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Effect of Interest Rates on Foreign Exchange Rates in Kenya: A Test of the Forward Premium Puzzle

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Abstract
The main objective of this study was to examine the presence of the forward premium puzzle in the foreign exchange market in Kenya. The study used the Kshs/USD exchange rate for the period 1994 to 2016. That data consisted of monthly observations of the exchange rate, monthly observations of the 91-day Kenya government Treasury Bills Rate and the 91-day US government Treasury Bills rate. As a matter of procedure the data were tested for nonstationarity using the ADF test in level forms and in first differences. The result revealed that foreign exchange rates, interest rates and the risk premium are nonstationary. Furthermore, these variables were found to be cointegrated. Therefore, this study applied the VECM instead of the classical Granger causality tests to the data. The results show that the coefficient of the forward premium is not only negative but also statistically significant at the 5 percent level. This indicates the presence of the forward premium puzzle in the foreign exchange rate market in Kenya. Moreover, the forward premium contains information that can be used to improve the prediction the foreign exchange rate.

1.1 Introduction

Exchange rates and interest rates influence the performance of the external sector especially exports, imports and the trade balance (Bergen, 2010). The impact of interest rates on exchange rates has attracted a lot of research in international finance. This has been best captured by the interest rate parity puzzle (IRP). The uncovered interest parity puzzle (UIP) is described as the empirical regularity that high interest rate economies usually have short term deposits earning higher expected returns (Engel, 2016). Another puzzle is that high real interest rate economies have currencies that are stronger than can be accounted for by expected real interest differentials under UIP (Engel, 2016). The two findings are puzzling when one considers the relationship between the foreign exchange risk premium and interest rate differentials.

The Mundell (1963) and Fleming (1962) model and the Dornbusch (1976) model are important models used in international finance. The two models are based on the interest parity. This implies that there are no ex ante excess returns from trading assets denominated in foreign currencies. These models are used to predict the level of the exchange rate. They demonstrate that when domestic interest rates are higher than average relative interest rate, the domestic currency should appreciate against the foreign currency. However, empirical evidence shows that the appreciation of the domestic currency is usually higher than is expected by interest rate parity condition. This means there are higher co-movement or increased volatility in exchange rates. These findings have been attributed to the influence of expected exchange rate risk premiums (Engel, 2016). High interest rates in a country can cause its foreign exchange rate to appreciate for two reasons. This could be that deposits at the bank pay a higher interest rate and have lower risk (Engel, 2016).

The predictions above about risk contradict one another. This is the case since the domestic economy has both higher expected returns and an appreciating currency in the short term. This first implies that the domestic currency is riskier as implied by the risk-return trade-off. Secondly a stronger currency means that it is less risky.

The interest rates strongly influence the foreign exchange rate. However, the nature of the relationships remains puzzling and continues to intrigue researchers in finance and economics (Engle, 2016; Fama, 1984; Williamson, 2001). There are two levels for examining the relationship between interest rates and exchange rates. The first is the rate of change. The second is about the magnitude or level of the exchange rates. The two approaches are crucial for illuminating interactions in international financial markets (Engel, 2016).

New models are required to study the above empirical relationships in international finance whether one studies the relationship between the two variables using the rates of change or their levels. Consequently, much of current research has focused on developing more sophisticated models to capture complex investor behavior and interactions in economic variables. However, a scrutiny of the two relationships yields a contradiction. The reasons put forward to explain one relationship cannot be used to explain the other. This is a puzzle (Engel, 2016).

In summary, the interest parity research is struggling to explain the common empirical finding that $cov(E_t \rho_{t+1}, r_t^* - r_t) > 0$ (Engel, 2016) . Where, ρ_{t+1} is the differential return between period t and $t+1$ on a foreign and the domestic short-term deposits; $r_t^* - r_t$ is the difference in the ex-ante real interest rate in the foreign economy and the domestic economy. The asterisk * denotes the foreign country. The "*cov*" refers to the unconditional covariance, and $E_t\rho_{t+1}$ is the conditional expectation of ρ_{t+1}. This means that there is a positive relationship between the ex-ante excess return on the foreign deposit and the foreign less domestic economy interest differential. Both the risk premium and the interest rate differential are known at time t.

There are so many empirical studies that have been carried out on the UIP puzzle. However, much of this research has been conducted in developed countries. Seminal and pioneer studies on the UIP puzzle are Bilson (1981) and Fama (1984). A survey of related literature is provided by Engel (1996, 2014). As correctly argued by Engel (2016: 437), to properly account for this puzzle the short-term interest rates in the high-interest rate economy are riskier (according to the risk-return trade-off), and therefore have an expected excess return which is compensation for exposure to higher risk. This expected risk premium is not constant and it varies with the interest differential.

Studies conducted in Kenya in relation to the effects of interest rates, inflation rates and how they affect exchange rates have yielded minimal significant results. This is the main reason for undertaking this study in Kenya. Hence the research question is: What is the effect of the interest rate on Kshs/US$ exchange rate in Kenya?

2. Interest Rates and Foreign Exchange Rate Fluctuations in Kenya

Before the start of Structural Adjustment Program (SAP) in 1983 there was severe repression of the financial sector in Kenya. This was characterized by interest rates controls. There was also direct control of credit by the Central Bank (Willem, 1995).

In the late 1980s and early 1990s economic and financial liberalization began. The interest rate on credit was feed from government control. From 1983 to 1987 the interest rate differentials between commercial banks and NBFIs became narrow. Consequently, there was an increase in the competitiveness of commercial banks. In 1991 there was liberalization of interest rates. Consequently, the difference between loan rates and deposit rates has reduced (Willem, 1995).

The highest lending rates were raised from 10 to 14 % in 1991. Also the interest rate for crop finance rose to 11.25 %. The lowest savings rate was increased to 12.5 %. The interest rate averaged 14.95 percent between 1994 and 2016. The highest rate (84.67 %) was recorded in July of 1993. The lowest interest rate (0.83 %) was witnessed in September of 2003 (KNBS, 2016).

The history of exchange rates in Kenya begins with the operations of the East African Currency Board during the colonial period. This was the fixed exchange rate regime. Since then the exchange rate regime in Kenya has undergone fundamental changes. In the early 1980s the shilling was pegged to SDR. The major problem then was how to manage exchange rate movements around the peg. This regime was abandoned in 1982 in favor of a basket of foreign currencies of Kenya's main trading partners (Wagacha, 2000).

The objective of the peg was to eliminate the volatilities of foreign currencies in the SDR unrelated to Kenya's trade flows. This was also aimed at bolstering Kenya's competitiveness on the international market. On the other hand the peg retained the technical capability of transmitting and maintaining inflation to Kenya at the levels obtaining in the major trading partners (Wagacha, 2000).

The initial step in liberalizing the foreign exchange market Kenya adopted a dual exchange rate (Wagacha, 2000). In the 1990s there was the official rate alongside the rate available in the market for those who purchased interest-bearing and marketable foreign exchange bearer certificates (the so-called Forex Cs). The Central Bank was therefore in a position to monitor the market performance of the paper and then adjust the official rates accordingly. In 1993, following elimination of controls on imports and most foreign exchange transactions, the exchange rate attained a full float (Wagacha, 2000).

Foreign exchange rate volatility has increased with the liberalization of the financial markets. Consequently, the cost of debt has risen thereby reducing the demand for credit.

There several studies that have been conducted on the efficiency of the foreign exchange market in Kenya (Kurgat, 1998; Ngugi, 1999; Ndunda, 2002; Muhoro, 2005; Kiptoo, 2007; Kisaka, et al., 2008). The study by Kurgat (1998) tested the efficiency of the forex bureaus currency market. Its focus was on whether arbitrage opportunities exist in currency trade in Kenya. Kurgat (1998) found that the forex bureaus market is far from efficient. There were significant arbitrage opportunities that could be exploited.

In her study Ndunda (2002) tested the the uncovered interest parity in the forward market. She regressed the forward premium on the lagged forward premium for each of the following currencies: US dollar, Sterling Pound, Swiss Franc, Euro and Japanese Yen. Her findings were that the foreign exchange market is not efficient.

Another study by Muhoro (2005) analyzed locational and triangular arbitrage in the currency market. She also found that the foreign exchange market is not efficient. Two years later Kimani (2007) re-examined this issue. She tested the rationality of market participants' expectations. She found that forward rates are biased predictors of the future spot rates and market participants were not rational.

Studies done by Ndung'u (2010), found that exchange rate volatility was caused by excess liquidity in the economy and the consequent high inflation rate. Citing data and methodological flaws in the previous studies Kisaka (2008) revisited the issue of the foreign exchange market efficiency in Kenya. He found that this market is not efficient.

3. Literature Review
The main focus of this section is on the Interest Rate Parity theory, the time varying risk premium and the empirical literature on the IRP puzzle.

3.1 Interest Rate Parity (IRP) Theory
IRP is the main theory that underpins this study. It states that the forward premium (or discount) is equal to the interest rate differentials between two different currencies in an efficient market (Bleaney, and Fielding, 2002; Engel, 2016; Mishkin, Frederic, 2006). The IRP is represented algebraically as:

$$i_t^* - i_t = \Delta_k s_{t+k}^e \quad (2.1)$$

Where the LHS is the interest rate differential and the RHS is the forward premium.

The IRP theory makes two main assumptions. First, capital is highly mobile. Second, assets can be substituted perfectly based on their level of risk and liquidity. Under these two assumptions investors hold only those currencies which offer higher returns (Levi, 2007).

The IRP theory is arguably one the best theories to explain the behavior of foreign exchange rates. In this theory currency is treated as an asset. This is known as the asset approach, or the interest rate parity model (Levi, 2007). The implication of IRP theory is that there is no arbitrage opportunity in the currency market. Consequently, the failure of the IRP implies the existence of arbitrage opportunities that can be profitably exploited by arbitrageurs (Levi, 2007).

3.2 Time-Varying Risk Premium
The failure of the IRP hypothesis is attributed to risk-averse and irrational behavior of market participants. Risk aversion makes traders to demand a premium as compensation for exposure to more risk. Therefore, the risk premium, p_t, is added to the interest rate differential as compensation for bearing the foreign currency risk. This result is summarized algebraically below.

$$i_t - i_t^* = \Delta_k s_{t+k}^e + p_t \quad (2.2)$$

Equivalently, using the covered interest rate parity condition (2.2) in (2.1), the forward premium may be thought of as composed of two parts – the expected depreciation and p_t.

$$f_t^{(k)} - s_t = \Delta_k s_{t+k}^e + p_t \quad (2.3)$$

The presence of a risk premium has significant implications for the regression in equation (2.7), which were first noted by Fama (1984) who also considered a similar regression of the excess return from taking an open forward position, $f_t^{(k)} - s_{t+k}$ onto the forward premium,

$$f_t^{(k)} - s_{t+k} = Y + \delta\left(f_t^{(k)} - s_t\right) + v_{t+k} \quad (2.4)$$

where v_{t+k} is the regression error.

3.3 Empirical Literature Review
This section discusses how different scholars have explained the effects of interest rates on exchange rate determination both locally and internationally. Different scholars have different perspectives on this matter. Some provide negative relationships while others view the positive side of the relationship.

There are so many empirical studies that have been carried out on the forward premium (FP) puzzle. However, much of this research has been conducted in developed countries. Seminal and pioneer studies on the FP puzzle are Bilson (1981) and Fama (1984). A survey of related literature is provided by Engel (2016). As correctly argued by Engel (2016: 437), to properly account for this puzzle the short-term deposits in the domestic economy are relatively riskier and have an expected higher return which is compensation for exposure to higher risk. This expected risk premium is not constant as it varies with the interest differential.

Thus under the assumption of covered interest rate parity (CIP) the UIP condition is empirically examined by the regression model:

$$\Delta_k s_{1+k} = \alpha + \beta\left(f_t^{(k)} - s_t\right) + \eta_{t+k} \quad (2.5)$$

where η_{t+k} is the disturbance term. The coefficient β is equal to one. The error term is expected to be white noise.

In general, the results obtained from (2.5) provide evidence that rejects the EMH (Frankel, 1980; Fama 1984; Bekaert and Hodrick, 1993). Generally β closer to -1 than +1 (Froot and Thaler, 1990).

Clarida and Taylor (1997) exploited the Engle and Granger (1987) framework and, employing a VECM in spot and forward rates provide evidence suggesting that the forward premium improves the exchange rate the prediction. Hadzi-Vaskov and Kool (2006) further examined the source of the bias in the coefficient of the forward premium. They found that volatility in the interest rate could explain part of the bias in the forward premium.

This study is similar to those studies that attempt to explain the UIP condition. The earlier studies applied the CAPM to exchange rates (Frankel and Engel, 1984). Other studies employed statistical models of currency premiums (Hansen and Hodrick, 1983; Domowitz and Hakkio, 1985; Cumby, 1988). Subsequent studies applied the behavioral science approach (Froot and Thaler, 1990; Eichenbaum and Evans, 1995; Mankiw and Reis, 2002).

The latest studies have focused on the skewness of returns (Brunnermeir, Nagel, and Pedersen, 2009; Chen and Gwati, 2013; Jurek and Xu, 2014; Farhi, Fraiberger, Gabaix, Ranciere, and Verdelan, 2015). Other studies have examined overconfidence (Burnside, Han, Hirshleifer, and Wang, 2011), habit formation (Verdelan, 2010), rare disaster (Farhi and Gabaix, 2014), long-run risks (Bansal and Shaliastovich, 2013), country size (Hassen, 2013), and infrequent portfolio decisions (Bacheta and Wincoop, 2010). There are more studies that are exploiting portfolio analysis to seek for risk factors that can illuminate the foreign exchange rate premiums (Lustig and Verdelan, 2007; Lustig, Rousanov, and Verdelan, 2011; Merkhoff, Sarno, Schmeling, Schrimpf, 2012).

In summary, the increasing sophistication in the econometric techniques employed has generated increasingly strong evidence against the UIP hypothesis. Several explanations of the forward premium anomaly have been presented in the literature. For instance, this anomaly has been attributed to a time varying risk premium (Hodrick, 1997; Hai, Mark and Wu, 1997); the peso problem (Lewis, 1995); nonlinearity (Mehl and Cappiello, 2007) and irrationality and heterogeneity of market participants (Frankel and Froot, 1987a). Engel (2016) provides a survey of the current literature on the forward premium puzzle.

4. Methodology

This section discusses the conceptual model, analytical models, parameterization and measurement of variables and the diagnostic tests.

4.1 Conceptual Model

This study used the following mathematical function to explain the interrelationship between interest rates, inflation and exchange rates. The formula is as given below:

$$s_{t+k} = f\left(s_t, f_t^{(k)}\right) \qquad (4.1)$$

s_t is the monthly spot exchange rates between Kenya Shillings and US Dollar at time *t*. s_{t+k} is the monthly future spot exchange rates between Kenya Shillings and US Dollar at time *t+k*. $f_t^{(k)}$ is the monthly forward rate between Kenya Shillings and US Dollar at time *t* for *k* periods ahead.

4.2 Analytical Model

The model given below was used to determine the relationship between exchange rates and the other variables.

$$f_t^{(k)} - s_{t+k} = \mu + \delta\left(f_t^{(k)} - s_t\right) + v_{t+k} \qquad (4.2)$$

Where $f_t^{(k)} - s_{t+k}$ the spot return on holding an asset denominated in a foreign currency (forward bias), $f_t^{(k)} - s_t$ is the expected rate of return on an asset denominated in a foreign currency (forward premium), s_t is the spot rate in Kshs/USD and s_{t+k} = is the future spot rate *k* periods ahead. μ is the mean exchange rate between US dollar and Kenya Shillings. δ is the co-efficient of interest rate. v_t is the disturbance term.

4.3 Diagnostic Tests

The analysis of data was preceded by the conduct of the following diagnostic tests.

4.3.1 Test for Normality

The normal distribution has the skewness of zero and the kurtosis is 3. The study applied the Jarque – Bera (JB) test of goodness-of-fit to the normal distribution. The JB test determines whether the sample skewness and kurtosis are significantly different from their expected values, as measured by the chi-square statistic. The null hypothesis tested is, H_0: The error terms are normally distributed. The alternate hypothesis is, H_1: The error terms are not normally distributed.

4.3.2 The Serial Correlation Test

To test for serial correlation the model below was applied:

$$R_t = \mu_t + \sum_{t=1}^{p} \rho_t R_{t-1} + \phi(i_{t-1} - i^*_{t-1}) + e_t$$
$$e_t = \rho e_{t-1} + \varepsilon_t$$
(4.3)

The variable μ_t is a constant, ρ and ϕ are the coefficients of R_{t-1} and the *AR (1)* process, respectively, p is the optimal lag structure and e_t is an AR (1) process. The serial correlation test is used to test the null hypothesis that error terms from the *AR (1)* process of returns are not autocorrelated. The focus here is on the first order serial correlation of the error term of the *AR (1)* process. Also, if $\rho = 1$ then R_t is non-stationary (i.e. $\phi = 1$).

The problem of serial correlation was solved by fitting an autoregressive model using Cochrane-Orcutt Iterative Least Squares. The null hypothesis tested is, H_0: The error terms are serially correlated. The alternate hypothesis is, H_1: The error terms are not serially correlated. The *t*-statistics and the Durbin-Watson statistic (DW) were used to determine the significance of the correlation coefficients of the lagged error terms in the regression model.

4.3.3 Unit Root Test

To test for non-stationarity and unit roots in spot rates the Augmented Dickey-Fuller (ADF) test was applied. The ADF test was based on model in equation (4.4). If $\rho < 0$ then R_t is stationary around the deterministic trend μ_t. However, if $\rho_t = 0$, $t = 1,...,p$, then R_t is non-stationary.
The equation used for conducting ADF test has the general structure of equation (4).

$$R_t = \alpha_0 + \sum_{t=1}^{p} \rho_t R_{t-1} + \sum_{k=2}^{l} \delta_k \Delta R_{t-k} + \varepsilon_t \quad (4.4)$$

Where ρ_t the coefficient of the lagged return, t is the time, ε_t is a white noise error term. The value of l is computed as $l = \left[12\left(\frac{T}{100}\right)^{1/4} \right]$ (Schwert, 1989). T is the sample size. The test statistics are computed from the above regression. The null hypotheses is H_0: $\rho_t = 0$, $t = 1,...,p$. If the null hypothesis is rejected then it shows that the foreign exchange market is inefficient.

4.3.4 Testing for the Time Varying Risk Premium

In this test the assumption that foreign exchange returns are constant is relaxed. The objective is to assign some structure on the returns and reduce the size of the error term in the constant returns model. Assuming that market participants are rational and risk averse, the UIP condition will be distorted by the presence of a risk premium as in equation. In order to test for the presence of a time varying risk premium equation (4.5) was estimated assuming the error term contains the risk premium. Then the error term is tested for whiteness. If the error term is not white noise, the risk premium is removed from the error term by incorporating the term ζ_{t+k-1}. As shown in equation (4.5) equilibrium will exist when the expected return on a Kenyan shilling is equal to the interest differential between Kenya and USA minus the risk premium for holding the US dollar.

$$R_t = \mu_t + \sum_{t=1}^{n} \rho_t R_{t-1} + \phi(i_{t-1} - i^*_{t-1}) - \zeta_{t-1} + \varphi_1 D_1 + e_t \quad (4.5)$$

The risk premium was computed at the 1-month horizon. This was substituted into equation (4.5) and the equation re-estimated.

The forward premium is decomposed into three parts – the risk premium, the spot return, and the rational expectations error term. From the fact that spot exchange rates follow a martingale process, the spot return series is a martingale difference or stationary process. The rational expectations error term is stationary by definition. Therefore, the order of integration of the risk premium depends on the on the order of integration of the forward premium. The tests for unit roots in the term structure of forward premium were achieved by applying the Johansen Likelihood Ratio (JLR) test to the 1-month forward premium.

The first step in testing for the forward premium puzzle in the market was to examine whether the one monthly expected return and the forward premiums are cointegrated. This was achieved using the Johansen cointegration test. Engle and Granger (1987) showed that if variables such as the forward bias (D_t) and the forward premium (P_t)

are integrated of order one, I (1), and $\eta_t = D_t - \alpha P_t$ and $\vartheta_t = P_t - \gamma D_t$ are both integrated of order zero, I (0), that is, if long-run relationships exist between these two variables, then D and P are said to be cointegrated. Such variables may be considered to be generated by an autoregressive error-correction model (VECM). In this model the error correction terms are expected to capture the adjustment of the changes in D and P toward the long run equilibrium, while the lagged differenced terms of these variables are expected to capture the short run dynamics in of the model. Table 1 shows the diagnostics of the Forward Premium puzzle

Table 1 Diagnostics of the Forward Premium Puzzle

Case		$\delta = \frac{\operatorname{cov}(D,P)}{\operatorname{var}(D+P)}$	**Var (D) and Var (P)**	$\operatorname{cov}(D,P)$
I	UIP holds	= 1	Var (D) > Var(P) = 0	$\operatorname{cov}(D,P) = 0$
II	Forward premium puzzle	< 0	Var (P) > $\operatorname{cov}(D,P)$ > Var (D)	$\operatorname{cov}(D,P) < 0$
III		>1	Var (D) > $\operatorname{cov}(D,P)$ Var (P)	$\operatorname{cov}(D,P) < 0$

Note: $D = \Delta s_{t+k}$, P= $f_t^{(k)} - s_t$

5. Empirical Results and Discussion

This section presents the results of the data analysis and the discussion of results.

5.1. Summary Statistics

Table 2 Summary Statistics

	KE_TBILL	US_TBILL	S_T	__KETBILL	LN_FT	LN_ST	__USTBILL
Mean	13.7166	4.8209	68.5039	1.1372	4.2967	4.2149	1.0453
Maximum	33.5500	5.2100	81.2044	1.3360	4.4572	4.3970	1.0521
Minimum	0.8300	4.3600	42.3823	1.0080	3.8532	3.7467	1.0000
Std. Dev.	8.0876	0.2152	10.1183	0.0809	0.1269	0.1590	0.0118
Skewness	0.4075	-0.1946	-0.6990	0.4081	-1.4555	-0.9515	-3.4520
Kurtosis	2.1553	2.1081	2.3909	2.1547	5.3486	3.1063	13.4075
Jarque-Bera	9.2999	6.1559	16.0854	9.3212	94.4347	25.1263	1052.886
Probability	0.0096	0.0460	0.0003	0.0094	0.0000	0.0000	0.0000
Observations	162	156	166	162	162	166	162

Table 2 displays the descriptive statistics for the data used in this study. The results show that all the variables are not normally distributed. This is attributed to the excess kurtosis. One reason for the rejection of market efficiency is the presence of non-normally distributed error terms. In this study the Jarque – Bera (JB) test of goodness-of-fit to the normal distribution was used. The test was applied to monthly returns. For the normal distribution the sample skewness should be close to zero and the sample kurtosis close to 3. The JB test shows that the sample skewness and kurtosis are significantly different from their expected values, as measured by the chi-square statistic. Therefore, the null hypothesis that the monthly returns are normally distributed is rejected. Hence monthly returns are not normally distributed. The excess kurtosis suggests that the market experiences large depreciations and appreciations in the exchange rates than is normal. Monthly returns have a kurtosis of 20.1554 and a skewness of 0.0594.

5.2 Results of Diagnostic Tests

The following tests were performed before the correct model for testing the forward premium puzzle was determined.

5.2.1 The Serial Correlation Test

Table 3 Results of the LM Serial Correlation Test

VARIABLE	**Monthly Returns**
M	-0.012228 (-2.2812)**
R (-1)	0.1025 (1.0964)
D(IDIFF (-1))	0.00127 (0.9667)*
RESID (-1)	-0.0233 (-0.0276)
AIC	-5.1110
LM	0.0009

Note: Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**), and 10% (*) levels, respectively. LM statistics are p-values. R= currency return, R (-1) = lagged R. IDIFF = the interest differential, IDIFF (-1) = lagged IDIFF. D (IDIFF (-1)) = first difference of lagged IDIFF. RESID = residuals, RESID (-1) = lagged residuals. R2 = Coefficient of determination. The results shown in this table are those of the best fitting models as indicated by the AIC. The dummies for Friday and December were eliminated to avoid the dummy trap in regression analysis.

The results of the serial correlation test are displayed in Table 3 indicate that there is statistically significant negative serial correlation in monthly foreign exchange rates. This implies that monthly foreign exchange rates are mean-reverting. In conclusion, and monthly returns are negatively autocorrelated.

5.2.2 Unit Root Test

Table 4 Unit Root Test for Foreign Exchange Rate Returns

This table summarizes the results of the unit root test for monthly returns. R = currency return, R (-1) = lagged R. The results for the best fitting models based on the AIC are reported in this table.

Variable	**Returns in Level Form**
Constant (μ)	0.000375 (0.247572)
R(-1)	-0.737278 (-4.798469)***
AIC	-5.083362
ADF	-4.798469***
LAG	5

Note: Critical values for the *ADF*-test and the indication of significance are -3.4718, -2.8796 and -2.5765 at 1% (***), 5% (**) and 10% (*) levels, respectively. Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**) and 10% (*) levels.

The first step in the analysis was to examine the time series characteristics of the data sets used to test for market efficiency. This was necessary because often the results of the tests are influenced by the characteristics of the data such as stationarity and seasonality. This section examines the stationarity of the data using the ADF test. The results of the unit root test based on the ADF tests are displayed in Table 4. The optimal lag for the returns was one, hence the use of R_{t-1} in the analysis. The exchange rates do not have a constant mean and variance this is confirmed by the unit root test. Clearly, returns fluctuate around a long-run mean.

As a matter of procedure, first, the ADF test was applied on the level form of the monthly returns. The computed *t*-statistic was -4.798469. The critical values at 1 percent and 5 percent significance level are -3.4718 and -2.8796, respectively. Thus the null hypothesis of unit root is rejected since the computed statistic is more negative than the critical values. Then, the ADF test was applied on the monthly return series in level form plus the time trend. The computed *t*-statistic was -5.616485 for the lagged return and -0.0506214 for the time trend. Thus the null hypothesis of unit root is rejected and there is a statistically insignificant trend in returns. Therefore monthly returns are integrated of order zero, *I (0).*

Table 5 Unit Root Test for Interest Rate Differentials

Variable	Monthly Interest Rate Differentials		
	Level Form	Level Form and Linear Trend	First Difference and Linear Trend
Constant (μ)	0.213222 (1.392740)	0.604014 (1.268033)	-0.091151 (-0.428989)
IDIFF(-1)	-0.039796 (-2.352538)**	-0.055472 (-1.935862)**	
D(IDIFF(-1))			-0.542638 (-5.139626)***
Trend(1)		-0.00486 (-1.12266)	0.000507 (0.189847)
AIC	1.306121	3.371629	3.183784
ADF	-2.352538	-1.935862	-5.139626***
LAG	1	0	2

Note: Critical values for the *ADF*-test and the indication of significance are -3.4718, -2.8796 and -2.5765 at 1% (***), 5% (**) and 10% (*) levels, respectively. Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**) and 10% (*) levels.

The same procedure for testing for unit roots in returns was applied to the interest rate differentials. Since the hypothesis of unit root could not be rejected in level form, first differences of the interest differentials were employed in the second stage. The results summarized in Table 5 indicate that interest rate differentials are integrated of order one, I (1). Thus, interest rate differentials are nonstationary. This implies that interest rate differentials have no tendency to return to their long run mean. Furthermore, the variance of the interest rate differentials is time-dependent and becomes infinite as time goes to infinity. Therefore, interest rate differentials follow a random walk and cannot be accurately forecasted. Also further analysis involving the interest differential applied the first differences of the interest rate differential. This is in accord with the assumptions of the classical regression model.

Table 6 Unit Root Test for the Risk Premiums

Variable	1 Month Risk Premium	
	Level Form and Linear Trend	First Difference and Linear Trend
Constant (μ)	3.78326 (2.9546)**	-0.20067 (-0.3679)
D_1(-1)	-0.247215 (-3.4104)	
D(D_1(-1))		-0.53617 (-5.0954)***
Trend(1)	-0.28242 (-2.7176)**	0.00074 (0.1162)
AIC	5.1389	5.2190
ADF	-3.4104	-5.0954***
LAG	2	0

Note: Critical values for the *ADF*-test and the indication of significance are -3.4718, -2.8796 and -2.5765 at 1% (***), 5% (**) and 10% (*) levels, respectively. Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**) and 10% (*) levels, respectively. D_1= risk premium at one month horizon, D_1 (-1) = lagged D_1. D (D_1 (-1)) = first difference of lagged D_1. D = Risk Premium. The results reported in this Table are for the best estimated models as indicated by the Akaike Information Criterion (AIC).[a]Results are based on the modified AIC.

In Table 6 the first column presents the results for the unit root test assuming a constant and linear trend in the risk premiums. The second column reports the result of the differenced series with assuming a constant and linear trend in the risk premiums. Overall, the results show that the risk premium is not stationary at the 1-month interval. Thus, further analysis using these variables employed their first difference according to classical theory of regression analysis.

Table 7 Unit Root Test for the Forward Premiums

Variable	1 Month Forward Premium	
	Level Form and Linear Trend	First Difference and Linear Trend
Constant (μ)	0.8623 (1.5620)	-0.1491 (-0.8729)
P_1(-1)	-0.0660 (-1.9499)*	
D(P_1(-1))		-0.5786 (-7.9807)***
Trend(1)	-0.00618 (-1.5131)	0.00112 (0.5655)
AIC	2.8174	5.2190
ADF	-1.9499	-7.9807***
LAG	10	0

Note: Critical values for the *ADF*-test and the indication of significance are -3.4718, -2.8796 and -2.5765 at 1% (***), 5% (**) and 10% (*) levels, respectively. Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**) and 10% (*) levels, respectively. P_1 = forward premium at one month horizon, P_1 (-1) = lagged P_1. D (P_1* (-1)) = first difference of lagged P_1. P = Forward Premium. The results reported in Table 3d are for the best estimated models as indicated by the Akaike Information Criterion (AIC).

There are similarities between the term structure of the forward premium and the term structure of the risk premium. Again the forward premium does not have a constant mean and variance is confirmed by the unit root test results in Table 7. The results of the unit root test in Table 7 indicate that the forward premium is nonstationary at the 1-month interval. However, the trend in the monthly forward premium is not significant at 5 percent level.

5.3 Results of Testing for the Forward Premium Puzzle

Table 8 Results of the Cointegration Test

Variable	D_1 vs P_1
Trace Statistic	46.2864**
Critical Value	15.49471
No CE(s)	Reject
At most 1 CE	Reject
CVs	4

**denotes rejection of the hypothesis at 5 percent level. D_1 is the one month expected return, P_1 is the one month forward premium, is the one month forward premium. CE = Cointegrating Equations. CV = Cointegrating Vectors.

Thus evidence adduced in this study support the argument that the risk premium is time varying. Furthermore, the results show that the term structure of the forward premiums contains significant information that can be exploited to forecast the future spot exchange rates.

Table 9 Vector Error Correction Estimates of the Risk Premiums

Variable	1-Month Risk Premium	
CE	D_1	
D(-i)	1.0000	
P(-i)	-1.1002 (-26.2733)***	
μ	0.5203	
CE	D(D_1)	D(P_1)
ECT	-0.794528 (-5.1734)***	0.119218 (2.2988)**
D(D(-1)	0.026018 (0.2024)	0.004208 (0.09692)
D(D(-2)	0.002256 (0.0239)	0.005974 (0.18761)
D(P(-1)	0.458649 (1.8438)*	0.508641 (6.0552)***
D(P(-2)	-0.046767 (-0.2023)	-0.169849 (-2.1756)**
μ	-0.049860 (-0.2112)	-0.062757 (-0.7872)
F-statistic	15.7353***	12.2246***
AIC	7.6443	

Note: Critical values for the *t*-test and the indication of significance are 2.576, 1.96 and 1.645 at 1% (***), 5% (**), 10% (*) and 25% ([a]) levels, respectively. The null hypothesis of market efficiency is analyzed by testing the restrictions that ECT = 1; D (P (-1)) = 1and D (D (-1)) = D (D (-2)) = D (P (-2)) onth expected return, D (D_1) = the difference of the error correction term D_1. Other error correction terms are defined in the same way. D (-i) = D lagged *i* times. P (-i) = P lagged *i* times. D = one month expected return, D (D (-1)) = First difference of D lagged once and D (P (-1)) = First difference of P lagged once. Other variables are defined in similar manner. μ = Constant. CE = Cointegration Equation, ECT = Error Correction Term, D_1 = Error correction term for the cointegration equation for the 1-month.

The results for estimating the error correction models for 1-month horizon are shown in Table 9. The null hypothesis that the coefficient of the error correction term is equal to 1 is rejected at all horizons. Indeed the coefficient is negative. Therefore, the forward premium puzzle exists in the foreign exchange market in Kenya. The first difference of the forward premium variable is significant at all horizons. Therefore, null hypothesis that the coefficient of the lagged one month expected return is equal to 1 is also rejected. The null hypothesis that the coefficients of the other lagged variables in the model are equal to zero is not rejected at the one month horizon. This implies that in the short run the market is not efficient at the one month horizon.

In summary, the results of the data analysis demonstrate the presence of the forward premium puzzle in the foreign exchange rate market in Kenya. This is attributed to the existence of the time varying risk premium in the foreign exchange market. The term structure of the interest rate differential and the foreign exchange risk premium are nonstationary and they are higher in the short run and decline steadily in the long run.

6. Conclusion

The main objective of this study was to examine the presence of the forward premium puzzle in the foreign exchange market in Kenya. The study used the Kshs/USD exchange rate for the period 1994 to 2016. That data consisted of monthly observations of the exchange rate, monthly observations of the 91-day Kenya government Treasury Bills Rate and the 91-day US government Treasury Bills rate. As a matter of procedure the data were tested for nonstationarity using the ADF test in level forms and in first differences. The result revealed that foreign exchange rates, interest rates and the risk premium are nonstationary. Therefore, this study applied the VECM instead of the classical Granger causality tests to the data.

The results show that the coefficient of the forward premium is not only negative but also statistically significant at the 5 percent level. This indicates the presence of the forward premium puzzle in the foreign exchange rate market in Kenya. Moreover, the forward premium contains information that can be used to improve the prediction the foreign exchange rate.

There are at least three conclusions that can be drawn from the data analyses in this study. First, the foreign exchange rate market exhibits the forward premium puzzle. Second, foreign exchange rates and interest rates are nonstationary. Thus, foreign exchange rates and interest rates have unit roots. Third, that the correct framework for testing for the forward premium puzzle is the vector error correction model (VECM). This is the result of the fact that foreign exchange rates and interest rates are cointegrated. Fourth, the forward premium contains information that can be used to improve the prediction the foreign exchange rate.

7. Recommendations for Policy

A number of policy implications can be derived from the findings of this. First, borrowing activities in the government securities market has impact on the foreign exchange rate. Specifically, increased government borrowing in the local market is likely to cause distortions in the foreign exchange rate market. The evidence provided in this study suggests that there is volatility spill over across markets.

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