug-15	103.8	3.0959%	-0.0028596	15.75	6.62	0.05	0.05
Sep-15	104.7	1.4160%	0.0020932	15.68	5.84	(0.17)	0.04
Oct-15	102	0.8185%	-0.003118	16.82	5.97	0.26	0.01
Nov-15	102	-2.5788%	0.0005219	16.58	6.72	(0.16)	(0.04)
Dec-15	102.2	0.1961%	0.0024118	17.16	7.32	0.53	0.05
Jan-16	102.3	0.0978%	0.0048547	18.3	8.01	(0.36)	0.03
Feb-16	102.4	0.0978%	0.0062903	18	7.78	(0.21)	0.02
Mar-16	101.9	-0.4883%	0.0001767	17.91	7.09	(0.16)	(0.00)
Apr-16	101.4						
May-16	101.5	-0.4416%	-0.0048902	17.87	6.45	0.23	0.01
Jun-16	101	-0.4436%	-0.000475	18.04	5.27	0.30	0.01
Jul-16	100.8	-0.1980%	-0.0005482	18.22	5.00	(0.15)	(0.00)
Aug-16	101.1	0.2976%	-0.0003137	18.18	5.80	0.19	0.07
Sep-16	101.4	0.2967%	-0.0002775	18.1	6.39	(0.12)	(0.00)
Oct-16	101.2						
Nov-16	101.5						
Dec-16	101.5						
Jan-17	101.5	-0.1479%	0.000829	17.66	6.26	0.24	0.00

Sep-16	101.3	0.0494%	-0.0039429	13.86	6.34	(0.09)	0.03
Oct-16	101.6	0.2962%	0.0025851	13.73	6.47	(0.07)	(0.00)
Nov-16	101.8 102.4	0.1969%	-0.0014019	13.67	6.68	0.09	(0.01)
Dec-16	7	0.6582%	-0.0018907 0.0123774	13.66	6.35	(0.04)	0.03
Highest:106.700							