# EFFICIENCY OF FOREIGN EXCHANGE MARKET IN KENYA: THE RATIONAL EXPECTATIONS APPROACH

BY

KIMANI SARAH W
REG NO: D61/P/8250/03



A RESEARCH PROJECT REPORT SUBMITTED TO SCHOOL OF BUSINESS IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE DEGREE OF MASTER OF BUSINESS ADMINISTRATION

UNIVERSITY OF NAIROBI



SEPTEMBER 2007

# Declaration

This research project report is my original work and has never been presented for a degree in any other university.

Signature ____________________ Date: 04/10/2007.

**KIMANI SARAH W.**

This research project report has been submitted for examination with my approval as the University Supervisor.

Signature ____________________ Date: 4/10/2007

**Mr. KISAKA SIFUNJO**

**LECTURER**

**DEPARTMENT OF FINANCE AND ACCOUNTING**

**SCHOOL OF BUSINESS**

**UNIVERSITY OF NAIROBI**

## Dedication

I dedicate this research report to my dear husband, loving daughters, my dad and my siblings for being supportive during the time of my studies.

# Acknowledgement

I would like to acknowledge the support, advice and tireless efforts of my supervisor Mr. Kisaka Sifunjo in the supervision during my research work and in writing of this research project report.

I would also like to acknowledge the assistance provided by the Head of Research Department at the Central Bank of Kenya in securing the time-series data on exchange rates and Treasury Bill rates over the sample period.

I also thank the Librarians at the University of Nairobi for allowing me the use of the library facilities.

Finally, I would like to acknowledge the assistance given by the staff at the School of Business, University of Nairobi.

## Abstract

The aim of this study was to establish the efficiency of foreign exchange markets in Kenya using the rational expectations approach. The study was based on the null hypothesis that the economic agents are rational. Assuming that market participants are rational, the expected change in the exchange rate should differ from the actual change only by a rational expectations forecast error. Historical data for the monthly (average) spot exchange rate and the three-month forward premiums for the Euro, the Sterling Pound, the US Dollar, and the two East African currencies were obtained from the Central Bank of Kenya based on all banking institutions that actively engage in foreign exchange business. The sample period was from November 1993 to June 2006. All the exchange rates were expressed in Kenya Shillings (Kshs) per unit of foreign currency. The US monthly averages for the 91-Day T-BILL rates were used in computing the forward rates for each of the currencies.

The key findings revealed that the forward rates are not unbiased predictors of the future spot rates for the Euro, the Sterling Pound, the US Dollar, the Uganda Shilling, and the Tanzanian Shilling. Secondly, the findings established that the participants in the foreign currency markets in Kenya are not risk-neutral and are not rational; a phenomenon that was reinforced by the presence of auto-correlations. The results of the study were consistent with the hypothesis that the forward exchange rates are not unbiased predictors of the future spot rates. This agreed with previous empirical works (Frankel, 1980; Fama 1984; Bekaert and Hodrick, 1993) which rejected the efficient markets hypothesis under risk-neutrality on the basis of regressing the applicable model for various currencies.

Under the presence of efficiency in the foreign exchange market, the forward exchange rate should be an unbiased predictor for the future spot rate. The rejection of the efficiency hypothesis implies the presence of unexploited profit opportunities for those who participate in exchange rate transactions in the Kenyan FOREX markets. In other words, the general conclusion emerging from the extensive empirical analysis is that the forward exchange rate is not an unbiased predictor of the future spot and the presence of a risk premium is apparent. The failure of the currency markets to be 'weak form' efficient also indicates that not all price information is fully reflected in currency prices, thus implying that the current price changes cannot be predicted from past prices. As a result, the participants in the FOREX markets in Kenya conduct their transactions on the basis of speculation rather than on prediction of future market behaviour based on the past or current performance of respective currency markets.

# Table of Contents

# List of Tables

# List of Abbreviations and Acronyms

| | | |
|---|---|---|
| ADF | : | Augmented Dickey-Fuller |
| CMA | : | Capital Markets Authority |
| EMH | : | Efficient Market Hypothesis |
| JCIF | : | Japan Center for International Finance |
| FOREX | : | Foreign Exchange |
| K-S | : | Kolmogorov-Smirnov |
| MMS | : | Money Market Services |
| NSE | : | Nairobi Stock Exchange |
| SSA | : | Southern Sahara African |
| UIRP | : | Uncovered Interest Rate Parity |
| UON | : | University of Nairobi |
| VAR | : | Vector Auto Regression |

# CHAPTER ONE

# 1.0 INTRODUCTION

## 1.1. Background to the study

### 1.1.1. Efficient market hypothesis

Using a very broad definition, a market is considered to be efficient if absolute price movements do not alter relative ones and if all markets are in equilibrium at current values. In other words, under efficiency conditions, monetary variables do not affect real ones and the economic system is dichotomous (Canale and Napolitano, 2001). The classic definition of an efficient market is due to Fama (1970), and is a market where prices fully reflect the information available, such that an unusual profit cannot be earned through exploiting this information set. In this case, decisions taken on the basis of these prices will promote the efficient allocation of resources (Levich, 1985).

Fama deduced three forms of market efficiency depending on how much information is used in forming expectations about the future price. They include 'weak form' efficiency; the 'semi-strong form' efficiency; and the 'strong form' efficiency. The 'weak form' efficiency of the EMH asserts that all price information is fully reflected in asset prices, in the sense that current price changes cannot be predicted from past prices (Fama, 1970). Security prices therefore fully reflect the information contained in past price movements hence they do not follow patterns which repeat and it is not possible to trade profitably purely on the basis of historical price information. The semi-strong form efficiency asserts that a market is efficient in the semi-strong form if security prices fully reflect all publicly available information. No investor can earn excess returns from trading rules based on publicly available information. The strong form efficiency asserts that a market is efficient in the strong form if security prices fully reflect all relevant information whether it is publicly available or not. In such case, no investor can earn excess returns using any information (not even using insider information) [Fama, 1970].

If foreign exchange markets are efficient, the spot or forward exchange rates should embody all relevant information, and they should not be able to forecast the spot or forward exchange rate as a function of another. Also the forward rate should be an unbiased predictor of the future spot rate assuming risk neutrality and a covariance stationary risk premium.

The traditional tests of the foreign exchange market efficiency hypothesis, EMH, are therefore based on a linear projection of the forward rate on the future spot exchange rate. To circumvent the non-stationarity problem in this estimation procedure, Froot and Frankel (1989) use the forward premium as the regressor and the exchange rate differential as the regressand. As shown in Liu and Maddala (1992a), this adjustment can lead to inconsistent estimate of the slope coefficient because the forward rate is correlated with the risk premium. Liu and Maddala suggest therefore regressing the forward premium on the exchange rate differential when both series are stationary. However, this approach can exhibit finite sample bias due to the presence of an endogenous regressor. Whether the small sample bias is large enough to result in rejection of the EMH even when it is true remains to our knowledge an open empirical question.

In its simplest form, market efficiency in foreign exchange markets can be presented as a joint hypothesis that participants in the foreign exchange market are (1) rational and (2) risk-neutral. Empirical studies of the efficiency of the foreign exchange worldwide shows that it is not efficient (Canale and Napolitano, 2001; Atingi and Kaggwa, 2003). No consensus exists at the moment concerning the actual behaviour of the exchange rate markets. For instance, different markets may be characterized by different statistical distributions. Several reasons have been advanced to explain the failure of the EMH but none has passed the empirical tests (Fama, 1991), including the studies conducted about the efficiency of the foreign exchange market in Kenya. This study used the rational expectations approach to test the efficiency of foreign exchange markets hypothesis in Kenya.

### 1.1.2. Rational Expectations

The rational expectation assumption, based on Muth (1961), argues that economic agents form expectations about future events. These expectations are rational in the sense that they combine all the available information and therefore do not lead to systematic forecasting errors. The implication of the rational expectations hypothesis is that policies will only be effective when they produce surprises. By definition, this is not possible in the long run since rational economic agents will detect any policy rule and will therefore no longer be surprised. This is also known as the 'irrelevance hypothesis'. This view has been applied to several policy instruments, most of the time - monetary policy; the core arguments are, however, also relevant to fiscal policy and taxation. Normally, rationality is defined in terms of two criteria: (1) whether the expected exchange rate is an unbiased predictor of the future spot exchange rate (unbiasedness); and (2) whether the expected exchange rate fully incorporates all available information (orthogonality). The tests of rational expectations reported in the literature are also based on these two criteria.

### 1.1.3. Foreign exchange markets in Kenya

Since the 1970s after the breakdown of the Fixed Exchange Rate Bretton Woods System, the major currencies (the US Dollar, EURO and others) float freely. Encouraged by the Bretton Woods institutions, many countries (Kenya included) adopted transitional systems toward unified, market determined and convertible exchange rates.

Following the repeal of the Exchange Control Act in 1995 and the licensing of foreign exchange bureaus, there has been witnessed some vibrancy in Kenya's foreign exchange market (Kurgat, 1998). In the period prior to 1995, Kenya maintained restrictions on foreign exchange currency transactions. However, Kenya currently pursues a floating exchange rate regime, in which market forces of demand and supply interplay to determine the exchange value of currencies. Indeed, as proposed by Friedman (1953), because speculators buy low and sell high, their activities ensure that exchange rates reflect the fundamental determinants of currency values. The major participants in the foreign exchange market in Kenya are commercial banks and foreign exchange bureaus. Other participants such as corporations, institutional investors, and seldom also individual persons usually have to contact their bank or broker in order to obtain foreign currencies. Efficiency of foreign exchange market in Kenya has not been widely tested. Few studies have been carried out on the efficiency of foreign exchange market in Kenya. The findings have favored the conclusion that the foreign exchange market in Kenya is inefficient due to existence of arbitrage opportunities.

## 1.2. Problem Statement

The market efficiency hypothesis formulation has two major problems: i) the interpretation associated with the rejection of market efficiency and ii) the ambiguity in constructing alternatives to the null hypothesis of efficiency. These problems arise since failure to find evidence in favour of the null hypothesis may imply either a rejection of the information set (probably on the assumption that agents are rational but have the wrong model) or that the information set has all the relevant information but agents are not using the available information and hence irrational (Atingi and Kaggwa, 2003).

Local studies carried out on efficiency of foreign exchange market in Kenya i.e. Ndunda (2002), Kurgat (1998) and Muhoro (2005) have looked at efficiency from the basis of profitability of simple trading rules. Ndunda (2002) tested whether forward exchange rates are predictors of future spot rates in Kenya. In her study, Ndunda focused on the foreign exchange market under floating exchange rate for the period between October 1993 and December 2002. The data involved comprised of weekly spot exchange rate and the three-month forward exchange premium for the US dollar, the UK sterling pound, the Swiss Franc, the Euro, and the Japanese Yen. Her study was based on the model by Hansen & Hodrick (1980). The hypothesis that the forecast error is uncorrelated with information available at a certain time was tested using ordinary least squares regression. She established that the forward rate is not a good predictor of the future spot rate, which led to the conclusion that the foreign exchange market in Kenya is inefficient as the rate of return to speculation is not equal to zero.

Kurgat (1998) carried out an empirical study of the spot markets' efficiency on foreign exchange bureaus in Kenya where he pointed out the inefficiency of the Kenyan foreign exchange market due to the existence of arbitrage opportunities. He showed that there was an opportunity to make instantaneous risk free profits through locational arbitrage. The study established that the foreign exchange markets in Kenya are not efficient.

Seven years later Muhoro (2005) carried out a similar study using locational and triangular arbitrage models. The study involved secondary data in the form of daily closing counter foreign exchange rates of the Kenya shilling against two currencies; the Euro and US dollar for six banks and fifty-seven bureaus for the year 2003. The researcher used the Chi-square as a test of goodness of fit and descriptive statistics in her data analysis. The study established that the FOREX market was inefficient due to many cases that arbitrage opportunities occur in the market. According to Muhoro (2005), higher profits could be made by carrying out a triangular arbitrage transaction rather than carrying out a locational arbitrage transaction in both banks and bureaus. It therefore appeared that currencies are not efficiently priced against one another.

The above local studies considered efficiency of foreign exchange market in Kenya from the arbitrage perspective i.e. profitability of simple trading rules. This is just one of the ways through which efficiency of foreign exchange market can be tested. Presence of risk premium, rationality of participants' behavior, presence of over/under reaction in the market, inefficient information processing can also be used to test EMH. This study will look at efficiency of foreign exchange market in Kenya from the rational expectations approach.

The local studies carried out were limited in the sense that the assumptions of normality, stationarity of data, and constant variance were not accounted for in the research models used. These assumptions need to be satisfied so that the estimated value of regression constants can be shown to be accurate. Prior research on efficiency of foreign exchange markets provide evidence that spot rates and forward rates are non-stationary and follow unit root processes. Failure to account for these assumptions may therefore put in doubt the studies' results and hence the conclusions arrived at by the researchers. This study will therefore go further to fill these gaps by testing for constant variance, normality distribution of error terms, as well as the stationarity of the time series data to be used.

The choice of rational expectations approach has also been motivated by the implication irrational participants in foreign exchange markets has on modern businesses. If participants are not rational, the error term will not be equal to zero. This may lead to wrong pricing of derivative products in the market which will in turn affect the cost of hedging and hence cost of doing business will be affected. The study was based on the null hypothesis that the economic agents are rational. Assuming that market participants are rational, the expected change in the exchange rate should differ from the actual change only by a rational expectations forecast error. The following research questions guided the study:

1. Is the current expected forward rate an unbiased predictor of the future spot exchange rate?
2. Does the expected exchange rate fully incorporate all available information?

## 1.3 Objectives of the Study

The aim of this study was to establish:

1. Whether the current expected forward rate is an unbiased predictor of the future spot exchange rate and;
2. Whether the participants in the foreign currency market in Kenya are rational and hence expected exchange rate fully incorporates all available information.

## 1.4 Importance of the Study

Since the collapse of the Breton Wood systems, most of the major exchange rates have been allowed to float freely for the longest period of time in recent economic history. Many smaller banks have as a result adopted policies of pegging their exchange rates to major foreign currencies. The findings of the study therefore provide a rationale for examining the exchange rate management systems in Kenya. In particular, the study will benefit the following:

(i) Investors: The study seeks to inform investors on the rationality of transacting businesses in foreign currency, as opposed to local currencies and further advice on the risks related to either of the approaches.

(ii) Financial institutions: This study will seek to inform financial institutions in developing of policies to advise their clients against the effects of unstable exchange rates especially in cases where business transactions are conducted in major foreign currencies.

(iii) The government, through the Central Bank of Kenya in formulating of guidelines towards the management of foreign exchange rate market and associated currency risks.

(iv) Researchers and Academicians: The study forms a basis for future researchers and academicians who may be conducting research on efficiency of financial markets and in the development of Efficiency Markets Hypothesis (EMH) considering it has gone through a paradigm shift over the years.

# CHAPTER TWO

# 2.0 LITERATURE REVIEW

## 2.1. Introduction

This chapter reviews the literature on rational expectations in the foreign exchange markets. Empirical tests from the literature are generally unfavourable to the hypothesis that exchange rate expectations are rational in terms of both unbiasedness and orthogonality. Except for certain time periods and horizons, survey expectations are shown to be biased predictors of future exchange rates, and the forecast errors are correlated with some variables that are known to be in the set of information available when the expectations are formed. Given the extraordinary nature of some sample periods, however, the rejection of the rationality hypothesis may be saying more about the peculiarity of actual exchange rate movements than the nature of exchange rate expectations.

The chapter is organized as follows: section 2.1 is the introduction; section 2.2 covers the efficient market hypothesis; section 2.3 is a review on efficiency of foreign exchange markets; section 2.4 covers the relationship between rational expectations and efficient markets; section 2.5 reviews the testing of foreign exchange markets' efficiency; section 2.6 reviews empirical evidence on FOREX market efficiency; section 2.7 reviews empirical evidence on FOREX market efficiency in Kenya; and finally section 2.8 gives the chapter summary.

## 2.2. Efficient Market Hypothesis (EMH)

Fama (1970) deduced different forms of efficiency of a market (i.e. weak form, semi-strong form and strong form efficiency) depending on how much information is used in forming expectations about the future price. The various forms of efficiency are tested using the methodology outlined below.

### 2.2.1 Weak form Efficiency

Tests for 'weak form' market efficiency have normally been based on the predictive power of the forward rate for the future spot rate (Swarna, 1994). The test is to determine whether the forward rate is an unbiased predictor of the future spot rate in a foreign exchange market. The procedure is specified as follows:

$$Ln\ S_{t+1} = \alpha + \beta\, Ln\ F_{t+1} + \mu_t \quad \text{.................................................} (1)$$

Where:

$S_{t+1}$ is the three-month future spot rate

$F_{t+1}$ is the calculated forward rate at time t for delivery at time (t+1)

$\beta$ is the relationship between $S_{t+1}$ and $F_{t+1}$

The test for efficiency in Equation 1 relates to testing the null hypothesis $\alpha = 0$ and $\beta = 1$

In the cases where the forward market is not very active in the foreign exchange market, the few agents that undertake these transactions base them on the interest rate differentials between the local and foreign interest rates. The forward rate $F_t$ is therefore computed as follows:

$$F_t = S_t * \frac{1+i_h}{1+i_0} \quad \text{.................................................................} (2)$$

Where:

$i_h$ is the local interest rate

$i_0$ is the foreign interest rate

$S_t$ is the spot rate at time t

### 2.2.2 Semi- Strong Form Efficiency

The "Semi-strong" form of EMH requires that current price incorporates all publicly available information, including its own past prices (Fama, 1970). Semi-strong form efficiency is perhaps the version of efficiency closest to the rational expectations hypothesis since it is assumed that economic agents know the true model of the economy and use all publicly available information in forming expectations. Geweke and Feige (1979) distinguished two categories within the semi-strong form of market efficiency: (a) single-market efficiency where all publicly available information concerning a single exchange rate is contained in the information set; and (b) multi-market efficiency where information on all other exchange rates and all available economic information is included in the information set.

### 2.2.3 Strong Form Efficiency

For the 'strong' form of the EMH, the literature suggests that there should be co-integration between future spot and forward rate series. The Engle-Granger (1987) bi-variate two-step co-integration regression procedure is applied. The reverse regression from Equation 1 above is specified as in equation (3) below:

$$Ln\ F_{t+1} = \alpha + \beta\, Ln\ S_{t+1} + \mu_{1t} \quad \text{.......} (3)$$

The direct regression specified in Equation 1 and the reverse regression in Equation 3 are conducted to determine whether the foreign exchange market is characterized by strong form efficiency. Co-integration tests involve establishing whether the stochastic trends in future spot and forward rate series have long-run relationship.

This is accomplished by testing whether the residuals of co-integration regressions are stationary by applying the Augmented Dickey-Fuller (ADF) unit root tests (Dickey and Fuller, 1979). The co-integration equations are of the form shown in equations (1) and (3). $\mu_t$ and $\mu_{1t}$ are the residuals to be tested for stationarity. If the computed ADF are found to be greater than the critical values (5% and/or 1%), the null hypothesis of existence of co-integration between the future spot and forward rate series will be rejected, and accepted otherwise.

## 2.3. Foreign Exchange Market Efficiency

The classic definition of an efficient market is due to Fama (1970), and is a market where prices fully reflect the information available, such that an unusual profit cannot be earned through exploiting this information set. In this case, decisions taken on the basis of these prices will promote the efficient allocation of resources (Levich, 1985).

More formally, expressing market equilibrium in terms of equilibrium returns, consider the following definition of the excess return $Z_{t+1}$ in the context of foreign exchange markets:

$$Z_{t+1} = \Delta S_{t+1} - E(\Delta S_{t+1}/\Psi_t) \qquad (4)$$

Where $\Delta S_{t+1}$, is the actual one-period percentage change in the spot exchange rate (or more precisely, the change in the log of the exchange rate); and the second term E $(\Delta S_{t+1}/\Psi_t)$ is the expectation at time t, given the market information set $\Psi_t$, of the equilibrium percentage change in the spot exchange rate. A currency market is said to be efficient, given the information set, when the difference between these two terms in equation (1), or the excess returns series $Z_{t+1}$, is a "fair game" (or martingale difference - LeRoy, 1989). This implies the series $Z_{t+1}$ has an expected value of zero and is unforecastable given $\Psi_t$ (i.e. the excess returns are independent of any information dated t or earlier in $\Psi_t$, especially St-i, for i $\geq$0). Clearly there will be no systematic large profits or losses in such a market. Note that where there are positive information and trading costs, the definition implies that deviations from a fair game in equation (4) will be within transactions and trading costs (Fama, 1991).

## 2.4. Rational Expectations and Efficient Markets

The crux of the argument in analysis of efficiency of financial markets changed with the incorporation of the theories of rational expectations put forward by Muth (1961) and efficient markets developed by Fama (1970) in the Fisher hypothesis. While Fisher argued that past changes in the price level became embodied in the current rate of interest, Fama (1975) argued that future price changes were reflected in the current rate of interest. This was interpreted by Fama as evidence of an efficient market. This approach rejected Fisher's conclusions of a distributed lag structure in the formation of expectations. Instead, it assumed that rational forecasters would use all available information in forming price expectations.

Using data for one-month Treasury bills to approximate interest rates and the rate of change in the consumer price index to approximate price changes, Fama(1975) tested the joint hypothesis that the U.S Government Treasury bill market was efficient and that the real return on one-to-six month Treasury bill was constant within a rational expectations framework. Fama computed sample autocorrelations of the expected change in purchasing power and real return for lags from 1–12 for the period January 1953 to July 1971. The estimated sample autocorrelations of the real return were large, indicating that past rates of change in the real return contained information about expected future rates of change. The sample autocorrelations of the real return were insignificantly different from zero, consistent with the hypothesis of a constant real return. Tests were also carried out for longer-term maturities for up to six months. Results for all maturities indicated that the market used all the available information about the rate of inflation in setting nominal rates of interest, thus supporting the efficient market hypothesis.

Fama's findings were subsequently challenged by Hess and Bicksler (1975), Carlson (1977), Joines (1977), and Nelson and Schwert (1977). Carlson (1977), using Livingston data on the CPI for the period 1953–1971, rejected Fama's findings that short-term interest rates were efficient predictors of subsequent rates of inflation. Carlson introduced a business cycle variable to Fama's regression equation, which was represented by the ratio of employment to population, lagged by six months. With the incorporation of this variable, the coefficient on the interest rate in Fama's model was found to deviate significantly, which led Carlson to conclude that information about inflation that was not fully incorporated in interest rates was reflected in this ratio.

Joines (1977) observed a seasonal pattern in the forecast errors of the rate of price inflation used by Fama, which he pointed out, was inconsistent with the concept of market efficiency leading him to question the accuracy of the price data used by Fama. Nelson and Schwert (1977) and Hess and Bicksler (1975) employed a Box-Jenkins approach to construct a time series predictor of inflation, based on past rates of inflation. The regression of the rate of inflation on the rate of interest and the estimated rate of inflation yielded a non-zero coefficient for estimated inflation, indicating that the forecast contained information about the rate of inflation not embodied in the rate of interest.

With the incorporation of rational expectations and efficient markets in the Fisher hypothesis, it was believed that the time series in question should approximate a random walk in an efficient market (Arusha, 2002). The random-walk model requires that changes in past rates of inflation and interest rates be uncorrelated with all prior information. This was is in sharp contrast to the distributed lag effect in expectations formation, which implied that inflation rates were highly and positively correlated. Although the studies of Hess and Bicksler (1975), Carlson (1977), Fama and Gibbons (1984) suggested that when expected real returns were assumed to display a unit root, Treasury bill rates were good predictors of inflation, no explicit tests for unit roots were carried out by them.

Normally, rationality is defined in terms of two criteria: (1) whether the expected exchange rate is an unbiased predictor of the future spot exchange rate (unbiasedness); and (2) whether the expected exchange rate fully incorporates all available information (orthogonality). The tests of rational expectations reported in the literature also correspond to these two types.

### 2.4.1. Unbiasedness

According to Shinji (1991), unbiasedness is an important aspect of the rationality of exchange rate expectations. The use of survey data allows direct testing of the hypothesis that the expected spot exchange rate for period $t + j$ (formed in period t) is an unbiased predictor of the future spot rate (in period $t + j$)

$$S_{t+j} = \alpha + \beta E_t S_{t+j} + \mu_t \quad \text{.......................................... .......(5)}$$

Where the survey expectation $E_t S_{t+j}$ is free from the presence of a risk premium, and $\mu$ is a random error term. Tests of the unbiasedness of exchange rate expectations would involve tests of the hypothesis of $\alpha = 0$ and $\beta = 1$, when equation (5) is estimated, usually in first-difference form.

Dominguez (1986) and Ito (1990) regressed actual depreciation on expected depreciation using Money Market Services and Japan Center for International Finance, respectively, for different time horizons and for different dollar exchange rates. For the earlier period (1983- 85), Dominguez almost unanimously rejected the joint hypothesis of $\alpha = 0$ and $\beta = 1$ for one-week, one- month, and three-month expectations for all currencies. The negative estimates of $b_2$ for some exchange rates from Dominguez's findings suggested that the forecasts missed the direction of exchange rate movements. Moreover, the estimate of $b_2$ was below unity in many cases, implying the tendency of forecasters to over predict the size of future dollar depreciations. For the later period (1985-87), however, Ito (1990) could not reject the joint hypothesis except for the six-month expectation. The difference between the two studies may reflect the extraordinary nature of the effects of the sample period used. The period studied by Dominguez was one in which the U.S. dollar continued to appreciate on a sustained basis despite expectations to the contrary. Given the extremely low values of $R^2$ in all of these studies, only a small portion of actual exchange rate changes was predicted in practice. The exact outcome of empirical tests of the unbiasedness hypothesis is thus likely to depend on the sample used.

### 2.4.2. Orthogonality

Orthogonality is another important aspect of the rationality of exchange rate expectations (Shinji, 1991). If expectations are to be efficient (in the sense that they incorporate all available information), their predictable power cannot be improved by inclusion of any variable that is already in the set of information available at the time when the expectations are formed. That is to say, prediction errors must be uncorrelated with any variable in the set of known information. Running the following regression can formally test this orthogonality condition:

$$E_t S_{t+j} - S_{t+j} = \alpha + \beta X_t + v_t \quad \text{.......................................} (6)$$

Where the left-hand-side variable is a prediction error, $X_t$ is a set of information known in period t, and v is a random error term; popular candidate variables for $X_t$, have included forward discounts (or nominal interest rate differentials) and lagged exchange rates. The orthogonality hypothesis is that $\alpha = \beta = 0$.

## 2.5. Testing of foreign exchange market efficiency

Early efficiency studies of the EMH tested for the randomness of exchange rate changes (Sarno and Taylor, 2004). It was established that there exists significant first order serial correlation for many of the exchange rates examined during the 1920s (Poole, 1967). Poole also provided evidence that simple trading rules could potentially yield large profits. If the risk neutral efficient markets hypothesis is true, then the expected foreign exchange gain from holding one currency rather than another must be equal to the interest rate differential between the home and foreign country. This condition is known as the Uncovered Interest Rate Parity (UIRP) condition. It constitutes the basic parity condition for testing the efficiency of the foreign exchange market (Taylor, 1987).

The second method for testing market efficiency is to test for the profitability of simple filter rules. A simple *n*-percent filter rule involves buying a currency whenever it raises *n*-percent above its most recent trough and selling the currency whenever it falls *n*- percent below its most recent peak. If the market is efficient and UIRP holds, the interest rate costs of such as strategy should on average eliminate any profit. A number of studies do indicate the profitability of simple filter rules (Dooley and Shafer, 1984; Levich and Thomas, 1993) although it is usually not clear that the optimal filter rule size could have been chosen *ex ante*. There are significant risks involved since substantial sub-period losses are often generated. Engel and Hamilton (1990) demonstrated that the dollar, from the early 1970s to the late 1980s, displayed largely uninterrupted trends, which were susceptible to trend following trading rules.

The third method of testing market efficiency is through the rational expectations approach. Assuming that market participants are rational, the expected change in the exchange rate should differ from the actual change only by a rational expectations forecast error. Hence assuming covered interest rate parity the uncovered interest rate parity condition can be tested by estimating the regression parameters of equation (7) below (Taylor, 1987).

$$\Delta_k S_{t+k} = \alpha + \beta\left(f_t^{(k)} - S_t\right) + \eta_{t+k} \quad \text{.........................................} \quad (7)$$

Where:

$S_t$, denotes the logarithm of the spot exchange rate at time t,

$\Delta_k S_{t+k} = S_{t+k} - S_t$

$\alpha$, $\beta$ are regression constants

$\eta_{t+k}$ is an error term

If market participants are risk-neutral and have rational expectations we should expect β to be equal to unity and $\eta_{t+k}$ to be uncorrelated with information available at time t.

Empirical work based on the estimation of equation (7) rejects the efficient markets hypothesis under risk-neutrality (Fama, 1984; and Bekaert and Hodrick, 1993). Indeed it is a stylized fact that estimates of β using exchange rates against the dollar, are generally closer to minus unity than plus unity (Froot and Thaler, 1990). Initial studies based on the regression model that test the weak form of the foreign exchange market efficiency usually found an estimated slope coefficient close to unity. It was subsequently realized, however that standard regression analysis was invalid because of the non-stationary data used (Engle and Granger, 1987). Dornbush (1980 and 1988) and Frenkel (1980 and1981) concluded that the best way to estimate the exchange rate market efficiency is to presume that the behaviour is due to interest rate differentials and any difference between forward and spot exchange rates at time t+1 results from the arrival of new information which agents have not predicted.

## 2.6. Empirical Evidence on FOREX Market Efficiency

Fama (1965) described an efficient market as consisting of a large number of competitive profit maximizers interacting in a market and utilizing all available information in a rational manner. In an efficient market, prices should fully reflect all the relevant and available information; hence, no profit opportunities are left unexploited. If currency markets are efficient, the spot or forward exchange rates should embody all relevant information, and they should not be able to forecast the spot or forward exchange rate as a function of another. Also, the current forward rate should be an unbiased predictor of the future spot rate if we assume risk neutrality and a covariance stationary risk premium (i.e. the current forward exchange rate should forecast the future spot rate if the markets are efficient).

This is a long-standing issue in the literature on foreign exchange markets. As Hodrick (1987) argues, '...there is very strong evidence against the hypothesis that forward exchange rates of any maturity from one day, to one week to one or three months are unbiased predictors of future spot rates.'p.17. When the unbiasedness hypothesis does not hold, there is evidence of a risk premium, market inefficiency or both.

While Baillie and Bollerslev(1989), MacDonald and Taylor (1989), and Diebold *et al* (1994) argued that co-integration among exchange rates in different currencies implies failure of market efficiency, Dwyer and Wallace(1992) and Engel (1996) have demonstrated that there is no connection between co-integration of spot rates and market inefficiency. Levin and Lin (1992), Im *et al.* (1995) and Wu and Chen(1998) showed that the improved statistical power of unit root tests derived from using grouped or pooled cross-sectional data other than individual series strongly supports the hypothesis of market efficiency. Alexakis and Apergis (1996) also prove the presence of the efficient foreign exchange market hypothesis by modeling conditional heteroskedasticity through ARCH models.

As is depicted by the survey by Froot and Thaler (1990), the conventional test for efficiency assumes that the forward exchange rate is an unbiased estimate of the ex post spot rate. A broad range of literature has also proposed the use of expectations survey data to improve further the efficiency test, just in case there are any biases that can be observed in this efficiency tests. Consequently, Elliot and Ito (1995) use micro survey data to examine the efficiency of the forward yen/dollar market and find that the survey data is an important source of supplementary information on the behavior of the markets.

Various researchers have used the martingale model to test efficiency of foreign exchange market from rational expectations approach.

$E[Z(T+1); Z(t), Z(t-1), \ldots, Z(0)] = Z(t)$ ……………………….(8)

This means that all information concerning the past history of prices which affect Z(t+1) is fully reflected in the current price Z(t). The best predictor of $Z_{(t+1)}$ is Z (t). To test the martingale hypothesis the researchers have examined whether disturbance term *u*(t+1) n the following equation is a serially uncorrelated term with zero expectation; P(t) is the spot price, $Q_T(t)$ is the forward price at time t for delivery at date T.

$P(t+1) - P(t) = u(t+1)$ ……………………………………….(9)

$P(t+1) - Qt+1(t) = u(t+1)$ …………………………………….(10)

Dooley and Shafer (1976) examined change in the dollar spot rates during the period March 13, 1973 to September 5, 1975 using the martingale model for Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Switzerland and the United States. The results led to rejection of the martingale model for spot exchange rates for four out of the nine countries at the ninety five percent confidence level implying that exchange markets for many currencies may not have been efficient in the use of price information.

Cummins et al. (1976) examined the Canadian-U.S. exchange rate using the martingale model in the 1970-74 period. They concluded that the spot market seems to behave efficiently and hence it does a random walk. However, their test indicated that the forward rate on the Canadian dollar does not do a random walk hence the respective forward market did not pass the usual weak form test of efficiency.

Levich (1978) examined equation (9) for nine countries during the period 1967-75. For the three-month horizon, the error $u(t+1)$ was not significantly different from zero in France and Italy; but the errors seemed to be significantly different from zero in Canada, the United Kingdom, Belgium, Germany, the Netherlands, Switzerland and Japan. Only in two out of nine countries was the martingale hypothesis consistent with the data.

Kaserman (1973) examined the U.S.-Canadian dollar during the period July 1955 to March 1961 for the relation between the subsequent spot price P(t+1), where the unit of time is one quarter, and the forward price $Q_{t+1}(t)$ at time t. He studied equation (10) and concluded that the forward rate under-predicted the spot rate in periods when the spot rate was rising and over-predicted it when the spot rate was falling.

## 2.7. Empirical Evidence on FOREX Market Efficiency in Kenya

Ndunda (2002) tested whether forward exchange rates are predictors of future spot rates in Kenya using the Hansen & Hodrick (1980) model. In her study, Ndunda focused on the foreign exchange market under floating exchange rate for the period between October 1993 and December 2002. The data involved comprised of weekly spot exchange rate and the three-month forward exchange premium for the US dollar, the UK sterling pound, the Swiss Franc, the Euro, and the Japanese Yen. The regression of the forecast errors of the own exchange rate was estimated on a constant two lagged errors using weekly data and a three-month or a 13-week forward rate. The tests of the regression model used were based on the joint hypothesis that all the coefficients in the regression are equal to zero. The findings of the study established strong evidence to support simple efficiency hypothesis for at least four of the five currencies. She established that in the Kenyan market the interest rates have been relatively high while the change in the foreign exchange rates has not been at the same rate. Hence the forward rates quoted had been higher than the future spot rates; an indication that the forward rate is not a good predictor of the future spot rate. She therefore concluded that the foreign exchange market in Kenya is inefficient as the rate of return to speculation is not equal to zero. The study however was limited in the sense that the assumptions of normality and constant variance were not accounted for in the research model used by Ndunda (2002). Available evidence shows that exchange rates are better characterized by ARCH models (Engle,1982; Hsieh, 1989). Besides using the rational expectations approach, this study will also go further to fill this gap by testing for constant variance, normality distribution of error terms, as well as the stationarity of the time series data to be used.

In the period prior to 1995, Kenya maintained restrictions on foreign exchange currency transactions. However, according to Kurgat (1998) Kenya's foreign exchange market became vibrant after the repeal of the Exchange Control Act in 1995 and the licensing of foreign exchange bureaus. The introduction of foreign exchange bureaus in the country improved the convertibility of the Kenya shilling in relation to other currencies (Kurgat, 1998). Kurgat carried out an empirical study of the spot markets' efficiency of foreign exchange bureaus in Kenya where he pointed out the inefficiency of the Kenyan foreign exchange market due to the existence of arbitrage opportunities. He showed that there was an opportunity to make instantaneous risk free profits through locational arbitrage. The study established that the foreign exchange markets in Kenya are not efficient.

Seven years later Muhoro (2005) carried out a similar study using locational and triangular arbitrage models. The study involved secondary data in the form of daily closing counter foreign exchange rates for six banks and fifty-seven bureaus for the year 2003. The data was analyzed though chi-square and line graphs. The aim of the study was to find out whether it was possible for an arbitrageur to make profits through locational and triangular arbitrage. The findings established that the FOREX market was inefficient due to many cases that arbitrage opportunities occur in the market. According to Muhoro (2005), higher profits could be made by carrying out a triangular arbitrage transaction rather than carrying out a locational arbitrage transaction in both banks and bureaus. It therefore appeared that currencies are not efficiently priced against one another.

## 2.8. Chapter Summary

Local studies carried out on efficiency of foreign exchange market in Kenya i.e. Ndunda (2002), Kurgat (1998) and Muhoro (2005) looked at efficiency from the basis of profitability of simple trading rules (arbitrage). This study will instead look at efficiency of the foreign exchange market in Kenya from the rational expectations approach. The results of the above local studies could also be questionable since in all the studies, the assumptions of regression models such as normally distributed errors terms, constant variance, and stationarity of time series data were not tested. Also prior research on the efficiency of the foreign exchange markets provides evidence that spot rates and forward rates are non-stationary and follow unit root processes (Meese and Singleton, 1982; Baillie and Bollerslev, 1989; Hakkio and Rush, 1989; Barnhart and Szakmary, 1991; Liu and Maddala, 1992; Naka and Whitney, 1995; Lin and Chen, 1998; and Lin et al., 2002). This study sought to fill this gap by testing for rational expectations, constant variance, normality distribution of error terms, as well as the stationarity of the time series data to be used.

# CHAPTER THREE

# 3.0 RESEARCH METHODOLOGY

## 3.1. Data and Sample

There were 43 commercial banks as at November 2006 (Appendix I). The data sources were limited to observations from all commercial banks that have relatively active business operations in foreign exchange markets. The research focused on the foreign exchange markets under floating exchange rates beginning November 1993 to June 2006. The start date in this case was dictated by the time when the government shifted its foreign exchange policy from fixed exchange rates to independently floating exchange rates.

The study involved the collection of secondary data. Historical data for the monthly (average) spot exchange rate and the three-month forward premiums for the Euro, the Sterling Pound, the US Dollar, and the two East African currencies were obtained from the Central Bank of Kenya. The premium was added to the spot exchange rates to obtain the three-month or 13-week forward exchange rate. Due to lack of documented weekly data on T-BILL rates, the sample was based on the monthly averages for both the T-BILL and spot rates. The spot rates were therefore the monthly averages, derived from taking the average of the daily rates for each month. All the exchange rates were expressed in Kenya Shillings (Kshs) per unit of foreign currency. The US monthly averages for the 91-Day T-BILL rates were obtained through a search query at the website link to the US treasury department. This assisted in computing the forward rate as outlined in equation (2) and explained in section 3.2.1 below.

## 3.2. Research Model

### 3.2.1. Analytical Model

The analytical model for testing FOREX market efficiency was based on regressing equation (7) below.

$$\Delta_k S_{t+k} = \alpha + \beta\left(f_t^{(k)} - s_t\right) + \eta_{t+k} \quad \text{.......................................... (7)}$$

Where:

$S_t$, denotes the logarithm of the spot exchange rate at time t,

$\Delta_k S_{t+k} = S_{t+k} - S_t$

$f_t^{(k)}$ = Level of k-period forward exchange rate determined at time t

$\alpha$, $\beta$ are regression constants

$\eta_{t+k}$ is an error term with $E_t(\eta_{t+k}) = 0$

If market participants are risk-neutral and have rational expectations it is expected that $\beta$ to be equal to unity and $\eta_{t+k}$ to be uncorrelated with information available at time t. The forward rates were computed by applying equation (2). The monthly averages for the US 91-Day T-BILL rates for November 1993 to June 2006 were applied in equation (2) as the proxy for foreign interest rates.

## 3.3. Statistical Tests

### 3.3.1. T-test

**The t-test** was used to test the hypothesis that the regression coefficients $\alpha$ , and $\beta$ are equal to 0 and 1, respectively. Equation (7) was estimated for each of the five currencies over the entire study period at both 1% and 5% levels of significance.

### 3.3.2. Non-Stationarity Tests

To examine the issue surrounding non-stationarity and unit roots associated with spot and forward rates, the study used an Augmented Dickey-Fuller (ADF) test, which allows for serial correlation in the error term $\eta_{t+k}$. This was important since unit root tests of spot and forward rates series should take into account any seasonality in the generation of time-series data. The equation used for conducting ADF test has the general structure of equations (11)

$$\Delta S_t = \alpha_0 + \beta_1 t + \rho_1 S_{t-1} + \sum_{k=1}^{n} \delta_k \Delta S_{t-k} + \varepsilon_t \quad \text{.................................... (11)}$$

Where:

| | | |
|---|---|---|
| $\Delta$ | = | First Difference Operator |
| $\Delta S_t$ | = | $S_t - S_{t-1}$ |
| $\delta_k$ | = | Coefficients of the lagged differences of the spot rates. |
| $\beta_1$ | = | Coefficients of the time trend for $S_t$ rates |
| $\rho_1$ | = | Coefficients of the lagged 1st difference of $S_t$ |
| t | = | Time trend |
| $\varepsilon_t$ | = | White noise error terms |

In equation (11), if (i) $\beta_1$=0 and $|\rho_1|$ <1, the series $S_t$ is stationary;

(ii) $\beta_1$=0 and $\rho_1 = 1$ then the series is non-stationary

(iii) $\beta_1 \neq 0$ and $|\rho_1|<1$ then the series is trend-stationary (i.e. stationary around a deterministic linear time trend).

### 3.3.3. Correlation Tests

Auto-correlation test is a reliable measure for testing of either dependence or independence of random variables in a series. The serial correlation coefficient measures the relationship between the values of a random variable at time t and its value in the previous period. Auto correlation test provides evidence whether the correlation coefficients for residuals are significantly different from zero. A way to test for the presence of autocorrelation is to regress equation (12) and check whether the $\gamma_i$'s i =1, 2, 3,.....n have values between [-1, 1]. Values of zero for $\gamma_i$'s i =1, 2, 3...n suggests no autocorrelation.

$$\Delta E_t = E_{t-1} + \gamma_1 \Delta E_{t-1} + \gamma_2 \Delta E_{t-2} + \gamma_3 \Delta E_{t-3} + \ldots + \gamma_n \Delta E_{t-n} + \varepsilon_t \;\ldots\ldots\ldots (12)$$

Where:

$E_t$ = Residual from the regression

$\gamma_i$ = Coefficient of the lagged residuals

$\Delta E_t$ = $E_t - E_{t-1}$

If auto correlation is present, this will imply that participants in the foreign exchange market are not rational. Ljung-Box Q statistics were used to test for autocorrelations. Ljung-Box Q statistic follows the chi-square distribution with m degrees of freedom as shown in equation (13):

$$LB = n(n+2)\sum_{k=1}^{m}(\hat{p}^2{}_k / n-k) \cong \chi^2 \;\ldots\ldots\ldots (13)$$

Where $\hat{p}^2{}_k$ = autocorrelation coefficients at lag k; and n = Sample size

# CHAPTER FOUR

# 4.0 DATA ANALYSIS, DISCUSSION AND CONCLUSION

## 4.1. Introduction

This chapter presents the data analysis, interpretation, and discussion of the research findings. The chapter is organized as follows: section 4.2 is on unit roots tests for time series properties; Section 4.3 covers tests on efficiency of FOREX markets and tests for rationality; Section 4.4 outlines the results derived from diagnostic tests; and Section 4.5 provides a discussion of the findings.

## 4.2. Unit Roots Tests for Time series Properties

The first step involved testing for the time series properties of each of the spot rate series. In particular, it involved examining whether the spot rates series are stationary. The Augmented Dickey-Fuller (ADF) unit root test was used (Dickey and Fuller, 1979) and the results are reported in Table 4.1 below. The ADF test allows for serial correlation in the error term $\eta_{t+k}$ in equation (7). The null hypothesis, $H_0$ was that the spot rates series is stationary (i.e., from equation 11; $H_0$: $\rho_1 = 1$) while the alternative hypothesis was that each of the series was non-stationary. The results of Table 4.1 were obtained by differencing each of the spot series twice. The results also indicate that each of the series was non-stationary at level form and at first difference. It was established that each of the spot series was a I (2) process. The decision rule was based on rejecting H0: the series is stationary, if the ADF statistics are greater than the critical values (Dickey and Fuller, 1979). Therefore the second differences were used in testing whether the forward rate is an unbiased predictor of the future spot exchange rate; and whether the exchange rates fully incorporate all available information.

**Table 4.1: Unit Root Test for the spot rates series**

| Spot Rate | ADF | Critical Values (5%) | Critical Values (1%) | Decision |
|---|---|---|---|---|
| **US Dollar** | | | | |
| $S_t$ | 12.634 | -3.45 | -3.99 | Reject $H_0$ |
| 1st Difference , $S_t$ | -5.234 | -3.45 | -3.99 | Reject $H_0$ |
| 2nd Difference, $S_t$ | -3.046 | -3.45 | -3.99 | Accept $H_0$ |
| **UK POUND** | | | | |
| $S_t$ | 16.556 | -3.45 | -3.99 | Reject $H_0$ |
| 1st Difference , $S_t$ | -6.236 | -3.45 | -3.99 | Reject $H_0$ |
| 2nd Difference, $S_t$ | -2.896 | -3.45 | -3.99 | Accept $H_0$ |
| **THE EURO** | | | | |
| $S_t$ | 11.446 | -3.45 | -3.99 | Reject $H_0$ |
| 1st Difference , $S_t$ | -4.473 | -3.45 | -3.99 | Reject $H_0$ |
| 2nd Difference, $S_t$ | -2.774 | -3.45 | -3.99 | Accept $H_0$ |
| **UGANDA SHILLING** | | | | |
| $S_t$ | 8.446 | -3.45 | -3.99 | Reject $H_0$ |
| 1st Difference , $S_t$ | -6.341 | -3.45 | -3.99 | Reject $H_0$ |
| 2nd Difference, $S_t$ | -2.456 | -3.45 | -3.99 | Accept $H_0$ |
| **TANZANIA SHILLING** | | | | |
| $S_t$ | 12.362 | -3.45 | -3.99 | Reject $H_0$ |
| 1st Difference , $S_t$ | -5.220 | -3.45 | -3.99 | Reject $H_0$ |
| 2nd Difference, $S_t$ | -3.116 | -3.45 | -3.99 | Accept $H_0$ |

$H_0$: the series is stationary

## 4.3. Efficiency of FOREX markets and Tests for Rationality

Tests for unbiasedness and orthogonality were carried out to test the foreign exchange market efficiency from the rational expectations approach.

### 4.3.1. Test for 'unbiasedness' hypothesis

The test for 'unbiasedness' was performed to determine whether the forward rate is an unbiased predictor of the future spot rate in a foreign exchange market. The findings are indicated in Table 4.2. The test for 'weak form' efficiency was based on testing the null hypothesis $\alpha = 0$ and $\beta = 1$ for each of the five currencies.

**Table 4.2: Testing Market Efficiency Using Forward Rates**

| **Equation (1):** $Ln\ S_{t+3} = \alpha + \beta Ln\ F_{t+3} + \mu_t$ | | | | |
|---|---|---|---|---|
| **Spot rate** | $\alpha = 0$ | $\beta = 0$ | **T statistic for** $H_0{:}\beta = 1$ | **Decision** |
| **US Dollar** | 0.780<br>(3.122)** | 0.793<br>(13.693)** | -15.683** | $H_0{:}\beta = 1$: Reject $H_0$<br>$H_0{:}\alpha = 0$: Reject $H_0$ |
| **UK Pound** | 0.373<br>(1.318) | 0.898<br>(15.195)** | -7.639** | $H_0{:}\beta = 1$: Reject $H_0$<br>$H_0{:}\alpha = 0$: Reject $H_0$ |
| **The Euro** | -0.719<br>(-3.999)** | 1.154<br>(28.365)** | 11.488** | $H_0{:}\beta = 1$: Reject $H_0$<br>$H_0{:}\alpha = 0$: Reject $H_0$ |
| **Uganda Shilling** | -0.957<br>(-3.090)** | 1.282<br>(13.037)** | 45.274** | $H_0{:}\beta = 1$: Reject $H_0$<br>$H_0{:}\alpha = 0$: Reject $H_0$ |
| **Tanzania Shilling** | -0.574<br>(-3.124)** | 1.199<br>(16.524)** | 23.514** | $H_0{:}\beta = 1$: Reject $H_0$<br>$H_0{:}\alpha = 0$: Reject $H_0$ |

* Significant at 5% level (P-values < 0.05); Critical values = 1.96 (at 5%) and 2.57 (at 1%)
** Significant at 1% level (P-values < 0.01); the t-statistics for the coefficients are in brackets
The T statistics for $\beta = 1$ were computed as follows:

$\left(\frac{\beta' - 1}{s/\sqrt{n}}\right)$ Where $\beta'$ is the computed value of $\beta$ and $s$ is the standard deviation. The decision rule was to reject the null where the computed T statistic for $H_0{:}\beta = 1$ was greater than 1.96

As per the results of Table 4.2, the null hypotheses for the forward rates being unbiased predictors of the future spot rates were rejected at both 95% and 99% levels of confidence since $\alpha \neq 0$ and $\beta \neq 1$ for each of the spot rates. The fact that the unbiasedness hypothesis does not hold in the five foreign exchange markets is evident of either existence of a risk premium and/or that the markets are not 'weak form' efficient.

The above findings are in agreement with previous study carried out by Ndunda (2002) which stated that forward exchange rates were biased predictors of future spot rates in Kenya.

### 4.3.2. Tests for Orthogonality

The orthogonality condition was tested by regression of equation (7). From equation (7), if market participants are risk-neutral and have rational expectations it was expected that β to be equal to unity and $\eta_{t+k}$ to be uncorrelated with information available at time *t*. Equation (7) was regressed and the findings are as indicated in Table 4.3. The t-statistics for $H_0{:}\beta = 1$ were computed using a similar procedure as specified in section 4.3.1. The decision rule was based on rejecting $H_0$ if the obtained values of t-statistics were greater than 1.96, when the tests are performed at 95% level of confidence.

**Table 4.3: Tests for Rational Expectations**

| Equation (7): $\Delta S_{t+3} = \alpha + \beta\left(f_t^{(3)} - S_t\right) + \eta_{t+3}$ | | | | |
|---|---|---|---|---|
| **Spot rate** | $\alpha = 0$ | $\beta = 0$ | **T statistic for $H_0{:}\beta = 1$** | **Decision** |
| **US Dollar** | 0.015 (1.374) | -0.006 (-0.092) | -105.464** | $H_0{:}\beta = 1$: Reject $H_0$ |
| **UK Pound** | 0.024 (2.255)* | -0.047 (-0.709) | -109.774** | $H_0{:}\beta = 1$: Reject $H_0$ |
| **The Euro** | 0.0323 (4.564)** | -0.490 (-4.014)** | -293.578** | $H_0{:}\beta = 1$: Reject $H_0$ |
| **Uganda Shilling** | -0.010 (-1.313) | 0.221 (2.875)** | -118.781** | $H_0{:}\beta = 1$: Reject $H_0$ |
| **Tanzania Shilling** | 0.005 (0.609) | 0.069 (0.875) | -142.099** | $H_0{:}\beta = 1$: Reject $H_0$ |

* Significant at 5% level (P-values < 0.05); Critical values = 1.96 (at 5%)
** Significant at 1% level (P-values < 0.01); Critical values = 2.57 (at 1%)

The findings of Table 4.3 indicate that the null hypothesis $H_0{:}\beta = 1$ was rejected for all the five currency markets at both 95% and 99% levels of confidence which indicates that the participants in the currency markets are not risk-neutral and lack rational expectations.

## 4.4. Diagnostic Tests Results

### 4.4.1. Assumptions of Normality of Error Terms

A one-sample Kolmogorov-Smirnov (K-S) test was applied in establishing whether the error terms fitted a normal distribution. The One-Sample Kolmogorov-Smirnov Test procedure is a non-parametric test procedure that compares the observed cumulative distribution function for a variable with a specified theoretical distribution, which may be normal, uniform, Poisson, or exponential. The Kolmogorov-Smirnov Z is computed from the largest difference (in absolute value) between the observed and theoretical cumulative distribution functions. This goodness-of-fit test tests whether the observations could reasonably have come from the specified distribution, in this case a normal distribution. Table 4.4 indicates the tests for normality of error terms arising from the regression of equation (7). The null hypothesis for the test was that error terms do not assume a normal distribution. The decision rule was to reject the null hypothesis if the computed K-S Z-statistics are greater than the critical values at 95% level of confidence. The findings indicate that the null hypothesis was rejected for all the five currencies thus indication that the error terms were log normally distributed. Based on the properties of a normal distribution, the findings also imply that the respective residual terms were characterized by constant variances.

**Table 4.4: One-Sample Kolmogorov-Smirnov test for normality of error terms**

| Spot rate | Kolmogorov-Smirnov Z statistics | Critical Values (5%) | Critical Values (1%) | Decision |
|---|---|---|---|---|
| **US Dollar** | 2.493 | 0.113 | 0.135 | Reject $H_0$ |
| **UK Pound** | 2.350 | 0.113 | 0.135 | Reject $H_0$ |
| **The Euro** | 0.455 | 0.158 | 0.189 | Reject $H_0$ |
| **Uganda Shilling** | 0.873 | 0.133 | 0.159 | Reject $H_0$ |
| **Tanzania Shilling** | 0.779 | 0.133 | 0.159 | Reject $H_0$ |

$H_0$: The error terms do not assume a normal distribution

### 4.4.2. Auto-correlation Tests

Auto correlation test provided evidence on whether or not the correlation coefficients for residuals were significantly different from zero. The presence of autocorrelation was checked by regressing equation (12) and checking whether or not the $\gamma_i$'s i =1, 2, 3,.....n have values between [-1, 1]. Values of zero for $\gamma_{i's}$ i =1, 2, 3...n suggests no autocorrelation. Ljung-Box Q statistics were used to test for autocorrelations. Ljung-Box Q statistic follows the chi-square distribution with m degrees of freedom as shown in equation (13). The null hypothesis for the tests was that there was absence of auto-correlations in the residual terms. The findings presented in Table 4.5 indicate Ljung-Box Q statistics obtained up to the fifth order. The auto-correlation functions for each currency residuals are presented in figures 1, 2, 3, 4, and 5 in Appendix II.

**Table 4.5: The results for Auto-correlation Tests**

| Spot rate residuals | Ljung-Box Q statistics obtained | P-values | Decision |
|---|---|---|---|
| **US Dollar** | $1^{st}$ Order = 91.352 | 0.000 | Reject $H_0$ |
| | $2^{nd}$ Order = 120.492 | 0.000 | Reject $H_0$ |
| | $3^{rd}$ Order = 125.581 | 0.000 | Reject $H_0$ |
| | $4^{th}$ Order = 127.990 | 0.000 | Reject $H_0$ |
| | $5^{th}$ Order = 129.684 | 0.000 | Reject $H_0$ |
| | $6^{th}$ Order = 129.854 | 0.000 | Reject $H_0$ |
| | $7^{th}$ Order = 130.596 | 0.000 | Reject $H_0$ |
| | $8^{th}$ Order = 132.900 | 0.000 | Reject $H_0$ |
| | $9^{th}$ Order = 135.964 | 0.000 | Reject $H_0$ |
| | $10^{th}$ Order = 140.633 | 0.000 | Reject $H_0$ |
| **UK Pound** | $1^{st}$ Order = 86.962 | 0.000 | Reject $H_0$ |
| | $2^{nd}$ Order = 110.717 | 0.000 | Reject $H_0$ |
| | $3^{rd}$ Order = 113.563 | 0.000 | Reject $H_0$ |
| | $4^{th}$ Order = 115.036 | 0.000 | Reject $H_0$ |
| | $5^{th}$ Order = 115.850 | 0.000 | Reject $H_0$ |
| | $6^{th}$ Order = 115.855 | 0.000 | Reject $H_0$ |
| | $7^{th}$ Order = 116.806 | 0.000 | Reject $H_0$ |
| | $8^{th}$ Order = 118.416 | 0.000 | Reject $H_0$ |
| | $9^{th}$ Order = 120.111 | 0.000 | Reject $H_0$ |
| | $10^{th}$ Order = 122.815 | 0.000 | Reject $H_0$ |

| | | | |
|---|---|---|---|
| **The Euro** | $1^{st}$ Order = 32.633 | 0.000 | Reject $H_0$ |
| | $2^{nd}$ Order = 34.868 | 0.000 | Reject $H_0$ |
| | $3^{rd}$ Order = 38.846 | 0.000 | Reject $H_0$ |
| | $4^{th}$ Order = 44.327 | 0.000 | Reject $H_0$ |
| | $5^{th}$ Order = 48.475 | 0.000 | Reject $H_0$ |
| | $6^{th}$ Order = 49.132 | 0.000 | Reject $H_0$ |
| | $7^{th}$ Order = 49.694 | 0.000 | Reject $H_0$ |
| | $8^{th}$ Order = 54.739 | 0.000 | Reject $H_0$ |
| | $9^{th}$ Order = 62.373 | 0.000 | Reject $H_0$ |
| | $10^{th}$ Order = 65.352 | 0.000 | Reject $H_0$ |
| **Uganda Shilling** | $1^{st}$ Order = 49.139 | 0.000 | Reject $H_0$ |
| | $2^{nd}$ Order = 59.094 | 0.000 | Reject $H_0$ |
| | $3^{rd}$ Order = 59.131 | 0.000 | Reject $H_0$ |
| | $4^{th}$ Order = 59.297 | 0.000 | Reject $H_0$ |
| | $5^{th}$ Order = 59.712 | 0.000 | Reject $H_0$ |
| | $6^{th}$ Order = 60.274 | 0.000 | Reject $H_0$ |
| | $7^{th}$ Order = 60.406 | 0.000 | Reject $H_0$ |
| | $8^{th}$ Order = 60.415 | 0.000 | Reject $H_0$ |
| | $9^{th}$ Order = 60.495 | 0.000 | Reject $H_0$ |
| | $10^{th}$ Order = 61.941 | 0.000 | Reject $H_0$ |
| **Tanzania Shilling** | $1^{st}$ Order = 51.931 | 0.000 | Reject $H_0$ |
| | $2^{nd}$ Order = 60.094 | 0.000 | Reject $H_0$ |
| | $3^{rd}$ Order = 60.764 | 0.000 | Reject $H_0$ |
| | $4^{th}$ Order = 63.245 | 0.000 | Reject $H_0$ |
| | $5^{th}$ Order = 69.257 | 0.000 | Reject $H_0$ |
| | $6^{th}$ Order = 79.406 | 0.000 | Reject $H_0$ |
| | $7^{th}$ Order = 88.456 | 0.000 | Reject $H_0$ |
| | $8^{th}$ Order = 91.088 | 0.000 | Reject $H_0$ |
| | $9^{th}$ Order = 91.119 | 0.000 | Reject $H_0$ |
| | $10^{th}$ Order = 91.196 | 0.000 | Reject $H_0$ |

$H_0$: There is no auto-correlation (up to the $10^{th}$ Lag)

# Auto-Correlation Functions

**Figure 1: Auto-correlation function for the dollar rates residuals**

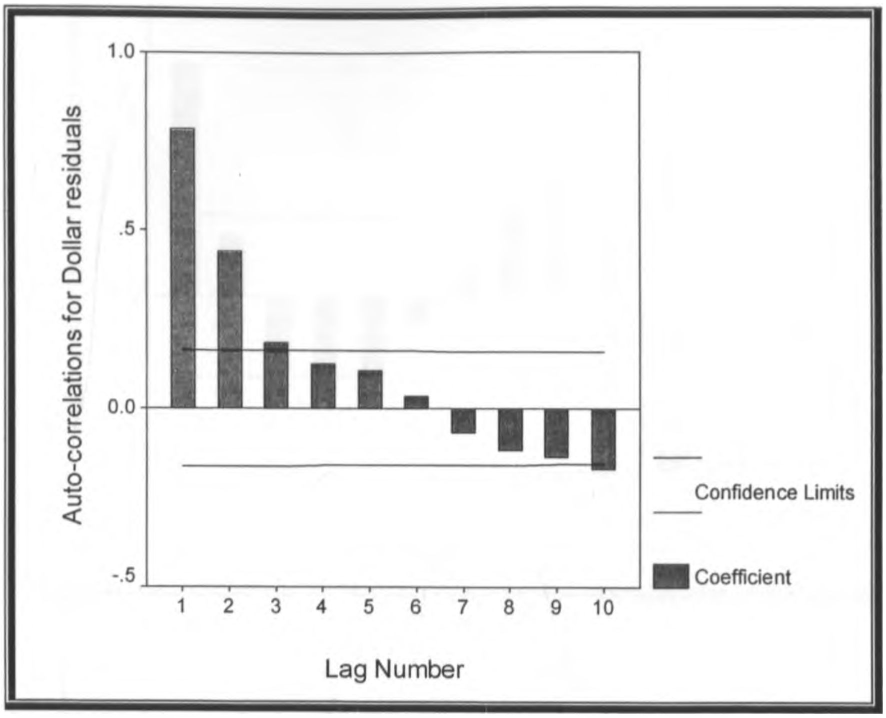



**Figure 2: Auto-correlation function for the Pound rates residuals**

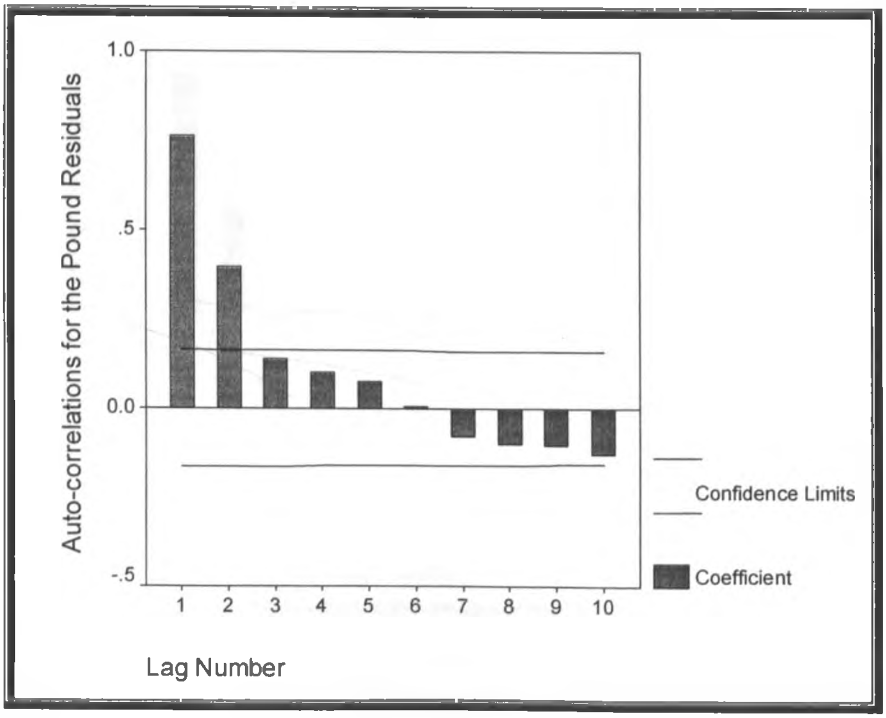


**Figure 3: Auto-correlation function for the Euro rates residuals**

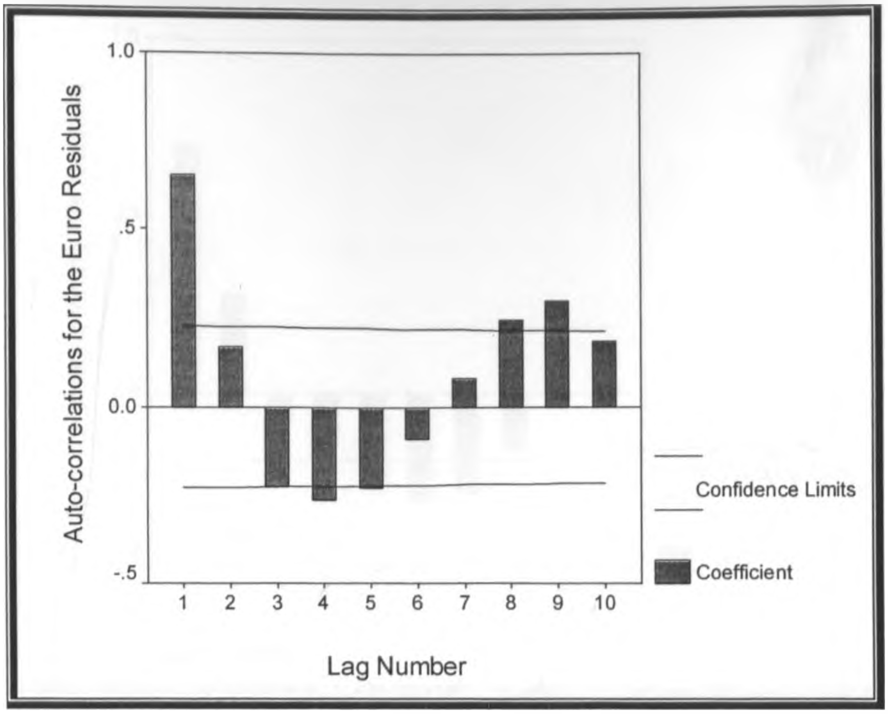



**Figure 4: Auto-correlation function for the Uganda Shilling residuals**

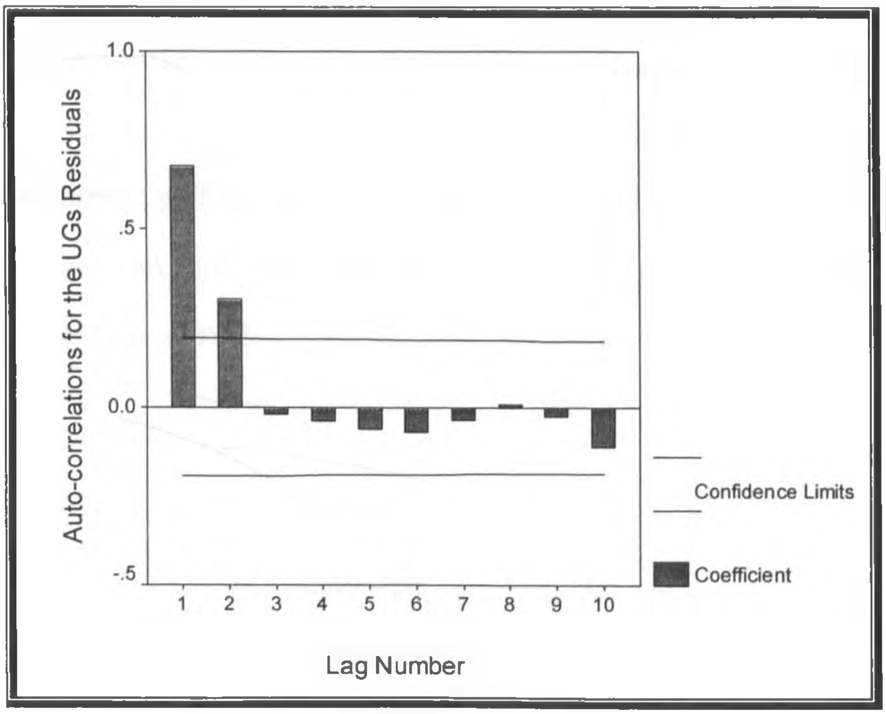
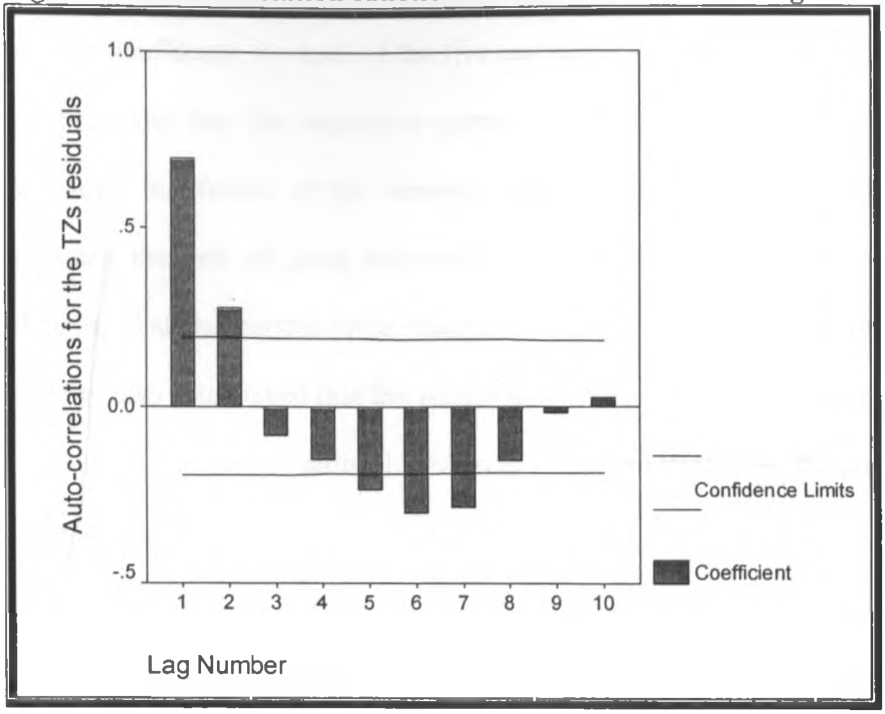


**Figure 5: Auto-correlation function for the Tanzanian Shilling residuals**




The results from the Table 4.5 and the above graphs confirmed that there is significant autocorrelation in each of the residual terms for the entire sample period. The order of auto-correlation was found to increase with the increase in the number of lags. The nonzero auto-correlation of the series associated with Ljung -Box Q statistics, which are jointly significant at 1% level, suggested that all the spot rate series do not follow random walk model behaviour. The presence of auto-correlations further reinforced the findings of Table 4.3 that the participants in the foreign exchange markets are not rational.

## 4.5. Discussion of Findings

The study was based on the null hypothesis that the economic agents are rational. Assuming that market participants are rational, the expected change in the exchange rate should differ from the actual change only by a rational expectations forecast error. The findings of the study established that the null hypotheses for the forward rates being unbiased predictors of the future spot rates were rejected at 95 percent level of confidence for each of the five currencies. This indicated existence of a risk premium and that the respective currency markets are not 'weak form' efficient. Secondly, the failure of the currency markets to be 'weak form' efficient also indicated that not all price information is fully reflected in currency prices, thus implying that the current price changes cannot be predicted from past prices. The findings also established that the participants in the foreign currency markets are not risk-neutral and are not rational. This was further reinforced by the presence of auto-correlations.

The findings further revealed that the residual series derived from each of the currency spot rates assumed a normal distribution with constant variance. Augmented Dickey-Fuller (ADF) unit root tests also revealed that the spot rate series were stationary at the second lag difference. Auto-correlation tests confirmed that there was significant autocorrelation in each of the residual terms for the entire sample period. The order of auto-correlation was found to increase with the increase in the number of lags. The nonzero auto-correlation of the series associated with Ljung -Box Q statistics, which are jointly significant at 1% level, suggested that all the spot rate series do not follow random walk model behaviour.

The findings of the study are in agreement with previous empirical works (Frankel, 1980; Fama 1984; Bekaert and Hodrick, 1993) which rejected the efficient markets hypothesis under risk-neutrality on the basis of estimating equation (7) for various currencies. Initial studies based on the regression model that test the weak form of the foreign exchange market efficiency usually found an estimated slope coefficient close to unity. It was subsequently realized, however that standard regression analysis was invalid because of the non-stationary data used (Engle and Granger, 1987). Since the previous works confounded the regressions of equation (7) by the non-stationary behaviour of spot exchange rates, the rationality tests and unit root tests performed in this study helped to address this phenomenon.

# CHAPTER FIVE

# 5.0 SUMMARY AND CONCLUSIONS

## 5.1. Introduction

This chapter presents the summary, conclusions and recommendations derived from the findings of the study. The chapter also presents the limitations that were encountered in the process of gathering findings.

## 5.2. Summary

The aim of this study was to establish the efficiency of foreign exchange markets in Kenya using the rational expectations approach. The following research questions guided the study: Is the current expected forward rate an unbiased predictor of the future spot exchange rate? Does the expected exchange rate fully incorporate all available information? In answering these two questions, the study applied historical data for the monthly (average) spot exchange rate and the three-month forward premiums for the Euro, the Sterling Pound, the US Dollar, and the two East African currencies ( Uganda shilling and Tanzanian shilling) which were obtained from the Central Bank of Kenya.

The key findings revealed that the forward rates are not unbiased predictors of the future spot rates for the Euro, the Sterling Pound, the US Dollar, the Uganda Shilling, and the Tanzanian Shilling. Secondly, the findings established that the participants in the foreign currency markets in Kenya are not risk-neutral and are not rational; a phenomenon that was reinforced by the presence of auto-correlations.

## 5.3. Conclusions

The results of the study were consistent with the hypothesis that the forward exchange rates are not unbiased predictors of the future spot rates. Under the presence of efficiency in the foreign exchange market, the forward exchange rate should be an unbiased predictor for the future spot rate. The rejection of the efficiency hypothesis implies the presence of unexploited profit opportunities for those who participate in exchange rate transactions in the Kenyan FOREX markets. The failure of the currency markets to be ‘weak form’ efficient also indicates that not all price information is fully reflected in currency prices, thus implying that the current price changes cannot be predicted from past prices. In other words, the general conclusion emerging from the extensive empirical analysis is that the forward exchange rate is a biased predictor of the future spot and the presence of a risk premium is apparent. As a result, the participants in the FOREX markets in Kenya conduct their transactions on the basis of speculation rather than on prediction of future market behaviour based on the past or current performance of respective currency markets.

Based on the rational expectations approach, the Foreign Exchange Market in Kenya is therefore inefficient.

## 5.4. Limitations of the Study

The study applied monthly observations, as opposed to daily or weekly observations. This was occasioned by lack of documented time series data on the weekly closing values of the T-BILL rates from the Central Bank of Kenya. These were relatively few especially considering that finer results could be obtained by using weekly rates. In addition, the forward rates were computed on the basis of the US 91-day T-BILL rate as a proxy for the foreign interest rates (equation 2). This was attributed to failure to obtain the 91-day T-BILL rate for each of the country whose currency was under study.

## 5.5. Recommendations

In the research, the monthly observations of foreign exchange rates to the Kenyan Shilling between November 1993 and June 2006 were used. To examine further the significance of the results achieved, empirical investigation on the efficiency of foreign exchange markets can be done by applying weekly data. The use of more frequent observations may better capture the dynamics of currency markets. In addition, the forward rate was computed on the basis of the US 91-day T-BILL rate as a proxy for the foreign interest rates (equation 2). Therefore, further research can be performed with the US 91-day T-BILL rate replaced by the respective currency country's local interest rates.

# REFERENCES


Alexakis, P. and Apergis N,(1996): "ARCH effects and Co-integration: Is the Foreign Exchange Market Efficient?" *Journal of Banking and Finance* Vol. 20(4).pp 687-697.

Arusha Cooray (2002), *The Fisher Effect: A Review of the Literature;* JEL Classification: E40, E51

Atingi Micheal Ego and Kaggwa Rachel Sebudde (2003) *Measuring Efficiency of a Market in Transition: The Ugandan Foreign Exchange Market.* Kampala: Bank of Uganda Research Department.

Ayogu M (1995): *Empirical Studies of Nigeria's Foreign Exchange Parallel Market I: Price Behavior and Rate Determination,* Research Paper 41, African Economic Research Consortium,

Ayogu M (1997): *Empirical Studies of Nigeria's Foreign Exchange Parallel Market II: Speculative Efficiency and Noisy Trading,* Research Paper 69, African Economic Research Consortium,

Baillie, R. T. and Bollerslev, T. (1989) Common stochastic trends in a system of exchange rates, *Journal of Finance*, 44, 167-81.

Ball R. P. Brown (1968) "An Empirical evaluation of accounting income numbers" *Founder of accounting research.*

Barnhart, S. and Szakmary, A.C. (1991), "Testing the Unbiased Forward Rate Hypothesis: Evidence on Unit Roots, Co-Integration, and Stochastic Coefficients," *Journal of Financial and Quantitative Analysis*, 26, 245 – 267.

Bekaert, G. and Hodrick, R.J. (1993) "On biases in measurement of foreign exchange risk premiums" *Journal of International Money and Finance* 12: 115-38

Canale R.R. and Napolitano O. (2001) *Efficiency and news in exchange rate market: the Euro/Dollar case* Department of Economics and Social Sciences, and Department of Finance: Brunel University, Uxbridge, Middlesex, UB8 3PH, UK.

Carlson, J. A. (1977), "Short Term Interest Rates as Predictors of Inflation: Comment", *American Economic Review* 67, 469–475

Cheung, Y.W. and M.D. Chiinn, (1999) Macroeconomic Implications of the Beliefs and Behavior of Foreign Exchange Traders, Working Paper 7417.

Cummins P. et al., (1976) *Aspects of Efficiency in the U.S./Canadian Foreign Exchange Market,* U.S. Treasury Conference, Washington.

Dickey, D. A. and W. A. Fuller, (1979), "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," *Journal of the American Statistical Association* 84, 427-31

Diebold, F.X. , Gardeazabal, J. Yilmaz, K (1994): "On co-integration and Exchange rate Dynamics", *Journal of Finance* 49; pp 727-735.

Dixit, A. and Pindyck, R. (1994) *Investment under Uncertainty*. Princeton, New Jersey: Princeton University Press.

Dockery E, and Taylor, K, (1998): "Some Tests on the long run Dynamics of Black and Official Exchange Rates: Evidence for Four East European Countries". *Journal of Multinational Financial Management* Vol. 7(4); pp 317-322.

Dominguez, Kathryn M., (1986) "Are Foreign Exchange Forecasts Rational? New Evidence from the Survey Data" *Economic Letters* Vol. 21 No. 3 pp 277-81

Dooley, M. P. and Shafer, J. (1984) "Analysis of Short-run Exchange Rate Behaviour. March 1973-November 1981", in *Exchange Rate and Trade Instability*, D. Bigman and T. Taya eds. Cambridge MA: Ballinger.

Dooley, M. and Shafer, J. (1976) "*Analysis of Short-run Exchange Rate Behaviour*, U.S. Treasury Conference, Washington.

Dornbush, R. (1980) Exchange rate economics: where do we stand?, *Brooking papers on Economic Activity*, vol. 1, 143-85.

Dornbush, R. (1988), *Exchange rate and inflation*, The MIT press, 1988.

Dwyer, G.P. and Wallace, M. S, (1992): Co-integration and Market Efficiency, Journal of *International Money Finance* 11; pp 318-327.

Elliott, G, and Ito T, (1995): *Heterogeneous Expectations and Tests of Efficiency in the Yen/Dollar Forward Foreign Exchange Rate Market*. NBER Working Paper Series 5376.

Engle, C. and J. Hamilton. (1990). "Long Swings in the Dollar: Are They in the Data and Do Markets Know it?" *American Economic Review*, 80: 689-713.

Engle, C. and Granger, C.W.J. (1987). "Co-integration and Error Correction: Representation, Estimation and Testing", *Econometrica*, 55: 251-76.

Engel, C, (1996): "A Note on Co-integration and International Capital Market efficiency". *Journal of International Money Finance* 15; pp 557-560.

Engle, R.F. (1982): "Autoregressive Conditional Heteroskedasticity eith Estimates of the Variance of U.K. Inflation." *Econometrica*, 50, 987-1008.

Fabozzi, Frank J., Modigliani, Franco, and Ferri, Michael G. (1994) *Foundations of Financial Markets and Institutions,* London: Prentice-Hall International.

Fama, E. (1965), "The behavior of Stock Market Prices", *Journal of Business*, vol. 38, p.34-105.

Fama, E. F. (1975), 'Short Term Interest Rates as Predictors of Inflation', *American Economic Review* 65, 269–282

Fama, E. (1970)"Efficient Capital Markets: A Review of Theory and Empirical Work." *Journal of Finance* 25: 383-417.

Fama, E. (1991) "Efficient Capital Markets: II." *The Journal of Finance* XLVI (5): 1575-1617.

Fama, E. F. and Gibbons, M.R. (1984), 'A Comparison of Inflation Forecasts', *Journal of Monetary Economics* 13, 327–348

Frankel, Jefrey A., and Kenneth A. Froot, (1989), "Forward discount bias: is it an exchange risk premium?" *Quarterly Journal of Economics* 104, 139–161.

Frenkel, J. A. (1980) "Exchange rates, prices and money: lessons from the 1920s" *American Economic Review*, 70, 235-42.

Frenkel, J. A. (1981) "Flexible exchange rates, prices, and the role of `news': lessons from the 1970s", *Journal of Political Economy*, 89, 665-705.

Friedman, M. (1953). "The Case for Flexible Exchange Rates", in his *Essays in Positive Economics*. Chicago: University of Chicago Press, 157-203.

Froot, K. and Thaler, R. (1990). "Anomalies: Foreign Exchange." *Journal of Economic Perspectives* 4 (3): 179-192.

Froot, K. and Thaler, R. (1990) "Anomalies: Foreign Exchange." *Journal of Economic Perspectives* 4 (3): 179-192.

Geweke, J. and Feige, E. (1979), "Some Joint Tests of the Efficiency of Markets for Forward Foreign Exchange," *Review of Economics and Statistics*, 61, 334- 341.

Hakkio, C.S. and Rush, M. (1989), "Market Efficiency and Co-integration: an Application to the Sterling and Deutschemark Exchange Markets," *Journal of International Money and Finance*, 8, 75 – 88.

Hamilton, J. G, (1989): New Approach to the Economic Analysis of Non-Stationary Time Series and the Business Cycle. *Econometrica* 57: pp. 357-384.

Hess, P. J. and Bicksler, J. L. (1975), "Capital Asset Prices Versus Time Series Models as Predictors of Inflation: The Expected Real Rate of Interest and Market Efficiency", *Journal of Financial Economics* 2, 341–360

Hodrick, R. (1987) *The Empirical Evidence on the Efficiency of Forward and Futures Foreign Exchange Markets,* New York: Harwood Academic Publishers.

Hsieh, D.A. (1989): Modelling Heteroskedasticity in Daily Foreign Exchange Rates, "*Journal of Business and Economics Statistics*, 7, 307-317.

Im, K. S, Pesaran, M.H, Shin, Y (1995): *Testing for Unit Roots in Heterogeneous Panels*. Working Paper. University of Cambridge.

Ito, Takatoshi (1990) "Foreign Exchange Rate Expectations: Micro Survey Data" *American Economic Review* Vol. 80 pp 434-49

Joines, D. (1977), 'Short Term Interest Rates as Predictors of Inflation: Comment', *American Economic Review* 67, 469–475

Kaserman, D. L. (1973) "The Forward Rate: Its Determination and Behaviour as a predictor of the Spot Rate," Amer. Statist. Assn,. Bus. Econ. Statist. Sec. 1973.

Kiguel, M., J. Saul Lizondo and Stephen O'Connell (eds.) (1997). *Parallel Exchange Rates in Developing Countries.* London: Macmillan and New York: St. Martin's.

Krugman, P. (1989). *Exchange Rate Instability.* Cambridge: MIT Press.

Kurgat, P.(1998) "An Empirical Study of Spot Market Efficiency on Kenya's Foreign Exchange Bureaus." UON – MBA project Nairobi: Faculty of Commerce.

LeRoy, S. (1989) "Efficient Capital Markets and Martingales." *Journal of Economic Literature* XXVII: 1583-1621.

Levich R. H. (1978) "Tests of Forecasting Models and Market Efficiency in the International Money Market," in Jacob A. Frenkel and Harry G. Johnson, eds., *The Economics of Exchange Rates: Selected Studies*, Reading 1978.

Levich, R. (1985) "Empirical Studies of Exchange Rates: Price Behaviour, Rate Determination and Market Efficiency", in Jones, R. and Kenen P., Eds, *Handbook of International Economics*, Volume 2, Amsterdam, North Holland, 1985.

Levich, R. and Thomas R. L. (1993) "The Significance of Technical Trading-Rules Profits in the Foreign Exchange Market: A Bootstrap Approach," *Journal of International Money and Finance* 12: 451-474.

Levin, A. and Lin, C.F,(1992) : *Unit Roots Tests in Panel Data : Asymptotic and Finite Sample Properties.* Discussion Paper. University of California, San Diego.

Lin W.T. and Chen, Y.H. (1998), "Forecasting Foreign Exchange Rates with an Intrinsically Nonlinear Dynamic Speed of Adjustment Model," *Applied Economics*, 30, 295 – 312.

Lin, W. T., Lin, H.J., and Chen, Y.H. (2002), "The Dynamics and Stochastics of Currency Betas Based on the Unbiasedness Hypothesis in Foreign Exchange Markets," *Multinational Finance Journal*, 6 176 – 195.

Liu, P.C. and Maddala, G.S. (1992), "Rationality of Survey Data and Tests for Market Efficiency in the Foreign Exchange Markets," *Journal of International Money and Finance*, 11, 366-381.

MacDonald, R and Taylor, M.P. (1989) "Foreign Exchange Market Efficiency and Co-integration: Some Evidence from the Recent Float". *Economic Letters* 29; pp. 63-68.

Mckinnon, R.I., (1976) *Floating Exchange Rates 1973-1974: The Emperor's New Clothes*, Carnegie-Rochester Conference Series on Public Policy 3: 79-114.

Meese, R. A. and Singleton, K. J. (1982), "On the Unit Roots and the Empirical Modeling of Exchange Rates," *Journal of Finance*, 37, 1029-1035.

Muhoro, J (2005): "Determining the Efficiency of the Foreign Exchange Market in Kenya." UON – MBA project Nairobi: Faculty of Commerce.

Muth, J. F. (1961) "Rational Expectations and the Theory of Price Movements", *Econometrica* 29, 315–335

Naka, A. and Whitney G. (1995), "A Re-Examination of the Unbiased Forward Rate Hypothesis," *Journal of International Money and Finance*, 14, 857-867.

Ndunda, F (2002): "Testing whether Forward Exchange Rates are predictors of Future Spot Rates in Kenya." UON – MBA project Nairobi: Faculty of Commerce.

Nelson, C. and Schwert, G. W. (1977), "Short-Term Interest Rates as Predictors of Inflation: On Testing the Hypothesis that the Real Rate of Interest is Constant", *American Economic Review* 67, 478–486

Nepal Rastra Bank (2002) *Money and Price Relationship in Nepal: A Revisit*; Monetary Division, Research Department, Nepal Rastra Bank

Ogiogio, G,(1994) : *A Statistical Analysis of Foreign Exchange Rate Behavior in Nigeria's Auction*. AERC Research Paper No. 49, African Economic Research Consortium.

Ondigo H.O (1995) "The information content of the annual reports & account" UON – MBA project Nairobi: Faculty of Commerce

Poole, W (1967) "Speculative Prices as Random Walks: An Analysis of Ten Time Series of Flexible Exchange Rates", *Southern Economic Journal*, 33: 468-78.

Sarno Lucio and Taylor Mark P., (2004). *The Economics of Exchange Rates;* Cambridge: Cambridge University Press

Sarwar, G,(1998) : "Efficiency of Black Markets in Foreign Currencies in Southern Asia". *Journal of Multinational Financial Management* Vol. 7(4); pp 333-344.

Shinji, T (1991): "Exchange rate expectations: A survey of survey of studies" IMF staff papers, 38, 156-183.

Stein, J.L (1980) "The Dynamics of Spot and Forward Prices in an Efficient Foreign Exchange Market with Rational Expectations," *The American Economic Review* Vol. 70(4) pp 565-583

Taylor, M. P. (1987). "Covered Interest Parity: A High Frequency, High Quality Data Study". *Economica*, 51: 129-38.

Wu, J.L. and Chen S.L,(1998): "Foreign Exchange market Efficiency Revisited". *Journal of International Money and Finance* 17(1998); pp 831-838.

# Appendix I: List of Commercial Banks in Kenya

1. African Banking Corporation
2. African Development Bank
3. Akiba Bank
4. Bank of Baroda
5. Bank of India
6. Bank of Africa
7. Barclays Bank of Kenya
8. Biashara Bank of Kenya
9. Charterhouse Bank
10. Consolidated Bank of Kenya
11. Credit Bank Ltd
12. CFC Bank
13. Citibank N.A. Kenya
14. City Finance Bank
15. Commercial Bank of Africa
16. Cooperative Bank of Kenya
17. Development Bank of Kenya
18. Diamond Trust Bank
19. East African Development Bank
20. Fidelity Commercial Bank
21. Fina Bank K. Ltd
22. Giro Commercial Bank Ltd
23. Guardian Bank Ltd
24. Habib Bank
25. Habib Bank A.G. Zurich
26. Housing Finance Ltd
27. Industrial Development Bank
28. Imperial Bank Ltd
29. Kenya Commercial Bank, Nairobi
30. K-Rep Bank(Microfinance)
31. Middle East Bank
32. National Bank of Kenya
33. National Industrial Credit Bank
34. Oriental Commercial Bank Ltd
35. Prudential Bank
36. Paramount Universal Bank Ltd
37. Stanbic Bank
38. Standard Chartered Bank
39. Southern Credit Banking Corp. Ltd
40. Prime Bank
41. Equity Bank
42. Victoria Commercial Bank
43. Transnational Bank of Kenya

## APPENDIX II

### US DOLLARS DATA

| S_t | Ln_St | S_t+3 | D_S_t+3 | KE_TBILL | 1+KETBILL | US_TBILL | 1+USTBILL | F/H | S_t(F/H) | Ln_Ft | LNFt - Ln St |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.2298 | 3.589882951 | 3.94892305 | 0.35904 | 17.870 | 1.179 | 4.85 | 1.0485 | 1.124177 | 40.73 | 3.706935 | 0.117051565 |
| 36.5566 | 3.598862155 | 4.12972082 | 0.530859 | 17.860 | 1.179 | 4.63 | 1.0463 | 1.126446 | 41.18 | 3.717929 | 0.119067162 |
| 43.1207 | 3.764002317 | 4.16126447 | 0.397262 | 25.070 | 1.251 | 4.875 | 1.04875 | 1.192563 | 51.42 | 3.940107 | 0.176104416 |
| 51.8795 | 3.948923047 | 4.17950207 | 0.230579 | 45.790 | 1.458 | 4.81 | 1.0481 | 1.390993 | 72.16 | 4.278941 | 0.330018043 |
| 62.1606 | 4.129720822 | 4.18084977 | 0.051129 | 68.040 | 1.680 | 4.86 | 1.0486 | 1.602518 | 99.61 | 4.601297 | 0.471575919 |
| 64.1526 | 4.161264472 | 4.18656291 | 0.025298 | 84.290 | 1.843 | 4.71 | 1.0471 | 1.760004 | 112.91 | 4.72658 | 0.56531598 |
| 65.3333 | 4.179502069 | 4.21911901 | 0.039617 | 84.670 | 1.847 | 4.78 | 1.0478 | 1.762455 | 115.15 | 4.74621 | 0.566707534 |
| 65.4214 | 4.180849769 | 4.23383941 | 0.05299 | 79.510 | 1.795 | 4.74 | 1.0474 | 1.713863 | 112.12 | 4.7196 | 0.538749828 |
| 65.7963 | 4.186562915 | 4.2255614 | 0.038998 | 75.690 | 1.757 | 4.85 | 1.0485 | 1.675632 | 110.25 | 4.702753 | 0.516190321 |
| 67.9736 | 4.219119007 | 4.21844117 | -0.000678 | 70.880 | 1.709 | 4.72 | 1.0472 | 1.63178 | 110.92 | 4.70879 | 0.489671434 |
| 68.9816 | 4.233839407 | 4.2107258 | -0.023114 | 55.260 | 1.553 | 4.83 | 1.0483 | 1.481065 | 102.17 | 4.626601 | 0.392761141 |
| 68.4129 | 4.225561403 | 4.1903993 | -0.035162 | 43.520 | 1.435 | 4.86 | 1.0486 | 1.368682 | 93.64 | 4.53941 | 0.313848271 |
| 67.9275 | 4.21844117 | 4.13959514 | -0.078846 | 33.550 | 1.336 | 5.18 | 1.0518 | 1.269728 | 86.25 | 4.457244 | 0.238802771 |
| 67.4054 | 4.210725801 | 4.06122743 | -0.149498 | 23.870 | 1.239 | 5.21 | 1.0521 | 1.17736 | 79.36 | 4.374 | 0.163274276 |
| 66.0492 | 4.190399299 | 4.02846173 | -0.161938 | 27.620 | 1.276 | 5.16 | 1.0516 | 1.213579 | 80.16 | 4.383973 | 0.193574099 |
| 62.7774 | 4.139595136 | 4.02479303 | -0.114802 | 30.850 | 1.309 | 4.895 | 1.04895 | 1.247438 | 78.31 | 4.360687 | 0.221091779 |
| 58.0455 | 4.061227432 | 4.01695787 | -0.04427 | 31.240 | 1.312 | 4.925 | 1.04925 | 1.250798 | 72.60 | 4.285009 | 0.223781899 |
| 56.1744 | 4.02846173 | 3.94470587 | -0.083756 | 32.380 | 1.324 | 5.145 | 1.05145 | 1.259023 | 70.72 | 4.258798 | 0.230336225 |
| 55.9687 | 4.024793031 | 3.74673132 | -0.278062 | 29.740 | 1.297 | 4.93 | 1.0493 | 1.236443 | 69.20 | 4.237032 | 0.212238987 |
| 55.5319 | 4.016957865 | 3.77273805 | -0.24422 | 24.130 | 1.241 | 4.93 | 1.0493 | 1.182979 | 65.69 | 4.184994 | 0.168035942 |
| 51.6611 | 3.944705872 | 3.81075318 | -0.133953 | 17.390 | 1.174 | 4.945 | 1.04945 | 1.118586 | 57.79 | 4.056771 | 0.112065321 |
| 42.3823 | 3.746731319 | 3.79499854 | 0.048267 | 16.950 | 1.170 | 5.135 | 1.05135 | 1.112379 | 47.15 | 3.853233 | 0.106501254 |
| 43.4990 | 3.772738054 | 3.79488411 | 0.022146 | 17.220 | 1.172 | 4.945 | 1.04945 | 1.116966 | 48.59 | 3.883354 | 0.110616108 |
| 45.1845 | 3.810753176 | 3.78732907 | -0.023424 | 17.490 | 1.175 | 5.17 | 1.0517 | 1.117144 | 50.48 | 3.921528 | 0.110775135 |
| 44.4782 | 3.794998539 | 3.78386294 | -0.011136 | 16.740 | 1.167 | 5.155 | 1.05155 | 1.110171 | 49.38 | 3.899512 | 0.104513788 |
| 44.4731 | 3.794884107 | 3.94906337 | 0.154179 | 17.630 | 1.176 | 4.94 | 1.0494 | 1.120926 | 49.85 | 3.909039 | 0.114155347 |
| 44.1384 | 3.787329068 | 3.98193608 | 0.194607 | 16.840 | 1.168 | 4.96 | 1.0496 | 1.113186 | 49.13 | 3.894555 | 0.107226152 |
| 43.9856 | 3.783862939 | 4.03586065 | 0.251998 | 15.160 | 1.152 | 5.095 | 1.05095 | 1.09577 | 48.20 | 3.875321 | 0.091457763 |
| 51.8867 | 3.949063371 | 4.01996937 | 0.070906 | 15.090 | 1.151 | 4.97 | 1.0497 | 1.096408 | 56.89 | 4.041103 | 0.092039836 |
| 53.6207 | 3.981936076 | 4.01516589 | 0.03323 | 16.390 | 1.164 | 5.07 | 1.0507 | 1.107738 | 59.40 | 4.084256 | 0.102319826 |
| 56.5916 | 4.035860648 | 4.0166483 | -0.019212 | 18.480 | 1.185 | 4.94 | 1.0494 | 1.129026 | 63.89 | 4.157216 | 0.121355412 |
| 55.6994 | 4.019969375 | 4.01703211 | -0.002937 | 19.650 | 1.197 | 4.97 | 1.0497 | 1.139849 | 63.49 | 4.150866 | 0.130896219 |
| 55.4325 | 4.015165893 | 4.02179308 | 0.006627 | 21.160 | 1.212 | 5.035 | 1.05035 | 1.15352 | 63.94 | 4.157984 | 0.142818358 |
| 55.5147 | 4.016648301 | 4.03802975 | 0.021381 | 24.070 | 1.241 | 4.955 | 1.04955 | 1.182126 | 65.63 | 4.183963 | 0.167314236 |
| 55.5360 | 4.017032114 | 4.06550758 | 0.048475 | 24.870 | 1.249 | 4.92 | 1.0492 | 1.190145 | 66.10 | 4.191107 | 0.174075041 |
| 55.8011 | 4.021793085 | 4.06752926 | 0.045736 | 21.670 | 1.217 | 4.925 | 1.04925 | 1.15959 | 64.71 | 4.16986 | 0.148066653 |
| 56.7145 | 4.03802975 | 4.06686956 | 0.02884 | 21.250 | 1.213 | 4.94 | 1.0494 | 1.155422 | 65.53 | 4.182496 | 0.144465772 |
| 58.2945 | 4.065507578 | 4.06451449 | -0.000993 | 25.960 | 1.260 | 4.87 | 1.0487 | 1.201106 | 70.02 | 4.24875 | 0.183242908 |
| 58.4125 | 4.067529256 | 4.06020324 | -0.007326 | 26.680 | 1.267 | 4.755 | 1.04755 | 1.209298 | 70.64 | 4.257569 | 0.190039931 |
| 58.3739 | 4.066869557 | 4.04850206 | -0.018367 | 24.160 | 1.242 | 4.83 | 1.0483 | 1.184394 | 69.14 | 4.236101 | 0.169231066 |
| 58.2366 | 4.064514491 | 4.0429058 | -0.021609 | 21.960 | 1.220 | 4.585 | 1.04585 | 1.166133 | 67.91 | 4.218207 | 0.153692984 |
| 57.9861 | 4.06020324 | 4.03295857 | -0.027245 | 21.850 | 1.219 | 4.81 | 1.0481 | 1.16258 | 67.41 | 4.210845 | 0.150641593 |
| 57.3115 | 4.04850206 | 4.02277536 | -0.025727 | 21.760 | 1.218 | 4.75 | 1.0475 | 1.162387 | 66.62 | 4.198977 | 0.150475335 |
| 56.9917 | 4.042905803 | 4.01860894 | -0.024297 | 21.630 | 1.216 | 4.795 | 1.04795 | 1.160647 | 66.15 | 4.191883 | 0.148977589 |
| 56.4276 | 4.032958569 | 4.01008213 | -0.022876 | 23.100 | 1.231 | 4.75 | 1.0475 | 1.175179 | 66.31 | 4.194379 | 0.161420474 |
| 55.8559 | 4.022775356 | 4.00256165 | -0.020214 | 24.080 | 1.241 | 4.54 | 1.0454 | 1.186914 | 66.30 | 4.194132 | 0.171356746 |
| 55.6237 | 4.018608941 | 4.00606089 | -0.012548 | 22.090 | 1.221 | 4.63 | 1.0463 | 1.166874 | 64.91 | 4.172937 | 0.15432816 |
| 55.1514 | 4.010082131 | 4.00532428 | -0.004758 | 21.530 | 1.215 | 4.905 | 1.04905 | 1.158477 | 63.89 | 4.157188 | 0.147105967 |
| 54.7382 | 4.002561654 | 3.99594904 | -0.006613 | 21.610 | 1.216 | 4.79 | 1.0479 | 1.160511 | 63.52 | 4.151423 | 0.148860856 |
| 54.9301 | 4.006060893 | 3.98433126 | -0.02173 | 21.440 | 1.214 | 5.175 | 1.05175 | 1.154647 | 63.42 | 4.149856 | 0.143794684 |
| 54.8896 | 4.005324279 | 3.99332996 | -0.011994 | 21.420 | 1.214 | 4.805 | 1.04805 | 1.158533 | 63.59 | 4.152478 | 0.147154129 |
| 54.3774 | 3.995949044 | 4.04933878 | 0.05339 | 21.020 | 1.210 | 4.665 | 1.04665 | 1.15626 | 62.87 | 4.14114 | 0.145191048 |
| 53.7493 | 3.984331264 | 4.20647582 | 0.222145 | 20.350 | 1.204 | 4.915 | 1.04915 | 1.147119 | 61.66 | 4.121585 | 0.137253666 |
| 54.2352 | 3.99332996 | 4.15522306 | 0.161893 | 19.440 | 1.194 | 5.15 | 1.0515 | 1.135901 | 61.61 | 4.120756 | 0.127426251 |
| 57.3595 | 4.049338783 | 4.13732598 | 0.087987 | 18.450 | 1.185 | 4.77 | 1.0477 | 1.130572 | 64.85 | 4.172062 | 0.122723459 |
| 67.1196 | 4.206475819 | 4.15780039 | -0.048675 | 19.690 | 1.197 | 4.84 | 1.0484 | 1.141644 | 76.63 | 4.338946 | 0.132469688 |
| 63.7662 | 4.155223056 | 4.14394674 | -0.011276 | 26.200 | 1.262 | 4.905 | 1.04905 | 1.202993 | 76.71 | 4.340036 | 0.184812771 |
| 62.6351 | 4.137325976 | 4.11356238 | -0.023764 | 27.150 | 1.272 | 5.16 | 1.0516 | 1.20911 | 75.73 | 4.32721 | 0.189884492 |
| 63.9307 | 4.157800388 | 4.1029282 | -0.054872 | 26.780 | 1.268 | 5.09 | 1.0509 | 1.206395 | 77.13 | 4.345437 | 0.187636175 |
| 63.0512 | 4.143946742 | 4.09642777 | -0.047519 | 26.360 | 1.264 | 4.955 | 1.04955 | 1.203945 | 75.91 | 4.32955 | 0.185603289 |
| 61.1642 | 4.113562378 | 4.08785136 | -0.025711 | 26.282 | 1.263 | 4.945 | 1.04945 | 1.203318 | 73.60 | 4.298645 | 0.185083078 |
| 60.5172 | 4.102928201 | 4.13682063 | 0.033892 | 26.326 | 1.263 | 4.965 | 1.04965 | 1.203508 | 72.83 | 4.288169 | 0.185240885 |
| 60.1251 | 4.09642777 | 4.10296232 | 0.006535 | 26.736 | 1.267 | 5.065 | 1.05065 | 1.206261 | 72.53 | 4.283953 | 0.187525398 |
| 59.6117 | 4.08785136 | 4.08322668 | -0.004625 | 26.981 | 1.270 | 4.96 | 1.0496 | 1.209804 | 72.12 | 4.27831 | 0.190458144 |
| 62.6035 | 4.136820628 | 4.08385608 | -0.052965 | 26.381 | 1.264 | 4.975 | 1.04975 | 1.203915 | 75.37 | 4.3224 | 0.185578927 |
| 60.5193 | 4.102962322 | 4.09448486 | -0.008477 | 25.475 | 1.255 | 5.065 | 1.05065 | 1.194263 | 72.28 | 4.280491 | 0.177528923 |
| 59.3366 | 4.083226683 | 4.09218954 | 0.008963 | 24.672 | 1.247 | 5.015 | 1.05015 | 1.187183 | 70.44 | 4.25481 | 0.171583091 |
| 59.3740 | 4.083856083 | 4.08815217 | 0.004296 | 23.741 | 1.237 | 4.975 | 1.04975 | 1.178763 | 69.99 | 4.248321 | 0.164465212 |
| 60.0084 | 4.094484855 | 4.12416819 | 0.029683 | 22.474 | 1.225 | 5.12 | 1.0512 | 1.165088 | 69.92 | 4.247281 | 0.152796208 |
| 59.8708 | 4.092189543 | 4.12393981 | 0.03175 | 20.587 | 1.206 | 4.97 | 1.0497 | 1.148771 | 68.78 | 4.230882 | 0.138692743 |
| 59.6296 | 4.088152175 | 4.13510303 | 0.046951 | 17.662 | 1.177 | 4.965 | 1.04965 | 1.120968 | 66.84 | 4.202345 | 0.114192546 |
| 61.8164 | 4.124168187 | 4.15905983 | 0.034892 | 12.565 | 1.126 | 4.965 | 1.04965 | 1.0724 | 66.29 | 4.194068 | 0.069899429 |
| 61.8023 | 4.123939814 | 4.18434933 | 0.06041 | 10.703 | 1.107 | 5.1 | 1.051 | 1.053311 | 65.10 | 4.175878 | 0.051938662 |
| 62.4960 | 4.135103035 | 4.23148236 | 0.096379 | 8.950 | 1.090 | 4.89 | 1.0489 | 1.038707 | 64.92 | 4.17308 | 0.037976879 |
| 64.0113 | 4.159059834 | 4.29870798 | 0.139648 | 8.845 | 1.088 | 4.95 | 1.0495 | 1.037111 | 66.39 | 4.195499 | 0.036438968 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 65.6508 | 4.18434933 | 4.29180735 | 0.107458 | 9.028 | 1.090 | 5.05 | 1.0505 | 1.03787 | 68.14 | 4.22152 | 0.037170596 |
| 68.8192 | 4.231482361 | 4.30964593 | 0.078164 | 9.626 | 1.096 | 4.955 | 1.04955 | 1.044507 | 71.88 | 4.275027 | 0.04354471 |
| 73.6046 | 4.298707977 | 4.32652251 | 0.027815 | 11.442 | 1.114 | 5.075 | 1.05075 | 1.060597 | 78.06 | 4.35754 | 0.058832139 |
| 73.0985 | 4.291807349 | 4.32507512 | 0.033268 | 14.472 | 1.145 | 4.835 | 1.04835 | 1.091923 | 79.82 | 4.379748 | 0.087940382 |
| 74.4141 | 4.309645929 | 4.31466443 | 0.005019 | 14.842 | 1.148 | 4.91 | 1.0491 | 1.094675 | 81.46 | 4.400104 | 0.090457914 |
| 75.6807 | 4.326522514 | 4.30329933 | -0.023223 | 15.778 | 1.158 | 4.79 | 1.0479 | 1.104853 | 83.62 | 4.426234 | 0.099711898 |
| 75.5712 | 4.325075119 | 4.25817136 | -0.066904 | 17.628 | 1.176 | 5.1 | 1.051 | 1.119196 | 84.58 | 4.437686 | 0.112610574 |
| 74.7885 | 4.314664434 | 4.29345872 | -0.021206 | 18.135 | 1.181 | 4.94 | 1.0494 | 1.125742 | 84.19 | 4.433107 | 0.118442666 |
| 73.9434 | 4.303299327 | 4.30986721 | 0.006568 | 19.975 | 1.200 | 5.075 | 1.05075 | 1.141799 | 84.43 | 4.435904 | 0.132604839 |
| 70.6806 | 4.25817136 | 4.30896217 | 0.050791 | 20.295 | 1.203 | 4.7 | 1.047 | 1.148949 | 81.21 | 4.397019 | 0.138847941 |
| 73.2193 | 4.293458722 | 4.33033685 | 0.036878 | 14.844 | 1.148 | 4.89 | 1.0489 | 1.094899 | 80.17 | 4.384121 | 0.090662504 |
| 74.4306 | 4.309867206 | 4.35086376 | 0.040997 | 11.278 | 1.113 | 5.09 | 1.0509 | 1.058885 | 78.81 | 4.367084 | 0.057216696 |
| 74.3633 | 4.308962167 | 4.33606328 | 0.027101 | 12.442 | 1.124 | 4.765 | 1.04765 | 1.073281 | 79.81 | 4.379682 | 0.07072001 |
| 75.9699 | 4.33033685 | 4.33660912 | 0.006272 | 11.222 | 1.112 | 5.03 | 1.0503 | 1.058956 | 80.45 | 4.387621 | 0.057283979 |
| 77.5454 | 4.350863756 | 4.35922519 | 0.008361 | 10.474 | 1.105 | 4.82 | 1.0482 | 1.05394 | 81.73 | 4.403399 | 0.052535606 |
| 76.4062 | 4.336063284 | 4.37269019 | 0.036627 | 9.904 | 1.099 | 4.585 | 1.04585 | 1.050862 | 80.29 | 4.385674 | 0.049610759 |
| 76.4479 | 4.336609122 | 4.36763574 | 0.031027 | 9.245 | 1.092 | 4.63 | 1.0463 | 1.04411 | 79.82 | 4.379774 | 0.043165037 |
| 78.1965 | 4.359225194 | 4.366065 | 0.00684 | 10.360 | 1.104 | 4.905 | 1.04905 | 1.052002 | 82.26 | 4.40992 | 0.050694836 |
| 79.2566 | 4.372690185 | 4.36444242 | -0.008248 | 10.654 | 1.107 | 4.78 | 1.0478 | 1.056056 | 83.70 | 4.427232 | 0.054541687 |
| 78.8570 | 4.36763574 | 4.35991317 | -0.007723 | 11.167 | 1.112 | 4.8 | 1.048 | 1.060756 | 83.65 | 4.426618 | 0.058982052 |
| 78.7332 | 4.366064996 | 4.3535307 | -0.012534 | 12.901 | 1.129 | 4.675 | 1.04675 | 1.078586 | 84.92 | 4.441716 | 0.075651017 |
| 78.6056 | 4.364442423 | 4.35027108 | -0.014171 | 14.756 | 1.148 | 4.7 | 1.047 | 1.096042 | 86.15 | 4.456148 | 0.091705532 |
| 78.2503 | 4.359913174 | 4.36360487 | 0.003692 | 15.297 | 1.153 | 4.86 | 1.0486 | 1.099535 | 86.04 | 4.454801 | 0.094887449 |
| 77.7525 | 4.353530705 | 4.36462682 | 0.011096 | 14.972 | 1.150 | 4.845 | 1.04845 | 1.096588 | 85.26 | 4.445734 | 0.092203377 |
| 77.4995 | 4.350271077 | 4.36968079 | 0.01941 | 12.899 | 1.129 | 4.62 | 1.0462 | 1.079136 | 83.63 | 4.426432 | 0.076160647 |
| 78.5398 | 4.363604866 | 4.36835694 | 0.004752 | 10.517 | 1.105 | 4.82 | 1.0482 | 1.054348 | 82.81 | 4.416527 | 0.0529225 |
| 78.6201 | 4.36462682 | 4.36876344 | 0.004137 | 12.070 | 1.121 | 4.715 | 1.04715 | 1.070233 | 84.14 | 4.432504 | 0.06787684 |
| 79.0184 | 4.369680794 | 4.369024 | -0.000657 | 12.873 | 1.129 | 4.635 | 1.04635 | 1.078733 | 85.24 | 4.445468 | 0.075786961 |
| 78.9139 | 4.368356944 | 4.36893259 | 0.000576 | 12.839 | 1.128 | 4.695 | 1.04695 | 1.077785 | 85.05 | 4.443265 | 0.074908447 |
| 78.9460 | 4.368763441 | 4.36547152 | -0.003292 | 12.393 | 1.124 | 4.8 | 1.048 | 1.072455 | 84.67 | 4.438714 | 0.06995011 |
| 78.9665 | 4.369024 | 4.36433249 | -0.004692 | 11.629 | 1.116 | 4.725 | 1.04725 | 1.065921 | 84.17 | 4.432863 | 0.063839423 |
| 78.9593 | 4.368932587 | 4.3599126 | -0.00902 | 11.498 | 1.115 | 4.805 | 1.04805 | 1.063857 | 84.00 | 4.430833 | 0.061900688 |
| 78.6865 | 4.365471524 | 4.35744541 | -0.008026 | 11.012 | 1.110 | 4.65 | 1.0465 | 1.060797 | 83.47 | 4.424492 | 0.059020458 |
| 78.596918 | 4.36433249 | 4.36021403 | -0.004118 | 10.855 | 1.109 | 4.72 | 1.0472 | 1.058582 | 83.20 | 4.421263 | 0.056930664 |
| 78.250295 | 4.359912599 | 4.36073631 | 0.000824 | 10.611 | 1.106 | 4.61 | 1.0461 | 1.057365 | 82.74 | 4.415693 | 0.055780392 |
| 78.057475 | 4.357445414 | 4.36517202 | 0.007727 | 10.144 | 1.101 | 4.81 | 1.0481 | 1.050892 | 82.03 | 4.407085 | 0.049639413 |
| 78.273886 | 4.360214032 | 4.36687708 | 0.006663 | 10.010 | 1.100 | 4.57 | 1.0457 | 1.052023 | 82.35 | 4.410929 | 0.050714567 |
| 78.314777 | 4.360736312 | 4.36403513 | 0.003299 | 9.040 | 1.090 | 4.67 | 1.0467 | 1.041748 | 81.58 | 4.401636 | 0.040899951 |
| 78.66293 | 4.365172015 | 4.36700322 | 0.001831 | 7.338 | 1.073 | 4.76 | 1.0476 | 1.024609 | 80.60 | 4.389483 | 0.024310715 |
| 78.79717 | 4.366877077 | 4.37354109 | 0.006664 | 8.634 | 1.086 | 4.63 | 1.0463 | 1.038264 | 81.81 | 4.404428 | 0.037550435 |
| 78.57355 | 4.364035129 | 4.37658046 | 0.012545 | 8.340 | 1.083 | 4.725 | 1.04725 | 1.034514 | 81.29 | 4.397967 | 0.033931948 |
| 78.80711 | 4.367003215 | 4.37618357 | 0.00918 | 7.601 | 1.076 | 4.53 | 1.0453 | 1.029377 | 81.12 | 4.395957 | 0.028953971 |
| 79.324029 | 4.373541091 | 4.35308078 | -0.02046 | 8.065 | 1.081 | 4.445 | 1.04445 | 1.034662 | 82.07 | 4.407616 | 0.034074594 |
| 79.56549 | 4.376580462 | 4.34173783 | -0.034843 | 8.299 | 1.083 | 4.73 | 1.0473 | 1.034073 | 82.28 | 4.410086 | 0.033505694 |
| 79.533918 | 4.376183568 | 4.33837033 | -0.037813 | 8.378 | 1.084 | 4.585 | 1.04585 | 1.036263 | 82.42 | 4.411805 | 0.035621288 |
| 77.717525 | 4.353080776 | 4.32620197 | -0.026879 | 8.384 | 1.084 | 4.7 | 1.047 | 1.035186 | 80.45 | 4.387662 | 0.034581359 |
| 76.84096 | 4.341737831 | 4.27119809 | -0.07054 | 7.774 | 1.078 | 4.555 | 1.04555 | 1.030785 | 79.21 | 4.372059 | 0.030320874 |
| 76.582633 | 4.338370332 | 4.30030479 | -0.038066 | 6.239 | 1.062 | 4.68 | 1.0468 | 1.014897 | 77.72 | 4.353157 | 0.01478696 |
| 75.656395 | 4.326201971 | 4.31411268 | -0.012089 | 6.254 | 1.063 | 4.525 | 1.04525 | 1.016539 | 76.91 | 4.342606 | 0.016403824 |
| 71.607376 | 4.271198088 | 4.33020889 | 0.059011 | 5.843 | 1.058 | 4.675 | 1.04675 | 1.011161 | 72.41 | 4.282297 | 0.011098914 |
| 73.72226 | 4.300304789 | 4.35547946 | 0.055175 | 2.998 | 1.030 | 4.67 | 1.0467 | 0.984028 | 72.54 | 4.284204 | -0.016101032 |
| 74.74727 | 4.314112684 | 4.35369244 | 0.03958 | 1.537 | 1.015 | 4.65 | 1.0465 | 0.970253 | 72.52 | 4.283914 | -0.030198185 |
| 75.960152 | 4.330208892 | 4.34039106 | 0.010182 | 1.181 | 1.012 | 4.545 | 1.04545 | 0.96782 | 73.52 | 4.2975 | -0.032709079 |
| 77.904168 | 4.355479458 | 4.33098877 | -0.024491 | 0.830 | 1.008 | 4.51 | 1.0451 | 0.964784 | 75.16 | 4.319629 | -0.035850797 |
| 77.765076 | 4.353692438 | 4.33460141 | -0.019091 | 1.003 | 1.010 | 4.67 | 1.0467 | 0.964961 | 75.04 | 4.318025 | -0.035667275 |
| 76.737542 | 4.340391055 | 4.33584813 | -0.004543 | 1.280 | 1.013 | 4.615 | 1.04615 | 0.968121 | 74.29 | 4.307993 | -0.032397986 |
| 76.019415 | 4.330988768 | 4.34720117 | 0.016212 | 1.458 | 1.015 | 4.585 | 1.04585 | 0.970103 | 73.75 | 4.300636 | -0.030353247 |
| 76.294543 | 4.334601414 | 4.35555277 | 0.020951 | 1.580 | 1.016 | 4.48 | 1.0448 | 0.972243 | 74.18 | 4.306452 | -0.028149 |
| 76.38972 | 4.335848132 | 4.37251319 | 0.036665 | 1.571 | 1.016 | 4.53 | 1.0453 | 0.971695 | 74.23 | 4.307135 | -0.028713589 |
| 77.261917 | 4.347201174 | 4.37286407 | 0.025663 | 1.592 | 1.016 | 4.6 | 1.046 | 0.971239 | 75.04 | 4.318018 | -0.029182697 |
| 77.90988 | 4.355552774 | 4.38190833 | 0.026356 | 2.110 | 1.021 | 4.57 | 1.0457 | 0.976475 | 76.08 | 4.331747 | -0.02380604 |
| 79.242533 | 4.372513192 | 4.39229532 | 0.019782 | 2.870 | 1.029 | 4.63 | 1.0463 | 0.983181 | 77.91 | 4.355551 | -0.016962318 |
| 79.270343 | 4.372864072 | 4.39099263 | 0.018129 | 2.015 | 1.020 | 4.5 | 1.045 | 0.976218 | 77.39 | 4.348794 | -0.024069661 |
| 79.990536 | 4.381908332 | 4.39693502 | 0.015027 | 1.707 | 1.017 | 4.38 | 1.0438 | 0.974387 | 77.94 | 4.355961 | -0.025946872 |
| 80.825727 | 4.392295322 | 4.39696996 | 0.004675 | 2.267 | 1.023 | 4.38 | 1.0438 | 0.979759 | 79.19 | 4.371846 | -0.02044909 |
| 80.720505 | 4.390992627 | 4.37920313 | -0.011789 | 2.749 | 1.027 | 4.49 | 1.0449 | 0.983333 | 79.38 | 4.374186 | -0.016807118 |
| 81.201605 | 4.396935016 | 4.35580964 | -0.041125 | 3.950 | 1.040 | 4.59 | 1.0459 | 0.993881 | 80.70 | 4.390797 | -0.00613793 |
| 81.204443 | 4.396969961 | 4.34300127 | -0.053969 | 5.061 | 1.051 | 4.36 | 1.0436 | 1.006721 | 81.75 | 4.403668 | 0.006698481 |
| 79.774438 | 4.379203129 | 4.31485544 | -0.064348 | 8.043 | 1.080 | 4.37 | 1.0437 | 1.035195 | 82.58 | 4.413793 | 0.034590103 |
| 77.929895 | 4.355809644 | 4.33265812 | -0.023152 | 8.259 | 1.083 | 4.43 | 1.0443 | 1.036666 | 80.79 | 4.391819 | 0.036009514 |
| 76.938105 | 4.343001267 | 4.33593844 | -0.007063 | 8.587 | 1.086 | 4.38 | 1.0438 | 1.040305 | 80.04 | 4.382515 | 0.039513609 |
| 74.80281 | 4.314855445 | | | 8.630 | 1.086 | 4.49 | 1.0449 | 1.039621 | 77.77 | 4.353712 | 0.038856239 |
| 76.146424 | 4.332658116 | | | 8.681 | 1.087 | 4.565 | 1.04565 | 1.039358 | 79.14 | 4.371262 | 0.038603498 |
| 76.396619 | 4.335938442 | | | 8.660 | 1.087 | 4.435 | 1.04435 | 1.040454 | 79.49 | 4.375595 | 0.039657032 |

UK POUNDS DATA

| S_t | Ln_St | S_t+3 | D_S_t+3 | KE_TBILL | 1+KETBILL | US_TBILL | 1+USTBILL | F/H | S_t(F/H) | Ln_Ft | LNFt - Ln_St |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 55.6225 | 4.018588425 | 4.38621884 | 0.36763041 | 17.87 | 1.1787 | 4.85 | 1.0485 | 1.124177 | 62.53 | 4.13564 | 0.11705156 |
| 52.675085 | 3.964142573 | 4.56826249 | 0.60411992 | 17.860 | 1.1786 | 4.63 | 1.0463 | 1.126446 | 59.34 | 4.08321 | 0.11906716 |
| 62.918641 | 4.141842478 | 4.57436418 | 0.43252171 | 25.070 | 1.2507 | 4.875 | 1.04875 | 1.192563 | 75.03 | 4.317947 | 0.17610442 |
| 80.33608 | 4.386218835 | 4.58434553 | 0.1981267 | 45.790 | 1.4579 | 4.81 | 1.0481 | 1.390993 | 111.75 | 4.716237 | 0.33001804 |
| 96.377 | 4.568262495 | 4.58227676 | 0.01401426 | 68.040 | 1.6804 | 4.86 | 1.0486 | 1.602518 | 154.45 | 5.039838 | 0.47157592 |
| 96.966 | 4.574364183 | 4.60839738 | 0.0340332 | 84.290 | 1.8429 | 4.71 | 1.0471 | 1.760004 | 170.66 | 5.13968 | 0.56531598 |
| 97.939068 | 4.584345532 | 4.62615792 | 0.04181239 | 84.670 | 1.8467 | 4.78 | 1.0478 | 1.762455 | 172.61 | 5.151053 | 0.56670753 |
| 97.736664 | 4.582276756 | 4.6265241 | 0.04424735 | 79.510 | 1.7951 | 4.74 | 1.0474 | 1.713863 | 167.51 | 5.121027 | 0.53874983 |
| 100.32324 | 4.608397382 | 4.62436063 | 0.01596325 | 75.690 | 1.7569 | 4.85 | 1.0485 | 1.675632 | 168.10 | 5.124588 | 0.51619032 |
| 102.12095 | 4.626157921 | 4.61836043 | -0.0077975 | 70.880 | 1.7088 | 4.72 | 1.0472 | 1.63178 | 166.64 | 5.115829 | 0.48967143 |
| 102.15835 | 4.626524105 | 4.60268746 | -0.0238366 | 55.260 | 1.5526 | 4.83 | 1.0483 | 1.481065 | 151.30 | 5.019285 | 0.39276114 |
| 101.93758 | 4.624360628 | 4.59083623 | -0.0335244 | 43.520 | 1.4352 | 4.86 | 1.0486 | 1.368682 | 139.52 | 4.938209 | 0.31384827 |
| 101.3278 | 4.61836043 | 4.53335048 | -0.0850099 | 33.55 | 1.3355 | 5.18 | 1.0518 | 1.269728 | 128.66 | 4.857163 | 0.23880277 |
| 99.752035 | 4.602687457 | 4.46949669 | -0.1331908 | 23.870 | 1.2387 | 5.21 | 1.0521 | 1.17736 | 117.44 | 4.765962 | 0.16327428 |
| 98.576829 | 4.590836232 | 4.45044712 | -0.1403891 | 27.620 | 1.2762 | 5.16 | 1.0516 | 1.213579 | 119.63 | 4.78441 | 0.1935741 |
| 93.069868 | 4.533350484 | 4.46011755 | -0.0732329 | 30.850 | 1.3085 | 4.895 | 1.04895 | 1.247438 | 116.10 | 4.754442 | 0.22109178 |
| 87.313 | 4.469496691 | 4.45084922 | -0.0186475 | 31.240 | 1.3124 | 4.925 | 1.04925 | 1.250798 | 109.21 | 4.693279 | 0.2237819 |
| 85.665 | 4.45044712 | 4.38944068 | -0.0610064 | 32.380 | 1.3238 | 5.145 | 1.05145 | 1.259023 | 107.85 | 4.680783 | 0.23033622 |
| 86.497676 | 4.460117549 | 4.21937372 | -0.2407438 | 29.740 | 1.2974 | 4.93 | 1.0493 | 1.236443 | 106.95 | 4.672357 | 0.21223899 |
| 85.699691 | 4.450849224 | 4.23351839 | -0.2173308 | 24.130 | 1.2413 | 4.93 | 1.0493 | 1.182979 | 101.38 | 4.618885 | 0.16803594 |
| 80.595328 | 4.389440685 | 4.25546966 | -0.133971 | 17.390 | 1.1739 | 4.945 | 1.04945 | 1.118586 | 90.15 | 4.501506 | 0.11206532 |
| 67.990889 | 4.219373718 | 4.24896887 | 0.02959515 | 16.950 | 1.1695 | 5.135 | 1.05135 | 1.112379 | 75.63 | 4.325875 | 0.10650125 |
| 68.959432 | 4.233518387 | 4.24765603 | 0.01413765 | 17.220 | 1.1722 | 4.945 | 1.04945 | 1.116966 | 77.03 | 4.344134 | 0.11061611 |
| 70.489916 | 4.255469661 | 4.25729621 | 0.00182655 | 17.490 | 1.1749 | 5.17 | 1.0517 | 1.117144 | 78.75 | 4.366245 | 0.11077514 |
| 70.0332 | 4.248968871 | 4.25977088 | 0.01080201 | 16.74 | 1.1674 | 5.155 | 1.05155 | 1.110171 | 77.75 | 4.353483 | 0.10451379 |
| 69.94128 | 4.247656033 | 4.40922824 | 0.1615722 | 17.630 | 1.1763 | 4.94 | 1.0494 | 1.120926 | 78.40 | 4.361811 | 0.11415535 |
| 70.618787 | 4.257296213 | 4.44911703 | 0.19182082 | 16.840 | 1.1684 | 4.96 | 1.0496 | 1.113186 | 78.61 | 4.364522 | 0.10722615 |
| 70.793761 | 4.259770877 | 4.50257911 | 0.24280824 | 15.160 | 1.1516 | 5.095 | 1.05095 | 1.09577 | 77.57 | 4.351229 | 0.09145776 |
| 82.206 | 4.409228237 | 4.47078909 | 0.06156085 | 15.090 | 1.1509 | 4.97 | 1.0497 | 1.096408 | 90.13 | 4.501268 | 0.09203984 |
| 85.551 | 4.449117031 | 4.45844013 | 0.0093231 | 16.390 | 1.1639 | 5.07 | 1.0507 | 1.107738 | 94.77 | 4.551437 | 0.10231983 |
| 90.249595 | 4.502579112 | 4.4735768 | -0.0290023 | 18.480 | 1.1848 | 4.94 | 1.0494 | 1.129026 | 101.89 | 4.623935 | 0.12135541 |
| 87.425683 | 4.470789091 | 4.46475353 | -0.0060356 | 19.650 | 1.1965 | 4.97 | 1.0497 | 1.139849 | 99.65 | 4.601685 | 0.13089622 |
| 86.352705 | 4.458440127 | 4.45395465 | -0.0044855 | 21.160 | 1.2116 | 5.035 | 1.05035 | 1.15352 | 99.61 | 4.601258 | 0.14281836 |
| 87.66974 | 4.4735768 | 4.46350387 | -0.0100729 | 24.070 | 1.2407 | 4.955 | 1.04955 | 1.182126 | 103.64 | 4.640891 | 0.16731424 |
| 86.899609 | 4.464753534 | 4.49498645 | 0.03023291 | 24.870 | 1.2487 | 4.92 | 1.0492 | 1.190145 | 103.42 | 4.638829 | 0.17407504 |
| 85.966239 | 4.453954648 | 4.49149019 | 0.03753554 | 21.670 | 1.2167 | 4.925 | 1.04925 | 1.15959 | 99.69 | 4.602021 | 0.14806665 |
| 86.7911 | 4.463503872 | 4.48288356 | 0.01937969 | 21.25 | 1.2125 | 4.94 | 1.0494 | 1.155422 | 100.28 | 4.60797 | 0.14446577 |
| 89.566955 | 4.494986446 | 4.47938595 | -0.0156005 | 25.960 | 1.2596 | 4.87 | 1.0487 | 1.201106 | 107.58 | 4.678229 | 0.18324291 |
| 89.254352 | 4.491490186 | 4.49338105 | 0.00189087 | 26.680 | 1.2668 | 4.755 | 1.04755 | 1.209298 | 107.94 | 4.68153 | 0.19003993 |
| 88.48947 | 4.482883562 | 4.48953333 | 0.00664977 | 24.160 | 1.2416 | 4.83 | 1.0483 | 1.184394 | 104.81 | 4.652115 | 0.16923107 |
| 88.181 | 4.479385953 | 4.48141675 | 0.0020308 | 21.960 | 1.2196 | 4.585 | 1.04585 | 1.166133 | 102.83 | 4.633079 | 0.15369298 |
| 89.423 | 4.493381051 | 4.47755616 | -0.0158249 | 21.850 | 1.2185 | 4.81 | 1.0481 | 1.16258 | 103.96 | 4.644023 | 0.15064159 |
| 89.079865 | 4.489533329 | 4.48350659 | -0.0060267 | 21.760 | 1.2176 | 4.75 | 1.0475 | 1.162387 | 103.55 | 4.640009 | 0.15047534 |
| 88.359768 | 4.481416755 | 4.52660465 | 0.0451879 | 21.630 | 1.2163 | 4.795 | 1.04795 | 1.160647 | 102.55 | 4.630394 | 0.14897759 |
| 88.019305 | 4.477556163 | 4.51987233 | 0.04231616 | 23.100 | 1.231 | 4.75 | 1.0475 | 1.175179 | 103.44 | 4.638977 | 0.16142047 |
| 88.544619 | 4.483506595 | 4.51180881 | 0.02830221 | 24.080 | 1.2408 | 4.54 | 1.0454 | 1.186914 | 105.09 | 4.654863 | 0.17135675 |
| 92.444148 | 4.526604653 | 4.49214511 | -0.0344595 | 22.090 | 1.2209 | 4.63 | 1.0463 | 1.166874 | 107.87 | 4.680933 | 0.15432816 |
| 91.823874 | 4.519872326 | 4.47993803 | -0.0399343 | 21.530 | 1.2153 | 4.905 | 1.04905 | 1.158477 | 106.38 | 4.666978 | 0.14710597 |
| 91.0864 | 4.511808806 | 4.48505263 | -0.0267562 | 21.61 | 1.2161 | 4.79 | 1.0479 | 1.160511 | 105.71 | 4.66067 | 0.14886086 |
| 89.312826 | 4.492145109 | 4.47493295 | -0.0172122 | 21.440 | 1.2144 | 5.175 | 1.05175 | 1.154647 | 103.12 | 4.63594 | 0.14379468 |
| 88.229205 | 4.479938034 | 4.49107071 | 0.01113267 | 21.420 | 1.2142 | 4.805 | 1.04805 | 1.158533 | 102.22 | 4.627092 | 0.14715413 |
| 88.681618 | 4.485052632 | 4.56374407 | 0.07869144 | 21.020 | 1.2102 | 4.665 | 1.04665 | 1.15626 | 102.54 | 4.630244 | 0.14519105 |
| 87.789 | 4.474932953 | 4.67954004 | 0.20460709 | 20.350 | 1.2035 | 4.915 | 1.04915 | 1.147119 | 100.70 | 4.612187 | 0.13725367 |
| 89.217 | 4.491070708 | 4.626084 | 0.1350133 | 19.440 | 1.1944 | 5.15 | 1.0515 | 1.135901 | 101.34 | 4.618497 | 0.12742625 |
| 95.942022 | 4.563744069 | 4.62713085 | 0.06338678 | 18.450 | 1.1845 | 4.77 | 1.0477 | 1.130572 | 108.47 | 4.686468 | 0.12272346 |
| 107.72051 | 4.679540042 | 4.68106001 | 0.00151996 | 19.690 | 1.1969 | 4.84 | 1.0484 | 1.141644 | 122.98 | 4.81201 | 0.13246969 |
| 102.1134 | 4.626084005 | 4.65165977 | 0.02557576 | 26.200 | 1.262 | 4.905 | 1.04905 | 1.202993 | 122.84 | 4.810897 | 0.18481277 |
| 102.22036 | 4.627130847 | 4.60596007 | -0.0211708 | 27.150 | 1.2715 | 5.16 | 1.0516 | 1.20911 | 123.60 | 4.817015 | 0.18988449 |
| 107.88437 | 4.681060005 | 4.59765728 | -0.0834027 | 26.780 | 1.2678 | 5.09 | 1.0509 | 1.206395 | 130.15 | 4.868696 | 0.18763617 |
| 104.75872 | 4.651659769 | 4.60377995 | -0.0478798 | 26.360 | 1.2636 | 4.955 | 1.04955 | 1.203945 | 126.12 | 4.837263 | 0.18560329 |
| 100.0790 | 4.605960074 | 4.60260375 | -0.0033563 | 26.28225 | 1.2628225 | 4.945 | 1.04945 | 1.203318 | 120.43 | 4.791043 | 0.18508308 |
| 99.251525 | 4.597657285 | 4.63010423 | 0.03244695 | 26.326 | 1.2632625 | 4.965 | 1.04965 | 1.203508 | 119.45 | 4.782898 | 0.18524088 |
| 99.861073 | 4.603779947 | 4.60318321 | -0.0005967 | 26.736 | 1.267358 | 5.065 | 1.05065 | 1.206261 | 120.46 | 4.791305 | 0.1875254 |
| 99.743685 | 4.602603745 | 4.58138667 | -0.0212171 | 26.981 | 1.26981 | 4.96 | 1.0496 | 1.209804 | 120.67 | 4.793062 | 0.19045814 |
| 102.525 | 4.630104233 | 4.5749592 | -0.055145 | 26.381 | 1.26381 | 4.975 | 1.04975 | 1.203915 | 123.43 | 4.815683 | 0.18557893 |
| 99.802 | 4.603183213 | 4.61361137 | 0.01042815 | 25.475 | 1.254752 | 5.065 | 1.05065 | 1.194263 | 119.19 | 4.780712 | 0.17752892 |
| 97.649709 | 4.581386674 | 4.61937862 | 0.03799195 | 24.672 | 1.24672 | 5.015 | 1.05015 | 1.187183 | 115.93 | 4.75297 | 0.17158309 |
| 97.02408 | 4.574959195 | 4.59643313 | 0.02147393 | 23.741 | 1.237406 | 4.975 | 1.04975 | 1.178763 | 114.37 | 4.739424 | 0.16446521 |
| 100.84769 | 4.613611368 | 4.63654019 | 0.02292882 | 22.474 | 1.22474 | 5.12 | 1.0512 | 1.165088 | 117.50 | 4.766408 | 0.15279621 |
| 101.43099 | 4.619378624 | 4.62490387 | 0.00552525 | 20.587 | 1.205865 | 4.97 | 1.0497 | 1.148771 | 116.52 | 4.758071 | 0.13869274 |
| 99.1301 | 4.596433129 | 4.62329715 | 0.02686402 | 17.662 | 1.176624 | 4.965 | 1.04965 | 1.120968 | 111.12 | 4.710626 | 0.11419255 |
| 103.18672 | 4.636540189 | 4.64250379 | 0.0059636 | 12.565 | 1.125645 | 4.965 | 1.04965 | 1.0724 | 110.66 | 4.70644 | 0.06989943 |
| 101.9930 | 4.624903874 | 4.66178244 | 0.03687857 | 10.703 | 1.10703 | 5.1 | 1.051 | 1.053311 | 107.43 | 4.676843 | 0.05193866 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 101.82923 | 4.623297145 | 4.7108848 | 0.08758765 | 8.950 | 1.0895 | 4.89 | 1.0489 | 1.038707 | 105.77 | 4.661274 | 0.03797688 |
| 103.80393 | 4.642503794 | 4.76660128 | 0.12409749 | 8.845 | 1.088448 | 4.95 | 1.0495 | 1.037111 | 107.66 | 4.678943 | 0.03643897 |
| 105.82454 | 4.66178244 | 4.74566131 | 0.08387887 | 9.028 | 1.0902825 | 5.05 | 1.0505 | 1.03787 | 109.83 | 4.698953 | 0.0371706 |
| 111.150 | 4.710884796 | 4.78376773 | 0.07288294 | 9.626 | 1.096262 | 4.955 | 1.04955 | 1.044507 | 116.10 | 4.75443 | 0.04354471 |
| 117.519 | 4.766601279 | 4.81056716 | 0.04396588 | 11.442 | 1.1144225 | 5.075 | 1.05075 | 1.060597 | 124.64 | 4.825433 | 0.05883214 |
| 115.08389 | 4.745661309 | 4.83040107 | 0.08473976 | 14.472 | 1.1447175 | 4.835 | 1.04835 | 1.091923 | 125.66 | 4.833602 | 0.08794038 |
| 119.55395 | 4.783767734 | 4.79929675 | 0.01552902 | 14.842 | 1.148424 | 4.91 | 1.0491 | 1.094675 | 130.87 | 4.874226 | 0.09045791 |
| 122.80125 | 4.810567158 | 4.78168877 | -0.0288784 | 15.778 | 1.157775 | 4.79 | 1.0479 | 1.104853 | 135.68 | 4.910279 | 0.0997119 |
| 125.26119 | 4.830401073 | 4.75371691 | -0.0766842 | 17.628 | 1.176275 | 5.1 | 1.051 | 1.119196 | 140.19 | 4.943012 | 0.11261057 |
| 121.425 | 4.799296751 | 4.76572619 | -0.0335706 | 18.135 | 1.181354 | 4.94 | 1.0494 | 1.125742 | 136.69 | 4.917739 | 0.11844267 |
| 119.30566 | 4.781688771 | 4.76713337 | -0.0145554 | 19.975 | 1.199745 | 5.075 | 1.05075 | 1.141799 | 136.22 | 4.914294 | 0.13260484 |
| 116.0147 | 4.753716907 | 4.76918411 | 0.0154672 | 20.295 | 1.20295 | 4.7 | 1.047 | 1.148949 | 133.30 | 4.892565 | 0.13884794 |
| 117.41635 | 4.765726185 | 4.74232858 | -0.0233976 | 14.844 | 1.14844 | 4.89 | 1.0489 | 1.094899 | 128.56 | 4.856389 | 0.0906625 |
| 117.5817 | 4.767133374 | 4.7624983 | -0.0046351 | 11.278 | 1.1127825 | 5.09 | 1.0509 | 1.058885 | 124.51 | 4.82435 | 0.0572167 |
| 117.82307 | 4.769184111 | 4.74809594 | -0.0210882 | 12.442 | 1.1244225 | 4.765 | 1.04765 | 1.073281 | 126.46 | 4.839904 | 0.07072001 |
| 114.701 | 4.742328584 | 4.73537988 | -0.0069487 | 11.222 | 1.112222 | 5.03 | 1.0503 | 1.058956 | 121.46 | 4.799613 | 0.05728398 |
| 117.038 | 4.762498302 | 4.71847723 | -0.0440211 | 10.474 | 1.10474 | 4.82 | 1.0482 | 1.05394 | 123.35 | 4.815034 | 0.05253561 |
| 115.36441 | 4.748095938 | 4.74638108 | -0.0017149 | 9.904 | 1.099044 | 4.585 | 1.04585 | 1.050862 | 121.23 | 4.797707 | 0.04961076 |
| 113.90672 | 4.735379883 | 4.72308436 | -0.0122955 | 9.245 | 1.0924525 | 4.63 | 1.0463 | 1.04411 | 118.93 | 4.778545 | 0.04316504 |
| 111.99758 | 4.71847723 | 4.74419052 | 0.02571329 | 10.360 | 1.1036025 | 4.905 | 1.04905 | 1.052002 | 117.82 | 4.769172 | 0.05069484 |
| 115.16675 | 4.746381078 | 4.7557527 | 0.00937162 | 10.654 | 1.106536 | 4.78 | 1.0478 | 1.056056 | 121.62 | 4.800923 | 0.05454169 |
| 112.51475 | 4.723084365 | 4.73439248 | 0.01130811 | 11.167 | 1.1116725 | 4.8 | 1.048 | 1.060756 | 119.35 | 4.782066 | 0.05898205 |
| 114.91475 | 4.744190524 | 4.72229976 | -0.0218908 | 12.901 | 1.12901 | 4.675 | 1.04675 | 1.078586 | 123.95 | 4.819842 | 0.07565102 |
| 116.2511 | 4.755752702 | 4.71134998 | -0.0444027 | 14.7556 | 1.147556 | 4.7 | 1.047 | 1.096042 | 127.42 | 4.847458 | 0.09170553 |
| 113.79431 | 4.734392477 | 4.71890362 | -0.0154889 | 15.297 | 1.1529725 | 4.86 | 1.0486 | 1.099535 | 125.12 | 4.82928 | 0.09488745 |
| 112.42651 | 4.722299756 | 4.70313665 | -0.0191631 | 14.972 | 1.1497175 | 4.845 | 1.04845 | 1.096588 | 123.29 | 4.814503 | 0.09220338 |
| 111.20218 | 4.711349976 | 4.71529179 | 0.00394181 | 12.899 | 1.128992 | 4.62 | 1.0462 | 1.079136 | 120.00 | 4.787511 | 0.07616065 |
| 112.045 | 4.718903619 | 4.73061907 | 0.01171545 | 10.517 | 1.1051675 | 4.82 | 1.0482 | 1.054348 | 118.13 | 4.771826 | 0.0529225 |
| 110.293 | 4.703136653 | 4.74901729 | 0.04588064 | 12.070 | 1.120695 | 4.715 | 1.04715 | 1.070233 | 118.04 | 4.771013 | 0.06787684 |
| 111.64138 | 4.715291786 | 4.74221044 | 0.02691866 | 12.873 | 1.128732 | 4.635 | 1.04635 | 1.078733 | 120.43 | 4.791079 | 0.07578696 |
| 113.36572 | 4.730619068 | 4.73149875 | 0.00087968 | 12.839 | 1.1283875 | 4.695 | 1.04695 | 1.077785 | 122.18 | 4.805528 | 0.07490845 |
| 115.47076 | 4.749017294 | 4.72949064 | -0.0195267 | 12.393 | 1.1239325 | 4.8 | 1.048 | 1.072455 | 123.84 | 4.818967 | 0.06995011 |
| 114.68743 | 4.742210444 | 4.72532713 | -0.0168833 | 11.629 | 1.116286 | 4.725 | 1.04725 | 1.065921 | 122.25 | 4.80605 | 0.06383942 |
| 113.46549 | 4.731498746 | 4.71275262 | -0.0187461 | 11.498 | 1.114975 | 4.805 | 1.04805 | 1.063857 | 120.71 | 4.793399 | 0.06190069 |
| 113.23787 | 4.729490639 | 4.71006303 | -0.0194276 | 11.012 | 1.110124 | 4.65 | 1.0465 | 1.060797 | 120.12 | 4.788511 | 0.05902046 |
| 112.76738 | 4.725327129 | 4.72655254 | 0.00122541 | 10.85475 | 1.1085475 | 4.72 | 1.0472 | 1.058582 | 119.37 | 4.782258 | 0.05693066 |
| 111.35827 | 4.712752616 | 4.73939751 | 0.0266449 | 10.611 | 1.10611 | 4.61 | 1.0461 | 1.057365 | 117.75 | 4.768533 | 0.05578039 |
| 111.05916 | 4.710063032 | 4.75871544 | 0.04865241 | 10.144 | 1.10144 | 4.81 | 1.0481 | 1.050892 | 116.71 | 4.759702 | 0.04963941 |
| 112.90565 | 4.726552535 | 4.80876923 | 0.0822167 | 10.010 | 1.1001 | 4.57 | 1.0457 | 1.052023 | 118.78 | 4.777267 | 0.05071457 |
| 114.365 | 4.739397513 | 4.79444054 | 0.05504302 | 9.040 | 1.0903975 | 4.67 | 1.0467 | 1.041748 | 119.14 | 4.780297 | 0.04089995 |
| 116.596 | 4.75871544 | 4.80849867 | 0.04978323 | 7.338 | 1.07338 | 4.76 | 1.0476 | 1.024609 | 119.47 | 4.783026 | 0.02431071 |
| 122.58066 | 4.808769234 | 4.81682525 | 0.00805602 | 8.634 | 1.086336 | 4.63 | 1.0463 | 1.038264 | 127.27 | 4.84632 | 0.03755043 |
| 120.83676 | 4.794440536 | 4.82895761 | 0.03451707 | 8.340 | 1.083395 | 4.725 | 1.04725 | 1.034514 | 125.01 | 4.828372 | 0.03393195 |
| 122.5475 | 4.808498671 | 4.83689871 | 0.02840004 | 7.601 | 1.076008 | 4.53 | 1.0453 | 1.029377 | 126.15 | 4.837453 | 0.02895397 |
| 123.57216 | 4.816825254 | 4.83359425 | 0.01676899 | 8.065 | 1.0806525 | 4.445 | 1.04445 | 1.034662 | 127.86 | 4.8509 | 0.03407459 |
| 125.08051 | 4.828957606 | 4.81895807 | -0.0099995 | 8.299 | 1.082985 | 4.73 | 1.0473 | 1.034073 | 129.34 | 4.862463 | 0.03350569 |
| 126.07774 | 4.83689871 | 4.7971639 | -0.0397348 | 8.378 | 1.083776 | 4.585 | 1.04585 | 1.036263 | 130.65 | 4.87252 | 0.03562129 |
| 125.66181 | 4.833594247 | 4.78063357 | -0.0529607 | 8.384 | 1.08384 | 4.7 | 1.047 | 1.035186 | 130.08 | 4.868176 | 0.03458136 |
| 123.836 | 4.818958069 | 4.7551999 | -0.0637582 | 7.774 | 1.0777375 | 4.555 | 1.04555 | 1.030785 | 127.65 | 4.849279 | 0.03032087 |
| 121.16629 | 4.797163904 | 4.80836639 | 0.01120248 | 6.239 | 1.062394 | 4.68 | 1.0468 | 1.014897 | 122.97 | 4.811951 | 0.01478696 |
| 119.17984 | 4.780633571 | 4.79963947 | 0.0190059 | 6.254 | 1.0625375 | 4.525 | 1.04525 | 1.016539 | 121.15 | 4.797037 | 0.01640382 |
| 116.187 | 4.755199896 | 4.79676854 | 0.04156864 | 5.843 | 1.0584325 | 4.675 | 1.04675 | 1.011161 | 117.48 | 4.766299 | 0.01109891 |
| 122.531 | 4.808366385 | 4.83198535 | 0.02361897 | 2.998 | 1.029982 | 4.67 | 1.0467 | 0.984028 | 120.57 | 4.792265 | -0.016101 |
| 121.46662 | 4.799639471 | 4.87070561 | 0.07106614 | 1.537 | 1.01537 | 4.65 | 1.0465 | 0.970253 | 117.85 | 4.769441 | -0.0301982 |
| 121.1184 | 4.79676854 | 4.86446225 | 0.06769371 | 1.181 | 1.0118075 | 4.545 | 1.04545 | 0.96782 | 117.22 | 4.764059 | -0.0327091 |
| 125.4598 | 4.831985352 | 4.88979649 | 0.05781114 | 0.830 | 1.008296 | 4.51 | 1.0451 | 0.964784 | 121.04 | 4.796135 | -0.0358508 |
| 130.4129 | 4.870705607 | 4.93412279 | 0.06341718 | 1.003 | 1.010025 | 4.67 | 1.0467 | 0.964961 | 125.84 | 4.835038 | -0.0356673 |
| 129.60123 | 4.864462246 | 4.96004049 | 0.09557825 | 1.280 | 1.0128 | 4.615 | 1.04615 | 0.968121 | 125.47 | 4.832064 | -0.032398 |
| 132.92652 | 4.889796494 | 4.95103768 | 0.06124119 | 1.458 | 1.014582 | 4.585 | 1.04585 | 0.970103 | 128.95 | 4.859443 | -0.0303532 |
| 138.9512 | 4.934122792 | 4.94538512 | 0.01126233 | 1.58 | 1.0158 | 4.48 | 1.0448 | 0.972243 | 135.09 | 4.905974 | -0.028149 |
| 142.59957 | 4.960040493 | 4.95205988 | -0.0079806 | 1.571 | 1.0157125 | 4.53 | 1.0453 | 0.971695 | 138.56 | 4.931327 | -0.0287136 |
| 141.32153 | 4.951037683 | 4.97564145 | 0.02460377 | 1.592 | 1.015916 | 4.6 | 1.046 | 0.971239 | 137.26 | 4.921855 | -0.0291827 |
| 140.52496 | 4.945385124 | 4.99324887 | 0.04786375 | 2.110 | 1.0211 | 4.57 | 1.0457 | 0.976475 | 137.22 | 4.921579 | -0.023806 |
| 141.466 | 4.952059877 | 4.99153384 | 0.03947396 | 2.870 | 1.028702 | 4.63 | 1.0463 | 0.983181 | 139.09 | 4.935098 | -0.0169623 |
| 144.842 | 4.975641455 | 4.97503409 | -0.0006074 | 2.015 | 1.0201475 | 4.5 | 1.045 | 0.976218 | 141.40 | 4.951572 | -0.0240697 |
| 147.41458 | 4.993248871 | 4.98887072 | -0.0043782 | 1.707 | 1.017065 | 4.38 | 1.0438 | 0.974387 | 143.64 | 4.967302 | -0.0259469 |
| 147.16197 | 4.991533835 | 5.01628107 | 0.02474724 | 2.267 | 1.022672 | 4.38 | 1.0438 | 0.979759 | 144.18 | 4.971085 | -0.0204491 |
| 144.75376 | 4.975034086 | 5.03653709 | 0.061503 | 2.749 | 1.027485 | 4.49 | 1.0449 | 0.983333 | 142.34 | 4.958227 | -0.0168071 |
| 146.77058 | 4.988870716 | 4.98710064 | -0.0017701 | 3.950 | 1.0395 | 4.59 | 1.0459 | 0.993881 | 145.87 | 4.982733 | -0.0061379 |
| 150.84926 | 5.016281073 | 4.97770179 | -0.0385793 | 5.061 | 1.050614 | 4.36 | 1.0436 | 1.006721 | 151.86 | 5.02298 | 0.00669848 |
| 153.93602 | 5.036537086 | 4.96079164 | -0.0757454 | 8.043 | 1.08043333 | 4.37 | 1.0437 | 1.035195 | 159.35 | 5.071127 | 0.0345901 |
| 146.51102 | 4.987100641 | 4.97189582 | -0.0152048 | 8.259 | 1.08259 | 4.43 | 1.0443 | 1.036666 | 151.88 | 5.02311 | 0.03600951 |
| 145.14044 | 4.977701791 | 4.95374958 | -0.0239522 | 8.587 | 1.08587 | 4.38 | 1.0438 | 1.040305 | 150.99 | 5.017215 | 0.03951361 |
| 142.70672 | 4.960791642 | | | 8.630 | 1.0863 | 4.49 | 1.0449 | 1.039621 | 148.36 | 4.999648 | 0.03885624 |
| 144.3002 | 4.971895819 | | | 8.681 | 1.086805 | 4.565 | 1.04565 | 1.039358 | 149.98 | 5.010499 | 0.0386035 |
| 141.705 | 4.953749583 | | | 8.660 | 1.086598 | 4.435 | 1.04435 | 1.040454 | 147.44 | 4.993407 | 0.03965703 |

| EURO DATA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S_t | Ln_St | S_t+3 | D_S_t+3 | KE_TBILL | 1+KETBILL | US_TBILL | 1+USTBILL | F/H | S_t(F/H) | Ln_Ft | LNFt - Ln_St |
| | | | | 17.870 | 1.179 | 4.85 | 1.049 | 1.124177 | | | |
| | | | | 17.860 | 1.179 | 4.63 | 1.046 | 1.126446 | | | |
| | | | | 25.070 | 1.251 | 4.875 | 1.049 | 1.192563 | | | |
| | | | | 45.790 | 1.458 | 4.81 | 1.048 | 1.390993 | | | |
| | | | | 68.040 | 1.680 | 4.86 | 1.049 | 1.602518 | | | |
| | | | | 84.290 | 1.843 | 4.71 | 1.047 | 1.760004 | | | |
| | | | | 84.670 | 1.847 | 4.78 | 1.048 | 1.762455 | | | |
| | | | | 79.510 | 1.795 | 4.74 | 1.047 | 1.713863 | | | |
| | | | | 75.690 | 1.757 | 4.85 | 1.049 | 1.675632 | | | |
| | | | | 70.880 | 1.709 | 4.72 | 1.047 | 1.63178 | | | |
| | | | | 55.260 | 1.553 | 4.83 | 1.048 | 1.481065 | | | |
| | | | | 43.520 | 1.435 | 4.86 | 1.049 | 1.368682 | | | |
| | | | | 33.550 | 1.336 | 5.18 | 1.052 | 1.269728 | | | |
| | | | | 23.870 | 1.239 | 5.21 | 1.052 | 1.17736 | | | |
| | | | | 27.620 | 1.276 | 5.16 | 1.052 | 1.213579 | | | |
| | | | | 30.850 | 1.309 | 4.895 | 1.049 | 1.247438 | | | |
| | | | | 31.240 | 1.312 | 4.925 | 1.049 | 1.250798 | | | |
| | | | | 32.380 | 1.324 | 5.145 | 1.051 | 1.259023 | | | |
| | | | | 29.740 | 1.297 | 4.93 | 1.049 | 1.236443 | | | |
| | | | | 24.130 | 1.241 | 4.93 | 1.049 | 1.182979 | | | |
| | | | | 17.390 | 1.174 | 4.945 | 1.049 | 1.118586 | | | |
| | | | | 16.950 | 1.170 | 5.135 | 1.051 | 1.112379 | | | |
| | | | | 17.220 | 1.172 | 4.945 | 1.049 | 1.116966 | | | |
| | | | | 17.490 | 1.175 | 5.17 | 1.052 | 1.117144 | | | |
| | | | | 16.740 | 1.167 | 5.155 | 1.052 | 1.110171 | | | |
| | | | | 17.630 | 1.176 | 4.94 | 1.049 | 1.120926 | | | |
| | | | | 16.840 | 1.168 | 4.96 | 1.050 | 1.113186 | | | |
| | | | | 15.160 | 1.152 | 5.095 | 1.051 | 1.09577 | | | |
| | | | | 15.090 | 1.151 | 4.97 | 1.050 | 1.096408 | | | |
| | | | | 16.390 | 1.164 | 5.07 | 1.051 | 1.107738 | | | |
| | | | | 18.480 | 1.185 | 4.94 | 1.049 | 1.129026 | | | |
| | | | | 19.650 | 1.197 | 4.97 | 1.050 | 1.139849 | | | |
| | | | | 21.160 | 1.212 | 5.035 | 1.050 | 1.15352 | | | |
| | | | | 24.070 | 1.241 | 4.955 | 1.050 | 1.182126 | | | |
| | | | | 24.870 | 1.249 | 4.92 | 1.049 | 1.190145 | | | |
| | | | | 21.670 | 1.217 | 4.925 | 1.049 | 1.15959 | | | |
| | | | | 21.250 | 1.213 | 4.94 | 1.049 | 1.155422 | | | |
| | | | | 25.960 | 1.260 | 4.87 | 1.049 | 1.201106 | | | |
| | | | | 26.680 | 1.267 | 4.755 | 1.048 | 1.209298 | | | |
| | | | | 24.160 | 1.242 | 4.83 | 1.048 | 1.184394 | | | |
| | | | | 21.960 | 1.220 | 4.585 | 1.046 | 1.166133 | | | |
| | | | | 21.850 | 1.219 | 4.81 | 1.048 | 1.16258 | | | |
| | | | | 21.760 | 1.218 | 4.75 | 1.048 | 1.162387 | | | |
| | | | | 21.630 | 1.216 | 4.795 | 1.048 | 1.160647 | | | |
| | | | | 23.100 | 1.231 | 4.75 | 1.048 | 1.175179 | | | |
| | | | | 24.080 | 1.241 | 4.54 | 1.045 | 1.186914 | | | |
| | | | | 22.090 | 1.221 | 4.63 | 1.046 | 1.166874 | | | |
| | | | | 21.530 | 1.215 | 4.905 | 1.049 | 1.158477 | | | |
| | | | | 21.610 | 1.216 | 4.79 | 1.048 | 1.160511 | | | |
| | | | | 21.440 | 1.214 | 5.175 | 1.052 | 1.154647 | | | |
| | | | | 21.420 | 1.214 | 4.805 | 1.048 | 1.158533 | | | |
| | | | | 21.020 | 1.210 | 4.665 | 1.047 | 1.15626 | | | |
| | | | | 20.350 | 1.204 | 4.915 | 1.049 | 1.147119 | | | |
| | | | | 19.440 | 1.194 | 5.15 | 1.052 | 1.135901 | | | |
| | | | | 18.450 | 1.185 | 4.77 | 1.048 | 1.130572 | | | |
| | | | | 19.690 | 1.197 | 4.84 | 1.048 | 1.141644 | | | |
| | | | | 26.200 | 1.262 | 4.905 | 1.049 | 1.202993 | | | |
| | | | | 27.150 | 1.272 | 5.16 | 1.052 | 1.20911 | | | |
| | | | | 26.780 | 1.268 | 5.09 | 1.051 | 1.206395 | | | |
| | | | | 26.360 | 1.264 | 4.955 | 1.050 | 1.203945 | | | |
| | | | | 26.282 | 1.263 | 4.945 | 1.049 | 1.203318 | | | |
| | | | | 26.326 | 1.263 | 4.965 | 1.050 | 1.203508 | | | |
| | | | | 26.736 | 1.267 | 5.065 | 1.051 | 1.206261 | | | |
| | | | | 26.981 | 1.270 | 4.96 | 1.050 | 1.209804 | | | |
| | | | | 26.381 | 1.264 | 4.975 | 1.050 | 1.203915 | | | |
| | | | | 25.475 | 1.255 | 5.065 | 1.051 | 1.194263 | | | |
| | | | | 24.672 | 1.247 | 5.015 | 1.050 | 1.187183 | | | |
| | | | | 23.741 | 1.237 | 4.975 | 1.050 | 1.178763 | | | |
| | | | | 22.474 | 1.225 | 5.12 | 1.051 | 1.165088 | | | |
| | | | | 20.587 | 1.206 | 4.97 | 1.050 | 1.148771 | | | |
| | | | | 17.662 | 1.177 | 4.965 | 1.050 | 1.120968 | | | |
| | | | | 12.565 | 1.126 | 4.965 | 1.050 | 1.0724 | | | |
| 71.752111 | 4.273217269 | 4.2524413 | -0.020776 | 10.703 | 1.107 | 5.1 | 1.051 | 1.053311 | 75.577297 | 4.325156 | 0.051938662 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.071535 | 4.249516649 | 4.29289756 | 0.043381 | 8.950 | 1.090 | 4.89 | 1.049 | 1.038707 | 72.783809 | 4.287494 | 0.037976879 |
| 69.722983 | 4.24453 | 4.3361248 | 0.091595 | 8.845 | 1.088 | 4.95 | 1.050 | 1.037111 | 72.310473 | 4.280969 | 0.036438968 |
| 70.27677 | 4.252441303 | 4.32644371 | 0.074002 | 9.028 | 1.090 | 5.05 | 1.051 | 1.03787 | 72.938156 | 4.289612 | 0.037170596 |
| 73.1782 | 4.292897562 | 4.36877104 | 0.075873 | 9.626 | 1.096 | 4.955 | 1.050 | 1.044507 | 76.43512 | 4.336442 | 0.04354471 |
| 76.410857 | 4.336124795 | 4.37545103 | 0.039326 | 11.442 | 1.114 | 5.075 | 1.051 | 1.060597 | 81.041141 | 4.394957 | 0.058832139 |
| 75.674686 | 4.32644371 | 4.39420091 | 0.067757 | 14.472 | 1.145 | 4.835 | 1.048 | 1.091923 | 82.630932 | 4.414384 | 0.087940382 |
| 78.94655 | 4.368771041 | 4.34944099 | -0.01933 | 14.842 | 1.148 | 4.91 | 1.049 | 1.094675 | 86.420849 | 4.459229 | 0.090457914 |
| 79.475677 | 4.375451029 | 4.31559833 | -0.059853 | 15.778 | 1.158 | 4.79 | 1.048 | 1.104853 | 87.808906 | 4.475163 | 0.099711898 |
| 80.979895 | 4.394200911 | 4.27427071 | -0.11993 | 17.628 | 1.176 | 5.1 | 1.051 | 1.119196 | 90.632375 | 4.506811 | 0.112610574 |
| 77.435164 | 4.349440988 | 4.27710293 | -0.072338 | 18.135 | 1.181 | 4.94 | 1.049 | 1.125742 | 87.172041 | 4.467884 | 0.118442666 |
| 74.8584 | 4.315598329 | 4.27435342 | -0.041245 | 19.975 | 1.200 | 5.075 | 1.051 | 1.141799 | 85.473225 | 4.448203 | 0.132604839 |
| 71.827737 | 4.274270708 | 4.25619733 | -0.018073 | 20.295 | 1.203 | 4.7 | 1.047 | 1.148949 | 82.526434 | 4.413119 | 0.138847941 |
| 72.031457 | 4.277102928 | 4.23290816 | -0.044195 | 14.844 | 1.148 | 4.89 | 1.049 | 1.094899 | 78.867201 | 4.367765 | 0.090662504 |
| 71.833678 | 4.274353423 | 4.29963632 | 0.025283 | 11.278 | 1.113 | 5.09 | 1.051 | 1.058885 | 76.063622 | 4.33157 | 0.057216696 |
| 70.541228 | 4.25619733 | 4.27537613 | 0.019179 | 12.442 | 1.124 | 4.765 | 1.048 | 1.073281 | 75.710537 | 4.326917 | 0.07072001 |
| 68.917364 | 4.232908158 | 4.2378676 | 0.004959 | 11.222 | 1.112 | 5.03 | 1.050 | 1.058956 | 72.980489 | 4.290192 | 0.057283979 |
| 73.672995 | 4.299636317 | 4.22084232 | -0.078794 | 10.474 | 1.105 | 4.82 | 1.048 | 1.05394 | 77.646923 | 4.352172 | 0.052535606 |
| 71.907181 | 4.275376134 | 4.2163801 | -0.058996 | 9.904 | 1.099 | 4.585 | 1.046 | 1.050862 | 75.564522 | 4.324987 | 0.049610759 |
| 69.260004 | 4.237867602 | 4.21142122 | -0.026446 | 9.245 | 1.092 | 4.63 | 1.046 | 1.04411 | 72.315077 | 4.281033 | 0.043165037 |
| 68.090814 | 4.220842318 | 4.25496269 | 0.03412 | 10.360 | 1.104 | 4.905 | 1.049 | 1.052002 | 71.63166 | 4.271537 | 0.050694836 |
| 67.787655 | 4.216380099 | 4.30155383 | 0.085174 | 10.654 | 1.107 | 4.78 | 1.048 | 1.056056 | 71.587594 | 4.270922 | 0.054541687 |
| 67.452336 | 4.211421221 | 4.27889994 | 0.067479 | 11.167 | 1.112 | 4.8 | 1.048 | 1.060756 | 71.550484 | 4.270403 | 0.058982052 |
| 70.454188 | 4.254962686 | 4.25995472 | 0.004992 | 12.901 | 1.129 | 4.675 | 1.047 | 1.078586 | 75.990908 | 4.330614 | 0.075651017 |
| 73.8144 | 4.301553835 | 4.23677867 | -0.064775 | 14.756 | 1.148 | 4.7 | 1.047 | 1.096042 | 80.903684 | 4.393259 | 0.091705532 |
| 72.161015 | 4.278899942 | 4.23156263 | -0.047337 | 15.297 | 1.153 | 4.86 | 1.049 | 1.099535 | 79.343568 | 4.373787 | 0.094887449 |
| 70.806777 | 4.25995472 | 4.20695625 | -0.052998 | 14.972 | 1.150 | 4.845 | 1.048 | 1.096588 | 77.64585 | 4.352158 | 0.092203377 |
| 69.184626 | 4.236778675 | 4.21698266 | -0.019796 | 12.899 | 1.129 | 4.62 | 1.046 | 1.079136 | 74.659615 | 4.312939 | 0.076160647 |
| 68.824695 | 4.231562626 | 4.26328068 | 0.031718 | 10.517 | 1.105 | 4.82 | 1.048 | 1.054348 | 72.565175 | 4.284485 | 0.0529225 |
| 67.151835 | 4.206956249 | 4.2752198 | 0.068264 | 12.070 | 1.121 | 4.715 | 1.047 | 1.070233 | 71.868143 | 4.274833 | 0.06787684 |
| 67.828514 | 4.216982662 | 4.27085831 | 0.053876 | 12.873 | 1.129 | 4.635 | 1.046 | 1.078733 | 73.168838 | 4.29277 | 0.075786961 |
| 71.04267 | 4.263280676 | 4.2504587 | -0.012822 | 12.839 | 1.128 | 4.695 | 1.047 | 1.077785 | 76.568757 | 4.338189 | 0.074908447 |
| 71.89594 | 4.275219796 | 4.25188316 | -0.023337 | 12.393 | 1.124 | 4.8 | 1.048 | 1.072455 | 77.105137 | 4.34517 | 0.06995011 |
| 71.58305 | 4.270858314 | 4.24189239 | -0.028966 | 11.629 | 1.116 | 4.725 | 1.047 | 1.065921 | 76.301892 | 4.334698 | 0.063839423 |
| 70.137577 | 4.250458703 | 4.22060637 | -0.029852 | 11.498 | 1.115 | 4.805 | 1.048 | 1.063857 | 74.616331 | 4.312359 | 0.061900688 |
| 70.237556 | 4.251883157 | 4.22591171 | -0.025971 | 11.012 | 1.110 | 4.65 | 1.047 | 1.060797 | 74.507785 | 4.310904 | 0.059020458 |
| 69.539323 | 4.241892387 | 4.23899248 | -0.0029 | 10.855 | 1.109 | 4.72 | 1.047 | 1.058582 | 73.613104 | 4.298823 | 0.056930664 |
| 68.07475 | 4.220606366 | 4.27413552 | 0.053529 | 10.611 | 1.106 | 4.61 | 1.046 | 1.057365 | 71.979889 | 4.276387 | 0.055780392 |
| 68.43687 | 4.225911714 | 4.31880711 | 0.092895 | 10.144 | 1.101 | 4.81 | 1.048 | 1.050892 | 71.919765 | 4.275551 | 0.049639413 |
| 69.337957 | 4.238992478 | 4.36021349 | 0.121221 | 10.010 | 1.100 | 4.57 | 1.046 | 1.052023 | 72.945096 | 4.289707 | 0.050714567 |
| 71.818027 | 4.274135521 | 4.34186943 | 0.067734 | 9.040 | 1.090 | 4.67 | 1.047 | 1.041748 | 74.816277 | 4.315035 | 0.040899951 |
| 75.09899 | 4.31880711 | 4.34732895 | 0.028522 | 7.338 | 1.073 | 4.76 | 1.048 | 1.024609 | 76.947073 | 4.343118 | 0.024310715 |
| 78.273843 | 4.360213492 | 4.35477246 | -0.005441 | 8.634 | 1.086 | 4.63 | 1.046 | 1.038264 | 81.268942 | 4.397764 | 0.037550435 |
| 76.851073 | 4.341869429 | 4.37801186 | 0.036142 | 8.340 | 1.083 | 4.725 | 1.047 | 1.034514 | 79.503526 | 4.375801 | 0.033931948 |
| 77.27179 | 4.347328953 | 4.39428008 | 0.046951 | 7.601 | 1.076 | 4.53 | 1.045 | 1.029377 | 79.54182 | 4.376283 | 0.028953971 |
| 77.84911 | 4.35477246 | 4.41404934 | 0.059277 | 8.065 | 1.081 | 4.445 | 1.044 | 1.034662 | 80.547499 | 4.388847 | 0.034074594 |
| 79.679462 | 4.37801186 | 4.41615423 | 0.038142 | 8.299 | 1.083 | 4.73 | 1.047 | 1.034073 | 82.394407 | 4.411518 | 0.033505694 |
| 80.986306 | 4.394280077 | 4.41481577 | 0.020536 | 8.378 | 1.084 | 4.585 | 1.046 | 1.036263 | 83.923139 | 4.429901 | 0.035621288 |
| 82.603276 | 4.414049343 | 4.40893009 | -0.005119 | 8.384 | 1.084 | 4.7 | 1.047 | 1.035186 | 85.509775 | 4.448631 | 0.034581359 |
| 82.77733 | 4.416154232 | 4.41663928 | 0.000485 | 7.774 | 1.078 | 4.555 | 1.046 | 1.030785 | 85.325649 | 4.446475 | 0.030320874 |
| 82.66661 | 4.414815766 | 4.45523307 | 0.040417 | 6.239 | 1.062 | 4.68 | 1.047 | 1.014897 | 83.89808 | 4.429603 | 0.01478696 |
| 82.18149 | 4.408930094 | 4.44316407 | 0.034234 | 6.254 | 1.063 | 4.525 | 1.045 | 1.016539 | 83.540698 | 4.425334 | 0.016403824 |
| 82.81749 | 4.416639277 | 4.43912072 | 0.022481 | 5.843 | 1.058 | 4.675 | 1.047 | 1.011161 | 83.741795 | 4.427738 | 0.011098914 |
| 86.07621 | 4.455233067 | 4.47136062 | 0.016128 | 2.998 | 1.030 | 4.67 | 1.047 | 0.984028 | 84.701392 | 4.439132 | -0.01610103 |
| 85.0436 | 4.443164066 | 4.51102851 | 0.067864 | 1.537 | 1.015 | 4.65 | 1.047 | 0.970253 | 82.513827 | 4.412966 | -0.03019818 |
| 84.700433 | 4.439120718 | 4.49731299 | 0.058192 | 1.181 | 1.012 | 4.545 | 1.045 | 0.96782 | 81.97478 | 4.406412 | -0.03270908 |
| 87.475664 | 4.471360625 | 4.53563569 | 0.064275 | 0.830 | 1.008 | 4.51 | 1.045 | 0.964784 | 84.395141 | 4.43551 | -0.0358508 |
| 91.015381 | 4.511028514 | 4.56664238 | 0.055614 | 1.003 | 1.010 | 4.67 | 1.047 | 0.964961 | 87.826321 | 4.475361 | -0.03566727 |
| 89.775579 | 4.497312989 | 4.5701303 | 0.072817 | 1.280 | 1.013 | 4.615 | 1.046 | 0.968121 | 86.913642 | 4.464915 | -0.03239799 |
| 93.282795 | 4.535635686 | 4.55227735 | 0.016642 | 1.458 | 1.015 | 4.585 | 1.046 | 0.970103 | 90.493899 | 4.505282 | -0.03035325 |
| 96.220495 | 4.566642383 | 4.53700167 | -0.029641 | 1.580 | 1.016 | 4.48 | 1.045 | 0.972243 | 93.54975 | 4.538493 | -0.028149 |
| 96.55669 | 4.570130297 | 4.55519692 | -0.014933 | 1.571 | 1.016 | 4.53 | 1.045 | 0.971695 | 93.823627 | 4.541417 | -0.02871359 |
| 94.848165 | 4.552277352 | 4.56628362 | 0.014006 | 1.592 | 1.016 | 4.6 | 1.046 | 0.971239 | 92.120238 | 4.523095 | -0.0291827 |
| 93.410305 | 4.537001671 | 4.58687748 | 0.049876 | 2.110 | 1.021 | 4.57 | 1.046 | 0.976475 | 91.212836 | 4.513196 | -0.02380604 |
| 95.125486 | 4.555196922 | 4.59001857 | 0.034822 | 2.870 | 1.029 | 4.63 | 1.046 | 0.983181 | 93.525545 | 4.538235 | -0.01696232 |
| 96.185981 | 4.566283619 | 4.59119056 | 0.024907 | 2.015 | 1.020 | 4.5 | 1.045 | 0.976218 | 93.898457 | 4.542214 | -0.02406966 |
| 98.187359 | 4.586877481 | 4.61937965 | 0.032502 | 1.707 | 1.017 | 4.38 | 1.044 | 0.974387 | 95.672472 | 4.560931 | -0.02594687 |
| 98.496259 | 4.590018569 | 4.65741533 | 0.067397 | 2.267 | 1.023 | 4.38 | 1.044 | 0.979759 | 96.502554 | 4.569569 | -0.02044909 |
| 98.611764 | 4.591190561 | 4.67170992 | 0.080519 | 2.749 | 1.027 | 4.49 | 1.045 | 0.983333 | 96.968234 | 4.574383 | -0.01680712 |
| 101.43109 | 4.619379646 | 4.62824472 | 0.008865 | 3.950 | 1.040 | 4.59 | 1.046 | 0.993881 | 100.81042 | 4.613242 | -0.00613793 |
| 105.3634 | 4.657415327 | 4.60658523 | -0.05083 | 5.061 | 1.051 | 4.36 | 1.044 | 1.006721 | 106.07154 | 4.664114 | 0.006698481 |
| 106.88034 | 4.671709918 | 4.59312349 | -0.078586 | 8.043 | 1.080 | 4.37 | 1.044 | 1.035195 | 110.64203 | 4.7063 | 0.034590103 |
| 102.33428 | 4.628244719 | 4.59055935 | -0.037685 | 8.259 | 1.083 | 4.43 | 1.044 | 1.036666 | 106.08644 | 4.664254 | 0.036009514 |
| 100.14161 | 4.606585234 | 4.57444089 | -0.032144 | 8.587 | 1.086 | 4.38 | 1.044 | 1.040305 | 104.17778 | 4.646099 | 0.039513609 |
| 98.802557 | 4.593123486 | | | 8.630 | 1.086 | 4.49 | 1.045 | 1.039621 | 102.71721 | 4.63198 | 0.038856239 |
| 98.549538 | 4.590559347 | | | 8.681 | 1.087 | 4.565 | 1.046 | 1.039358 | 102.42828 | 4.629163 | 0.038603498 |
| 96.973805 | 4.574440888 | | | 8.660 | 1.087 | 4.435 | 1.044 | 1.040454 | 100.89677 | 4.614098 | 0.039657032 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| UGANDA SHILLINGS DATA | | | | | | | | | | | | |
| S_t | Ln_St | S_t+3 | D_S_t+3 | KE_TBILL | 1+KETBILL | US_TBILL | 1+USTBILL | F/H | S_t(F/H) | Ln_Ft | LNFt - Ln_St |
| | | | | 17.870 | 1.179 | 4.85 | 1.049 | 1.124177 | | | |
| | | | | 17.860 | 1.179 | 4.63 | 1.046 | 1.126446 | | | |
| | | | | 25.070 | 1.251 | 4.875 | 1.049 | 1.192563 | | | |
| | | | | 45.790 | 1.458 | 4.81 | 1.048 | 1.390993 | | | |
| | | | | 68.040 | 1.680 | 4.86 | 1.049 | 1.602518 | | | |
| | | | | 84.290 | 1.843 | 4.71 | 1.047 | 1.760004 | | | |
| | | | | 84.670 | 1.847 | 4.78 | 1.048 | 1.762455 | | | |
| | | | | 79.510 | 1.795 | 4.74 | 1.047 | 1.713863 | | | |
| | | | | 75.690 | 1.757 | 4.85 | 1.049 | 1.675632 | | | |
| | | | | 70.880 | 1.709 | 4.72 | 1.047 | 1.63178 | | | |
| | | | | 55.260 | 1.553 | 4.83 | 1.048 | 1.481065 | | | |
| | | | | 43.520 | 1.435 | 4.86 | 1.049 | 1.368682 | | | |
| | | | | 33.550 | 1.336 | 5.18 | 1.052 | 1.269728 | | | |
| | | | | 23.870 | 1.239 | 5.21 | 1.052 | 1.17736 | | | |
| | | | | 27.620 | 1.276 | 5.16 | 1.052 | 1.213579 | | | |
| | | | | 30.850 | 1.309 | 4.895 | 1.049 | 1.247438 | | | |
| | | | | 31.240 | 1.312 | 4.925 | 1.049 | 1.250798 | | | |
| | | | | 32.380 | 1.324 | 5.145 | 1.051 | 1.259023 | | | |
| | | | | 29.740 | 1.297 | 4.93 | 1.049 | 1.236443 | | | |
| | | | | 24.130 | 1.241 | 4.93 | 1.049 | 1.182979 | | | |
| | | | | 17.390 | 1.174 | 4.945 | 1.049 | 1.118586 | | | |
| | | | | 16.950 | 1.170 | 5.135 | 1.051 | 1.112379 | | | |
| | | | | 17.220 | 1.172 | 4.945 | 1.049 | 1.116966 | | | |
| | | | | 17.490 | 1.175 | 5.17 | 1.052 | 1.117144 | | | |
| | | | | 16.740 | 1.167 | 5.155 | 1.052 | 1.110171 | | | |
| | | | | 17.630 | 1.176 | 4.94 | 1.049 | 1.120926 | | | |
| | | | | 16.840 | 1.168 | 4.96 | 1.050 | 1.113186 | | | |
| | | | | 15.160 | 1.152 | 5.095 | 1.051 | 1.09577 | | | |
| | | | | 15.090 | 1.151 | 4.97 | 1.050 | 1.096408 | | | |
| | | | | 16.390 | 1.164 | 5.07 | 1.051 | 1.107738 | | | |
| | | | | 18.480 | 1.185 | 4.94 | 1.049 | 1.129026 | | | |
| | | | | 19.650 | 1.197 | 4.97 | 1.050 | 1.139849 | | | |
| | | | | 21.160 | 1.212 | 5.035 | 1.050 | 1.15352 | | | |
| | | | | 24.070 | 1.241 | 4.955 | 1.050 | 1.182126 | | | |
| | | | | 24.870 | 1.249 | 4.92 | 1.049 | 1.190145 | | | |
| | | | | 21.670 | 1.217 | 4.925 | 1.049 | 1.15959 | | | |
| | | | | 21.250 | 1.213 | 4.94 | 1.049 | 1.155422 | | | |
| | | | | 25.960 | 1.260 | 4.87 | 1.049 | 1.201106 | | | |
| | | | | 26.680 | 1.267 | 4.755 | 1.048 | 1.209298 | | | |
| | | | | 24.160 | 1.242 | 4.83 | 1.048 | 1.184394 | | | |
| | | | | 21.960 | 1.220 | 4.585 | 1.046 | 1.166133 | | | |
| | | | | 21.850 | 1.219 | 4.81 | 1.048 | 1.16258 | | | |
| 18.383643 | 2.911461328 | 2.98400449 | 0.072543 | 21.760 | 1.218 | 4.75 | 1.048 | 1.162387 | 21.368901 | 3.061937 | 0.15047534 |
| 18.710805 | 2.92910114 | 2.97420897 | 0.045108 | 21.630 | 1.216 | 4.795 | 1.048 | 1.160647 | 21.716639 | 3.078079 | 0.14897759 |
| 19.035438 | 2.946302405 | 2.9488376 | 0.002535 | 23.100 | 1.231 | 4.75 | 1.048 | 1.175179 | 22.370047 | 3.107723 | 0.16142047 |
| 19.766814 | 2.984004485 | 2.94497018 | -0.039034 | 24.080 | 1.241 | 4.54 | 1.045 | 1.186914 | 23.461511 | 3.155361 | 0.17135675 |
| 19.574133 | 2.974208967 | 2.93820491 | -0.036004 | 22.090 | 1.221 | 4.63 | 1.046 | 1.166874 | 22.840542 | 3.128537 | 0.15432816 |
| 19.083758 | 2.948837601 | 2.93095681 | -0.017881 | 21.530 | 1.215 | 4.905 | 1.049 | 1.158477 | 22.108089 | 3.095944 | 0.14710597 |
| 19.010095 | 2.944970178 | 2.94830852 | 0.003338 | 21.610 | 1.216 | 4.79 | 1.048 | 1.160511 | 22.061434 | 3.093831 | 0.14886086 |
| 18.881921 | 2.938204906 | 2.98667543 | 0.048471 | 21.440 | 1.214 | 5.175 | 1.052 | 1.154647 | 21.801954 | 3.082 | 0.14379468 |
| 18.745558 | 2.930956812 | 2.9797007 | 0.048744 | 21.420 | 1.214 | 4.805 | 1.048 | 1.158533 | 21.717338 | 3.078111 | 0.14715413 |
| 19.073664 | 2.948308516 | 2.92325648 | -0.025052 | 21.020 | 1.210 | 4.665 | 1.047 | 1.15626 | 22.054123 | 3.0935 | 0.14519105 |
| 19.819681 | 2.986675432 | 2.78898043 | -0.197695 | 20.350 | 1.204 | 4.915 | 1.049 | 1.147119 | 22.735535 | 3.123929 | 0.13725367 |
| 19.681925 | 2.979700702 | 2.8593347 | -0.120366 | 19.440 | 1.194 | 5.15 | 1.052 | 1.135901 | 22.35672 | 3.107127 | 0.12742625 |
| 18.601765 | 2.92325648 | 2.89985496 | -0.023402 | 18.450 | 1.185 | 4.77 | 1.048 | 1.130572 | 21.03063 | 3.04598 | 0.12272346 |
| 16.264429 | 2.788980427 | 2.88662642 | 0.097646 | 19.690 | 1.197 | 4.84 | 1.048 | 1.141644 | 18.568194 | 2.92145 | 0.13246969 |
| 17.449914 | 2.859334699 | 2.89807427 | 0.03874 | 26.200 | 1.262 | 4.905 | 1.049 | 1.202993 | 20.992127 | 3.044147 | 0.18481277 |
| 18.17151 | 2.899854957 | 2.93167577 | 0.031821 | 27.150 | 1.272 | 5.16 | 1.052 | 1.20911 | 21.971353 | 3.089739 | 0.18988449 |
| 17.93271 | 2.88662642 | 2.94684057 | 0.060214 | 26.780 | 1.268 | 5.09 | 1.051 | 1.206395 | 21.633923 | 3.074263 | 0.18763617 |
| 18.139181 | 2.89807427 | 2.95294149 | 0.054867 | 26.360 | 1.264 | 4.955 | 1.050 | 1.203945 | 21.838568 | 3.083678 | 0.18560329 |
| 18.75904 | 2.93167577 | 2.96877106 | 0.037095 | 26.282 | 1.263 | 4.945 | 1.049 | 1.203318 | 22.573098 | 3.116759 | 0.18508308 |
| 19.045685 | 2.946840567 | 2.95997996 | 0.013139 | 26.326 | 1.263 | 4.965 | 1.050 | 1.203508 | 22.92164 | 3.132081 | 0.18524088 |
| 19.162236 | 2.952941486 | 3.01202829 | 0.059087 | 26.736 | 1.267 | 5.065 | 1.051 | 1.206261 | 23.114656 | 3.140467 | 0.1875254 |
| 19.46798 | 2.968771065 | 3.03498936 | 0.066218 | 26.981 | 1.270 | 4.96 | 1.050 | 1.209804 | 23.552435 | 3.159229 | 0.19045814 |
| 19.297585 | 2.959979959 | 3.04073432 | 0.080754 | 26.381 | 1.264 | 4.975 | 1.050 | 1.203915 | 23.232656 | 3.145559 | 0.18557893 |
| 20.32859 | 3.012028293 | 3.05673501 | 0.044707 | 25.475 | 1.255 | 5.065 | 1.051 | 1.194263 | 24.277675 | 3.189557 | 0.17752892 |
| 20.800757 | 3.034989357 | 3.08427218 | 0.049283 | 24.672 | 1.247 | 5.015 | 1.050 | 1.187183 | 24.6943 | 3.206572 | 0.17158309 |
| 20.9206 | 3.040734319 | 3.11793368 | 0.077199 | 23.741 | 1.237 | 4.975 | 1.050 | 1.178763 | 24.66042 | 3.2052 | 0.16446521 |
| 21.258036 | 3.056735006 | 3.09533673 | 0.038602 | 22.474 | 1.225 | 5.12 | 1.051 | 1.165088 | 24.767473 | 3.209531 | 0.15279621 |
| 21.851557 | 3.084272184 | 3.09528821 | 0.011016 | 20.587 | 1.206 | 4.97 | 1.050 | 1.148771 | 25.102437 | 3.222965 | 0.13869274 |
| 22.599633 | 3.117933682 | 3.09113018 | -0.026804 | 17.662 | 1.177 | 4.965 | 1.050 | 1.120968 | 25.333464 | 3.232126 | 0.11419255 |
| 22.094677 | 3.095336732 | 3.07124178 | -0.024095 | 12.565 | 1.126 | 4.965 | 1.050 | 1.0724 | 23.694339 | 3.165236 | 0.06989943 |
| 22.093605 | 3.095288212 | 3.08638663 | -0.008902 | 10.703 | 1.107 | 5.1 | 1.051 | 1.053311 | 23.27144 | 3.147227 | 0.05193866 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 22.00193 | 3.091130177 | 3.10127199 | 0.010142 | 8.950 | 1.090 | 4.89 | 1.049 | 1.038707 | 22.853563 | 3.129107 | 0.03797688 |
| 21.56867 | 3.071241779 | 2.97735734 | -0.093884 | 8.845 | 1.088 | 4.95 | 1.050 | 1.037111 | 22.369105 | 3.107681 | 0.03643897 |
| 21.89781 | 3.086386632 | 2.99046022 | -0.095926 | 9.028 | 1.090 | 5.05 | 1.051 | 1.03787 | 22.727081 | 3.123557 | 0.0371706 |
| 22.226205 | 3.101271987 | 2.97821034 | -0.123062 | 9.626 | 1.096 | 4.955 | 1.050 | 1.044507 | 23.21542 | 3.144817 | 0.04354471 |
| 19.635857 | 2.977357341 | 2.97832297 | 0.000966 | 11.442 | 1.114 | 5.075 | 1.051 | 1.060597 | 20.825735 | 3.036189 | 0.05883214 |
| 19.894836 | 2.990460219 | 2.99533009 | 0.00487 | 14.472 | 1.145 | 4.835 | 1.048 | 1.091923 | 21.72363 | 3.078401 | 0.08794038 |
| 19.652614 | 2.978210339 | 3.00123664 | 0.023026 | 14.842 | 1.148 | 4.91 | 1.049 | 1.094675 | 21.513233 | 3.068668 | 0.09045791 |
| 19.654827 | 2.978322971 | 3.01114587 | 0.032823 | 15.778 | 1.158 | 4.79 | 1.048 | 1.104853 | 21.715686 | 3.078035 | 0.0997119 |
| 19.991958 | 2.995330087 | 3.0588573 | 0.063527 | 17.628 | 1.176 | 5.1 | 1.051 | 1.119196 | 22.374919 | 3.107941 | 0.11261057 |
| 20.110391 | 3.001236642 | 3.03318976 | 0.031953 | 18.135 | 1.181 | 4.94 | 1.049 | 1.125742 | 22.639118 | 3.119679 | 0.11844267 |
| 20.31066 | 3.011145871 | 3.01138008 | 0.000234 | 19.975 | 1.200 | 5.075 | 1.051 | 1.141799 | 23.190685 | 3.143751 | 0.13260484 |
| 21.3032 | 3.058857296 | 3.01843402 | -0.040423 | 20.295 | 1.203 | 4.7 | 1.047 | 1.148949 | 24.476298 | 3.197705 | 0.13884794 |
| 20.763357 | 3.033189757 | 3.01918976 | -0.014 | 14.844 | 1.148 | 4.89 | 1.049 | 1.094899 | 22.733788 | 3.123852 | 0.0906625 |
| 20.315417 | 3.011380075 | 3.01167944 | 0.000299 | 11.278 | 1.113 | 5.09 | 1.051 | 1.058885 | 21.511696 | 3.068597 | 0.0572167 |
| 20.459228 | 3.018434017 | 3.04587957 | 0.027446 | 12.442 | 1.124 | 4.765 | 1.048 | 1.073281 | 21.958494 | 3.089154 | 0.07072001 |
| 20.474695 | 3.019189756 | 3.09047095 | 0.071281 | 11.222 | 1.112 | 5.03 | 1.050 | 1.058956 | 21.681812 | 3.076474 | 0.05728398 |
| 20.3215 | 3.011679439 | 3.12129492 | 0.109615 | 10.474 | 1.105 | 4.82 | 1.048 | 1.05394 | 21.417643 | 3.064215 | 0.05253561 |
| 21.028519 | 3.045879566 | 3.13931495 | 0.093435 | 9.904 | 1.099 | 4.585 | 1.046 | 1.050862 | 22.098071 | 3.09549 | 0.04961076 |
| 21.98743 | 3.090470946 | 3.15420425 | 0.063733 | 9.245 | 1.092 | 4.63 | 1.046 | 1.04411 | 22.9573 | 3.133636 | 0.04316504 |
| 22.675724 | 3.121294917 | 3.11142869 | -0.009866 | 10.360 | 1.104 | 4.905 | 1.049 | 1.052002 | 23.854903 | 3.17199 | 0.05069484 |
| 23.088045 | 3.139314951 | 3.14377192 | 0.004457 | 10.654 | 1.107 | 4.78 | 1.048 | 1.056056 | 24.38228 | 3.193857 | 0.05454169 |
| 23.434382 | 3.154204252 | 3.0971255 | -0.057079 | 11.167 | 1.112 | 4.8 | 1.048 | 1.060756 | 24.858166 | 3.213186 | 0.05898205 |
| 22.4531 | 3.111428689 | 3.11218412 | 0.000755 | 12.901 | 1.129 | 4.675 | 1.047 | 1.078586 | 24.217602 | 3.18708 | 0.07565102 |
| 23.191177 | 3.143771916 | 3.12970587 | -0.014066 | 14.756 | 1.148 | 4.7 | 1.047 | 1.096042 | 25.418505 | 3.235477 | 0.09170553 |
| 22.134235 | 3.097125505 | 3.12685224 | 0.029727 | 15.297 | 1.153 | 4.86 | 1.049 | 1.099535 | 24.337368 | 3.192013 | 0.09488745 |
| 22.470068 | 3.112184121 | 3.11864237 | 0.006458 | 14.972 | 1.150 | 4.845 | 1.048 | 1.096588 | 24.640403 | 3.204387 | 0.09220338 |
| 22.867253 | 3.129705871 | 3.08766257 | -0.042043 | 12.899 | 1.129 | 4.62 | 1.046 | 1.079136 | 24.676874 | 3.205867 | 0.07616065 |
| 22.802091 | 3.126852238 | 3.09883729 | -0.028015 | 10.517 | 1.105 | 4.82 | 1.048 | 1.054348 | 24.041337 | 3.179775 | 0.0529225 |
| 22.615655 | 3.118642366 | 3.09972037 | -0.018922 | 12.070 | 1.121 | 4.715 | 1.047 | 1.070233 | 24.204031 | 3.186519 | 0.06787684 |
| 21.925768 | 3.087662574 | 3.0934742 | 0.005812 | 12.873 | 1.129 | 4.635 | 1.046 | 1.078733 | 23.652044 | 3.16345 | 0.07578696 |
| 22.172157 | 3.098837291 | 3.09110629 | -0.007731 | 12.839 | 1.128 | 4.695 | 1.047 | 1.077785 | 23.896828 | 3.173746 | 0.07490845 |
| 22.191745 | 3.099720373 | 3.08450093 | -0.015219 | 12.393 | 1.124 | 4.8 | 1.048 | 1.072455 | 23.799641 | 3.16967 | 0.06995011 |
| 22.053564 | 3.093474205 | 3.10090502 | 0.007431 | 11.629 | 1.116 | 4.725 | 1.047 | 1.065921 | 23.507362 | 3.157314 | 0.06383942 |
| 22.001405 | 3.091106294 | 3.10747779 | 0.016371 | 11.498 | 1.115 | 4.805 | 1.048 | 1.063857 | 23.406341 | 3.153007 | 0.06190069 |
| 21.856556 | 3.084500934 | 3.12307921 | 0.038578 | 11.012 | 1.110 | 4.65 | 1.047 | 1.060797 | 23.185368 | 3.143521 | 0.05902046 |
| 22.21805 | 3.100905022 | 3.13122944 | 0.030324 | 10.855 | 1.109 | 4.72 | 1.047 | 1.058582 | 23.519637 | 3.157836 | 0.05693066 |
| 22.364565 | 3.107477787 | 3.13374446 | 0.026267 | 10.611 | 1.106 | 4.61 | 1.046 | 1.057365 | 23.647518 | 3.163258 | 0.05578039 |
| 22.71622 | 3.123079207 | 3.12935191 | 0.006273 | 10.144 | 1.101 | 4.81 | 1.048 | 1.050892 | 23.872296 | 3.172719 | 0.04963941 |
| 22.902119 | 3.131229441 | 3.1311128 | -0.000117 | 10.010 | 1.100 | 4.57 | 1.046 | 1.052023 | 24.093546 | 3.181944 | 0.05071457 |
| 22.959791 | 3.133744465 | 3.13482462 | 0.00108 | 9.040 | 1.090 | 4.67 | 1.047 | 1.041748 | 23.918313 | 3.174644 | 0.04089995 |
| 22.85916 | 3.129351912 | 3.13281859 | 0.003467 | 7.338 | 1.073 | 4.76 | 1.048 | 1.024609 | 23.421693 | 3.153663 | 0.02431071 |
| 22.899448 | 3.131112798 | 3.13722626 | 0.006113 | 8.634 | 1.086 | 4.63 | 1.046 | 1.038264 | 23.775681 | 3.168663 | 0.03755043 |
| 22.984605 | 3.134824624 | 3.13675657 | 0.001932 | 8.340 | 1.083 | 4.725 | 1.047 | 1.034514 | 23.7779 | 3.168757 | 0.03393195 |
| 22.938543 | 3.13281859 | 3.14449477 | 0.011676 | 7.601 | 1.076 | 4.53 | 1.045 | 1.029377 | 23.612413 | 3.161773 | 0.02895397 |
| 23.039871 | 3.137226255 | 3.18135473 | 0.044128 | 8.065 | 1.081 | 4.445 | 1.044 | 1.034662 | 23.838474 | 3.171301 | 0.03407459 |
| 23.029052 | 3.136756566 | 3.20048719 | 0.063731 | 8.299 | 1.083 | 4.73 | 1.047 | 1.034073 | 23.813729 | 3.170262 | 0.03350569 |
| 23.207947 | 3.144494766 | 3.23453262 | 0.090038 | 8.378 | 1.084 | 4.585 | 1.046 | 1.036263 | 24.049544 | 3.180116 | 0.03562129 |
| 24.079352 | 3.181354726 | 3.26361685 | 0.082262 | 8.384 | 1.084 | 4.7 | 1.047 | 1.035186 | 24.926614 | 3.215936 | 0.03458136 |
| 24.544485 | 3.200487185 | 3.32999459 | 0.129507 | 7.774 | 1.078 | 4.555 | 1.046 | 1.030785 | 25.300093 | 3.230808 | 0.03032087 |
| 25.3945 | 3.234532615 | 3.30024362 | 0.065711 | 6.239 | 1.062 | 4.68 | 1.047 | 1.014897 | 25.772798 | 3.24932 | 0.01478696 |
| 26.143925 | 3.26361685 | 3.28468262 | 0.021066 | 6.254 | 1.063 | 4.525 | 1.045 | 1.016539 | 26.576322 | 3.280021 | 0.01640382 |
| 27.93819 | 3.329994587 | 3.27046931 | -0.059525 | 5.843 | 1.058 | 4.675 | 1.047 | 1.011161 | 28.250001 | 3.341094 | 0.01109891 |
| 27.119245 | 3.300243623 | 3.24204124 | -0.058202 | 2.998 | 1.030 | 4.67 | 1.047 | 0.984028 | 26.686094 | 3.284143 | -0.01610103 |
| 26.700509 | 3.284682617 | 3.24241618 | -0.042266 | 1.537 | 1.015 | 4.65 | 1.047 | 0.970253 | 25.906255 | 3.254484 | -0.03019818 |
| 26.32369 | 3.270469312 | 3.24710109 | -0.023368 | 1.181 | 1.012 | 4.545 | 1.045 | 0.96782 | 25.476596 | 3.23776 | -0.03270908 |
| 25.585895 | 3.242041241 | 3.23845451 | -0.003587 | 0.830 | 1.008 | 4.51 | 1.045 | 0.964784 | 24.684868 | 3.20619 | -0.0358508 |
| 25.59549 | 3.242416183 | 3.23435446 | -0.008062 | 1.003 | 1.010 | 4.67 | 1.047 | 0.964961 | 24.698658 | 3.206749 | -0.03566727 |
| 25.715684 | 3.247101086 | 3.1951336 | -0.051967 | 1.280 | 1.013 | 4.615 | 1.046 | 0.968121 | 24.895899 | 3.214703 | -0.03239799 |
| 25.49429 | 3.238454506 | 3.2172033 | -0.021251 | 1.458 | 1.015 | 4.585 | 1.046 | 0.970103 | 24.732082 | 3.208101 | -0.03035325 |
| 25.389976 | 3.234354458 | 3.20357192 | -0.030783 | 1.580 | 1.016 | 4.48 | 1.045 | 0.972243 | 24.685239 | 3.206205 | -0.028149 |
| 24.413435 | 3.195133596 | 3.15254247 | -0.042591 | 1.571 | 1.016 | 4.53 | 1.045 | 0.971695 | 23.722406 | 3.16642 | -0.02871359 |
| 24.958222 | 3.217203297 | 3.13434967 | -0.082854 | 1.592 | 1.016 | 4.6 | 1.046 | 0.971239 | 24.240398 | 3.188021 | -0.0291827 |
| 24.620315 | 3.203571915 | 3.08445739 | -0.119115 | 2.110 | 1.021 | 4.57 | 1.046 | 0.976475 | 24.041124 | 3.179766 | -0.02380604 |
| 23.395471 | 3.152542475 | 3.06306993 | -0.089473 | 2.870 | 1.029 | 4.63 | 1.046 | 0.983181 | 23.001977 | 3.13558 | -0.01696232 |
| 22.97369 | 3.134349669 | 3.05993231 | -0.074417 | 2.015 | 1.020 | 4.5 | 1.045 | 0.976218 | 22.427323 | 3.11028 | -0.02406966 |
| 21.855605 | 3.08445739 | 3.06174816 | -0.022709 | 1.707 | 1.017 | 4.38 | 1.044 | 0.974387 | 21.295814 | 3.058511 | -0.02594687 |
| 21.393132 | 3.063069927 | 3.05984459 | -0.003225 | 2.267 | 1.023 | 4.38 | 1.044 | 0.979759 | 20.960104 | 3.042621 | -0.02044909 |
| 21.326114 | 3.059932314 | 3.08145508 | 0.021523 | 2.749 | 1.027 | 4.49 | 1.045 | 0.983333 | 20.970678 | 3.043125 | -0.01680712 |
| 21.364874 | 3.061748157 | 3.10066291 | 0.038915 | 3.950 | 1.040 | 4.59 | 1.046 | 0.993881 | 21.234139 | 3.05561 | -0.00613793 |
| 21.324243 | 3.059844588 | 3.10306287 | 0.043218 | 5.061 | 1.051 | 4.36 | 1.044 | 1.006721 | 21.467562 | 3.066543 | 0.00669848 |
| 21.790086 | 3.081455083 | 3.12953738 | 0.048082 | 8.043 | 1.080 | 4.37 | 1.044 | 1.035195 | 22.556994 | 3.116045 | 0.0345901 |
| 22.212671 | 3.100662911 | 3.15070466 | 0.050042 | 8.259 | 1.083 | 4.43 | 1.044 | 1.036666 | 23.027115 | 3.136672 | 0.03600951 |
| 22.266045 | 3.103062872 | 3.14602593 | 0.042963 | 8.587 | 1.086 | 4.38 | 1.044 | 1.040305 | 23.16347 | 3.142576 | 0.03951361 |
| 22.8634 | 3.129537379 | | | 8.630 | 1.086 | 4.49 | 1.045 | 1.039621 | 23.769271 | 3.168394 | 0.03885624 |
| 23.352514 | 3.150704657 | | | 8.681 | 1.087 | 4.565 | 1.046 | 1.039358 | 24.271629 | 3.189308 | 0.0386035 |
| 23.24351 | 3.146025933 | | | 8.660 | 1.087 | 4.435 | 1.044 | 1.040454 | 24.183799 | 3.185683 | 0.03965703 |

TANZANIAN SHILLINGS DATA

| S_t | Ln_St | S_t+3 | D_S_t+3 | KE_TBILL | 1+KETBILL | US_TBILL | 1+USTBILL | F/H | S_t(F/H) | Ln_Ft | LNFt - Ln_St |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 17.870 | 18.870 | 4.85 | 5.85 | 3.225641 | | | |
| | | | | 17.860 | 18.860 | 4.63 | 5.63 | 3.349911 | | | |
| | | | | 25.070 | 26.070 | 4.875 | 5.875 | 4.437447 | | | |
| | | | | 45.790 | 46.790 | 4.81 | 5.81 | 8.053356 | | | |
| | | | | 68.040 | 69.040 | 4.86 | 5.86 | 11.78157 | | | |
| | | | | 84.290 | 85.290 | 4.71 | 5.71 | 14.93695 | | | |
| | | | | 84.670 | 85.670 | 4.78 | 5.78 | 14.8218 | | | |
| | | | | 79.510 | 80.510 | 4.74 | 5.74 | 14.02613 | | | |
| | | | | 75.690 | 76.690 | 4.85 | 5.85 | 13.1094 | | | |
| | | | | 70.880 | 71.880 | 4.72 | 5.72 | 12.56643 | | | |
| | | | | 55.260 | 56.260 | 4.83 | 5.83 | 9.650086 | | | |
| | | | | 43.520 | 44.520 | 4.86 | 5.86 | 7.59727 | | | |
| | | | | 33.550 | 34.550 | 5.18 | 6.18 | 5.590615 | | | |
| | | | | 23.870 | 24.870 | 5.21 | 6.21 | 4.004831 | | | |
| | | | | 27.620 | 28.620 | 5.16 | 6.16 | 4.646104 | | | |
| | | | | 30.850 | 31.850 | 4.895 | 5.895 | 5.402884 | | | |
| | | | | 31.240 | 32.240 | 4.925 | 5.925 | 5.44135 | | | |
| | | | | 32.380 | 33.380 | 5.145 | 6.145 | 5.432059 | | | |
| | | | | 29.740 | 30.740 | 4.93 | 5.93 | 5.183811 | | | |
| | | | | 24.130 | 25.130 | 4.93 | 5.93 | 4.237774 | | | |
| | | | | 17.390 | 18.390 | 4.945 | 5.945 | 3.093356 | | | |
| | | | | 16.950 | 17.950 | 5.135 | 6.135 | 2.925835 | | | |
| | | | | 17.220 | 18.220 | 4.945 | 5.945 | 3.06476 | | | |
| | | | | 17.490 | 18.490 | 5.17 | 6.17 | 2.996759 | | | |
| | | | | 16.740 | 17.740 | 5.155 | 6.155 | 2.88221 | | | |
| | | | | 17.630 | 18.630 | 4.94 | 5.94 | 3.136364 | | | |
| | | | | 16.840 | 17.840 | 4.96 | 5.96 | 2.993289 | | | |
| | | | | 15.160 | 16.160 | 5.095 | 6.095 | 2.651354 | | | |
| | | | | 15.090 | 16.090 | 4.97 | 5.97 | 2.695142 | | | |
| | | | | 16.390 | 17.390 | 5.07 | 6.07 | 2.864909 | | | |
| | | | | 18.480 | 19.480 | 4.94 | 5.94 | 3.279461 | | | |
| | | | | 19.650 | 20.650 | 4.97 | 5.97 | 3.458961 | | | |
| | | | | 21.160 | 22.160 | 5.035 | 6.035 | 3.671914 | | | |
| | | | | 24.070 | 25.070 | 4.955 | 5.955 | 4.209908 | | | |
| | | | | 24.870 | 25.870 | 4.92 | 5.92 | 4.369932 | | | |
| | | | | 21.670 | 22.670 | 4.925 | 5.925 | 3.82616 | | | |
| | | | | 21.250 | 22.250 | 4.94 | 5.94 | 3.745791 | | | |
| | | | | 25.960 | 26.960 | 4.87 | 5.87 | 4.592845 | | | |
| | | | | 26.680 | 27.680 | 4.755 | 5.755 | 4.809731 | | | |
| | | | | 24.160 | 25.160 | 4.83 | 5.83 | 4.315609 | | | |
| | | | | 21.960 | 22.960 | 4.585 | 5.585 | 4.111012 | | | |
| | | | | 21.850 | 22.850 | 4.81 | 5.81 | 3.932874 | | | |
| 10.488657 | 2.350294342 | 2.35985485 | 0.009561 | 21.760 | 22.760 | 4.75 | 5.75 | 3.958261 | 41.516839 | 3.726099 | 1.375804754 |
| 10.3906 | 2.340901551 | 2.37423975 | 0.033338 | 21.630 | 22.630 | 4.795 | 5.795 | 3.905091 | 40.576234 | 3.703183 | 1.362280983 |
| 10.468157 | 2.348337996 | 2.37942966 | 0.031092 | 23.100 | 24.100 | 4.75 | 5.75 | 4.191304 | 43.875233 | 3.78135 | 1.433011986 |
| 10.589414 | 2.35985485 | 2.38909718 | 0.029242 | 24.080 | 25.080 | 4.54 | 5.54 | 4.527076 | 47.939081 | 3.869931 | 1.510076215 |
| 10.742843 | 2.374239752 | 2.38865994 | 0.01442 | 22.090 | 23.090 | 4.63 | 5.63 | 4.101243 | 44.059013 | 3.78553 | 1.411290181 |
| 10.798742 | 2.379429656 | 2.39061621 | 0.011187 | 21.530 | 22.530 | 4.905 | 5.905 | 3.815411 | 41.201636 | 3.718478 | 1.339048305 |
| 10.903645 | 2.389097179 | 2.39967757 | 0.01058 | 21.610 | 22.610 | 4.79 | 5.79 | 3.905009 | 42.57883 | 3.751357 | 1.362259995 |
| 10.898879 | 2.388659935 | 2.42862348 | 0.039964 | 21.440 | 22.440 | 5.175 | 6.175 | 3.634008 | 39.606614 | 3.678996 | 1.290336198 |
| 10.920221 | 2.390616213 | 2.44373954 | 0.053123 | 21.420 | 22.420 | 4.805 | 5.805 | 3.862188 | 42.175944 | 3.74185 | 1.351233802 |
| 11.019623 | 2.399677568 | 2.38903798 | -0.01064 | 21.020 | 22.020 | 4.665 | 5.665 | 3.887026 | 42.833556 | 3.757322 | 1.357644237 |
| 11.343257 | 2.428623483 | 2.22658045 | -0.202043 | 20.350 | 21.350 | 4.915 | 5.915 | 3.609467 | 40.943117 | 3.712184 | 1.283560242 |
| 11.516025 | 2.443739544 | 2.26967138 | -0.174068 | 19.440 | 20.440 | 5.15 | 6.15 | 3.323577 | 38.274399 | 3.644781 | 1.201041684 |
| 10.903 | 2.389037981 | 2.28545589 | -0.103582 | 18.450 | 19.450 | 4.77 | 5.77 | 3.370884 | 36.752747 | 3.604213 | 1.21517499 |
| 9.268119 | 2.226580452 | 2.26004652 | 0.033466 | 19.690 | 20.690 | 4.84 | 5.84 | 3.542808 | 32.835168 | 3.4915 | 1.264919695 |
| 9.6762205 | 2.269671376 | 2.29041523 | 0.020744 | 26.200 | 27.200 | 4.905 | 5.905 | 4.606266 | 44.571244 | 3.797089 | 1.527417524 |
| 9.8301667 | 2.285455889 | 2.33266415 | 0.047208 | 27.150 | 28.150 | 5.16 | 6.16 | 4.569805 | 44.921947 | 3.804926 | 1.519470577 |
| 9.583535 | 2.260046522 | 2.36612358 | 0.106077 | 26.780 | 27.780 | 5.09 | 6.09 | 4.561576 | 43.716027 | 3.777715 | 1.517668256 |
| 9.8790389 | 2.290415229 | 2.41069115 | 0.120276 | 26.360 | 27.360 | 4.955 | 5.955 | 4.594458 | 45.388834 | 3.815266 | 1.52485089 |
| 10.30536 | 2.332664148 | 2.41083977 | 0.078176 | 26.282 | 27.282 | 4.945 | 5.945 | 4.589108 | 47.292415 | 3.85635 | 1.523685777 |
| 10.656005 | 2.366123583 | 2.36311089 | -0.003013 | 26.326 | 27.326 | 4.965 | 5.965 | 4.581098 | 48.816204 | 3.888062 | 1.521938723 |
| 11.141659 | 2.410691154 | 2.39422361 | -0.016468 | 26.736 | 27.736 | 5.065 | 6.065 | 4.573092 | 50.951827 | 3.930881 | 1.520189455 |
| 11.143315 | 2.410839767 | 2.42055864 | 0.009719 | 26.981 | 27.981 | 4.96 | 5.96 | 4.694799 | 52.31562 | 3.957295 | 1.546455227 |
| 10.62395 | 2.363110886 | 2.42139382 | 0.058283 | 26.381 | 27.381 | 4.975 | 5.975 | 4.582594 | 48.685251 | 3.885376 | 1.522265244 |
| 10.959686 | 2.394223605 | 2.41171137 | 0.017488 | 25.475 | 26.475 | 5.065 | 6.065 | 4.365243 | 47.841694 | 3.867898 | 1.473673903 |
| 11.252143 | 2.420558642 | 2.42169127 | 0.001133 | 24.672 | 25.672 | 5.015 | 6.015 | 4.267997 | 48.024111 | 3.871703 | 1.451144554 |
| 11.261545 | 2.421393825 | 2.4273738 | 0.00598 | 23.741 | 24.741 | 4.975 | 5.975 | 4.140686 | 46.630524 | 3.842255 | 1.420861521 |
| 11.153032 | 2.411711373 | 2.39579099 | -0.01592 | 22.474 | 23.474 | 5.12 | 6.12 | 3.835621 | 42.778802 | 3.756043 | 1.344331329 |
| 11.264895 | 2.421691274 | 2.40055155 | -0.02114 | 20.587 | 21.587 | 4.97 | 5.97 | 3.615829 | 40.731937 | 3.707012 | 1.285321192 |
| 11.32909 | 2.427373796 | 2.38263811 | -0.044736 | 17.662 | 18.662 | 4.965 | 5.965 | 3.12865 | 35.444764 | 3.567976 | 1.140601749 |
| 10.976877 | 2.395790994 | 2.37994461 | -0.015846 | 12.565 | 13.565 | 4.965 | 5.965 | 2.274015 | 24.961585 | 3.217338 | 0.82154703 |
| 11.029258 | 2.40055155 | 2.35668921 | -0.043862 | 10.703 | 11.703 | 5.1 | 6.1 | 1.918525 | 21.159902 | 3.052108 | 0.651556448 |
| 10.833445 | 2.382638108 | 2.33310922 | -0.049529 | 8.950 | 9.950 | 4.89 | 5.89 | 1.689304 | 18.300981 | 2.906955 | 0.524316554 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.804304 | 2.379944605 | 2.27528192 | -0.104663 | 8.845 | 9.845 | 4.95 | 5.95 | 1.654588 | 17.876675 | 2.883497 | 0.503552177 |
| 10.555945 | 2.356689208 | 2.34813973 | -0.008549 | 9.028 | 10.028 | 5.05 | 6.05 | 1.657562 | 17.497133 | 2.862037 | 0.505347838 |
| 10.309948 | 2.333109217 | 2.36511327 | 0.032004 | 9.626 | 10.626 | 4.955 | 5.955 | 1.784416 | 18.39724 | 2.912201 | 0.579091447 |
| 9.7306619 | 2.275281921 | 2.35477553 | 0.079494 | 11.442 | 12.442 | 5.075 | 6.075 | 2.048107 | 19.929437 | 2.992198 | 0.71691595 |
| 10.466082 | 2.348139725 | 2.35655131 | 0.008412 | 14.472 | 15.472 | 4.835 | 5.835 | 2.651542 | 27.75126 | 3.323281 | 0.975141515 |
| 10.645245 | 2.365113271 | 2.36653807 | 0.001425 | 14.842 | 15.842 | 4.91 | 5.91 | 2.680609 | 28.53574 | 3.351157 | 0.986044059 |
| 10.535764 | 2.35477553 | 2.37815813 | 0.023383 | 15.778 | 16.778 | 4.79 | 5.79 | 2.897668 | 30.529149 | 3.418682 | 1.063906411 |
| 10.554489 | 2.356551312 | 2.42532751 | 0.068776 | 17.628 | 18.628 | 5.1 | 6.1 | 3.053689 | 32.230123 | 3.472902 | 1.116350212 |
| 10.660423 | 2.366538073 | 2.39179009 | 0.025252 | 18.135 | 19.135 | 4.94 | 5.94 | 3.221448 | 34.341995 | 3.536369 | 1.169830889 |
| 10.78502 | 2.378158134 | 2.37581899 | -0.002339 | 19.975 | 20.975 | 5.075 | 6.075 | 3.452593 | 37.23628 | 3.617284 | 1.239125425 |
| 11.305932 | 2.425327506 | 2.37551745 | -0.04981 | 20.295 | 21.295 | 4.7 | 5.7 | 3.735965 | 42.238564 | 3.743334 | 1.318006129 |
| 10.933048 | 2.391790094 | 2.3533024 | -0.038488 | 14.844 | 15.844 | 4.89 | 5.89 | 2.689983 | 29.409712 | 3.381325 | 0.989534882 |
| 10.759822 | 2.375818988 | 2.33325932 | -0.04256 | 11.278 | 12.278 | 5.09 | 6.09 | 2.016133 | 21.693232 | 3.077 | 0.701181323 |
| 10.756578 | 2.375517454 | 2.3471819 | -0.028336 | 12.442 | 13.442 | 4.765 | 5.765 | 2.3317 | 25.081111 | 3.222115 | 0.846597578 |
| 10.520255 | 2.353302403 | 2.34719968 | -0.006103 | 11.222 | 12.222 | 5.03 | 6.03 | 2.026899 | 21.323492 | 3.059809 | 0.70650696 |
| 10.311495 | 2.333259315 | 2.32624907 | -0.00701 | 10.474 | 11.474 | 4.82 | 5.82 | 1.971478 | 20.328883 | 3.012043 | 0.678783344 |
| 10.456062 | 2.347181897 | 2.31192088 | -0.035261 | 9.904 | 10.904 | 4.585 | 5.585 | 1.952444 | 20.414876 | 3.016264 | 0.669081945 |
| 10.456248 | 2.347199678 | 2.3185497 | -0.02865 | 9.245 | 10.245 | 4.63 | 5.63 | 1.81976 | 19.027864 | 2.945904 | 0.598704741 |
| 10.239462 | 2.32624907 | 2.32124635 | -0.005003 | 10.360 | 11.360 | 4.905 | 5.905 | 1.923836 | 19.699043 | 2.98057 | 0.65432097 |
| 10.093795 | 2.311920879 | 2.32468277 | 0.012762 | 10.654 | 11.654 | 4.78 | 5.78 | 2.016194 | 20.351047 | 3.013132 | 0.701211462 |
| 10.160927 | 2.318549705 | 2.34206298 | 0.023513 | 11.167 | 12.167 | 4.8 | 5.8 | 2.097802 | 21.315611 | 3.05944 | 0.740889998 |
| 10.188365 | 2.321246354 | 2.37031426 | 0.049068 | 12.901 | 13.901 | 4.675 | 5.675 | 2.449515 | 24.956556 | 3.217137 | 0.895890217 |
| 10.223436 | 2.324682767 | 2.4300164 | 0.105334 | 14.756 | 15.756 | 4.7 | 5.7 | 2.76414 | 28.259013 | 3.341412 | 1.016729683 |
| 10.402675 | 2.342062985 | 2.42803042 | 0.085967 | 15.297 | 16.297 | 4.86 | 5.86 | 2.781101 | 28.930887 | 3.36491 | 1.022846778 |
| 10.700755 | 2.370314257 | 2.42758822 | 0.057274 | 14.972 | 15.972 | 4.845 | 5.845 | 2.732549 | 29.240338 | 3.375549 | 1.005234942 |
| 11.359068 | 2.430016405 | 2.42219595 | -0.00782 | 12.899 | 13.899 | 4.62 | 5.62 | 2.473167 | 28.092876 | 3.335516 | 0.905499621 |
| 11.336532 | 2.428030415 | 2.42452258 | -0.003508 | 10.517 | 11.517 | 4.82 | 5.82 | 1.978823 | 22.43299 | 3.110533 | 0.682502236 |
| 11.33152 | 2.427588223 | 2.42712525 | -0.000463 | 12.070 | 13.070 | 4.715 | 5.715 | 2.286877 | 25.913788 | 3.254775 | 0.827186974 |
| 11.270582 | 2.422195952 | 2.42866733 | 0.006471 | 12.873 | 13.873 | 4.635 | 5.635 | 2.46197 | 27.747832 | 3.323158 | 0.900961774 |
| 11.296835 | 2.424522579 | 2.44640362 | 0.021881 | 12.839 | 13.839 | 4.695 | 5.695 | 2.429982 | 27.45111 | 3.312407 | 0.887884031 |
| 11.326275 | 2.427125248 | 2.45524556 | 0.02812 | 12.393 | 13.393 | 4.8 | 5.8 | 2.309181 | 26.154419 | 3.264018 | 0.836892931 |
| 11.343755 | 2.428667332 | 2.46411433 | 0.035447 | 11.629 | 12.629 | 4.725 | 5.725 | 2.205869 | 25.022836 | 3.219789 | 0.791121534 |
| 11.546745 | 2.446403618 | 2.49832908 | 0.051925 | 11.498 | 12.498 | 4.805 | 5.805 | 2.152885 | 24.85882 | 3.213213 | 0.766809009 |
| 11.649294 | 2.455245556 | 2.51784324 | 0.062598 | 11.012 | 12.012 | 4.65 | 5.65 | 2.126088 | 24.767429 | 3.209529 | 0.754283904 |
| 11.753068 | 2.464114328 | 2.52566007 | 0.061546 | 10.855 | 11.855 | 4.72 | 5.72 | 2.072509 | 24.358337 | 3.192874 | 0.728759826 |
| 12.162155 | 2.498329081 | 2.52628195 | 0.027953 | 10.611 | 11.611 | 4.61 | 5.61 | 2.069697 | 25.171975 | 3.225731 | 0.727402205 |
| 12.40182 | 2.517843236 | 2.49958301 | -0.01826 | 10.144 | 11.144 | 4.81 | 5.81 | 1.918072 | 23.787587 | 3.169164 | 0.651320666 |
| 12.499143 | 2.525660071 | 2.48340226 | -0.042258 | 10.010 | 11.010 | 4.57 | 5.57 | 1.976661 | 24.706564 | 3.207069 | 0.681408897 |
| 12.506918 | 2.526281946 | 2.54967668 | 0.023395 | 9.040 | 10.040 | 4.67 | 5.67 | 1.770679 | 22.145738 | 3.097645 | 0.571363096 |
| 12.177415 | 2.499583007 | 2.51482792 | 0.015245 | 7.338 | 8.338 | 4.76 | 5.76 | 1.447569 | 17.627654 | 2.869469 | 0.369885905 |
| 11.981961 | 2.483402258 | 2.50982494 | 0.026423 | 8.634 | 9.634 | 4.63 | 5.63 | 1.711119 | 20.502561 | 3.02055 | 0.537147546 |
| 12.802964 | 2.549676678 | 2.51686587 | -0.032811 | 8.340 | 9.340 | 4.725 | 5.725 | 1.631354 | 20.886162 | 3.039087 | 0.489410168 |
| 12.364481 | 2.514827923 | 2.50928931 | -0.005539 | 7.601 | 8.601 | 4.53 | 5.53 | 1.555298 | 19.230457 | 2.956495 | 0.441667407 |
| 12.302776 | 2.509824943 | 2.54997182 | 0.040147 | 8.065 | 9.065 | 4.445 | 5.445 | 1.664876 | 20.482597 | 3.019576 | 0.509750666 |
| 12.389705 | 2.516865867 | 2.58658929 | 0.069723 | 8.299 | 9.299 | 4.73 | 5.73 | 1.622775 | 20.105702 | 3.001003 | 0.484137566 |
| 12.296188 | 2.509289315 | 2.60632364 | 0.097034 | 8.378 | 9.378 | 4.585 | 5.585 | 1.679069 | 20.646148 | 3.027529 | 0.518239434 |
| 12.806743 | 2.549971818 | 2.62001066 | 0.070039 | 8.384 | 9.384 | 4.7 | 5.7 | 1.646316 | 21.083943 | 3.048512 | 0.498539937 |
| 13.284385 | 2.586589285 | 2.67631969 | 0.08973 | 7.774 | 8.774 | 4.555 | 5.555 | 1.579433 | 20.981795 | 3.043655 | 0.457065886 |
| 13.549148 | 2.606323639 | 2.645614 | 0.03929 | 6.239 | 7.239 | 4.68 | 5.68 | 1.274542 | 17.268961 | 2.848911 | 0.242587097 |
| 13.73587 | 2.620010659 | 2.63435124 | 0.014341 | 6.254 | 7.254 | 4.525 | 5.525 | 1.312896 | 18.033768 | 2.892246 | 0.272235329 |
| 14.531514 | 2.67631969 | 2.61957177 | -0.056748 | 5.843 | 6.843 | 4.675 | 5.675 | 1.205859 | 17.522958 | 2.863512 | 0.187192202 |
| 14.092095 | 2.645614002 | 2.59789166 | -0.047722 | 2.998 | 3.998 | 4.67 | 5.67 | 0.70515 | 9.9370395 | 2.296269 | -0.349344858 |
| 13.93427 | 2.634351242 | 2.59830407 | -0.036047 | 1.537 | 2.537 | 4.65 | 5.65 | 0.449027 | 6.256857 | 1.833678 | -0.800673265 |
| 13.729843 | 2.619571774 | 2.61523407 | -0.004338 | 1.181 | 2.181 | 4.545 | 5.545 | 0.393282 | 5.3997033 | 1.686344 | -0.933227766 |
| 13.435382 | 2.597891661 | 2.63223626 | 0.034345 | 0.830 | 1.830 | 4.51 | 5.51 | 0.332051 | 4.4612295 | 1.495424 | -1.102467259 |
| 13.440924 | 2.598304069 | 2.65204272 | 0.053739 | 1.003 | 2.003 | 4.67 | 5.67 | 0.353175 | 4.7469929 | 1.557511 | -1.040792718 |
| 13.670416 | 2.615234066 | 2.67402347 | 0.058789 | 1.280 | 2.280 | 4.615 | 5.615 | 0.406055 | 5.5509435 | 1.713968 | -0.901266145 |
| 13.90483 | 2.632236262 | 2.66321018 | 0.030974 | 1.458 | 2.458 | 4.585 | 5.585 | 0.440143 | 6.1201169 | 1.811581 | -0.820655058 |
| 14.182981 | 2.652042721 | 2.65763687 | 0.005594 | 1.580 | 2.580 | 4.48 | 5.48 | 0.470803 | 6.6773888 | 1.898727 | -0.753315702 |
| 14.498185 | 2.674023469 | 2.64283251 | -0.031191 | 1.571 | 2.571 | 4.53 | 5.53 | 0.464964 | 6.7411317 | 1.908228 | -0.765795654 |
| 14.342257 | 2.663210181 | 2.6412841 | -0.021926 | 1.592 | 2.592 | 4.6 | 5.6 | 0.462786 | 6.6373914 | 1.892719 | -0.770491152 |
| 14.262545 | 2.65763687 | 2.62106659 | -0.03657 | 2.110 | 3.110 | 4.57 | 5.57 | 0.558348 | 7.9634677 | 2.074865 | -0.582772328 |
| 14.052952 | 2.642832508 | 2.59757393 | -0.045259 | 2.870 | 3.870 | 4.63 | 5.63 | 0.687425 | 9.6603439 | 2.268029 | -0.374803257 |
| 14.03121 | 2.6412841 | 2.58572368 | -0.05556 | 2.015 | 3.015 | 4.5 | 5.5 | 0.548136 | 7.6910162 | 2.040053 | -0.601231184 |
| 13.750382 | 2.621066592 | 2.57013629 | -0.05093 | 1.707 | 2.707 | 4.38 | 5.38 | 0.503067 | 6.9173622 | 1.934035 | -0.687032087 |
| 13.431114 | 2.597573929 | 2.56647713 | -0.031097 | 2.267 | 3.267 | 4.38 | 5.38 | 0.607286 | 8.1565306 | 2.098819 | -0.498755025 |
| 13.272891 | 2.585723678 | 2.5782517 | -0.007472 | 2.749 | 3.749 | 4.49 | 5.49 | 0.682787 | 9.0625558 | 2.204151 | -0.381572496 |
| 13.067605 | 2.570136287 | 2.6349851 | 0.064849 | 3.950 | 4.950 | 4.59 | 5.59 | 0.88551 | 11.571493 | 2.448545 | -0.121591711 |
| 13.019876 | 2.566477128 | 2.66858839 | 0.102111 | 5.061 | 6.061 | 4.36 | 5.36 | 1.130858 | 14.723634 | 2.689454 | 0.122976821 |
| 13.174086 | 2.578251697 | 2.6946275 | 0.116376 | 8.043 | 9.043 | 4.37 | 5.37 | 1.684047 | 22.185782 | 3.099452 | 0.521199929 |
| 13.943105 | 2.634985104 | 2.67394699 | 0.038962 | 8.259 | 9.259 | 4.43 | 5.43 | 1.705157 | 23.775176 | 3.168642 | 0.533656918 |
| 14.4196 | 2.668588392 | 2.68037912 | 0.011791 | 8.587 | 9.587 | 4.38 | 5.38 | 1.78197 | 25.695298 | 3.246308 | 0.57771964 |
| 14.800005 | 2.694627503 | | | 8.630 | 9.630 | 4.49 | 5.49 | 1.754098 | 25.960664 | 3.256582 | 0.56195497 |
| 14.497076 | 2.673946987 | | | 8.681 | 9.681 | 4.565 | 5.565 | 1.739533 | 25.218139 | 3.227564 | 0.553616568 |
| 14.590624 | 2.680379118 | | | 8.660 | 9.660 | 4.435 | 5.435 | 1.777332 | 25.932384 | 3.255493 | 0.575113424 |