VALUATION OF CURRENCY OPTIONS WITH STOCHASTIC VOLATILITY

BY

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Declaration

I declare that this project is my original work and has not been presented for an award of a degree in any other University.
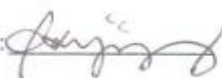
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DEDICATION

This research paper is dedicated to my parents Mr. and Mrs. Ositu who have inspired me to be the best I can be and to my siblings Oscar and Steve.

ACKNOWLEDGEMENT

First and foremost I would like to thank the Almighty God for according me the opportunity to enroll for this program and for taking me through all the difficult times. It's through His Grace and Mercy that I have come this far. To my parents (Mr. and Mrs. Ositu) and my siblings for their support through prayers, encouragement and advice. They believed in me and have been with me through it all. I thank my supervisors Dr Mwaniki for taking his time out of his busy schedule to guide me through the research.

Lastly, I thank my colleagues for their support and encouragement.

Without you all, I might never have been able to make it this far. I appreciate you all.

ABSTRACT

Currency options have gained acceptance as invaluable tools in managing foreign exchange risk. They are extensively used and bring a much wider range of hedging alternatives as a result of their unique nature. Options are fundamentally different from forward contracts, as whereas the parties are committed or 'locked-in' to a future transaction in a forward contract, the buyer (holder) of an option contract has the right, but not the obligation to complete the transaction at some time in the future. Options are attractive financial instruments to portfolio managers and corporate treasuries because of this flexibility.

This research study sought to show how foreign currency options can be valued in Kenya under stochastic volatility and also to come up with a model for predicting variance and volatility of exchange rates. The study focuses on developing a model for predicting variance based on the USD and Kenya Shillings exchange rates in Kenya for a period of five years between 2008-2012 and show how foreign currency options would be priced from the available data. This research used descriptive research design and the Garman Kohlhagen model for valuation of foreign currency options. The research uses Garch (1, 1) model to fit the variance regression line which was used to predict variance and subsequently the volatility that together with other variables is plugged into the Garman Kohlhagen model to price the foreign currency options.

The research gave findings that were consistent with research done in the area of valuation of foreign currency options. The research shows that foreign currency options can be valued in Kenya by use of a Garch $(1, 1)$ framework which was a good fit for the actual data as the coefficients of the model were within the model constraints of $(\beta + \alpha = 0.9765\ ) < 1$ for using Garch (1, 1) .The research found out that for call options when the spot exchange rate is below the strike price the option has statistically zero value and when above strike price the option has a positive value. On the other hand the price of a put currency option is positive when the spot exchange rate is below the strike price and statistically zero when the spot exchange rates are above the strike prices and the further away from the strike price the spot exchange rate is the higher the value of the option.

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ABBREVIATIONS

ATM……………….. At-the-money

ARCH……………….Auto Regressive Conditional Heteroscedasticity

BA-W……………….. BaroneAdesi Whaley Model.

B-S…………………..Black Scholes Model.

CMA………………...Capital Markets Authority.

GARCH…………….Generalized Autoregressive Conditional Heteroscedasticity

GBP………………….Great Britain Pound

ITM…………….. …..In-the-money

JPY………………….Japanese Yen.

NSE…………………Nairobi Securities Exchange.

OTC…………………Over the Counter.

OTM………………… Out-the-money

PHLX ……………….Philadelphia Stock Exchange

REITS……………….Real Estate Investments Trusts.

USD…………………United States Dollar.

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Currency options are derivative financial instrument where there is an agreement between two parties that gives the purchaser the right, but not the obligation, to exchange a given amount of one currency for another, at a specified rate, on an agreed date in the future, . For this right, a premium is paid to the broker, which will vary depending on the number of contracts purchased. Currency options insure the purchaser against adverse exchange rate movements. Investors can hedge against foreign currency risk by purchasing a currency option put or call. Option prices implicitly contain information about market participants' volatility expectations. These volatility expectations implied by option prices typically differ across times to maturity of option contracts, and thereby form a term structure of volatilities According to Scott Mixon (2011) foreign exchange option markets were active during and after the First World War where call options on German marks were the dominant instrument, but calls on French francs, Italian lira, and other currencies also traded. The market evolved from one involving relatively large sums of money per transaction to one focused on tiny retail transactions. The ultimate focus on less sophisticated investors, and the low status of the entities offering options, provides insight into the perception of option brokers and dealers in the early 20th century. The largest clientele for the options consisted of optimistic investors of German heritage. Initially there were fixed exchange rate regimes in operation and hence this limited growth of the foreign currency options market.

Trading in foreign currency options began in 1970's and 1980's in listed futures and options market of Chicago, Philadelphia and London but from 1990's the trading in foreign currency options shifted to the over the counter market. While options on foreign currencies are traded on several organized exchanges, liquidity in currency options trading is predominant in (OTC) market. Liquidity in currency options trading is centered in (OTC) market. In fact, according to Malz (1998), the prices of OTC currency options provide a better expression of changing views of future exchange rates than do prices of exchange traded currency options. According to Chance (2008) the currency options are therefore a useful tool for a business to use in order to

reduce costs and increase benefits from having increasing certainty in financial transactions that involve currency conversions.

Since the price of an option is decisively determined by the market's assessment of the volatility of the underlying asset over the remaining life of the option, market prices of options implicitly contain information about market participants' volatility expectations. Consequently, given an option pricing model, these volatility expectation sampled by option prices can be extracted. Most conventionally, the Black-Scholes (1973) option pricing framework is applied to extract volatilities, and hence implied volatility is typically defined as the value of standard deviation of the underlying asset price process that produces the observed market price of an option when substituted into the Black-Scholes option pricing formula. Although the Black-Scholes model assumes constant volatility, this assumption is obviously not made by the market. It is now well known that implied volatilities differ across times to maturity of option contracts, and thereby form a term structure of volatilities

1.1.1 Definition of terms
In pricing of foreign currency options there are various terms to be defined:

Derivatives are financial instruments that derive their value in response to changes in interest rates, financial instrument prices, commodity prices, foreign exchange rates, credit risk and which in foreign currency options is the exchange rate,

Currency Option: Currency options are derivative financial instrument where there is an agreement between two parties that gives the purchaser the right, but not the obligation, to exchange a given amount of one currency for another, at a specified rate, on an agreed date in the future, . For this right, a premium is paid to the broker, which will vary depending on the number of contracts purchased. Currency options insure the purchaser against adverse exchange rate movements.

There are two types of foreign currency options a call currency option and a put currency option.

A call option is an option contract in which the holder (buyer) has the right (but not the obligation) to buy a specified quantity of a security at a specified price (strike price) within a fixed period of time (until its expiration).For the writer (seller) of a call option, it represents an

obligation to sell the underlying security at the strike price if the option is exercised. The call option writer is paid a premium for taking on the risk associated with the obligation.

A put option is an option contract in which the holder (buyer) has the right (but not the obligation) to sell a specified quantity of a security at a specified price (strike price) within a fixed period of time (until its expiration).For the writer (seller) of a put option, it represents an obligation to buy the underlying security at the strike price if the option is exercised. The put option writer is paid a premium for taking on the risk associated with the obligation.

The seller or writer of the option, receives a payment, referred to as the optionpremium, that then obligates him to sell the exchange currency at the pre specified price

Strike price: or exercise price is the price at which the foreign currency can be purchased or sold, if the option purchaser chooses to exercise his right to buy or sell the currency. The holder will only decide to exchange currencies if the strike price is a more favorable rate than can be obtained in the spot market at expiration.

Foreign currency options can either be European Option or American Option.

American Option: An American option gives the holder the right to exercise the option at any time between the date of writhing and the expiration or maturity date.

European Option: A European option gives the holder the right to exercise the option only at the expiration date.

Foreign currency options can either be traded over the counter or in exchange markets which occur in developed financial markets that have an option market. Over-the-counter options are written by financial institutions. These OTC options are more liquid than forward contracts. At any moment, the holder can sell them back to the original writer, who quotes tow-say prices. The main advantage of OTC options is that they are tailored to the specific needs of the firm: Financial institutions are willing to write or buy options that vary by contract size, maturity, and strike price. As a consequence, the bid-ask spread in the OTC market is higher than in the traded-options market.

Firms buying and selling currency options as part of their risk management program do so primarily in the OTC market.

In OTC market, most of the options are written at a strike price equal to the spot price of that moment (at-the-money options).

A firm wishing to purchase an option in the OTC market normally places a call to the currency option desk of a major money center bank, specifies the currencies, maturity, strike price(s), and asks for an indication (a bid-ask quote). The bank normally takes a few minutes to a few hours to price the option and return the call.
The majority of currency options traded over the counter (OTC) are European style.

Expiration date: Is the date on which the foreign currency option contract ends. Currency options can be at the money (ATM) where currency options have an exercise price equal to the spot rate of the underlying currency, in the money (ITM) where currency options may be profitable, excluding premium costs, if exercised immediately or the foreign currency options may be Out the money (OTM) options would not be profitable, excluding the premium costs, if exercised.

According to Kotz'e (2011) the holder of a call option on a currency will only exercise the option if the underlying currency is trading in the market at a higher price than the strike price of the option. The call option gives the right to buy, so in exercising it the holder buys currency at the strike price and can then sell it in the market at a higher price. Similarly, the holder of a put option on a currency will only exercise the option if the spot currency is trading in the market at a lower price than the strike price. The put option gives the right to sell, so in exercising it the holder sells currency at the strike price and can then buy it in the market at a lower price. From the point of view of the option holder, the negative profit and loss represent the premium that is paid for the option. Thus, the premium is the maximum loss that can result from purchasing an option.

1.1.2 Capital Market in Kenya and Foreign Currency Options
The Capital Markets Authority is an independent public agency established by an Act of Parliament, Cap 485 A under the Ministry of Finance. The Authority came into being on December 15, 1989 when the Act was passed and was inaugurated in March1990.

The CMA is a regulating body charged with the prime responsibility of supervising, licensing and monitoring the activities of market intermediaries, including the stock exchange and the central

depository and settlement system and all the other persons licensed under the Capital Markets Act. It plays a critical role in the economy by facilitating mobilization and allocation of capital resources to finance long term productive investments. The capital market in Kenya is composed of the primary and secondary market. The primary market has the equity market that offers trading in shares through the Nairobi securities exchange (NSE) and debt market like Treasury Bonds, Corporate Bonds, Commercial Papers, Preference Shares Infrastructure Bonds, Municipal Bonds, Asset Backed Securities, and Mortgage Backed Securities. The secondary market has the derivative market; that is Futures and Options, Swaps, Commodity Futures and other products like Collective Investment Schemes (CIS) (Unit Trusts), Exchange Traded Funds (EFTs), Real Estate Investment Trusts (REIT). The derivatives market in Kenya is still at its infant stage of development. The (CMA) is undertaking major reforms in the capital markets to introduce financial instruments of hybrid OTC bond trading. There is an ongoing drive to introduce the derivatives and commodities futures in Kenya and also real estate's investments trusts (REITS) are being introduced. The securities and investment bill 2011 seeks to provide additional framework necessary for the introduction of all these additional financial instruments.

The demand for instruments to manage the currency risk associated with portfolio investment, as well as foreign direct investment, is expanding quickly. In Kenya the capital account has been liberalized hence leading to increased currency risk exposure hence the need to develop an appropriate foreign currency option pricing framework so as to provide an additional tool to hedge against this risk. Currency options have gained acceptance as invaluable tools in managing foreign exchange risk and are extensively used and bring a much wider range of hedging alternatives as a result of their unique nature.

Aloo (2011) in his exploratory study of currency options in the Kenyan financial market with a specific focus on the use or lack of use of currency options in the Kenyan financial market found out that currency options markets did exist in Kenya but only to a limited extent as only 4.1% of respondents said that the commercial banks they worked for offered currency options as one of their treasury products. Twenty three percent of respondents attributed the slow growth of a currency options market to low risk appetite by Kenyan commercial banks. There existed

demand from clients to support the growth of a currency option market as 56% of the respondents said they had received inquiries for currency options.

The Kenya Shilling is among the most volatile currency in the world; in 2011 it reached a record low of 107 to the greenback. Sometime in 2008 it was USD/KES 61, 75% depreciation, everyone is affected, and some positively but the majority are negatively affected by this steep decline in value of the local unit.

Importers are feeling the heat by buying the USD at a very high rate and most of them are adjusting their prices accordingly. Kenya is a net-importer of goods, we import almost 10 times what we export and it is very unsustainable. Our petroleum import bill is larger than our whole export receipts and that is why the Kenya shilling is losing value fast. Our current account/GDP is the same as Greece so need a change of game plan. Oil importers have revised their prices upwards as well as food importers and infrastructure material dealers. Most of the trading in imports and exports involve the dealing with the USD and hence development of foreign currency options market will enable hedge against foreign exchange risk

Most of the trading in currency options in Kenya today is OTC by various commercial banks like the Kenya commercial bank and Commercial bank of Africa offer currency options but on a limited scale. Understanding the valuation of currency options will be important in development of an efficient currency options market in Kenya.

1.2. Statement of the Problem

There are two views in pricing of foreign currency options. One assumes that the volatility used in the valuation of currency options is known and is constant and the other argues that volatility is stochastic.

Garman and Kohlhagen (1983) developed a variation of (B-S) used in the valuation of currency options. Black and Scholes (1973) developed the landmark paper in valuation of options. Most of pricing models today seek to relax the assumptions made by Black and Scholes (1973) and most focus on stochastic volatility to develop a model for predicting volatility which is then plugged into the (B-S) model and Garman Kohlhagen Model.

Various studies have been done in Kenya relating to derivatives

Akinyi (2007) in her paper a comparison of the classical black-Scholes model and the Garch option pricing model for currency options looked at the consequences of introducing heteroscedasticity in option pricing. The analysis showed that introducing heteroscedasticity results in a better fitting of the empirical distribution of foreign exchange rates than in the Brownian model. In the Black-Scholes world the assumption is that the variance is constant, which is definitely not the case when looking at financial time series data. The study priced a European call option under a Garch model Framework using the Locally Risk Neutral Valuation Relationship. Option prices for different spot prices are calculated using simulations. Alaro (1998) studied the conditions necessary for the existence of a currency options market in Kenya. His study analyzed the conditions necessary for the operation of currency options by reviewing available literature. He concluded that main conditions for an options market to exist were a growing economy, supported by the Central Bank of Kenya, a fairly independent exchange rate mechanism, market liquidity and efficiency, a regulatory organization and a strong and developing banking system. The study recommended the strengthening of the regulatory framework to provide clear guidelines as to the operation of currency option markets.

Aloo (2011)in his exploratory study of currency options in the Kenyan financial market with a specific focus on the use or lack of use of currency options in the Kenyan financial market. The study found that currency markets did exist in Kenya but only to a limited extent as only 4.1% of

respondents said that the commercial banks they worked for offered currency options as one of their treasury products. Twenty three percent of respondents attributed the slow growth of a currency options market to low risk appetite by Kenyan commercial banks. There existed demand from clients to support the growth of a currency option market as 56% of the respondents said they had received inquiries for currency options.Orina (2009) in a survey to a survey of the factors hindering the trading of financial derivatives in the NSE found out that there existed factors of lack of adequate regulation and lack of adequate demand that hindered the trading of financial derivatives at NSE.

In Kenya few researches have been done in the area of foreign currency options and the ones that have been done are exploratory in nature. This research seeks to fill this research gap and show how foreign currency options can be priced in Kenya. This research will be important especially now that derivatives' trading is being introduced in Kenya and it will offer useful insights into foreign currency options pricing.

1.3 RESEARCH OBJECTIVES
This research seeks to achieve the following key research objectives:

- ➢ To come up with a model for predicting volatility of USD/KSHS exchange rate.

- ➢ To conduct variance analysis for USD/KSHS foreign currency options.

- ➢ To value foreign currency options in Kenya using the predicted volatility values.

1.4 SIGNIFICANCE OF THE STUDY
The research into valuation of foreign currency options in Kenya is very important in hedging against foreign exchange risk exposures. Foreign currency exchange rates in Kenya are unpredictable and are not stable due to the opening up of the foreign exchange market by the central bank. The exchange rates are determined by the market hence foreign currency options will be of Importance to the following: This research will use the USD/KSHS exchange rates.

The first are the importers who have to pay for their imports in the foreign currency and by the use of the pricing framework brought by this foreign currency options pricing. Here the importers can first buy a call option on the foreign currency which gives the importer the right

to buy the foreign currency at a certain fixed price. Under if the Kenya shilling depreciates against the USD the importer exercises the call option to cover the downside risk and on the other hand if the Kenya shilling appreciates against the USD the importer will exercise the put option then he can sell the currency in the market at a higher rate and earn a profit.

Exporters on the other hand usually receive the payment for their exports in foreign currency equivalent of their Kenya shillings price and here they can buy some call and put options.

1.5 SCOPE OF STUDY

The scope of study covers the period from 2008 to July2012. The data used in this study is obtained from the Central Bank of Kenya, during this study; data is collected for the exchange rate for the selected time period. Then it is identified the most appropriate methodology to analyze the data. Collected data is then analyzed using the identified methodology to predict the volatility of USD/KSHS exchange rate.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter seeks to analyze the literature relating to foreign currency options pricing. The chapter will have three broad areas where various theories of foreign currency options will first be analyzed. The chapter will show how the pricing of foreign currency options has evolved by analyzing three theories of Black and Scholes (1973) model, Garman and Kohlhagen (1983) model and the binomial option pricing model. Once the various theories of foreign currency option pricing have been analyzed empirical studies will then be analyzed showing clearly findings of various researchers who have ventured into the area of foreign currency option valuation.

The chapter will show clearly the various empirical findings done by the researchers in this area of foreign currency option pricing. The chapter will show clearly the different researches done and how they differ from each other and also show the similarities of the various studies done by different researchers. The evolution of the research into the area of foreign currency pricing will be clearly stipulated showing how the valuation of foreign currency options has evolved from the seminal paper to date. Then finally the chapter will offer a conclusion that can be drawn from the literature review showing what are the major themes of the literature on pricing of foreign currency options. Major contestations will also be spelt out in the literature review and research gaps identified.

2.1 REVIEW OF THEORIES

2.2.1 Black-Scholes Model

The Black and Scholes Option Pricing Model didn't appear overnight, in fact, Fisher Black started out working to create a valuation model for stock warrants. This work involved calculating a derivative to measure how the discount rate of a warrant varies with time and stock price. The result of this calculation held a striking resemblance to a well-known heat transfer equation. Soon after this discovery, Myron Scholes joined Black and the result of their work is a startlingly accurate option pricing model. Black and Scholes can't take all credit for their work; in fact their

model is actually an improved version of a previous model developed by A. James Boness in his Ph.D. dissertation at the University of Chicago. Black and Scholes' improvements on the Boness model come in the form of a proof that the risk-free interest rate is the correct discount factor, and with the absence of assumptions regarding investor's risk preferences. The key assumption in Black-Scholes Option pricing model is lack of arbitrage opportunities and operating in a frictionless market. Arbitrage is generally defined as 'the simultaneous purchase and sale of the same securities, commodities or foreign exchange in different markets to profit from unequal prices'

Any no arbitrage argument for pricing a derivative is ultimately based on a replication strategy, which is a trading strategy that uses market instruments to 'replicate' the initial and final positions required by the derivative. If we have two strategies with the same initial position, and guaranteed final positions, then these final positions must be equal. Otherwise, by going long on the strategy with the higher final value and short on the other we would generate an arbitrage. The arbitrage pricing theory does not depend on the real world probabilities. The pricing is done in a risk neutral world.

This is implied by the following assumptions:-

(i) There is unlimited short selling of stock.

(ii) There is unlimited borrowing and lending.

(iii) There are no transaction costs or commissions.

(iv) At time $t = 0$ there is only one market price for each security and each investor can buy and sell as many securities as desired without changing the market price. The investor is a price taker, i.e., his/her trading does not move the market.

(v) All parties have the same access to relevant information.(vi) All assets are perfectly divisible and liquid.

Black and Scholes (1973) developed (B-S) Model and suggested the following stochastic differential equation as a model for the dynamics of a stock price process:

$$dS_t = \mu S_t dt + \alpha S_t dW_t$$

2.2.2 Garman and Kohlhagen model

Garman and Kohlhagen (1983) extended the Black Scholes model to cover the foreign exchange market, Garman and Kohlhagen suggested that foreign exchange rates could be treated as non-dividend paying stocks. Where they allowed for the fact that currency pricing involves two interest rates and that a currency can trade at a premium or discount forward depending on the interest rate differential. The Garman and Kohlhagen formula applies only to European options.

Garman and Kohlhagen (1983) extended the (B-S) to cope with the presence of two interest rates the domestic interest rate and the foreign currency interest rate.

The model assumed that It is easy to convert the domestic currency into the foreign currency and that we can invest in foreign bonds without any restrictions. The standard Garman and Kohlhagen foreign currency option pricing model has the following form:

$$C = Se^{r_f t}N(d_1) - Ke^{r_d t}N(d_2)$$

$$P = -Se^{-r_f t}N(-d_1) + Ke^{r_d t}N(-d_2)$$

2.2.3 Binomial option pricing model

Cox, Ross and Rubinstein (1979) developed the binomial option pricing model that is a discrete time model which contains the continuous time (B-S) model as a special limiting case. Despite its simplicity, the model can be applied to European and American style options.

Furthermore, it is applicable for the valuation of a variety of complex derivatives. In the binomial model as indicated by the name the price of the underlying stock S is assumed to follow a multiplicative binomial process over discrete time periods. We can also say that the stock price follows a random walk, because in each period, it may either move up by a certain percentage amount $u - 1$ where $u > 1$ or down by a certain percentage amount $1 - d$ where $d < 1$.

We denote the (physical) probability of an upward move as p and the (physical) probability of a downward move as $1 - p$. Let f_0 be the current value of a European style option, whereas f can be either a call C_0 or a put P_0 option. Then $f_u (C_U or P_u)$ is the option's

price if the stock price moves upward, and $f_d(C_d\,or\,P_d)$ its price if the stock price moves downward:

If the call option is only away one period from expiration, then $f_u(C_U\,or\,P_u)$ and $f_d(C_d\,or\,P_d)$ are given

$$c_u = \max(S_0\,u - K; 0)\ or\ P_u = \max(K - S_0\ u; 0)$$

$$C_d = \max(S_0\,d - K; 0)\ or\ P_d = \max(K - S_0\ d; 0)$$

2.3 Review of Empirical Studies

Bodurtha and Courtadon (1987) assume a lognormal probability distribution for exchange rates and predict option prices using implied volatilities. The implied volatilities are chosen so as to maximize the correspondence between their model's predictions and the option prices observed on the previous market day. They find that this procedure produces fairly small biases in the average predicted price for most categories of options; although on average they consistently overestimate call and put option prices. Bodurtha and Courtadon also report that their model produces pricing errors that have a large dispersion. In particular, the average ratio of the absolute forecast error to the actual price is about 13 percent for both the puts and the calls.' Melino and Turnbull (1987) question the assumption of lognormal-

Fabozzi, Hauser and Yaari (1990) conducted a research that compared the performance of the BaroneAdesi Whaley (BA-W) model for currency options and Garman Kohlhagen model in pricing American currency options. It was shown that the (BA-W) model is superior to the Garman Kohlhagen model in pricing out-of-the-money long-term put options and inferior in pricing in-the-money short-term put options. The two models performed equally well in pricing call options. The research further shown that the interest rate differential across countries has a greater effect on the probability of gainful early exercise in foreign currency puts than that of calls. The American model identified a large number of opportunities in our sample for gainful early exercise among in-the-money options maturing in less than 45 days. These findings suggest the need for a further investigation of the ex-post consequences of early exercise decisions based on the (BA-W) model. In

combination with our results, such an investigation was found to be useful in the developments of trading strategies and the testing of market efficiency.

Rubinstein (1994) points out that if all options on the same underlying security with the same time-to-expiration but with different strike prices should have the same implied volatility. He carried out an empirical test on the S&P500 index options from 1986 to1992 using Black-Scholes formula and the results were statistically measured in minimax percentage errors for S&P 500 index calls with time-to-expiration of 125 to 215 days. The results showed Black Scholes miss pricing is increased each year, the error was significant; furthermore, low strike price option has significantly higher implied volatilities than high striking price options. Based on his empirical test results, Rubinstein (1994) argued that the Black-Scholes model is true, but the market was inefficient. The constant volatility Black-Scholes model will fail under any of the following four violations of its assumptions: First, the local volatility of the underlying asset, the riskless interest rate, or the asset payout rate is a function of the concurrent underlying asset price or time. Secondly, the local volatility of the underlying asset, the riskless interest rate, or the asset payout rate is a function of the prior path of the underlying asset price. Third, the local volatility of the underlying asset, the riskless interest rate, or the asset payout rate is a function of a state-variable which is not the concurrent underlying asset price or the prior path of the underlying asset price; or the underlying asset price, interest rate or payout rate can experience jumps in level between successive opportunities to trade. Finally, the market has imperfections such as significant transactions costs, restrictions on short selling, taxes, non-competitive pricing, etc. It is assumed in the BS model that the underlying security pays no cash distributions, that there are no transaction costs in buying or selling the option or underlying security, that there are no taxes and there are no restriction on short sale.(Black and Scholes, 1973)

ElizavetaKrylova Sami Vähämaa in there paper cross-dynamics of Volatility term Structures implied By foreign exchange Options demonstrate that that the implied volatilities of major currencies exhibit considerable term structure behavior. For the euro, British pound and Swiss franc, the implied volatilities of longer maturity options exceed, on average, the volatilities of shorter maturity options, while the implied volatilities of the Japanese yen and Canadian dollar appear to decrease with time to maturity. However, it is also found that implied volatility term structures vary heavily over time. Although the

volatility term structures of the European currencies tend to be upward sloping, sustained periods of downward sloping term structures can also be observed.

Furthermore, the empirical findings of the paper indicate that implied volatility term structures exhibit somewhat similar patterns over time. The term structures of the European currencies, in particular, are found to be closely linked with each other. Our findings also suggest that a vast proportion of the variation in volatility term structures across currencies can be explained by two common factors. These two factors, however, describe the dynamics of the European volatility term structures more adequately than the dynamics of the Japanese yen and Canadian dollar implied volatilities.

Campa and Chang (1995, 1998) conducted a research to test the suitability of the (B-S) model argue that the (B-S) model generates accurate option values even though it may be misspecified,and use (B-S) implied volatilities to forecast exchange rate variance and the correlations between exchange rates.

Hamilton and Susmel (1994) present a regime switching model in which each regime is characterized by a different ARCH process. In their model, the null of a single regime would be equivalent to a single ARCH process governing innovations. In this sense their regime switching model nests a standard ARCH process. However, as Hamilton and Susmel point out, the general econometric problem of regime switching models remains: the null of a single regime is not testable in the usual way since parameters of the other regimes are not identified. Hamilton and Susmel rely on standard linear regression statistics as a simple measure of relative fit.

Bollen et al (2003) compares the performance of three competing option valuation models in the foreign exchange market, one based on a regime-switching process for exchange rate changes, one based on a GARCH process, and the other based on jump diffusion. Three tests are executed based on the parameter values implicit in option prices. The first test compares in sample fit of option prices. The study found out that GARCH model is superior to the regime-switching model for the GBP, but the two models perform about the same for the JPY. Both models dominate an ad hoc valuation model based on Black Scholes, but both are dominated by the jump diffusion model. The second test compares out-of-sample fit of option prices. Here the GARCH model performs better than the regime-switching model for both exchange rates, and again both are superior to an ad hoc valuation model. The jump-

diffusion model offers only modest improvement over the others for the GBP options. The third test simulates the role of a market maker who sells options and uses the competing valuation models to hedge the positions. In this test, the GARCH and regime-switching models perform almost identically. An ad hoc strategy is superior for the GBP and is inferior for the JPY. The jump-diffusion model performs as well as the ad-hoc strategy for the GBP and is superior to all others for the JPY options.

Kalivas and Dritsakis (1997) in their study dealing with volatility forecasting techniques and volatility trading in the case of currency options they sought to provide evidence on how foreign exchange rates are moving under time varying volatility. They sought to identify the existence of heteroscedasticity then applied widely acclaimed methods in order to estimate future exchange rates under changing volatility. They then used different methods for estimating future foreign exchange volatility, such as implied volatility and historical volatility approaches. In their study implied and historical volatility were compared and it was found, that historical volatility is the best approximation. The white's test for existence of heteroscedasticity showed that there was time variation in volatility.

Abken and Nandi (1996) model the volatility in such a way that the future volatility depends on a constant and a constant proportion of the last period's volatility. They used the ARCH framework to predict volatility. Thus, ARCH models provide a well-established quantitative method for estimating and updating volatility.

Natenberg (1994) proposed a forecast by using a weighting method, giving more distant volatility data progressively less weight in the forecast. The above weighting characteristic is a method which many traders and academics use to forecast volatility. It depends on identifying the typical characteristics of volatility, and then projecting volatility over the forecasting period.

Melino and Turnbull (1990) found that the stochastic volatility model dominates the standard option valuation models. In addition, they pointed out that a stochastic volatility model yield option prices which coincide with the observed option prices market prices. They generalized the model to allow stochastic volatility and they report that this approach is successful in explaining the prices of currency options. Though this model has the disadvantage that their models do not have closed form solutions and requires extensive use of numerical techniques to solve two dimensional partial differential equations.

Scott and Tucker (1989) examined the relative performance of three different weighting schemes for calculating implied volatility from American foreign exchange call options on the British pound, Canadian dollar, Deutschemark, Yen; and Swiss franc. They found no evidence that one of the three weighting schemes is superior to the others.

Kroner et al. (1995) found out implied volatility being higher than historical volatility due to the fact that if interest rates are stochastic, then the implied volatility will capture both asset price volatility and interest rate volatility, thus skewing implied volatility upwards, and that if volatility is stochastic but the option pricing formula is constant, then this additional source of volatility will be picked up by the implied volatility.Kroner et al (1995) also point out that, since expectations of future volatility play such a critical role in the determination of option prices, better forecasts of volatility should lead to a more accurate pricing and should therefore help an option trader to identify over- or underpriced options. Therefore a profitable trading strategy can be established based on the difference between the prevailing market implied volatility and the volatility forecast.

Dontwi, Dedu and Biney (2010)in pricing of foreign currency options in a developing financial Market. They conducted a research seeking to develop a suitable approach to the valuation of foreign currency options in an underdeveloped financial market in Ghana. Volatility analysis was done. This included the application of the GARCH model which resulted in the marginal volatility measure. Further, the pricing of basic foreign currency options in the local market was obtained from the marginal volatility measure. The research had the following findings and conclusions: The resulting GARCH specification volatility measure can then be implemented as an input in the pricing of theoretically formed currency options in the local market. This analysis can form the basis for the pricing of currency options in developing financial the local markets. Implementation of the standardized instruments is expected to follow the further development of the domestic Forex market, its size, liquidity and legislative framework. In the beginning the further Pricing of Foreign Currency Options in a Developing Financial Market implementation of forward and swap contracts is appropriate, until the volume of trading reaches levels that would require standardization of contracts and their variety. More complex pricing schemes would then be available and adequate Forex management schemes created. This opens avenue for further research directions.

Heston (1993) proposed a closed form solution for options with stochastic volatility with applications to bond and currency options where he used a new technique to derive a closed-form solution for the price of a European call option on an asset with stochastic volatility. The model allows arbitrary correlation between volatility and spot asset returns. He introduced stochastic interest rates and shows how to apply the model to bond options and foreign currency options. Simulations show that correlation between volatility and the spot asset's price is important for explaining return skewness and strike-price biases in the Black Scholes (1973) model. The solution technique is based on characteristic functions and can be applied to other problems.

Chen and Gau (2004) investigates the relative pricing performance between constant volatility and stochastic volatility pricing models, based on a comprehensive sample of options on four currencies, including the British pound, Deutsche mark, Japanese yen and Swiss franc, traded frequently in the Philadelphia Stock Exchange (PHLX) from 1994 to 2001. The results show that Heston model outperforms the (G-S) model in terms of sum of squared pricing errors for all currency options and the adjustment speed toward the long-run mean volatility in the currency market is faster than that in the stock market.

Posedel (2006) analyzed the implications of volatility that changes over time for option pricing. The nonlinear-in-mean asymmetric GARCH model that reflects asymmetry in the distribution of returns and the correlation between returns and variance is recommended. He used the NGARCH model for the pricing of foreign currency options. Possible prices for such options having different strikes and maturities are then determined using Monte Carlo simulations. The improvement provided by the NGARCH model is that the option price is a function of the risk premium embedded in the underlying asset. This contrasts with the standard preference-free option pricing result that is obtained in the Black-Scholes model.

Akinyi (2007) in her paper a comparison of the classical black-Scholes model and the Garch option pricing model for currency options established that there is a lot of foreign trade and other foreign currency activities in the Kenyan market and therefore the Kenyan investor or any investor in the market will be interested in any initiative that can hedge against exchange rate risk also that the Black-Scholes model under prices options that are at the money even for the Kenyan market and therefore pricing under the GARCH

framework can be used to arrive at more realistic prices. She looked at the consequences of introducing heteroscedasticity in option pricing. The analysis showed that introducing heteroscedasticity results in a better fitting of the empirical distribution of foreign exchange rates than in the Brownian model. In the Black-Scholes world the assumption is that the variance is constant, which is definitely not the case when looking at financial time series data. The study priced a European call option under a Garch model Framework using the Locally Risk Neutral Valuation Relationship. Option prices for different spot prices are calculated using simulations. The study used the non-linear in mean Garch model in analyzing the Kenyan foreign exchange market.

Aloo (2011)in his exploratory study of currency options in the Kenyan financial market with a specific focus on the use or lack of use of currency options in the Kenyan financial market. The study found that currency markets did exist in Kenya but only to a limited extent as only 4.1% of respondents said that the commercial banks they worked for offered currency options as one of their treasury products. Twenty three percent of respondents attributed the slow growth of a currency options market to low risk appetite by Kenyan commercial banks. There existed demand from clients to support the growth of a currency option market as 56% of the respondents said they had received inquiries for currency options.

2.4 Conclusion from literature review
The original option pricing model was developed by Black and Scholes (1973). Since then, it has been extended to apply to foreign currency options in Garman and Kohlhagen, 1983; Grabbe, (1986). Garman and Kohlhagen (1983) suggested that foreign exchange rates could be treated as non-dividend-paying stocks. From the initial studies of foreign currency option valuation various assumptions were made by Black and Scholes (1973) and research from that time has been focused of relaxing some of the assumptions. From the literature volatility is the main variable involved where by most researchers now focus on developing a model of predicting future volatility based on either historical data or implied volatility. Volatility forecasts have many practical applications such as use in the analysis of market timing decisions, aid with portfolio selection and the provision of estimates of variance for use in option pricing models. Thus, it follows that it is important to distinguish between various models in order to find the model which provides the most accurate forecast the literature provides conflicting evidence about the superiority of each method.

One the one hand, some researchers stress that relatively complex forecasts (ARCH) and (GARCH) models and implied volatility forecasts provide estimations with the best quality.

From the literature review we can conclude that most of the models of option pricing are based on the initial model of Black and Scholes and almost all the models start there and go on and relax some of the unrealistic assumptions made by the black Scholes model of option pricing. In general we can say that Black & Scholes assumed that the financial market is a system that is in equilibrium.

Most research on pricing of currency options have concentrated in developed markets and there is a research gap to conduct research in valuation of developing and emerging markets like the Kenya market. The financial markets of developed countries where most of the research on the

valuation of foreign currency options has been carried out is different from the financial market in Kenya in terms of efficiency and the way they are structured .Also there is currently no market for trading of options in Kenya and some data used in the model is not readily available as in the developed financial markets. Due to the above differences in the financial markets in developed economies and Kenya's financial market there is need to come up with a model that properly fits the available data in Kenya hence the model developed specifically for Kenya will give more accurate results in valuation of foreign currency options in Kenya compared to using the already developed models for developed countries.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter discusses the type of research methodology used in the study. First the research design used is discussed and it's very important to select the appropriate research design as this will enable you to achieve the research objectives. The population of the study is then defined and the sample that will be used is then selected and justified. Data collection methods and data analysis methods that will be used are then discussed. Then the conceptual and empirical models are then defined and various variables defined and then finally the data validity and reliability is explained.

3.2 Research design

Research design refers to how data collection and analysis are structured in order to meet the research objectives through empirical evidence economically Schindler (2006). This research uses descriptive research design which is a scientific method which involves observing and describing the behavior of a subject without influencing it in any way. The research looks at USD/KSHS exchange rate in the past and analyses it to come up with a pricing model for foreign currency options in Kenya.

3.3 Population

Cooper and Emory (1995) define population as the total collection of elements about which the researcher wishes to make inferences. The population of interest in this study is the foreign currency exchange rates in Kenya.

3.4 Sample

The sample for this research will be the daily USD/KSHS exchange rate for 5 years from 2008 to 2012.The exchange rates used in formulating the model for predicting volatility are the mean daily exchange rates from January 2008 to December 2012 with 1253 daily data exchange rates for the USD against the KSHS. The exchange rate for the USD against the Kenya Shilling range from a low of 61.51 in May 2008 to a high of 105.91 in October 2011 but the majority of the exchange rates lies between 70-90 against the USD. For the simulation of the foreign currency option pricing exchange rate data for January 2013 is used. The USD is used for it's the most traded currency and most transactions in Kenya are

pegged against the USD which also acts as the intermediary in triangular currency transactions. The exchange rates are given by appendix 3.

3.5 Data Collection
This study will use secondary data for the various variables that will be put into the model. The secondary data will be obtained from Central bank of Kenya and Kenya bureau of statistics. The secondary data collected will cover a period of five years from 2008 to 2012.

3.6 Data Analysis
This study will use both descriptive and inferential statistics to analyze the data. Analysis will be done using the Statistical package for social scientists (SPSS Version 20).Secondary data will be collected then regression analysis will be carried out to model the volatility equation and the gained volatility estimate used in the valuation of foreign currency options.

3.7 Conceptual model
This study will use GARCH (1, 1) which estimates current volatility as a function of the long-run average variance, a single lagged squared return and a single lagged variance. The model is based is based on the original propositions of Black and Scholes model as adjusted by the Garman Kohl Hagen Model. Under this model the foreign currency call (C) and put (P) option is a function of the following six variables below

$C/P = f(S, K, T, r_d r_f \sigma)$. Where: ($S$) is the current currency spot rate, (K) the strike price,(T) the time to expiration,(r_d) the local risk free interest rate, ,(r_f) the foreign risk free interest rate and(σ) is the volatility.

3.7.1 Introduction
Financial markets react nervously to political disorders, economic crises, wars or natural disasters. In such stress periods prices of financial assets tend to fluctuate very much. Statistically speaking, it means that the conditional variance for the given past

$$Var(X_t|X_{t-1}, X_{t-2}, \dots)$$

is not constant over time and the process X_T is conditionally heteroskedastic. Econometricians usually say that volatility

$$e_t = \sqrt{Var(X_t|X_{t-1}, X_{t-2}, \dots)}$$

changes over time. Understanding the nature of such time dependence is very important for many macroeconomic and financial applications, e.g. irreversible investments, option pricing, asset pricing etc. Models of conditional heteroskedasticity for time series have a very important role in today's financial risk management and its attempts to make financial decisions on the basis of the observed price asset data P_t in discrete time. Prices P_t are believed to be nonstationary so they are usually transformed in the so-called *log returns*

$X_t = logP_t - logP_{t-1}$. Log returns are supposed to be stationary, at least in periods of time that are not too long. Very often in the past it was suggested that (X_t) represents a sequence of inde- pendent identically distributed random variable, in other words, that log returns evolve like a random walk. Samuelson suggested modeling speculative prices in the continuous time with the geometric Brownian motion. Discretization of that model leads to a random walk with independent identically distributed Gaussian increments of log return prices in discrete time. This hypothesis was rejected in the early sixties. Empirical studies based on the log return time series data of some US stocks showed the following observations, the so-called stylized facts of financial data:

• Serial dependence is present in the data

• Volatility changes over time

• Distribution of the data is heavy-tailed, asymmetric and therefore not Gaussian.

These observations clearly show that a random walk with Gaussian increments is not a very realistic model for financial data. It took some time before R. Engle found a discrete model that described very well the previously mentioned stylized facts of financial data, but it was also relatively simple and stationary so the inference was possible. Engle called his model autoregressive conditionally heteroskedastic- ARCH, because the conditional variance (squared volatility) is not constant over time and shows autoregressive structure. Some years later, T. Bollerslev generalized the model by introducing generalized autoregressive conditionally heteroskedastic - GARCH model. The properties of GARCH models are not easy to determine.

3.7.2 Black-Scholes Model

Black and Scholes (1973) developed (B-S) Model and suggested the following stochastic differential equation as a model for the dynamics of a stock price process:

$$dS_t = \mu S_t dt + \alpha S_t dW_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3.1)$$

Where S_t is the stock price at time t, μ is the return on the stock and σ is the volatility of the stock, defined as the standard deviation of the log returns and W_t is a standard Brownian motion. The first term of the right hand side is called the drift. It is the deterministic part of the equation, and contributes to driving the process value S_t in a deterministic way. The second part, called the diffusion, is the stochastic part. It adds a random noise to S_t. This random noise is amplified by the volatility.

From the above we can apply simple arbitrage arguments to get a derivative pricing formula. By solving the above equation we get the solution below:

$$dS_t/S_t = \mu dt + \sigma dW_t$$

The stock price is said to follow a geometric Brownian motion.

μ is the drift, and σ the diffusion of the process.

Instantaneously, the stock price change is normally distributed , $\varphi(\mu S t dt, \sigma 2 S2\ t\ dt)$.

Over longer horizons, the price change is log normally distributed.

The log return (continuous compounded return) is normally distributed over all horizons:

$d\ lnS_t = (\mu - \frac{1}{2}\sigma^2)dt + \sigma dW_t$. (By Ito's lemma)

$d\ lnS_t \sim \phi(\mu dt - \frac{1}{2}\sigma^2 dt, \sigma^2 dt)$.

$lnS_t \sim \phi(lnS_0 + \mu t - \frac{1}{2}\sigma^2 t, \sigma^2 t)$.

$lnS_T/S_t \sim \phi((\mu - \frac{1}{2}\sigma^2)\ (T - t), \sigma^2(T - t)$.

Integral form: $S_t = S_0 e^{\mu t - \frac{1}{2}\sigma^2 t + \sigma W_t}$, ...(3.2)

$$\ln S_t = \ln S_0 + \mu t - \frac{1}{2}\sigma^2 t + \sigma W_t$$

The above is sometimes called a geometric Brownian motion. The stock price in this model is log-normally distributed.

The (B-S) option pricing model is a function of the parameters of the diffusion process describing the dynamics of the underlying asset price. The no arbitrage principle states that if options are correctly priced in the market it should not be possible to make a guaranteed profit by creating portfolios of long and short positions in options and their underlying assets.

By respecting this principle they derived a theoretical valuation formula for European options on common stocks. It is derived for a geometric Brownian motion with a constant volatility parameter σ. The (B-S) formula was initially developed for the shares but the spot exchange rate can also replace the share price as the underlying asset.

The (B-S) model for pricing of currency options has various assumptions which can be summarized as:

1. Frictionless Markets -No taxes, transaction costs, no restrictions on taking long or short positions, and no market control.

2. Interest rates are riskless, continuously compounded, and constant.

3. Spot rates change instantaneously and they have a normal distribution

$C = S_0 N(d_1) - X e^{-rT} N(d_2)$ ....(3.3)

$P = X e^{-rT} N(-d_2) - S_0 N(-d_1)$ ....(3.4)

Where

$$d_1 = \frac{\ln\left(\frac{S_0}{X}\right) + \left(r + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad ...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,. (3.5)$$

$$d_2 = \frac{\ln\left(\frac{S_0}{X}\right) + \left(r - \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}} \quad ...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,...\,... (3.6)$$

Where

S_0= Current market of underlying asset-Spot Exchange rate.

X= Option's exercise price

r= Risk free rate of interest

T= time, in years, until the option expires

σ= Volatility (as measured by the standard deviation) of the price of underlying asset. Ln =
Natural log

e = a mathematical constant number: 2.718...

N= Cumulative area under the normal curve.

For the Black-Scholes model, the only input that is unobservable is the future volatility of the underlying asset. One way to determine this volatility is to select a value that equates the theoretical (B-S) price of the option to the observed market price. This value is often referred to as the implied or implicit volatility of the option. Under the (B-S) model implied volatilities from options should be the same regardless of which option is used to compute the volatility.

3.7.3 Garman and Kohlhagen model
Garman and Kohlhagen (1983) extended the Black Scholes model to cover the foreign exchange market, Garman and Kohlhagen suggested that foreign exchange rates could be treated as non-dividend paying stocks. Where they allowed for the fact that currency pricing involves two interest rates and that a currency can trade at a premium or discount forward depending on the interest rate differential. The Garman and Kohlhagen formula applies only to European options.

Garman and Kohlhagen (1983) extended the (B-S) to cope with the presence of two interest rates the domestic interest rate and the foreign currency interest rate.

The model assumed that It is easy to convert the domestic currency into the foreign currency and that we can invest in foreign bonds without any restrictions. The standard Garman and Kohlhagen foreign currency option pricing model has the following form:

$$C = Se^{r_f t} N(d_1) - Ke^{r_d t} N(d_2) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3.7)}$$

$$P = -Se^{-r_f t} N(-d_1) + Ke^{r_d t} N(-d_2) \dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3.8)}$$

Where:

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r_d - r_f + \frac{\sigma^2}{2}\right)}{\sigma\sqrt{T}} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \text{(3.9)}$$

$$d_2 = d_1 - \sigma\sqrt{T} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\text{(3.10)}$$

And

C: Theoretical price of a call option

P: Theoretical price of a put option

S: Price of the underlying currency

K: Strike price

t: Time to expiration in years

σ: Annual volatility

r_f : Risk-free rate in the foreign currency

r_d : Risk-free rate in the foreign currency

$N(d_1)$ and $N(d_1)$: the cumulative normal distribution function.

This model is similar to the black Scholes model but was adapted to be used in valuation of currency options and the key difference is that it uses two interest rates; the domestic risk free rate and the foreign currency interest rate. Garman and Kohlhagen (1983) suggested that foreign exchange rates could be treated as non-dividend-paying stocks.

3.7.4 GARCH (1,1) process

Definition 1: Let (Z_n) be a sequence of i.i.d. random variables such that $Z_t \sim N(0,1)$. (X_t) Is called the generalized autoregressive conditionally heteroskedastic or GARCH (q,p) process if

$$X_t = \sigma_t Z_t, \quad t \in \mathbb{Z} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (3.11)$$

Where (σ_t) is a nonnegative process such that

$$\sigma_t^2 = \alpha_0 + \alpha_1 X_{t-1}^2 + \dots + \alpha_q X_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_p \sigma_{t-p}^2, \quad t \in Z \dots\dots\dots\dots\dots \quad (3.12)$$

And

$$\alpha_0 > 0, \alpha_i \geq 0 \quad i = 1, \dots, q \ \beta_i \geq 0 \ i = 1, \dots, p. \ \dots\dots\dots\dots\dots\dots\dots\dots \quad (3.13)$$

The conditions on parameters ensure strong positivity of the conditional variance (12). If we write the equation (12) in terms of the lag-operator B we get

$$\sigma_t^2 = \alpha_0 + \alpha(B)X_t^2 + \beta(B)\sigma_t^2 \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (3.14)$$

Where

$$\alpha(B) = \alpha_1 B + \alpha_2 B^2 + \dots + \alpha_q B^q$$

And

$$\beta(B) = \beta_1 B + \beta_2 B^2 + \dots + \beta_p B^p. \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (3.15)$$

If the roots of the characteristic equation, i.e.

$$1 - \beta_1 x - \beta_2 x^2 - \dots - \beta_p x^p = 0$$

lie outside the unit circle and the process (X_t) is stationary, then we can write (3.12) as

$$\sigma_t^2 = \frac{\alpha_0}{1 - \beta(1)} + \frac{\alpha(B)}{1 - \beta(B)} X_t^2$$

$$= \alpha_0^* + \sum_{i=1}^{\infty} \sigma_i X_{t-i}^2 \quad \text{...(3.16)}$$

Where $\alpha_0^* = \frac{\alpha_0}{1-\beta(1)}$, and σ_i are coefficients of B^i in the expansion of $\alpha(B)[1 - \beta(B)]^{-1}$. Note that the expression (3.16) tells us that the GARCH (q,p) process is an ARCH process of infinite order with a fractional structure of the coefficients. From (3.11) it is obvious that the GARCH (1, 1) process is stationary if the process (σ_t^2) is stationary

3.8 The Empirical model
A standard GARCH (1, 1) model is used to estimate the volatility of the foreign currency option.

GARCH is an approach to estimating conditional volatility. GARCH (1, 1) estimates current Volatility as a function of the long-run average variance, a single lagged squared return and a

Single lagged variance.

$$\sigma_t^2 = \omega + \beta \sigma_{t-1}^2 + \alpha \varepsilon_{t-1}^2$$

Where

σ_t^2 Is the conditional variance of the return,

ε_{t-1}^2 : The squared random component of the return in the previous period,

σ_{t-1}^2: The previous period historical variance.

And

$$\varepsilon_t = \ln \frac{E_t}{E_{t-1}}$$

The analysis entails the fitting of the GARCH (1, 1) specification for the (KSHS) and (USD) exchange rate and the implementation of the gained volatility measure in the pricing of foreign currency options in the Kenyan market. Once the variance is estimated standard deviation which represents the volatility is attained by finding the square root of the variance. The volatility is estimated on monthly basis and is assumed to be constant over that month.

The above volatility model is used to predict volatility for the next period which is the month that follows .The volatility will be predicted by the above model then the resultant volatility plugged into the Garman and Kohlhagen model stipulated below. All the variables below are observable except volatility which will be estimated from the above model.

$$C = Se^{r_f t}N(d_1) - Ke^{r_d t}N(d_2)$$ .... (3.7)

$$P = -Se^{-r_f t}N(-d_1) + Ke^{r_d t}N(-d_2)$$ .... (3.8)

Where:

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r_d - r_f + \frac{\sigma^2}{2}\right)}{\sigma\sqrt{T}}$$ .... (3.9)

$$d_2 = d_1 - \sigma\sqrt{T}$$ ....(3.10)

And

C: Theoretical price of a call option

P: Theoretical price of a put option

S: Price of the underlying currency

K: Strike price

t: Time to expiration in years

σ: Annual volatility

r_f : Risk-free rate in the foreign currency

r_d : Risk-free rate in the foreign currency

$N(d_1)$ And $N(d_1)$: the cumulative normal distribution function.

All the above variables are observable except annual volatility which will be estimated by the

Garch (1, 1) model above and the foreign currency call and put options will be valued at various simulated strike prices.

3.9 Data Validity & Reliability
The data validity and reliability will be assured for this study will use secondary data from trusted sources of Central bank of Kenya and the Kenya national bureau of statistics.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION

4.1 Introduction

This of data analysis and presentations has two major parts. First the data is clearly presented and defined, data analysis methods used for the research is also discussed and finally summary and findings are clearly interpreted.

4.2 Data Presentation

4.2.1 Variance

The variance is a measure of the squared deviations of the observations from the mean. In this research first price relatives are calculated from the exchange rates given, then natural logs of the price relatives are now used as the variable by which the variance is estimated. In this research variance is assumed to follow an historical trend where the variance of today's period determines the variance of the following periods. The variance in this research is a function of two main dependent variable whereby current period's variance depends on previous period variance and previous period squared log returns. The variance used in the study is the historical variance which is calculated based on the returns of the USD/KSHS exchange rates and the variance period is thirty days.

4.2.2 Squared log Returns

Squared log returns is one of the independent variable is this research. For this research squared log returns for the exchange rates is used to estimate variance and consequently the volatility. The squared log returns has been determined to be a goon variable for estimating the variance from previous studies done in this area of pricing of foreign currency options. To determine the squared log returns first the exchange price relative rates is calculated and the price relative relates the current daily exchange rate with the previous day's exchange rate and it's computed by dividing current daily exchange rate by the previous day exchange rate. The squared log returns is based on the natural logarithm of price relative of the USD/KSHS exchange rates as illustrated in appendix 1.

4.2.3 Risk free rate

Risk free interest rate is the theoretical rate of return of an investment with zero risk including the default risk. The risk free rate represents the interest that an investor would expect from an absolutely risk free investment over a given period of time. Risk free rate can be said to be the rate of interest with no risk. Therefore any rational investor will reject all the investments yielding sub risk free returns. The risk free rate is usually obtained from government securities which offer a guaranteed return with no risk. The risk free rates used are the 364 days Treasury bill rate for the domestic Kenya interest rate which in January 2013 averaged 11.67% and the foreign risk free rate the 1 year Treasury bill for USA was used in the study and the foreign risk free rate is as shown in appendix 2.

4.2.4 Strike price

The strike price is defined as the price at which the holder of currency options can buy in the case of a call option or sell in the case of a put option the underlying security when the option is exercised. Since we don't have the options market in Kenya the foreign currency options was priced based on simulated strike prices of 70,80,90 and 100.These four strike prices are adequate in this analysis as they help portray various pricing dynamics of foreign currency options pricing. The strike prices selected will be adequate in illustrating the pricing of foreign currency options the exchange rate for the USD versus the Kenya shilling is usually within this range.

4.2.5 Time to maturity

The time to maturity is the period that remaining before the option expires. This research assumes that the currency options are European currency options that can only be exercised on the maturity date on their expiry date. The time to maturity used in this study is a foreign currency option of 6 months and this translates to a 0.5 fraction of a year.

4.2.6 Volatility

Volatility is one of the major variable in this research and coming up with a good volatility estimate is very key in coming up with an adequate and accurate foreign currency pricing model. Volatility shows the variation in data in relation to the mean. If the data is close together, the standard deviation will be small. If the data is spread out, the standard deviation will be large. Volatility is estimated from a sample of recent continuously compounded returns .This research uses historical volatility estimates and assumes that

volatility of the past will hold in the future and in this research variance from past data of the exchange rates for the USD against the Kenya shilling is calculated and a regression model based on the Garch (1, 1) framework is formulated to predict future volatility. From the predicted variance estimates we obtain the standard deviation by finding the square-root of the estimated variance which represents the volatility used in pricing of foreign currency options. The volatility used in this study is as predicted by the variance model and it's shown in appendix 2

4.3 Regression results analysis and application of model.

Regression analysis was conducted for the above model and produced the following results

Table 1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.995	.990	.990	.000005765254121

Predictors: $\omega,\ \varepsilon_{t-1}{}^2,\ \sigma_{t-1}{}^2$

Dependent Variable: $\sigma_t{}^2$

R square is the coefficient of determination and shows by what proportion the variations of the dependent variable are explained by the independent variables. From above the R Square statistic gives the goodness of fit of the model which shows how good the regression model approximates the real data points. An R square of 1.0 indicates that the regression line perfectly fits the data.

The R square of this model is .990 which shows that the model is a good fit of the actual data. Coefficient of correlation ranges between -1 to 1 and in this model the coefficient of correlation is .995 which shows a high positive correlation between current period variance, previous period variance and previous period log returns.

Table 2: Coefficients

Model	Coefficients		T Value	Sig
	β	Std. Error		
ω	4.153E-007	.000	2.139	.033
$\sigma_{t-1}{}^2$	0.9645	.003	321.410	.000
$\varepsilon_{t-1}{}^2$	0.12	.002	6.589	.000

Predictors: $\varepsilon_{t-1}{}^2, \sigma_{t-1}{}^2$

Dependent Variable: $\sigma_t{}^2$

From above the analysis of the data a variance model can be fitted for the exchange rate data of USD against Kenya Shilling. From the coefficients obtained above we have the following variance model which satisfies the Garch (1, 1) conditions as $(\beta + \alpha) < 1$

$\sigma_t{}^2 = \omega + \beta\sigma_{t-1}{}^2 + \alpha\varepsilon_{t-1}{}^2$ Substituted with values becomes

$$\sigma_t{}^2 = 0.0000004153 + 0.9645\sigma_{t-1}{}^2 + 0.12\varepsilon_{t-1}{}^2$$

The above model is the model that is used to predict variance then we find the square root of the estimated variance to get the standard deviation which will be used as the volatility in the Garman Kohlhagen model as illustrated below.

By use of simulation for a hypothetical foreign currency call and put option can be valued as shown below. Since strike price data is not available valuation of the currency option can be valued under for strike prices of 70, 80, 90 and 100 exchange rates for the USD. January 2013 USD/KSHS exchange rates are used to generate the variables inputted in the variance model which is used to estimate volatility for the period of January 2-15.

Table 3: Strike price at 70.

K=70							
Date January 2013	Exchange Rate	σ%	364 day T-Bill -CBK	r_f	T	Call Price	Put price
2	86.0769	1.7334	11.67%	15%	0.5	13.8249	9.2527E- 56
3	86.3569	1.7355	11.67%	15%	0.5	14.0847	1.7818E-57
4	86.4417	2.1387	11.67%	15%	0.5	14.1633	3.6419E-39
7	86.4264	2.1572	11.67%	15%	0.5	14.1491	1.7790E-38
8	86.4775	2.1611	11.67%	14%	0.5	14.5987	2.0432E-40
9	86.5242	2.1609	11.67%	13%	0.5	15.0466	1.5563E-42
10	86.6053	2.1588	11.67%	14%	0.5	14.7179	4.7017E-41
11	86.6722	2.1719	11.67%	14%	0.5	14.7802	6.9805E-41
14	86.6844	2.1673	11.67%	14%	0.5	14.7916	4.2508E-41
15	86.6853	2.0142	11.67%	14%	0.5	14.7924	3.7089E-47

First for the analysis of the model in practice first we look at the foreign currency option having a strike price of 70.The strike price of 70 is below the spot exchange rates which are above 86 for the simulation period of January 2013 and hence its advantageous for the currency call holders to exercise the calls as they would gain while for put holders they would lose out hence no put holder would exercise their put currency options. For this reason based on the laws of demand and supply and practical options trading we have a higher demand for currency call options hence the higher price compared to the currency put options. The price of the currency call option ranges between $13.82 - 15.04$ while the currency put option prices for this period of simulation are statistically Zero as shown in the above table.

Table 4: Strike price at 80.

K=80							
Date January 2013	Exchange Rate	σ%	364 day T-Bill CBK	r_f	T	Call Price	Put price
2	86.0769	1.7340	0.1167	0.2	0.5	4.3917	3.7707E-07
3	86.3569	1.7355	0.1167	0.2	0.5	4.6515	9.9542E-08
4	86.4417	2.1387	0.1167	0.2	0.5	4.7302	7.6900E-06
7	86.4264	2.1572	0.1167	0.2	0.5	4.7160	9.5133E-06
8	86.4775	2.1611	0.1167	0.1	0.5	5.1655	1.8539E-06
9	86.5242	2.1609	0.1167	0.1	0.5	5.6134	3.1287E-07
10	86.6053	2.1588	0.1167	0.1	0.5	5.2847	1.141E-06
11	86.6722	2.1719	0.1167	0.1	0.5	5.3470	1.0245E-06
14	86.6844	2.1673	0.1167	0.1	0.5	5.3584	9.3387E-07
15	86.6853	2.0142	0.1167	0.1	0.5	5.3593	1.5616E-07

Now looking at the option prices at strike price of 80 where the strike price of 80 is below the spot exchange rates which are above 86 for the simulation period of January 2013 and hence its advantageous for the currency call holders to exercise the calls as they would gain while for put holders they would lose out hence no put holder would exercise their put currency options. For this reason based on the laws of demand and supply and practical options trading we have a higher demand for currency call options hence the higher price compared to the currency put options. The price of the currency call option ranges between 4.39-5.61 while the currency put option prices for this period of simulation are statistically Zero as shown in the above table.

From above we can see that the call prices are lower that for the strike price of 70 and this is for the reason that the strike price of 80 is closer to the spot exchange rate than that of 70.

Table 5: Strike price at 90.

K=90							
Date-January 2013	Exchange Rate (S)	σ%	364 day T-Bill -CBK	r_f	T	Call Price	Put price
2	86.0769	1.7350	11.67%	15%	0.5	5.6039E-08	5.0415
3	86.3569	1.7360	11.67%	15%	0.5	13.2211	4.7817
4	86.4417	2.1387	11.67%	15%	0.5	2.4276E-05	4.7031
7	86.4264	2.1572	11.67%	15%	0.5	2.6718E-05	4.7173
8	86.4775	2.1611	11.67%	14%	0.5	0.0002	4.2678
9	86.5242	2.1609	11.67%	13%	0.5	0.0005	3.8202
10	86.6053	2.1588	11.67%	14%	0.5	0.0002	4.1487
11	86.6722	2.1719	11.67%	14%	0.5	0.0002	4.0864
14	86.6844	2.1673	11.67%	14%	0.5	0.0002	4.0750
15	86.6853	2.0142	11.67%	14%	0.5	8.3214E-05	4.0740

Now looking at the option prices at strike price of 90 where the strike price of 90 is now above the spot exchange rates which are above 86 for the simulation period of January 2013 and hence its advantageous for the currency put holders to exercise the puts as they would gain for they can buy the currency from the foreign currency market at a lower exchange rate of 86 and then sell it at 90 hence gaining from exercising their put options.

while for call holders they would lose out by exercising the currency call options as they will be buying the currency at 90 and can only sell the currency to the market at only 86 hence no call holder would exercise their call currency options. For this reason based on the laws of demand and supply and practical options trading we have a higher demand for currency put options hence the higher price compared to the currency call options. The price of the currency put option ranges between 3.82-5.04 while the currency call option prices for this period of simulation are statistically Zero as shown in the above table.

Table 6: Strike price at 100.

Date-January 2013	Exchange Rate (S)	σ%	364 day T-Bill -CBK	r_f	T	Call Price	Put price
2	86.0769	1.7334	11.67%	15%	0.5	1.8741E-43	14.4747
3	86.3569	1.7355	11.67%	15%	0.5	8.0845E-42	14.2149
4	86.4417	2.1387	11.67%	15%	0.5	4.1739E-28	14.1362
7	86.4264	2.1573	11.67%	15%	0.5	1.0109E-27	14.1504
8	86.4775	2.1611	11.67%	14%	0.5	6.1503E-26	13.7009
9	86.5242	2.16087	11.67%	13%	0.5	2.5321E-24	13.2530
10	86.6053	2.1588	11.67%	14%	0.5	1.5031E-25	13.5817
11	86.6722	2.1719	11.67%	14%	0.5	4.7899E-25	13.5193
14	86.6844	2.1673	11.67%	14%	0.5	4.2179E-25	13.5080
15	86.6853	2.0142	11.67%	14%	0.5	1.1231E-28	13.5071

(Note: K=100)

Now finally looking at the option prices at strike price of 100 where the strike price of 100 is now above the spot exchange rates which are above 86 for the simulation period of January 2013 and hence its advantageous for the currency put holders to exercise the puts as they would gain for they can buy the currency from the foreign currency market at a lower exchange rate of 86 and then sell it at 100 hence gaining from exercising their put options. while for call holders they would lose out by exercising the currency call options as they will be buying the currency at 100 and can only sell the currency to the market at only 86 hence no call holder would exercise their call currency options.

For this reason based on the laws of demand and supply and practical options trading we have a higher demand for currency put options hence the higher price compared to the currency call options. The price of the currency put option ranges between 13.25-14.47 while the currency call option prices for this period of simulation are statistically Zero as shown in the above table. From above we can see that the currency put prices are higher

for the strike price of 100 compared to that of 90 and this is due to the fact that at strike price of 100 is further away from the spot exchange rates of 86 hence you will be gaining more when you exercise the put currency options hence the higher price.

4.4 Summary and Interpretation of Findings

The research used a two-step approach in pricing of foreign currency options in Kenya by first developing a model for predicting volatility and then plugging the predicted volatility estimates into the Garman Kohlhagen model to obtain the price of the foreign currency options in Kenya. The research used regression analysis and the Garch (1, 1) model to formulate a model for predicting variance. The predicted variance estimates are then converted into volatility estimates that are in turn used in valuation of foreign currency options. The Garch (1, 1) model obtained   yields an appropriate model which has a high coefficient of determination of 0.990 and this implies that the Garch (1, 1) is a good model for fitting volatility using the USD/KSHS daily exchange rate data. The model also satisfies Garch (1, 1) condition for the coefficients in the model ($\beta+\alpha=0.9765$) <1 and this shows that the model is a good fit for actual data.

The selected independent variables of the previous day squared log returns and previous day's variance determine to a large extent current day's variance estimates. From the above simulated foreign currency option prices as shown in tables 3-6 where we have strike prices of 70,80,90 and 100 the foreign currency call price is higher than the currency put price which is almost statistically zero when the strike price is below the daily spot exchange rates for the strike prices of 70 and 80. This is due to the fact that when the strike is below the spot exchange rate exercising the currency call options a holder of the currency call option would gain as he can buy the currency at the lower strike price and sell it in the market at the higher exchange rate. While for the foreign currency put option holders they would lose out if they exercised the puts for they would have to sell the currency at a lower price than that that they can freely obtain from the foreign exchange market. When the strike price is above the daily spot exchange rate as shown in tables 5 and 6 the foreign currency options the foreign currency put price is higher than the currency call price which is almost statistically zero when the strike price is above the daily spot exchange rates for strike prices of 90 and 100.

 This is due to the fact that when the strike is above the spot exchange rate exercising the currency put options a holder of the currency put option would gain as he can buy the currency at the lower spot exchange rate and sell it at the higher spot exchange rate. While for the foreign currency call option holders they would lose out if they exercised the calls

for they would have to pay more than the market spot exchange rate for the currency and hence they would not exercise them.

From above simulation as shown in tables 3, 4, 5 and 6 using January 2013 USD/KSHS exchange rate data foreign currency options can be valued in Kenya and the results obtained show that the valuation is consistent with previous literature and studies done on the valuation of foreign currency options especially the studies that used the GARCH pricing like in Dontwi, Dedu and Biney (2010)in pricing of foreign currency options in a developing financial Market in Ghana. The exchange rates between January 2-15 range between 86.0769-86.6853 and using the strike prices of 70, 80, 90 and 100 this study yields results consistent with previous theories and literature. From theory and previous studies done in the area of currency options valuation for call options, the higher the strike price, the cheaper the currency call option and for put option the lower the strike price the cheaper the currency put option. This model results also shows that the Garch (1, 1) also yields a good model for estimating the variance and the volatility used in pricing of foreign currency options.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

The main objective of this study was to show how foreign currency options can be valued in Kenya under stochastic volatility and also to come up with a model for predicting variance and volatility of exchange rates. This research used descriptive research design which is a scientific method which involves observing and describing the behavior of a subject without influencing it in any way. The research looked at USD/KSHS exchange rate in the past and analyses it to come up with a pricing model for foreign currency options in Kenya. The research looked at various literatures on valuation of foreign currency options identifying the major models used. The research sought to show how currency options can be valued in Kenya under stochastic volatility.

The study used Garman Kohlhagen model for valuation of foreign currency options whereby two interest rates of domestic and foreign risk free rate. The study used Garch (1, 1) model to fit the variance regression line which was used to predict variance and subsequently the volatility that is plugged into the Garman Kohlhagen model. The research had various findings that were consistent with previous research done in the area of valuation of currency options. The research found out that for call options when the spot exchange rate is below the strike price the option has statistically zero value and when above strike price the option has a positive value. On the other hand the price of a put currency option is positive when the spot exchange rate is below the strike price and statistically zero when the spot exchange rates are above the strike prices and the further away from the strike price the spot exchange rate is the higher the value of the option.

5.2 Conclusions

From the findings various conclusions can be drawn. First from the findings the Garch (1, 1) model used for predicting variance used for predicting the volatility used in valuation of foreign currency yields an appropriate model which has a high coefficient of determination of 0.990 and this implies that the Garch (1,1) is a good model for fitting volatility using the USD/KSHS exchange rate data. The model also satisfies Garch (1, 1) condition for the coefficients in the model

$(\beta + \alpha = 0.9765)\ < 1$ And this shows that the model is a good fit for actual data

From the study another conclusion is that the prices of currency call and put option obtained from the model are consistent with historical literature and empirical studies in the area of foreign currency options valuation. From the research findings we can conclude that if the spot exchange rate is below or above the strike price of the foreign currency determines to a great extent thee price of the foreign currency option.

When the spot exchange rate is below the currency option strike price the price of the currency call option is statistically zero and the price of the currency put option is positive as a holder of the put option would gain from exercising them hence high demand and price subsequently. On the other hand when the spot exchange rate is above the strike price the price of the currency put option is statistically zero and the price of the currency call option is positive as the holders of the currency options would gain by exercising the call options and hence high demand and price of the currency call options. Hence the further the spot exchange rate is from the strike price the higher the price of the foreign currency calls and put option.

5.3 Policy Recommendations

For introduction of currency options in Kenya the first policy recommendation is to formulate a good and robust regulation framework. Under this the Central bank of Kenya should formulate an adequate regulatory framework for introduction of derivative trading in Kenya. The regulatory framework should give definitions of the various derivative instruments like swaps, calls, puts and clearly spell out the procedures that will be followed when trading in the derivatives trading. For currency options the regulatory framework should indicate the minimum trade of the currency options allowable, clearly spell out conditions that you need to fulfill in order to be allowed to trade in the currency options for the dealers.

The Central Bank of Kenya and the Capital markets authority should also spearhead faster introduction of an options market in Kenya where options and other derivatives and futures can be traded. The options market will be very important as it will provide increased liquidity in the financial market. The options market will also be another source of capital and it will be very essential in management of risks associated with various underlying assets like foreign exchange rates which are volatile. The options market will also enhance stability of importers and exporters cash flows and this will in turn lead to a more stable economy.

The Central bank of Kenya should adopt measures to improve market efficiency especially in the foreign exchange market whereby stable macroeconomic policies should be adopted and the foreign exchange market left to operate more freely devoid of interference. Exchange rates should be determined by market forces of demand and supply and be more liberalized and with the increased efficiency in the foreign exchange market this will lead to better and more accurate models of valuation of foreign currency options in Kenya.

5.4 Limitations of the Study

When conducting this various limitations were encountered. The first limitation was the lack of an options market in Kenya and this is the main limitation to this study for one to ascertain how good the model is in valuation of foreign currency options you need to compare the price obtained from the model and the prices that are in the options market. The prices given by model should of valuation of foreign currency options should be consistent with the prices of the same options in the actual options market for foreign currency options.

Another limitation is the lack of high levels of efficiency in the foreign exchange market especially informational efficiency and the foreign exchange market in Kenya is subject to interference through various macroeconomic policies and the market is even subject to political interference. This interference inhibits the foreign exchange market which affects foreign exchange rates which in turn affects the quality of the model obtained.

Another limitation of the study is the assumptions in the study of no taxes and no transaction costs some of which are not realistic. This has an impact for in today's financial markets taxes are in all financial transactions and transaction costs are in all financial dealings as the financial intermediaries usually charge a commission and in this study we assume no transaction costs which in reality is not possible in reality of today's financial markets.

Another limitation of this study is that some variables used do not exist like the strike prices where valuation of the foreign currency options have to be valued by simulation of prices of the foreign currency options at various strike price of 70, 80, 90 and 100.

5.5 Suggestions for Further Studies

Further studies relating to this study can be done in the following areas. First valuation of currency options under constant volatility using Black Scholes model can be conducted and here volatility would be constant and not vary as in this study and the resulting valuation of currency options can be compared with the values of the foreign currency options obtained in this study.

The volatility risk premium embedded in currency options whereby volatility risk premium can be analyzed for over the counter currency options. Here we analyze if volatility has a term structure which volatility risk premium decreases towards maturity of the option. Here we look at volatility and how volatility varies in the life of the currency option up to the maturity date of the currency option.

Hedging with foreign currency options is another area where additional studies can be conducted and here one can look at how you can use the currency options to hedge against foreign currency risk. Here one will be able to come up with hedging strategies, whether to purchase a call or a put and the volume to purchase.

Another area that further studies can be conducted is the pricing of currency Swap. Currency swap is the best way to fully hedge a loan transaction as the terms can be structured to exactly mirror the underlying loan. It is also flexible in that it can be structured to fully hedge a fixed rate loan with a combined currency and interest ratehedge via a fixed-floating cross currency swap. The currency swaps will be an additional tool for hedging against financial risk.

REFERENCES

Amin, K., and R. Jarrow (1991) "Pricing Foreign Currency Options Under Stochastic Interest Rates," *Journal of International Money and Finance*, 10, 310-329.

Bakaert, G.(1994) "Exchange rate Volatility and Derivations from Unbiasedness in Cash-in-Advance   Model, "*Journal of International Economics*, 36, 29-52

Biger, N., and J. Hull, (1983) "The Valuation of currency Options," *Financial Management*, 12, 24-28

Black, F. (1976), "The Pricing of Commodity Contracts," Journal of Financial Economics, 3, 167-179

Black, F., and M. Scholes (1973) "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy,* 81, 637-655

Bodurtha, J. N. Jr., and G.R Courtadon, "Test Of an American Option Pricing Model on Foreign Currency Option Market," *Journal of Financial and Quantitave Analysis*, 1987, 22, 153-167

German, M. B., and S. W. Kohlhagen (1983) "Foreign Currency Option Values," Journal of International Money and Finance, 2, 231-237

Jorion, P.., (1988) "On Jump Processes in the Foreign Exchange and Stock Markets," *Review of Financial Studies*, 1, No. 4, 427-445

Fabozzi, Hauser and Yaari, (1990), "Early Exercise of foreign currency options: Determinants of American premium and critical exchange rate". *Advances in Futures and Options Research, Volume* 4, pages 219-236.

Heston, S. (1993) "A Closed-Form Solution for Options with Stochastic Volatility," *Review of Financial Studies* 6, 327-344.

Gesser, V. and P. Poncet (1997), "Volatility Patterns: Theory and Some Evidence from the Dollar-Mark Option Market," *Journal of Derivatives*, 5, 46-65.

MacBeth, J.D., and L.J. Merville,(1979) "An Empirical Examination of Black-Scholes Call Option Pricing Model," *Journal of Finance*, 34, 1173-1186

Melino, A., and S. Turnbull, (1990), "Pricing Foreign Currency Options With Stochastic Volatility," *Journal of Econometrics'*, 45,239-265

Heston, S., and S. Nandi,(2000) "A Closed Form GARCH Option Pricing Model", *The Review Of Financial Studies* , 13, 585-625. ,

Melino, A., and S. Turnbull (1991,) "The Pricing of currency Options," Canadian Journal of Economics, 24, 251-281

Aloo (2011), "An exploratory study of currency options in Kenya financial market" *MBA Thesis, United States International University*.

Bakshi, G., C. Cao and Z. Chen (1997), "Empirical Performance of Alternative Option Pricing models" *The Journal of Finance*, 53, 499-547.

Bates, D. (1996), "Jumps and Stochastic Volatility: Exchange Rate Processes Implicit in Deutsche Market Options," *Reviews of Financial Studies*, 9, 69-107.

Cox, J. C., Ingersoll, J. E, and Ross, S. A. (1985), "An Intertemporal General Equilibrium Model of Asset Prices," *Econometric*, 53, 363-384.

Day, T. E., and Lewis, C. M. (1992), "Stock Market Volatility and the Information Content of Stock Index Options," *Journal of Econometrics*, 52, 267-287.

Fleming, J. (1998), "The Quality of Market Volatility Forecasts Implied by S&P 100 Index Option Prices," *Journal of Empirical Finance*, 5, 317-345.

Guo, D. (1996), "The Predictive Power of Implied Stochastic Variance From Currency Options," *Journal of Futures Markets*, 16, 915-942.

Guo, D. (1998), "The Risk Premium of Volatility Implicit in Currency Options, *"Journal of Business & Economic Statistics*, 16, 498-507.

Hsieh, D. A. (1989), "Modeling Heteroscedasticity in Daily Foreign Exchange Rates*," Journal of Business and Economic Statistics,* 7, 307-317.

Hull, J., and White, A. (1987), "The Pricing of Options on Assets with Stochastic Volatility," *Journal of Finance*, 42,281-300.

Nandi, S. (1998), "How Important Is the Correlation between Returns and Volatility in A Stochastic Volatility Model? Empirical Evidence from Pricing and Hedging in the S&P 500 Index Options Market," *Journal of Banking and Finance*, 22, 589-610.

Stein, E. M., and Stein, J. C. (1991), "Stock Price Distributions with Stochastic Volatility: An Analytic Approach," *Reviews of Financial Studies*, 4, 727-752.

Whaley, R. E. (1982), "Valuation of American Call Options on Dividend Paying Stocks: Empirical Tests," *Journal of Financial Economics*, 10, 29-58

Chesney, M. and Scott, L., (1989) "Pricing European Currency Options: A comparison of the Modified Black-Scholes model and a random variance model" *Journal of Financial and Quantitative Analysis*, Vol. 24, pp. 267-284,

Mixon, S., (2009) Option markets and implied volatility: Past versus present, *Journal of Financial Economics,* 94, 171-191latility," Journal of Econometrics, 45, 7-39.

Mixon, S., (2011), the Foreign Exchange Option Market, 1917-1921.

Wiggins, J. (1987), "Option Values Under Stochastic Volatility: Theory and Empirical Estimates," *Journal of Financial Economics*, 19, 351-372.

Abken, Peter A. and Nandi, Saikat, (1996), "Options and Volatility", *Economic Review - Federal Reserve Bank of Atlanta*, Vol. 81, pp. 21-35,

Baillie, R. T. and T. Bollerslev (1990), "Intra-day and Inter-market Volatility in Foreign Exchange Rates", *Review of Economic Studies*, 58, 565-85.

Bardhan, Indrajit, (1995) "Exchange rate shocks, currency options and the Siegel paradox," *Journal of International Money and Finance*, 14, 441-458,

Bollerslev, T. (1986) "Generalized Autoregressive Conditional Heteroscedasticity". *Journal of Econometrics*, 31, 307-327.

Bollen, P. B., S. F. Gray and R. E. Whaley (2000), "Regime-Switching in Foreign Exchange Rates: Evidence from Currency Option Prices", *Journal of Econometrics,* 94

Bollen and Basiel, (2003), "The performance of alternative valuation models in the OTC currency options market"; *Journal of International Money and Finance, vol* 22, pp. 33–64

Kotz´e, (2011), "Foreign Exchange Derivatives: Advanced Hedging and trading techniques.

Lampros Kalivas and NikolaosDritsakis. (1997) "Volatility Forecasting Techniques and Volatility Trading: the case of currency options".

Brails ford, Timothy J. and Faff, Robert W., (1996) "An evaluation of volatility forecasting techniques", *Journal of Banking and Finance, Vo*l. 20, pp. 419-438,

Campa, J.M., Chang, P.H., 1995. "Testing the expectations hypothesis on the term structure of volatilities in foreign exchange options*". Journal of Finance 50* (2), 529–547.

Campa, J.M., Chang, P.H., 1998. "The forecasting ability of correlations implied in foreign exchange options". *Journal of International Money and Finance* 17 (6), 855–880

Chance, D.M., and Brooks, R., (2008), "An Introduction to Derivatives and Risk Management", Seventh Edition, Thomson South-Western, Mason, Ohio.

Chen and Gau (2004), "Pricing Currency Options Under Stochastic Volatility*"; National Cheng Chi University*.

Dontwi, Dedu and Biney (2010), "Pricing of Foreign Currency Options in a Developing Financial Market", Vol.45 No.4, pp.608-619

Duan, J.C. (1995), "The GARCH option pricing model", *Mathematical Finance 5,* 13{32.

Duan, J.C. (1996), "A unified theory of option pricing under stochastic volatility from GARCH to diffusion". *Working paper, Hong Kong University of Science and Technology.*

Duan, J.C., Gauthier, G. &Simonato, J. (1999), "An analytical approximation for the GARCH Option pricing model", Journal of Computational Finance 2, 75{116.

Jorion, Philippe (1995) "Predicting Volatility in the Foreign Exchange Market", *The Journal of Finance* , Vol. 1, No. 2, pp. 507-528,

Natenberg, Sheldon, (1994) Option Volatility and Pricing, Irwin Professional Publishing.

APPENDICES

APPENDIX 1:

Date	Exchange Rate-Mean Rate	Un-1	(Un-1)^2	daily volatilitly	standard deviation	standard deviation %	garch volatility
2	86.0769	6.16E-07	3.95E-07	0.00000119	0.01733956	1.73395590	0.00000110623
3	86.3569	3.15E-07	3.96E-07	0.00000120	0.01735500	1.73549983	0.00000835172
4	86.4417	1.05471E-05	7.11E-07	0.00000182	0.02138662	2.13866191	0.00000261108
7	86.4264	9.63322E-07	7.27E-07	0.00000185	0.02157176	2.15717596	0.00000076062
8	86.4775	3.13338E-08	7.31E-07	0.00000185	0.02161130	2.16113022	0.00000040130
9	86.5242	3.49375E-07	7.30E-07	0.00000185	0.02160869	2.16086907	0.00000011725
10	86.6053	2.91469E-07	7.29E-07	0.00000185	0.02158834	2.15883403	0.00000019914
11	86.6722	8.77727E-07	7.40E-07	0.00000187	0.02171929	2.17192908	0.00000013274
14	86.6844	5.96249E-07	7.36E-07	0.00000186	0.02167331	2.16733148	0.00000030516
15	86.6853	1.98107E-08	6.07E-07	0.00000161	0.02014238	2.01423830	0.00000012068
16	86.6989	1.07795E-10	6.01E-07	0.00000160	0.02006569	2.00656887	0.00000012313
17	86.7042	2.46104E-08	5.89E-07	0.00000157	0.01991544	1.99154423	0.00000011695
18	86.8653	3.73678E-09	5.85E-07	0.00000157	0.01987272	1.98727215	0.00000171104
21	86.8531	3.44591E-06	6.53E-07	0.00000170	0.02069584	2.06958378	0.00000203880
22	86.9792	1.97282E-08	6.59E-07	0.00000171	0.02076970	2.07697040	0.00000136052
23	87.3794	2.10489E-06	6.85E-07	0.00000176	0.02108362	2.10836233	0.00000514929
24	87.4694	2.10731E-05	1.27E-06	0.00000292	0.02711344	2.71134395	0.00000627526
25	87.5206	1.05979E-06	1.25E-06	0.00000287	0.02691404	2.69140404	0.00000021194
28	87.5828	3.42431E-07	1.25E-06	0.00000287	0.02689871	2.68987101	0.00000012612
29	87.5906	5.04721E-07	1.25E-06	0.00000287	0.02689653	2.68965263	0.00000029893
30	87.5861	7.93072E-09	1.24E-06	0.00000285	0.02681749	2.68174903	0.00000012202
31	87.6111	2.63956E-09	1.24E-06	0.00000285	0.02681997	2.68199696	0.00000016816

APPENDIX 2:

Date	Exchange Rate	σ %	364 day T-Bill -CBK	r_f	T
2	86.0769	1.7340	11.67%	15%	0.50
3	86.3569	1.7355	11.67%	15%	0.50
4	86.4417	2.1387	11.67%	15%	0.50
7	86.4264	2.1572	11.67%	15%	0.50
8	86.4775	2.1611	11.67%	14%	0.50
9	86.5242	2.1610	11.67%	13%	0.50
10	86.6053	2.1588	11.67%	14%	0.50
11	86.6722	2.1719	11.67%	14%	0.50
14	86.6844	2.1673	11.67%	14%	0.50
15	86.6853	2.0142	11.67%	14%	0.50
16	86.6989	2.0066	11.67%	14%	0.50
17	86.7042	1.9915	11.67%	14%	0.50
18	86.8653	1.9873	11.67%	14%	0.50
21	86.8531	2.0696	11.67%	14%	0.50
22	86.9792	2.0770	11.67%	14%	0.50
23	87.3794	2.1084	11.67%	15%	0.50
24	87.4694	2.7113	11.67%	15%	0.50
25	87.5206	2.6914	11.67%	15%	0.50
28	87.5828	2.6899	11.67%	16%	0.50
29	87.5906	2.6897	11.67%	15%	0.50
30	87.5861	2.6817	11.67%	15%	0.50
31	87.6111	2.6820	11.67%	15%	0.50

APPENDIX 3:

Date	CRNCY	Un-1	(Un-1)^2	standard deviation	daily volatilitly	standard deviation %	garch volatility
9/4/2010	80.750	0.0000	0.0000			0.0000%	
9/6/2010	80.850	0.0012	0.0000	0.0009	0.0000	0.0876%	0.0000
9/7/2010	81.100	0.0031	0.0000	0.0013	0.0000	0.1311%	0.0000
9/8/2010	81.300	0.0025	0.0000	0.0004	0.0000	0.0443%	0.0000
9/9/2010	81.200	-0.0012	0.0000	0.0026	0.0000	0.2614%	0.0000
9/10/2010	81.050	-0.0018	0.0000	0.0004	0.0000	0.0436%	0.0000
9/13/2010	80.950	-0.0012	0.0000	0.0004	0.0000	0.4338%	0.0000
9/14/2010	81.050	0.0012	0.0000	0.0017	0.0000	1.7459%	0.0000
9/15/2010	80.850	-0.0025	0.0000	0.0026	0.0000	2.6184%	0.0000
9/16/2010	80.650	-0.0025	0.0000	0.0000	0.0000	0.0043%	0.0000
9/17/2010	80.750	0.0012	0.0000	0.0026	0.0000	2.6259%	0.0000
9/18/2010	80.650	-0.0012	0.0000	0.0018	0.0000	1.7524%	0.0000
9/20/2010	80.950	0.0037	0.0000	0.0035	0.0000	3.5060%	0.0000
9/21/2010	81.150	0.0025	0.0000	0.0009	0.0000	0.8833%	0.0000
9/22/2010	80.950	-0.0025	0.0000	0.0035	0.0000	3.4897%	0.0000
9/23/2010	81.200	0.0031	0.0000	0.0039	0.0000	3.9265%	0.0000
9/24/2010	80.950	-0.0031	0.0000	0.0044	0.0000	4.3608%	0.0000
9/25/2010	80.950	0.0000	0.0000	0.0022	0.0000	2.1771%	0.0000
9/27/2010	80.900	-0.0006	0.0000	0.0004	0.0000	0.4368%	0.0000
9/28/2010	80.950	0.0006	0.0000	0.0009	0.0000	0.8738%	0.0000
9/29/2010	80.750	-0.0025	0.0000	0.0022	0.0000	2.1840%	0.0000
9/30/2010	80.850	0.0012	0.0000	0.0026	0.0000	2.6227%	0.0000
10/1/2010	80.850	0.0000	0.0000	0.0009	0.0000	0.8757%	0.0000
10/2/2010	80.850	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/4/2010	80.850	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/5/2010	80.750	-0.0012	0.0000	0.0009	0.0000	0.8746%	0.0000
10/6/2010	80.650	-0.0012	0.0000	0.0000	0.0000	0.0011%	0.0000
10/7/2010		-0.0019	0.0000	0.0004	0.0000	0.4395%	0.0000

Date	Price						
	80.500						
10/8/2010	80.600	0.0012	0.0000	0.0022	0.0000	2.1935%	0.0000
10/9/2010	80.600	0.0000	0.0000	0.0009	0.0000	0.8784%	0.0000
10/11/2010	80.650	0.0006	0.0000	0.0004	0.0000	0.4387%	0.0000
10/12/2010	80.850	0.0025	0.0000	0.0013	0.0000	1.3149%	0.0000
10/13/2010	80.800	-0.0006	0.0000	0.0022	0.0000	2.1908%	0.0000
10/14/2010	80.450	-0.0043	0.0000	0.0026	0.0000	2.6257%	0.0000
10/15/2010	80.500	0.0006	0.0000	0.0035	0.0000	3.5024%	0.0000
10/16/2010	80.500	0.0000	0.0000	0.0004	0.0000	0.4395%	0.0000
10/18/2010	80.800	0.0037	0.0000	0.0026	0.0000	2.6352%	0.0000
10/19/2010	80.900	0.0012	0.0000	0.0018	0.0000	1.7600%	0.0000
10/21/2010	80.850	-0.0006	0.0000	0.0013	0.0000	1.3122%	0.0000
10/22/2010	80.750	-0.0012	0.0000	0.0004	0.0000	0.4376%	0.0000
10/23/2010	80.750	0.0000	0.0000	0.0009	0.0000	0.8746%	0.0000
10/25/2010	80.650	-0.0012	0.0000	0.0009	0.0000	0.8757%	0.0000
10/26/2010	80.730	0.0010	0.0000	0.0016	0.0000	1.5771%	0.0000
10/27/2010	80.800	0.0009	0.0000	0.0001	0.0000	0.0883%	0.0000
10/28/2010	80.800	0.0000	0.0000	0.0006	0.0000	0.6131%	0.0000
10/29/2010	80.800	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/30/2010	80.800	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/1/2010	80.750	-0.0006	0.0000	0.0004	0.0000	0.4376%	0.0000
11/2/2010	80.500	-0.0031	0.0000	0.0018	0.0000	1.7516%	0.0000
11/3/2010	80.550	0.0006	0.0000	0.0026	0.0000	2.6284%	0.0000
11/4/2010	80.200	-0.0043	0.0000	0.0035	0.0000	3.5117%	0.0000
11/5/2010	80.200	0.0000	0.0000	0.0031	0.0000	3.0725%	0.0000
11/6/2010	80.200	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/8/2010	80.550	0.0044	0.0000	0.0031	0.0000	3.0859%	0.0000
11/9/2010	80.500	-0.0006	0.0000	0.0035	0.0000	3.5248%	0.0000
11/10/2010	80.500	0.0000	0.0000	0.0004	0.0000	0.4389%	0.0000
11/11/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/12/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000

Date							
11/13/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/15/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/17/2010	80.250	-0.0031	0.0000	0.0022	0.0000	2.1960%	0.0000
11/18/2010	80.150	-0.0012	0.0000	0.0013	0.0000	1.3149%	0.0000
11/19/2010	80.100	-0.0006	0.0000	0.0004	0.0000	0.4400%	0.0000
11/20/2010	80.100	0.0000	0.0000	0.0004	0.0000	0.4411%	0.0000
11/22/2010	80.150	0.0006	0.0000	0.0004	0.0000	0.4414%	0.0000
11/23/2010	80.300	0.0019	0.0000	0.0009	0.0000	0.8820%	0.0000
11/24/2010	80.300	0.0000	0.0000	0.0013	0.0000	1.3233%	0.0000
11/25/2010	80.400	0.0012	0.0000	0.0009	0.0000	0.8806%	0.0000
11/26/2010	80.800	0.0050	0.0000	0.0026	0.0000	2.6374%	0.0000
11/27/2010	80.800	0.0000	0.0000	0.0035	0.0000	3.5179%	0.0000
11/29/2010	80.950	0.0019	0.0000	0.0013	0.0000	1.3127%	0.0000
11/30/2010	80.900	-0.0006	0.0000	0.0017	0.0000	1.7495%	0.0000
12/1/2010	80.650	-0.0031	0.0000	0.0017	0.0000	1.7484%	0.0000
12/2/2010	80.550	-0.0012	0.0000	0.0013	0.0000	1.3084%	0.0000
12/3/2010	80.500	-0.0006	0.0000	0.0004	0.0000	0.4378%	0.0000
12/4/2010	80.500	0.0000	0.0000	0.0004	0.0000	0.4389%	0.0000
12/6/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/7/2010	80.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/8/2010	80.650	0.0019	0.0000	0.0013	0.0000	1.3176%	0.0000
12/9/2010	80.600	-0.0006	0.0000	0.0018	0.0000	1.7560%	0.0000
12/10/2010	80.600	0.0000	0.0000	0.0004	0.0000	0.4384%	0.0000
12/11/2010	80.600	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/14/2010	80.500	-0.0012	0.0000	0.0009	0.0000	0.8773%	0.0000
12/15/2010	80.650	0.0019	0.0000	0.0022	0.0000	2.1949%	0.0000
12/16/2010	80.550	-0.0012	0.0000	0.0022	0.0000	2.1944%	0.0000
12/17/2010	80.500	-0.0006	0.0000	0.0004	0.0000	0.4378%	0.0000
12/18/2010	80.500	0.0000	0.0000	0.0004	0.0000	0.4389%	0.0000
12/20/2010	80.450	-0.0006	0.0000	0.0004	0.0000	0.4392%	0.0000
12/21/2010		0.0000	0.0000	0.0004	0.0000	0.4392%	0.0000

Date	Price						
	80.450						
12/22/2010	80.550	0.0012	0.0000	0.0009	0.0000	0.8789%	0.0000
12/23/2010	80.600	0.0006	0.0000	0.0004	0.0000	0.4400%	0.0000
12/24/2010	80.650	0.0006	0.0000	0.0000	0.0000	0.0003%	0.0000
12/27/2010	80.650	0.0000	0.0000	0.0004	0.0000	0.4387%	0.0000
12/28/2010	80.650	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/29/2010	80.700	0.0006	0.0000	0.0004	0.0000	0.4384%	0.0000
12/30/2010	80.800	0.0012	0.0000	0.0004	0.0000	0.4378%	0.0000
12/31/2010	80.800	0.0000	0.0000	0.0009	0.0000	0.8762%	0.0000
1/3/2011	80.800	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
1/4/2011	80.950	0.0019	0.0000	0.0013	0.0000	1.3127%	0.0000
1/5/2011	81.100	0.0019	0.0000	0.0000	0.0000	0.0024%	0.0000
1/6/2011	81.100	0.0000	0.0000	0.0013	0.0000	1.3103%	0.0000
1/7/2011	81.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
1/8/2011	81.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
1/10/2011	81.250	0.0018	0.0000	0.0013	0.0000	1.3078%	0.0000
1/11/2011	81.100	-0.0018	0.0000	0.0026	0.0000	2.6133%	0.0000
1/12/2011	81.100	0.0000	0.0000	0.0013	0.0000	1.3054%	0.0000
1/13/2011	80.850	-0.0031	0.0000	0.0022	0.0000	2.1797%	0.0000
1/14/2011	80.950	0.0012	0.0000	0.0031	0.0000	3.0543%	0.0000
1/15/2011	80.950	0.0000	0.0000	0.0009	0.0000	0.8746%	0.0000
1/17/2011	81.100	0.0019	0.0000	0.0013	0.0000	1.3103%	0.0000
1/18/2011	81.000	-0.0012	0.0000	0.0022	0.0000	2.1822%	0.0000
1/19/2011	81.100	0.0012	0.0000	0.0017	0.0000	1.7449%	0.0000
1/20/2011	81.100	0.0000	0.0000	0.0009	0.0000	0.8730%	0.0000
1/21/2011	81.050	-0.0006	0.0000	0.0004	0.0000	0.4359%	0.0000
1/22/2011	81.100	0.0006	0.0000	0.0009	0.0000	0.8722%	0.0000
1/24/2011	81.100	0.0000	0.0000	0.0004	0.0000	0.4362%	0.0000
1/25/2011	81.050	-0.0006	0.0000	0.0004	0.0000	0.4359%	0.0000
1/26/2011	81.000	-0.0006	0.0000	0.0000	0.0000	0.0003%	0.0000
1/27/2011	81.050	0.0006	0.0000	0.0009	0.0000	0.8727%	0.0000

1/28/2011	81.150	0.0012	0.0000	0.0004	0.0000	0.4359%	0.0000
1/29/2011	81.150	0.0000	0.0000	0.0009	0.0000	0.8724%	0.0000
1/31/2011	81.250	0.0012	0.0000	0.0009	0.0000	0.8714%	0.0000
2/1/2011	81.200	-0.0006	0.0000	0.0013	0.0000	1.3065%	0.0000
2/2/2011	81.100	-0.0012	0.0000	0.0004	0.0000	0.4357%	0.0000
2/3/2011	81.150	0.0006	0.0000	0.0013	0.0000	1.3068%	0.0000
2/4/2011	81.150	0.0000	0.0000	0.0004	0.0000	0.4359%	0.0000
2/7/2011	81.250	0.0012	0.0000	0.0009	0.0000	0.8714%	0.0000
2/8/2011	81.250	0.0000	0.0000	0.0009	0.0000	0.8714%	0.0000
2/9/2011	81.250	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
2/10/2011	81.350	0.0012	0.0000	0.0009	0.0000	0.8703%	0.0000
2/11/2011	81.450	0.0012	0.0000	0.0000	0.0000	0.0011%	0.0000
2/12/2011	81.450	0.0000	0.0000	0.0009	0.0000	0.8692%	0.0000
2/14/2011	81.450	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
2/15/2011	81.350	-0.0012	0.0000	0.0009	0.0000	0.8681%	0.0000
2/16/2011	81.400	0.0006	0.0000	0.0013	0.0000	1.3028%	0.0000
2/17/2011	81.500	0.0012	0.0000	0.0004	0.0000	0.4341%	0.0000
2/18/2011	81.750	0.0031	0.0000	0.0013	0.0000	1.3004%	0.0000
2/19/2011	81.750	0.0000	0.0000	0.0022	0.0000	2.1690%	0.0000
2/21/2011	81.800	0.0006	0.0000	0.0004	0.0000	0.4325%	0.0000
2/22/2011	81.900	0.0012	0.0000	0.0004	0.0000	0.4320%	0.0000
2/23/2011	81.900	0.0000	0.0000	0.0009	0.0000	0.8644%	0.0000
2/24/2011	82.050	0.0018	0.0000	0.0013	0.0000	1.2951%	0.0000
2/25/2011	82.350	0.0037	0.0000	0.0013	0.0000	1.2903%	0.0000
2/26/2011	82.350	0.0000	0.0000	0.0026	0.0000	2.5854%	0.0000
2/28/2011	82.550	0.0024	0.0000	0.0017	0.0000	1.7173%	0.0000
3/1/2011	82.850	0.0036	0.0000	0.0009	0.0000	0.8524%	0.0000
3/2/2011	82.850	0.0000	0.0000	0.0026	0.0000	2.5697%	0.0000
3/3/2011	83.100	0.0030	0.0000	0.0021	0.0000	2.1337%	0.0000
3/4/2011	83.050	-0.0006	0.0000	0.0026	0.0000	2.5592%	0.0000
3/5/2011		0.0000	0.0000	0.0004	0.0000	0.4255%	0.0000

Date							
	83.050						
3/7/2011	83.100	0.0006	0.0000	0.0004	0.0000	0.4257%	0.0000
3/8/2011	83.080	-0.0002	0.0000	0.0006	0.0000	0.5959%	0.0000
3/9/2011	83.950	0.0105	0.0001	0.0076	0.0001	7.5749%	0.0001
3/10/2011	83.950	0.0000	0.0000	0.0074	0.0001	7.4047%	0.0001
3/11/2011	85.700	0.0208	0.0004	0.0147	0.0002	14.7402%	0.0002
3/12/2011	85.700	0.0000	0.0000	0.0147	0.0002	14.7402%	0.0002
3/14/2011	86.150	0.0053	0.0000	0.0037	0.0000	3.7129%	0.0000
3/15/2011	85.750	-0.0046	0.0000	0.0070	0.0000	6.9961%	0.0000
3/16/2011	85.950	0.0023	0.0000	0.0049	0.0000	4.9324%	0.0000
3/17/2011	85.600	-0.0041	0.0000	0.0045	0.0000	4.5287%	0.0000
3/18/2011	84.600	-0.0117	0.0001	0.0054	0.0000	5.3812%	0.0000
3/19/2011	84.600	0.0000	0.0000	0.0083	0.0001	8.2606%	0.0001
3/21/2011	84.600	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
3/22/2011	85.000	0.0047	0.0000	0.0033	0.0000	3.3433%	0.0000
3/23/2011	85.000	0.0000	0.0000	0.0033	0.0000	3.3433%	0.0000
3/24/2011	84.950	-0.0006	0.0000	0.0004	0.0000	0.4159%	0.0000
3/25/2011	84.400	-0.0065	0.0000	0.0042	0.0000	4.1621%	0.0000
3/26/2011	84.400	0.0000	0.0000	0.0046	0.0000	4.5781%	0.0000
3/28/2011	84.100	-0.0036	0.0000	0.0025	0.0000	2.5134%	0.0000
3/29/2011	83.600	-0.0059	0.0000	0.0017	0.0000	1.6906%	0.0000
3/30/2011	83.250	-0.0042	0.0000	0.0012	0.0000	1.2436%	0.0000
3/31/2011	83.150	-0.0012	0.0000	0.0021	0.0000	2.1110%	0.0000
4/1/2011	83.350	0.0024	0.0000	0.0026	0.0000	2.5502%	0.0000
4/2/2011	83.350	0.0000	0.0000	0.0017	0.0000	1.7008%	0.0000
4/4/2011	83.700	0.0042	0.0000	0.0030	0.0000	2.9693%	0.0000
4/5/2011	83.900	0.0024	0.0000	0.0013	0.0000	1.2796%	0.0000
4/6/2011	84.550	0.0077	0.0001	0.0038	0.0000	3.7886%	0.0000
4/7/2011	84.450	-0.0012	0.0000	0.0063	0.0000	6.3145%	0.0000
4/8/2011	84.100	-0.0041	0.0000	0.0021	0.0000	2.0943%	0.0000
4/9/2011	84.100	0.0000	0.0000	0.0029	0.0000	2.9306%	0.0000

Date	Price						
4/11/2011	84.200	0.0012	0.0000	0.0008	0.0000	0.8408%	0.0000
4/12/2011	84.100	-0.0012	0.0000	0.0017	0.0000	1.6806%	0.0000
4/13/2011	84.100	0.0000	0.0000	0.0008	0.0000	0.8398%	0.0000
4/14/2011	84.150	0.0006	0.0000	0.0004	0.0000	0.4204%	0.0000
4/15/2011	83.950	-0.0024	0.0000	0.0021	0.0000	2.1010%	0.0000
4/16/2011	83.950	0.0000	0.0000	0.0017	0.0000	1.6806%	0.0000
4/18/2011	83.850	-0.0012	0.0000	0.0008	0.0000	0.8423%	0.0000
4/19/2011	83.900	0.0006	0.0000	0.0013	0.0000	1.2639%	0.0000
4/20/2011	84.000	0.0012	0.0000	0.0004	0.0000	0.4211%	0.0000
4/21/2011	84.000	0.0000	0.0000	0.0008	0.0000	0.8428%	0.0000
4/26/2011	83.700	-0.0036	0.0000	0.0025	0.0000	2.5254%	0.0000
4/27/2011	83.750	0.0006	0.0000	0.0029	0.0000	2.9478%	0.0000
4/28/2011	83.400	-0.0042	0.0000	0.0034	0.0000	3.3775%	0.0000
4/29/2011	83.450	0.0006	0.0000	0.0034	0.0000	3.3790%	0.0000
4/30/2011	83.450	0.0000	0.0000	0.0004	0.0000	0.4239%	0.0000
5/3/2011	83.500	0.0006	0.0000	0.0004	0.0000	0.4237%	0.0000
5/4/2011	83.600	0.0012	0.0000	0.0004	0.0000	0.4232%	0.0000
5/5/2011	83.850	0.0030	0.0000	0.0013	0.0000	1.2677%	0.0000
5/6/2011	84.150	0.0036	0.0000	0.0004	0.0000	0.4153%	0.0000
5/7/2011	84.150	0.0000	0.0000	0.0025	0.0000	2.5299%	0.0000
5/9/2011	84.550	0.0048	0.0000	0.0034	0.0000	3.3612%	0.0000
5/10/2011	85.250	0.0083	0.0001	0.0025	0.0000	2.4931%	0.0000
5/11/2011	85.800	0.0065	0.0000	0.0013	0.0000	1.2922%	0.0000
5/12/2011	86.200	0.0047	0.0000	0.0013	0.0000	1.2654%	0.0000
5/13/2011	85.850	-0.0041	0.0000	0.0062	0.0000	6.1676%	0.0000
5/14/2011	85.850	0.0000	0.0000	0.0029	0.0000	2.8711%	0.0000
5/16/2011	86.330	0.0056	0.0000	0.0040	0.0000	3.9535%	0.0000
5/17/2011	86.650	0.0037	0.0000	0.0013	0.0000	1.3325%	0.0000
5/18/2011	87.100	0.0052	0.0000	0.0011	0.0000	1.0512%	0.0000
5/19/2011	86.150	-0.0109	0.0001	0.0114	0.0001	11.3846%	0.0001
5/20/2011		-0.0017	0.0000	0.0065	0.0000	6.4812%	0.0000

Date							
86.000							
5/21/2011 86.000	0.0000	0.0000	0.0012	0.0000	1.2312%	0.0000
5/23/2011 86.850	0.0099	0.0001	0.0070	0.0000	6.9888%	0.0000
5/24/2011 86.350	-0.0058	0.0000	0.0111	0.0001	11.0597%	0.0001
5/25/2011 86.400	0.0006	0.0000	0.0045	0.0000	4.4803%	0.0000
5/26/2011 85.650	-0.0087	0.0001	0.0065	0.0000	6.5475%	0.0000
5/27/2011 85.600	-0.0006	0.0000	0.0057	0.0000	5.7253%	0.0000
5/28/2011 85.600	0.0000	0.0000	0.0004	0.0000	0.4128%	0.0000
5/30/2011 86.000	0.0047	0.0000	0.0033	0.0000	3.3042%	0.0000
5/31/2011 85.850	-0.0017	0.0000	0.0045	0.0000	4.5376%	0.0000
6/2/2011 87.000	0.0134	0.0002	0.0107	0.0001	10.7053%	0.0001
6/3/2011 86.930	-0.0008	0.0000	0.0100	0.0001	10.0410%	0.0001
6/4/2011 86.930	0.0000	0.0000	0.0006	0.0000	0.5689%	0.0000
6/6/2011 87.050	0.0014	0.0000	0.0010	0.0000	0.9761%	0.0000
6/7/2011 87.800	0.0086	0.0001	0.0051	0.0000	5.1161%	0.0000
6/8/2011 87.550	-0.0028	0.0000	0.0081	0.0001	8.1056%	0.0001
6/9/2011 87.650	0.0011	0.0000	0.0028	0.0000	2.8211%	0.0000
6/10/2011 87.950	0.0034	0.0000	0.0016	0.0000	1.6126%	0.0000
6/11/2011 87.950	0.0000	0.0000	0.0024	0.0000	2.4202%	0.0000
6/13/2011 89.650	0.0193	0.0004	0.0137	0.0002	13.6678%	0.0002
6/14/2011 89.400	-0.0028	0.0000	0.0156	0.0002	15.6396%	0.0002
6/15/2011 88.350	-0.0117	0.0001	0.0063	0.0000	6.3331%	0.0000
6/16/2011 90.350	0.0226	0.0005	0.0243	0.0006	24.3119%	0.0006
6/17/2011 89.650	-0.0077	0.0001	0.0215	0.0005	21.4854%	0.0004
6/18/2011 89.650	0.0000	0.0000	0.0055	0.0000	5.4784%	0.0000
6/20/2011 90.850	0.0134	0.0002	0.0095	0.0001	9.4649%	0.0001
6/21/2011 91.700	0.0094	0.0001	0.0028	0.0000	2.8491%	0.0000
6/22/2011 91.250	-0.0049	0.0000	0.0101	0.0001	10.0857%	0.0001
6/23/2011 90.100	-0.0126	0.0002	0.0054	0.0000	5.4415%	0.0000
6/24/2011 90.400	0.0033	0.0000	0.0113	0.0001	11.2659%	0.0001
6/25/2011 90.400	0.0000	0.0000	0.0024	0.0000	2.3544%	0.0000

Date	Price						
6/27/2011	90.900	0.0055	0.0000	0.0039	0.0000	3.9110%	0.0000
6/28/2011	90.050	-0.0094	0.0001	0.0105	0.0001	10.5231%	0.0001
6/29/2011	89.900	-0.0017	0.0000	0.0054	0.0000	5.4343%	0.0000
6/30/2011	89.450	-0.0050	0.0000	0.0024	0.0000	2.3616%	0.0000
7/1/2011	88.650	-0.0089	0.0001	0.0028	0.0000	2.7846%	0.0000
7/2/2011	88.650	0.0000	0.0000	0.0063	0.0000	6.3240%	0.0000
7/4/2011	88.450	-0.0023	0.0000	0.0016	0.0000	1.5953%	0.0000
7/5/2011	88.900	0.0051	0.0000	0.0052	0.0000	5.1928%	0.0000
7/6/2011	89.800	0.0101	0.0001	0.0036	0.0000	3.5611%	0.0000
7/7/2011	90.050	0.0028	0.0000	0.0052	0.0000	5.1900%	0.0000
7/8/2011	90.150	0.0011	0.0000	0.0012	0.0000	1.1833%	0.0000
7/9/2011	90.150	0.0000	0.0000	0.0008	0.0000	0.7852%	0.0000
7/11/2011	90.250	0.0011	0.0000	0.0008	0.0000	0.7844%	0.0000
7/12/2011	90.050	-0.0022	0.0000	0.0024	0.0000	2.3514%	0.0000
7/13/2011	89.600	-0.0050	0.0000	0.0020	0.0000	1.9666%	0.0000
7/14/2011	89.600	0.0000	0.0000	0.0035	0.0000	3.5336%	0.0000
7/15/2011	89.800	0.0022	0.0000	0.0016	0.0000	1.5784%	0.0000
7/16/2011	89.800	0.0000	0.0000	0.0016	0.0000	1.5784%	0.0000
7/18/2011	90.250	0.0050	0.0000	0.0035	0.0000	3.5434%	0.0000
7/19/2011	90.150	-0.0011	0.0000	0.0043	0.0000	4.3269%	0.0000
7/20/2011	90.100	-0.0006	0.0000	0.0004	0.0000	0.3913%	0.0000
7/21/2011	90.000	-0.0011	0.0000	0.0004	0.0000	0.3926%	0.0000
7/22/2011	90.300	0.0033	0.0000	0.0031	0.0000	3.1418%	0.0000
7/23/2011	90.300	0.0000	0.0000	0.0024	0.0000	2.3570%	0.0000
7/25/2011	90.450	0.0017	0.0000	0.0012	0.0000	1.1746%	0.0000
7/26/2011	90.550	0.0011	0.0000	0.0004	0.0000	0.3928%	0.0000
7/27/2011	90.650	0.0011	0.0000	0.0000	0.0000	0.0009%	0.0000
7/28/2011	91.150	0.0055	0.0000	0.0031	0.0000	3.1193%	0.0000
7/29/2011	91.100	-0.0005	0.0000	0.0043	0.0000	4.2881%	0.0000
7/30/2011	91.100	0.0000	0.0000	0.0004	0.0000	0.3879%	0.0000
8/1/2011		0.0016	0.0000	0.0012	0.0000	1.1643%	0.0000

Date	Price						
	91.250						
8/2/2011	91.550	0.0033	0.0000	0.0012	0.0000	1.1605%	0.0000
8/3/2011	91.700	0.0016	0.0000	0.0012	0.0000	1.1662%	0.0000
8/4/2011	92.300	0.0065	0.0000	0.0035	0.0000	3.4681%	0.0000
8/5/2011	92.850	0.0060	0.0000	0.0004	0.0000	0.4131%	0.0000
8/6/2011	92.850	0.0000	0.0000	0.0042	0.0000	4.2135%	0.0000
8/8/2011	93.450	0.0065	0.0000	0.0046	0.0000	4.5693%	0.0000
8/9/2011	95.000	0.0166	0.0003	0.0072	0.0001	7.1590%	0.0001
8/10/2011	94.000	-0.0105	0.0001	0.0192	0.0004	19.1716%	0.0004
8/11/2011	93.700	-0.0032	0.0000	0.0052	0.0000	5.1865%	0.0000
8/12/2011	92.700	-0.0107	0.0001	0.0053	0.0000	5.2898%	0.0000
8/13/2011	92.700	0.0000	0.0000	0.0075	0.0001	7.5465%	0.0001
8/15/2011	92.900	0.0022	0.0000	0.0015	0.0000	1.5256%	0.0000
8/16/2011	93.200	0.0032	0.0000	0.0008	0.0000	0.7579%	0.0000
8/17/2011	93.300	0.0011	0.0000	0.0015	0.0000	1.5247%	0.0000
8/18/2011	92.800	-0.0054	0.0000	0.0045	0.0000	4.5481%	0.0000
8/19/2011	93.000	0.0022	0.0000	0.0053	0.0000	5.3134%	0.0000
8/20/2011	93.000	0.0000	0.0000	0.0015	0.0000	1.5239%	0.0000
8/22/2011	93.000	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
8/23/2011	92.800	-0.0022	0.0000	0.0015	0.0000	1.5207%	0.0000
8/24/2011	92.400	-0.0043	0.0000	0.0015	0.0000	1.5272%	0.0000
8/25/2011	92.400	0.0000	0.0000	0.0030	0.0000	3.0479%	0.0000
8/26/2011	92.850	0.0049	0.0000	0.0034	0.0000	3.4437%	0.0000
8/27/2011	92.850	0.0000	0.0000	0.0034	0.0000	3.4437%	0.0000
8/29/2011	93.800	0.0102	0.0001	0.0072	0.0001	7.2348%	0.0001
8/30/2011	93.700	-0.0011	0.0000	0.0080	0.0001	7.9886%	0.0001
9/1/2011	94.150	0.0048	0.0000	0.0041	0.0000	4.1498%	0.0000
9/2/2011	94.150	0.0000	0.0000	0.0034	0.0000	3.3959%	0.0000
9/3/2011	94.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
9/5/2011	94.750	0.0064	0.0000	0.0045	0.0000	4.5063%	0.0000
9/6/2011	94.000	-0.0079	0.0001	0.0101	0.0001	10.1034%	0.0001

Date	Price						
9/7/2011	94.200	0.0021	0.0000	0.0071	0.0001	7.1016%	0.0000
9/8/2011	93.700	-0.0053	0.0000	0.0053	0.0000	5.2577%	0.0000
9/9/2011	94.100	0.0043	0.0000	0.0068	0.0000	6.7718%	0.0000
9/10/2011	94.100	0.0000	0.0000	0.0030	0.0000	3.0186%	0.0000
9/12/2011	95.600	0.0159	0.0003	0.0113	0.0001	11.2716%	0.0001
9/13/2011	94.650	-0.0099	0.0001	0.0183	0.0003	18.2983%	0.0003
9/14/2011	94.650	0.0000	0.0000	0.0070	0.0000	7.0267%	0.0000
9/15/2011	94.900	0.0026	0.0000	0.0019	0.0000	1.8677%	0.0000
9/16/2011	95.000	0.0011	0.0000	0.0011	0.0000	1.1226%	0.0000
9/17/2011	95.000	0.0000	0.0000	0.0007	0.0000	0.7451%	0.0000
9/19/2011	95.600	0.0063	0.0000	0.0045	0.0000	4.4659%	0.0000
9/20/2011	95.950	0.0037	0.0000	0.0019	0.0000	1.8772%	0.0000
9/21/2011	96.800	0.0089	0.0001	0.0037	0.0000	3.6753%	0.0000
9/22/2011	98.500	0.0176	0.0003	0.0062	0.0000	6.1541%	0.0000
9/23/2011	98.500	0.0000	0.0000	0.0124	0.0002	12.4182%	0.0001
9/24/2011	98.500	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
9/26/2011	102.000	0.0355	0.0013	0.0251	0.0006	25.1256%	0.0006
9/27/2011	102.750	0.0074	0.0001	0.0199	0.0004	19.9263%	0.0004
9/28/2011	101.250	-0.0146	0.0002	0.0155	0.0002	15.5220%	0.0002
9/29/2011	99.750	-0.0148	0.0002	0.0002	0.0000	0.1529%	0.0000
9/30/2011	99.750	0.0000	0.0000	0.0105	0.0001	10.4757%	0.0001
10/1/2011	99.750	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/3/2011	101.350	0.0160	0.0003	0.0113	0.0001	11.3421%	0.0001
10/4/2011	102.000	0.0064	0.0000	0.0068	0.0000	6.8071%	0.0000
10/5/2011	101.250	-0.0074	0.0001	0.0097	0.0001	9.7343%	0.0001
10/6/2011	102.250	0.0099	0.0001	0.0122	0.0001	12.1831%	0.0001
10/7/2011	102.500	0.0024	0.0000	0.0053	0.0000	5.2549%	0.0000
10/8/2011	102.500	0.0000	0.0000	0.0017	0.0000	1.7289%	0.0000
10/10/2011	103.650	0.0112	0.0001	0.0079	0.0001	7.9334%	0.0001
10/11/2011	106.500	0.0275	0.0008	0.0115	0.0001	11.5095%	0.0001
10/12/2011		-0.0235	0.0006	0.0360	0.0013	36.0416%	0.0013

Date	Price						
	104.000						
10/13/2011	102.750	-0.0120	0.0001	0.0081	0.0001	8.0999%	0.0001
10/14/2011	99.750	-0.0292	0.0009	0.0121	0.0001	12.1466%	0.0002
10/15/2011	99.750	0.0000	0.0000	0.0206	0.0004	20.6455%	0.0004
10/17/2011	99.350	-0.0040	0.0000	0.0028	0.0000	2.8355%	0.0000
10/18/2011	99.800	0.0045	0.0000	0.0060	0.0000	6.0383%	0.0000
10/19/2011	100.200	0.0040	0.0000	0.0004	0.0000	0.3687%	0.0000
10/21/2011	100.250	0.0005	0.0000	0.0025	0.0000	2.4812%	0.0000
10/22/2011	100.250	0.0000	0.0000	0.0004	0.0000	0.3528%	0.0000
10/24/2011	100.750	0.0050	0.0000	0.0035	0.0000	3.5267%	0.0000
10/25/2011	102.000	0.0124	0.0002	0.0052	0.0000	5.2463%	0.0000
10/26/2011	101.000	-0.0098	0.0001	0.0157	0.0002	15.7055%	0.0002
10/27/2011	99.800	-0.0119	0.0001	0.0015	0.0000	1.4688%	0.0000
10/28/2011	100.000	0.0020	0.0000	0.0098	0.0001	9.8183%	0.0001
10/29/2011	100.000	0.0000	0.0000	0.0014	0.0000	1.4170%	0.0000
10/31/2011	99.700	-0.0030	0.0000	0.0021	0.0000	2.1213%	0.0000
11/1/2011	98.500	-0.0120	0.0001	0.0064	0.0000	6.3895%	0.0000
11/2/2011	97.250	-0.0127	0.0002	0.0005	0.0000	0.4626%	0.0000
11/3/2011	97.250	0.0000	0.0000	0.0090	0.0001	8.9734%	0.0001
11/4/2011	97.450	0.0021	0.0000	0.0015	0.0000	1.4542%	0.0000
11/5/2011	97.450	0.0000	0.0000	0.0015	0.0000	1.4542%	0.0000
11/7/2011	97.150	-0.0031	0.0000	0.0022	0.0000	2.1768%	0.0000
11/8/2011	96.650	-0.0051	0.0000	0.0015	0.0000	1.4624%	0.0000
11/9/2011	96.000	-0.0067	0.0000	0.0011	0.0000	1.1163%	0.0000
11/10/2011	94.950	-0.0109	0.0001	0.0030	0.0000	2.9785%	0.0000
11/11/2011	93.450	-0.0158	0.0002	0.0034	0.0000	3.4367%	0.0000
11/12/2011	93.450	0.0000	0.0000	0.0112	0.0001	11.1707%	0.0001
11/14/2011	93.850	0.0043	0.0000	0.0030	0.0000	3.0267%	0.0000
11/15/2011	94.000	0.0016	0.0000	0.0019	0.0000	1.8965%	0.0000
11/16/2011	93.850	-0.0016	0.0000	0.0023	0.0000	2.2585%	0.0000
11/17/2011	92.400	-0.0155	0.0002	0.0098	0.0001	9.7966%	0.0001

Date	Price						
11/18/2011	91.300	-0.0119	0.0001	0.0025	0.0000	2.5070%	0.0000
11/19/2011	91.300	0.0000	0.0000	0.0084	0.0001	8.4179%	0.0001
11/21/2011	90.800	-0.0055	0.0000	0.0039	0.0000	3.8724%	0.0000
11/22/2011	90.000	-0.0088	0.0001	0.0024	0.0000	2.3576%	0.0000
11/23/2011	90.300	0.0033	0.0000	0.0086	0.0001	8.5870%	0.0001
11/24/2011	90.300	0.0000	0.0000	0.0024	0.0000	2.3570%	0.0000
11/25/2011	90.650	0.0039	0.0000	0.0027	0.0000	2.7407%	0.0000
11/26/2011	90.650	0.0000	0.0000	0.0027	0.0000	2.7407%	0.0000
11/28/2011	90.450	-0.0022	0.0000	0.0016	0.0000	1.5601%	0.0000
11/29/2011	89.800	-0.0072	0.0001	0.0035	0.0000	3.5214%	0.0000
11/30/2011	89.850	0.0006	0.0000	0.0055	0.0000	5.4752%	0.0000
12/1/2011	90.200	0.0039	0.0000	0.0024	0.0000	2.3607%	0.0000
12/2/2011	89.900	-0.0033	0.0000	0.0051	0.0000	5.1062%	0.0000
12/3/2011	89.900	0.0000	0.0000	0.0024	0.0000	2.3518%	0.0000
12/5/2011	89.500	-0.0044	0.0000	0.0031	0.0000	3.1462%	0.0000
12/6/2011	89.700	0.0022	0.0000	0.0047	0.0000	4.7263%	0.0000
12/7/2011	89.750	0.0006	0.0000	0.0012	0.0000	1.1860%	0.0000
12/8/2011	89.500	-0.0028	0.0000	0.0024	0.0000	2.3638%	0.0000
12/9/2011	89.450	-0.0006	0.0000	0.0016	0.0000	1.5746%	0.0000
12/10/2011	89.450	0.0000	0.0000	0.0004	0.0000	0.3950%	0.0000
12/13/2011	89.000	-0.0050	0.0000	0.0036	0.0000	3.5573%	0.0000
12/14/2011	87.600	-0.0157	0.0002	0.0076	0.0001	7.5658%	0.0001
12/15/2011	85.500	-0.0240	0.0006	0.0058	0.0000	5.8282%	0.0000
12/16/2011	84.000	-0.0175	0.0003	0.0045	0.0000	4.5458%	0.0000
12/17/2011	84.000	0.0000	0.0000	0.0124	0.0002	12.4054%	0.0001
12/19/2011	84.100	0.0012	0.0000	0.0008	0.0000	0.8418%	0.0000
12/20/2011	83.450	-0.0077	0.0001	0.0063	0.0000	6.3069%	0.0000
12/21/2011	83.550	0.0012	0.0000	0.0063	0.0000	6.3125%	0.0000
12/22/2011	83.700	0.0018	0.0000	0.0004	0.0000	0.4221%	0.0000
12/23/2011	83.750	0.0006	0.0000	0.0008	0.0000	0.8471%	0.0000
12/24/2011		0.0000	0.0000	0.0004	0.0000	0.4224%	0.0000

Date	Price						
	83.750						
12/27/2011	83.850	0.0012	0.0000	0.0008	0.0000	0.8443%	0.0000
12/28/2011	84.250	0.0048	0.0000	0.0025	0.0000	2.5289%	0.0000
12/29/2011	85.200	0.0113	0.0001	0.0046	0.0000	4.6001%	0.0000
12/30/2011	85.200	0.0000	0.0000	0.0080	0.0001	7.9733%	0.0001
12/31/2011	85.200	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
1/3/2012	85.650	0.0053	0.0000	0.0037	0.0000	3.7347%	0.0000
1/4/2012	87.700	0.0239	0.0006	0.0132	0.0002	13.1896%	0.0002
1/5/2012	87.000	-0.0080	0.0001	0.0226	0.0005	22.5683%	0.0005
1/6/2012	87.150	0.0017	0.0000	0.0069	0.0000	6.8631%	0.0000
1/7/2012	87.150	0.0000	0.0000	0.0012	0.0000	1.2191%	0.0000
1/9/2012	87.300	0.0017	0.0000	0.0012	0.0000	1.2171%	0.0000
1/10/2012	87.350	0.0006	0.0000	0.0008	0.0000	0.8121%	0.0000
1/11/2012	87.400	0.0006	0.0000	0.0000	0.0000	0.0002%	0.0000
1/12/2012	87.600	0.0023	0.0000	0.0012	0.0000	1.2133%	0.0000
1/13/2012	87.450	-0.0017	0.0000	0.0028	0.0000	2.8289%	0.0000
1/14/2012	87.450	0.0000	0.0000	0.0012	0.0000	1.2108%	0.0000
1/16/2012	87.000	-0.0051	0.0000	0.0036	0.0000	3.6386%	0.0000
1/17/2012	86.400	-0.0069	0.0000	0.0012	0.0000	1.2380%	0.0000
1/18/2012	86.300	-0.0012	0.0000	0.0041	0.0000	4.0582%	0.0000
1/19/2012	85.750	-0.0064	0.0000	0.0037	0.0000	3.6881%	0.0000
1/20/2012	86.000	0.0029	0.0000	0.0066	0.0000	6.5680%	0.0000
1/23/2012	86.350	0.0041	0.0000	0.0008	0.0000	0.8162%	0.0000
1/24/2012	86.000	-0.0041	0.0000	0.0057	0.0000	5.7439%	0.0000
1/25/2012	85.650	-0.0041	0.0000	0.0000	0.0000	0.0117%	0.0000
1/26/2012	85.100	-0.0064	0.0000	0.0017	0.0000	1.6629%	0.0000
1/27/2012	85.000	-0.0012	0.0000	0.0037	0.0000	3.7098%	0.0000
1/28/2012	85.000	0.0000	0.0000	0.0008	0.0000	0.8309%	0.0000
1/30/2012	84.750	-0.0029	0.0000	0.0021	0.0000	2.0797%	0.0000
1/31/2012	84.100	-0.0077	0.0001	0.0033	0.0000	3.3435%	0.0000
2/1/2012	83.700	-0.0048	0.0000	0.0021	0.0000	2.0601%	0.0000

Date	Price						
2/2/2012	83.850	0.0018	0.0000	0.0046	0.0000	4.6304%	0.0000
2/3/2012	83.850	0.0000	0.0000	0.0013	0.0000	1.2672%	0.0000
2/4/2012	83.850	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
2/6/2012	83.550	-0.0036	0.0000	0.0025	0.0000	2.5299%	0.0000
2/7/2012	83.350	-0.0024	0.0000	0.0008	0.0000	0.8372%	0.0000
2/8/2012	82.750	-0.0072	0.0001	0.0034	0.0000	3.3975%	0.0000
2/9/2012	83.700	0.0115	0.0001	0.0132	0.0002	13.2080%	0.0002
2/10/2012	82.850	-0.0102	0.0001	0.0153	0.0002	15.2987%	0.0002
2/11/2012	82.850	0.0000	0.0000	0.0072	0.0001	7.1809%	0.0000
2/13/2012	83.000	0.0018	0.0000	0.0013	0.0000	1.2802%	0.0000
2/14/2012	82.900	-0.0012	0.0000	0.0021	0.0000	2.1322%	0.0000
2/15/2012	83.000	0.0012	0.0000	0.0017	0.0000	1.7049%	0.0000
2/16/2012	83.100	0.0012	0.0000	0.0000	0.0000	0.0010%	0.0000
2/17/2012	83.000	-0.0012	0.0000	0.0017	0.0000	1.7028%	0.0000
2/18/2012	83.000	0.0000	0.0000	0.0009	0.0000	0.8509%	0.0000
2/20/2012	83.300	0.0036	0.0000	0.0026	0.0000	2.5558%	0.0000
2/21/2012	83.150	-0.0018	0.0000	0.0038	0.0000	3.8291%	0.0000
2/22/2012	83.000	-0.0018	0.0000	0.0000	0.0000	0.0023%	0.0000
2/23/2012	82.700	-0.0036	0.0000	0.0013	0.0000	1.2802%	0.0000
2/24/2012	82.750	0.0006	0.0000	0.0030	0.0000	2.9833%	0.0000
2/25/2012	82.750	0.0000	0.0000	0.0004	0.0000	0.4275%	0.0000
2/27/2012	82.850	0.0012	0.0000	0.0009	0.0000	0.8545%	0.0000
2/28/2012	82.900	0.0006	0.0000	0.0004	0.0000	0.4278%	0.0000
2/29/2012	83.150	0.0030	0.0000	0.0017	0.0000	1.7057%	0.0000
3/1/2012	83.300	0.0018	0.0000	0.0009	0.0000	0.8568%	0.0000
3/2/2012	83.250	-0.0006	0.0000	0.0017	0.0000	1.7000%	0.0000
3/3/2012	83.250	0.0000	0.0000	0.0004	0.0000	0.4244%	0.0000
3/5/2012	83.350	0.0012	0.0000	0.0008	0.0000	0.8494%	0.0000
3/6/2012	82.800	-0.0066	0.0000	0.0055	0.0000	5.5153%	0.0000
3/7/2012	82.850	0.0006	0.0000	0.0051	0.0000	5.0930%	0.0000
3/8/2012		-0.0012	0.0000	0.0013	0.0000	1.2805%	0.0000

	82.750						
3/9/2012	82.750	0.0000	0.0000	0.0009	0.0000	0.8535%	0.0000
3/10/2012	82.750	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
3/12/2012	82.450	-0.0036	0.0000	0.0026	0.0000	2.5635%	0.0000
3/13/2012	82.300	-0.0018	0.0000	0.0013	0.0000	1.2771%	0.0000
3/14/2012	82.350	0.0006	0.0000	0.0017	0.0000	1.7160%	0.0000
3/15/2012	82.850	0.0061	0.0000	0.0039	0.0000	3.8637%	0.0000
3/16/2012	83.000	0.0018	0.0000	0.0030	0.0000	3.0131%	0.0000
3/17/2012	83.000	0.0000	0.0000	0.0013	0.0000	1.2802%	0.0000
3/19/2012	82.700	-0.0036	0.0000	0.0026	0.0000	2.5558%	0.0000
3/20/2012	82.900	0.0024	0.0000	0.0043	0.0000	4.2659%	0.0000
3/21/2012	82.800	-0.0012	0.0000	0.0026	0.0000	2.5630%	0.0000
3/22/2012	83.100	0.0036	0.0000	0.0034	0.0000	3.4149%	0.0000
3/23/2012	83.000	-0.0012	0.0000	0.0034	0.0000	3.4129%	0.0000
3/24/2012	83.000	0.0000	0.0000	0.0009	0.0000	0.8509%	0.0000
3/26/2012	83.150	0.0018	0.0000	0.0013	0.0000	1.2779%	0.0000
3/27/2012	83.100	-0.0006	0.0000	0.0017	0.0000	1.7031%	0.0000
3/28/2012	83.050	-0.0006	0.0000	0.0000	0.0000	0.0003%	0.0000
3/29/2012	83.100	0.0006	0.0000	0.0009	0.0000	0.8512%	0.0000
3/30/2012	83.100	0.0000	0.0000	0.0004	0.0000	0.4257%	0.0000
3/31/2012	83.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
4/2/2012	83.050	-0.0006	0.0000	0.0004	0.0000	0.4255%	0.0000
4/3/2012	83.200	0.0018	0.0000	0.0017	0.0000	1.7026%	0.0000
4/4/2012	83.050	-0.0018	0.0000	0.0026	0.0000	2.5520%	0.0000
4/5/2012	83.150	0.0012	0.0000	0.0021	0.0000	2.1263%	0.0000
4/10/2012	83.250	0.0012	0.0000	0.0000	0.0000	0.0010%	0.0000
4/11/2012	83.300	0.0006	0.0000	0.0004	0.0000	0.4257%	0.0000
4/12/2012	83.450	0.0018	0.0000	0.0008	0.0000	0.8486%	0.0000
4/13/2012	83.150	-0.0036	0.0000	0.0038	0.0000	3.8153%	0.0000
4/14/2012	83.150	0.0000	0.0000	0.0025	0.0000	2.5420%	0.0000
4/16/2012	83.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000

4/17/2012	83.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
4/18/2012	83.200	0.0006	0.0000	0.0004	0.0000	0.4252%	0.0000
4/19/2012	83.250	0.0006	0.0000	0.0000	0.0000	0.0003%	0.0000
4/20/2012	83.250	0.0000	0.0000	0.0004	0.0000	0.4249%	0.0000
4/21/2012	83.250	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
4/23/2012	83.200	-0.0006	0.0000	0.0004	0.0000	0.4247%	0.0000
4/24/2012	83.300	0.0012	0.0000	0.0013	0.0000	1.2746%	0.0000
4/25/2012	83.250	-0.0006	0.0000	0.0013	0.0000	1.2743%	0.0000
4/26/2012	83.250	0.0000	0.0000	0.0004	0.0000	0.4244%	0.0000
4/27/2012	83.200	-0.0006	0.0000	0.0004	0.0000	0.4247%	0.0000
4/28/2012	83.200	0.0000	0.0000	0.0004	0.0000	0.4247%	0.0000
4/30/2012	83.300	0.0012	0.0000	0.0008	0.0000	0.8499%	0.0000
5/2/2012	83.450	0.0018	0.0000	0.0004	0.0000	0.4234%	0.0000
5/3/2012	83.250	-0.0024	0.0000	0.0030	0.0000	2.9680%	0.0000
5/4/2012	83.250	0.0000	0.0000	0.0017	0.0000	1.6947%	0.0000
5/5/2012	83.250	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
5/7/2012	83.300	0.0006	0.0000	0.0004	0.0000	0.4247%	0.0000
5/8/2012	83.300	0.0000	0.0000	0.0004	0.0000	0.4247%	0.0000
5/9/2012	83.450	0.0018	0.0000	0.0013	0.0000	1.2733%	0.0000
5/10/2012	83.650	0.0024	0.0000	0.0004	0.0000	0.4214%	0.0000
5/11/2012	83.650	0.0000	0.0000	0.0017	0.0000	1.6947%	0.0000
5/12/2012	83.650	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
5/14/2012	83.900	0.0030	0.0000	0.0021	0.0000	2.1133%	0.0000
5/15/2012	84.050	0.0018	0.0000	0.0008	0.0000	0.8491%	0.0000
5/16/2012	84.400	0.0042	0.0000	0.0017	0.0000	1.6803%	0.0000
5/17/2012	84.400	0.0000	0.0000	0.0029	0.0000	2.9445%	0.0000
5/18/2012	84.600	0.0024	0.0000	0.0017	0.0000	1.6756%	0.0000
5/19/2012	84.600	0.0000	0.0000	0.0017	0.0000	1.6756%	0.0000
5/21/2012	85.000	0.0047	0.0000	0.0033	0.0000	3.3433%	0.0000
5/22/2012	85.150	0.0018	0.0000	0.0021	0.0000	2.0955%	0.0000
5/23/2012		0.0018	0.0000	0.0000	0.0000	0.0022%	0.0000

Date	Price						
	85.300						
5/24/2012	85.350	0.0006	0.0000	0.0008	0.0000	0.8312%	0.0000
5/25/2012	85.450	0.0012	0.0000	0.0004	0.0000	0.4140%	0.0000
5/26/2012	85.450	0.0000	0.0000	0.0008	0.0000	0.8285%	0.0000
5/28/2012	85.550	0.0012	0.0000	0.0008	0.0000	0.8275%	0.0000
5/29/2012	85.950	0.0047	0.0000	0.0025	0.0000	2.4787%	0.0000
5/30/2012	86.750	0.0093	0.0001	0.0033	0.0000	3.2754%	0.0000
5/31/2012	86.250	-0.0058	0.0000	0.0107	0.0001	10.6571%	0.0001
6/2/2012	86.250	0.0000	0.0000	0.0041	0.0000	4.0755%	0.0000
6/4/2012	85.950	-0.0035	0.0000	0.0025	0.0000	2.4595%	0.0000
6/5/2012	85.900	-0.0006	0.0000	0.0020	0.0000	2.0482%	0.0000
6/6/2012	85.550	-0.0041	0.0000	0.0025	0.0000	2.4698%	0.0000
6/7/2012	84.700	-0.0099	0.0001	0.0041	0.0000	4.1445%	0.0000
6/8/2012	84.950	0.0030	0.0000	0.0091	0.0001	9.1127%	0.0001
6/9/2012	84.950	0.0000	0.0000	0.0021	0.0000	2.0871%	0.0000
6/11/2012	85.300	0.0041	0.0000	0.0029	0.0000	2.9133%	0.0000
6/12/2012	85.500	0.0023	0.0000	0.0013	0.0000	1.2554%	0.0000
6/13/2012	85.250	-0.0029	0.0000	0.0037	0.0000	3.7255%	0.0000
6/14/2012	85.150	-0.0012	0.0000	0.0012	0.0000	1.2381%	0.0000
6/15/2012	84.900	-0.0029	0.0000	0.0012	0.0000	1.2466%	0.0000
6/16/2012	84.900	0.0000	0.0000	0.0021	0.0000	2.0761%	0.0000
6/18/2012	84.500	-0.0047	0.0000	0.0033	0.0000	3.3315%	0.0000
6/19/2012	84.300	-0.0024	0.0000	0.0017	0.0000	1.6579%	0.0000
6/20/2012	83.700	-0.0071	0.0001	0.0034	0.0000	3.3592%	0.0000
6/21/2012	84.000	0.0036	0.0000	0.0076	0.0001	7.5672%	0.0001
6/22/2012	84.000	0.0000	0.0000	0.0025	0.0000	2.5344%	0.0000
6/23/2012	84.000	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
6/25/2012	84.300	0.0036	0.0000	0.0025	0.0000	2.5254%	0.0000
6/26/2012	84.200	-0.0012	0.0000	0.0034	0.0000	3.3642%	0.0000
6/27/2012	84.150	-0.0006	0.0000	0.0004	0.0000	0.4189%	0.0000
6/28/2012	84.300	0.0018	0.0000	0.0017	0.0000	1.6803%	0.0000

6/29/2012	84.100	-0.0024	0.0000	0.0029	0.0000	2.9380%	0.0000
6/30/2012	84.100	0.0000	0.0000	0.0017	0.0000	1.6776%	0.0000
7/2/2012	84.150	0.0006	0.0000	0.0004	0.0000	0.4204%	0.0000
7/3/2012	84.000	-0.0018	0.0000	0.0017	0.0000	1.6808%	0.0000
7/4/2012	84.000	0.0000	0.0000	0.0013	0.0000	1.2604%	0.0000
7/5/2012	84.250	0.0030	0.0000	0.0021	0.0000	2.1045%	0.0000
7/6/2012	84.100	-0.0018	0.0000	0.0034	0.0000	3.3634%	0.0000
7/7/2012	84.100	0.0000	0.0000	0.0013	0.0000	1.2589%	0.0000
7/9/2012	83.900	-0.0024	0.0000	0.0017	0.0000	1.6816%	0.0000
7/10/2012	83.950	0.0006	0.0000	0.0021	0.0000	2.1030%	0.0000
7/11/2012	83.900	-0.0006	0.0000	0.0008	0.0000	0.8425%	0.0000
7/12/2012	84.050	0.0018	0.0000	0.0017	0.0000	1.6853%	0.0000
7/13/2012	84.150	0.0012	0.0000	0.0004	0.0000	0.4229%	0.0000
7/14/2012	84.150	0.0000	0.0000	0.0008	0.0000	0.8413%	0.0000
7/16/2012	84.200	0.0006	0.0000	0.0004	0.0000	0.4201%	0.0000
7/17/2012	84.150	-0.0006	0.0000	0.0008	0.0000	0.8400%	0.0000
7/18/2012	84.150	0.0000	0.0000	0.0004	0.0000	0.4199%	0.0000
7/19/2012	84.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
7/20/2012	84.200	0.0006	0.0000	0.0004	0.0000	0.4201%	0.0000
7/21/2012	84.200	0.0000	0.0000	0.0004	0.0000	0.4201%	0.0000
7/23/2012	84.250	0.0006	0.0000	0.0004	0.0000	0.4199%	0.0000
7/24/2012	84.300	0.0006	0.0000	0.0000	0.0000	0.0002%	0.0000
7/25/2012	84.250	-0.0006	0.0000	0.0008	0.0000	0.8390%	0.0000
7/26/2012	84.250	0.0000	0.0000	0.0004	0.0000	0.4194%	0.0000
7/27/2012	84.200	-0.0006	0.0000	0.0004	0.0000	0.4196%	0.0000
7/28/2012	84.200	0.0000	0.0000	0.0004	0.0000	0.4196%	0.0000
7/30/2012	84.200	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
7/31/2012	84.250	0.0006	0.0000	0.0004	0.0000	0.4199%	0.0000
8/1/2012	84.200	-0.0006	0.0000	0.0008	0.0000	0.8395%	0.0000
8/2/2012	84.250	0.0006	0.0000	0.0008	0.0000	0.8395%	0.0000
8/3/2012		-0.0006	0.0000	0.0008	0.0000	0.8395%	0.0000

Date	Price						
	84.200						
8/4/2012	84.200	0.0000	0.0000	0.0004	0.0000	0.4196%	0.0000
8/6/2012	84.050	-0.0018	0.0000	0.0013	0.0000	1.2597%	0.0000
8/7/2012	83.900	-0.0018	0.0000	0.0000	0.0000	0.0022%	0.0000
8/8/2012	84.100	0.0024	0.0000	0.0029	0.0000	2.9475%	0.0000
8/9/2012	84.000	-0.0012	0.0000	0.0025	0.0000	2.5264%	0.0000
8/10/2012	84.050	0.0006	0.0000	0.0013	0.0000	1.2617%	0.0000
8/11/2012	84.050	0.0000	0.0000	0.0004	0.0000	0.4209%	0.0000
8/13/2012	83.850	-0.0024	0.0000	0.0017	0.0000	1.6826%	0.0000
8/14/2012	83.900	0.0006	0.0000	0.0021	0.0000	2.1042%	0.0000
8/15/2012	83.950	0.0006	0.0000	0.0000	0.0000	0.0003%	0.0000
8/16/2012	84.100	0.0018	0.0000	0.0008	0.0000	0.8420%	0.0000
8/17/2012	83.900	-0.0024	0.0000	0.0029	0.0000	2.9450%	0.0000
8/18/2012	83.900	0.0000	0.0000	0.0017	0.0000	1.6816%	0.0000
8/21/2012	84.000	0.0012	0.0000	0.0008	0.0000	0.8428%	0.0000
8/22/2012	84.000	0.0000	0.0000	0.0008	0.0000	0.8428%	0.0000
8/23/2012	83.950	-0.0006	0.0000	0.0004	0.0000	0.4209%	0.0000
8/24/2012	84.050	0.0012	0.0000	0.0013	0.0000	1.2632%	0.0000
8/25/2012	84.050	0.0000	0.0000	0.0008	0.0000	0.8423%	0.0000
8/27/2012	84.150	0.0012	0.0000	0.0008	0.0000	0.8413%	0.0000
8/28/2012	84.100	-0.0006	0.0000	0.0013	0.0000	1.2614%	0.0000
8/29/2012	84.150	0.0006	0.0000	0.0008	0.0000	0.8405%	0.0000
8/30/2012	84.350	0.0024	0.0000	0.0013	0.0000	1.2602%	0.0000
8/31/2012	84.150	-0.0024	0.0000	0.0034	0.0000	3.3572%	0.0000
9/1/2012	84.150	0.0000	0.0000	0.0017	0.0000	1.6766%	0.0000
9/3/2012	84.300	0.0018	0.0000	0.0013	0.0000	1.2604%	0.0000
9/4/2012	84.800	0.0059	0.0000	0.0029	0.0000	2.9336%	0.0000
9/5/2012	84.350	-0.0053	0.0000	0.0079	0.0001	7.9463%	0.0001
9/6/2012	84.450	0.0012	0.0000	0.0046	0.0000	4.5906%	0.0000
9/7/2012	84.300	-0.0018	0.0000	0.0021	0.0000	2.0943%	0.0000
9/8/2012	84.300	0.0000	0.0000	0.0013	0.0000	1.2560%	0.0000

Date	Price						
9/10/2012	84.200	-0.0012	0.0000	0.0008	0.0000	0.8388%	0.0000
9/11/2012	84.150	-0.0006	0.0000	0.0004	0.0000	0.4189%	0.0000
9/12/2012	84.250	0.0012	0.0000	0.0013	0.0000	1.2602%	0.0000
9/13/2012	84.450	0.0024	0.0000	0.0008	0.0000	0.8383%	0.0000
9/14/2012	84.350	-0.0012	0.0000	0.0025	0.0000	2.5159%	0.0000
9/15/2012	84.350	0.0000	0.0000	0.0008	0.0000	0.8373%	0.0000
9/17/2012	84.800	0.0053	0.0000	0.0038	0.0000	3.7724%	0.0000
9/18/2012	84.900	0.0012	0.0000	0.0029	0.0000	2.9385%	0.0000
9/19/2012	84.850	-0.0006	0.0000	0.0013	0.0000	1.2503%	0.0000
9/20/2012	84.800	-0.0006	0.0000	0.0000	0.0000	0.0002%	0.0000
9/21/2012	84.850	0.0006	0.0000	0.0008	0.0000	0.8336%	0.0000
9/22/2012	84.850	0.0000	0.0000	0.0004	0.0000	0.4169%	0.0000
9/24/2012	84.900	0.0006	0.0000	0.0004	0.0000	0.4167%	0.0000
9/25/2012	85.000	0.0012	0.0000	0.0004	0.0000	0.4162%	0.0000
9/26/2012	85.200	0.0024	0.0000	0.0008	0.0000	0.8309%	0.0000
9/27/2012	85.300	0.0012	0.0000	0.0008	0.0000	0.8338%	0.0000
9/28/2012	85.300	0.0000	0.0000	0.0008	0.0000	0.8299%	0.0000
9/29/2012	85.300	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/1/2012	85.150	-0.0018	0.0000	0.0012	0.0000	1.2434%	0.0000
10/2/2012	84.950	-0.0023	0.0000	0.0004	0.0000	0.4174%	0.0000
10/3/2012	84.900	-0.0006	0.0000	0.0012	0.0000	1.2447%	0.0000
10/4/2012	84.900	0.0000	0.0000	0.0004	0.0000	0.4162%	0.0000
10/5/2012	84.950	0.0006	0.0000	0.0004	0.0000	0.4164%	0.0000
10/6/2012	84.950	0.0000	0.0000	0.0004	0.0000	0.4164%	0.0000
10/8/2012	85.100	0.0018	0.0000	0.0012	0.0000	1.2486%	0.0000
10/9/2012	85.100	0.0000	0.0000	0.0012	0.0000	1.2486%	0.0000
10/10/2012	85.150	0.0006	0.0000	0.0004	0.0000	0.4155%	0.0000
10/11/2012	85.150	0.0000	0.0000	0.0004	0.0000	0.4155%	0.0000
10/12/2012	85.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/13/2012	85.150	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/15/2012		0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000

Date						
	85.150					
10/16/2012 85.000	-0.0018	0.0000	0.0012	0.0000	1.2456%	0.0000
10/17/2012 85.050	0.0006	0.0000	0.0017	0.0000	1.6616%	0.0000
10/18/2012 85.200	0.0018	0.0000	0.0008	0.0000	0.8312%	0.0000
10/19/2012 85.250	0.0006	0.0000	0.0008	0.0000	0.8321%	0.0000
10/22/2012 85.250	0.0000	0.0000	0.0004	0.0000	0.4150%	0.0000
10/23/2012 85.250	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/24/2012 85.150	-0.0012	0.0000	0.0008	0.0000	0.8295%	0.0000
10/25/2012 85.150	0.0000	0.0000	0.0008	0.0000	0.8295%	0.0000
10/26/2012 85.200	0.0006	0.0000	0.0004	0.0000	0.4152%	0.0000
10/27/2012 85.200	0.0000	0.0000	0.0004	0.0000	0.4152%	0.0000
10/29/2012 85.200	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
10/30/2012 85.150	-0.0006	0.0000	0.0004	0.0000	0.4150%	0.0000
10/31/2012 85.250	0.0012	0.0000	0.0012	0.0000	1.2454%	0.0000
11/1/2012 85.350	0.0012	0.0000	0.0000	0.0000	0.0010%	0.0000
11/2/2012 85.450	0.0012	0.0000	0.0000	0.0000	0.0010%	0.0000
11/3/2012 85.450	0.0000	0.0000	0.0008	0.0000	0.8285%	0.0000
11/5/2012 85.600	0.0018	0.0000	0.0012	0.0000	1.2413%	0.0000
11/6/2012 85.500	-0.0012	0.0000	0.0021	0.0000	2.0673%	0.0000
11/7/2012 85.400	-0.0012	0.0000	0.0000	0.0000	0.0010%	0.0000
11/8/2012 85.350	-0.0006	0.0000	0.0004	0.0000	0.4130%	0.0000
11/9/2012 85.400	0.0006	0.0000	0.0008	0.0000	0.8282%	0.0000
11/10/2012 85.400	0.0000	0.0000	0.0004	0.0000	0.4142%	0.0000
11/12/2012 85.550	0.0018	0.0000	0.0012	0.0000	1.2420%	0.0000
11/13/2012 85.700	0.0018	0.0000	0.0000	0.0000	0.0022%	0.0000
11/14/2012 85.650	-0.0006	0.0000	0.0017	0.0000	1.6524%	0.0000
11/15/2012 85.650	0.0000	0.0000	0.0004	0.0000	0.4125%	0.0000
11/16/2012 85.650	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/17/2012 85.650	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/19/2012 85.750	0.0012	0.0000	0.0008	0.0000	0.8256%	0.0000
11/20/2012 85.700	-0.0006	0.0000	0.0012	0.0000	1.2379%	0.0000

Date							
11/21/2012	85.700	0.0000	0.0000	0.0004	0.0000	0.4123%	0.0000
11/22/2012	85.700	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/23/2012	85.850	0.0018	0.0000	0.0012	0.0000	1.2376%	0.0000
11/24/2012	85.850	0.0000	0.0000	0.0012	0.0000	1.2376%	0.0000
11/26/2012	86.050	0.0023	0.0000	0.0016	0.0000	1.6473%	0.0000
11/27/2012	85.950	-0.0012	0.0000	0.0025	0.0000	2.4690%	0.0000
11/28/2012	85.950	0.0000	0.0000	0.0008	0.0000	0.8217%	0.0000
11/29/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
11/30/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/1/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/3/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/4/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/5/2012	86.000	0.0006	0.0000	0.0004	0.0000	0.4113%	0.0000
12/6/2012	86.000	0.0000	0.0000	0.0004	0.0000	0.4113%	0.0000
12/7/2012	86.100	0.0012	0.0000	0.0008	0.0000	0.8222%	0.0000
12/8/2012	86.100	0.0000	0.0000	0.0008	0.0000	0.8222%	0.0000
12/10/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/11/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/13/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/14/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/15/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/17/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/18/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/19/2012	86.100	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/20/2012	85.950	-0.0017	0.0000	0.0012	0.0000	1.2319%	0.0000
12/21/2012	85.950	0.0000	0.0000	0.0012	0.0000	1.2319%	0.0000
12/22/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/24/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/27/2012	85.950	0.0000	0.0000	0.0000	0.0000	0.0000%	0.0000
12/28/2012	86.100	0.0017	0.0000	0.0012	0.0000	1.2340%	0.0000
12/29/2012	86.100	0.0000	0.0000	0.0012	0.0000	1.2340%	0.0000

CURRICULUM VITAE

OSITU VERAH MORAA

P.O BOX 14578-00800   Cell phone: 0718102346
NAIROBI,   Email address: veeositu@gmail.com
KENYA

Career Objectives

To apply knowledge acquired in Economics, Mathematics, and Accounting in a manner compatible with current Information Technology to a challenging and dynamic environment that offers opportunities for growth and development. To find a position where I can develop my skills further as well as leading innovation and change.

To leave a remarkable difference in the field of business in an organization and use the knowledge I have acquired in finance both regionally and internationally.

Personal Details

Am a 24 year old female individual who is hard working, energetic and skilled known for accuracy, attention to details and timeliness in reporting visionary and highly motivated, possess knowledge in MS Word, C++, SQL, Rgui, spss, power point QuickBooks, Oracle(Very proficient in Enterprise Retail Planning and Tquest) , Excel, pivot table analysis and pivot charts . I am well versed in recent Technology. I am a consultant, strategist and speaker who likes to get hands-on solving problems and applying ideas that will change the future of this continent and emerging markets

Key Skills and Attributes

ANALYTICAL

- Very proficient with Excel and Pivot Tables analysis

- Possess a keen eye for spotting irregularities/mistakes

- Attentive to details.

- Good with numbers.

INTERPERSONAL SKILLS

- Creates a positive environment that fosters acceptance and tolerance with my colleagues;

- Provides employee training to upgrade skills and increase knowledge in Accounting and Finance Field.

- Deals with employee related issues falling under section supervised.

LEADERSHIP

- Successfully led a section in the Accounting department and attained set goals and reporting timelines
- Young dynamic and dedicated individual, highly sociable opinion leader

COMMUNICATION

- Assertive and communicates effectively across all levels of management.

- Maintains two-way dialogue at all levels.

- Experienced on formal communication and report writing for use by top management

Work History

Position: Assistant Accountant
Employer: Cannon Assurance Kenya Limited
Period: March 2013 to Present
Responsibilities:
- Payment of commissions.
- Coding associates.
- Reconciliations of all Financial Management Systems vs Life Management Systems integration control accounts
- Updating Agency statements for loans, advances, commissions and capital accumulation
- Monthly reconciliation of all associates General ledger accounts
- Management of policy loans
- Calculation of monthly policy loans interest
- Circulating accurate policy loans balances and overpayments
- Payment of all withholding taxes on commissions
- Posting of Life Management Systems premium and loan transfers
- Posting of Life Management Systems check off receipts and other bank receipts
- Investigating premium from time to time
- Sending SMS to Mpesa clients
- Reconciling premium receipts control accounts
- Reconciling check off control account
- Reconciling unallocated, proposal receipts and circulating reconciliation
- Reconciling premium income and risk premium and circulating reconciliation.

Position: Supply Assistant
Employer: Galana Oil Kenya Limited
Period: August 2011 to February 2013
Responsibilities:
•Updating Platts summary, local and transit costing with plats and Crude costing Mombasa
•Stocks and sales projection
•Updating the Projected sales for the current month and the subsequent one month.
•Stocks management at the refinery
•Updating the following transactions at the refinery: Batches, Loadings, Imports both for crude and white products, ASES, Pump overs, Refining Programs, HCV (hydro carbon Values) values

•Confirmation of Daily stocks report from KPC (Stocks entitlement)
•Submission of Transit closing stocks to Pipecor
•Borrow loan process
•Monthly Stock Statements and Certification
•CFA management
•Import Declaration Form (IDF) application
•W707 Entry management for industry tenders
•Outturn Management and Due Dates
•Helping in Major trading activities in trading like: Record Supplier Contract, Sending Offers to customer, Handling customer Prepayment , Handling Letter of Credit, Handling Direct Deposit, Issuing Outturn Amendment, Issuing ASE and C21, Forwarding Discharge instructions, Issuing Release Authorization by Bank, Capturing Bill of Lading and Outturn quantity
•Computation of Demurrage and Late payment charges
•Ensure accurate preliminary taxes are paid on stocks and to ensure that the payment is done in an orderly timely manner to ensure that we do not attract penalties.
•Stocks Management and monthly reconciliation using the monthly KPC statements namely the one for KOSF (KPC/OPS11/2(A)) and KPC Mainline (KPC/OPS10) to the stocks movement and ensures they are correctly captured

Education Achievements
Institution: KASNEB
Period: April 2014 to present
Certificate: Pursuing CPA(PART 1: SEC 1 &2)

Institution: University of Nairobi
Period: January 2012- Present
Degree: Masters in Actuarial Science

Institution: Jomo Kenyatta University of Agriculture and Technology
Period: May 2008- July 2011
Qualification: Bachelor of Science in Actuarial Science (First Class honours)

Institution: Institute of Actuaries (UK)
Period: August 2010
Qualification: Certificate in Financial Mathematics
Institution: The sacred Heart Mukumu Girls High School
Period: 2004-2007
Qualification: Kenya Certificate of Secondary Education (KCSE)

Mean Grade: B

Institution: St. Jude Shikoti Girls

Period: 1996-2003

Qualification: Kenya Certificate of Primary Education (KCPE)

Mean Grade: A-

Computing Skills
MS Word, Excel, C++, SQL, Rgui, power point, QuickBooks, SPSS, java, Oracle (ERP and Tquest)

Other Achievements   and awards
- Named student of the year 2009/2010 academic year.
- Former Vice-Chairperson JKUAT Insurance Students Association.
- Best student in ITEN Mathematics contest year 2007

Hobbies and Interests
Assisting Physically challenged people in society, Cooking, Swimming, Reading inspirational books

References Available Upon Request
1. Mr Samuel Muthee
   Cannon Assurance Kenya Limited
   Reinsurance Officer
   P.O Box 41864-00100
   Tell: 0721 1787461

2. Mrs. Beatrice Gathondu
   Jomo Kenyatta University of Agriculture and Technology
   Lecturer
   P. O. Box 62000,
    Nairobi, Kenya.
   Tel: 0722123608

3. Mr. Edwin Abongo Odera
   Galana Oil Kenya Limited
   Network Accountant
   Tell: 0723057216