Effect of Treasury Bill Rate on Exchange Rate Level and Volatility in Kenya.

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ABSTRACT

Government through central bank sells or purchase Treasury bills to represent government securities’ interest rate in open markets operations with the aim of influencing liquidity conditions in the financial system. Again central bank make adjustment in the treasury bill rates with the intention of devaluing her currency so as to encourage export and discourage imports. Kenya has been facing high volatility of exchange rate and a continuous depreciation of Kenya shilling to US dollar. Depreciation of the home currency decreases return on investment when investing internationally. A combination of a stable exchange rate environment and a competitive currency attracts investment, increase aggregate output and expand country’s economic prosperity. This study aimed at evaluating the effect of 91-day Treasury bill rate on exchange rate level and volatility. Monthly series data on US Dollar-Kenya shilling bilateral exchange rate, 91-day Treasury bill rates, net foreign exchange intervention by central Bank, central bank rate, and inflation rate was purposively selected from January 1997 to June 2016 was used for analysis. Using GARCH model it was found that holding other things equal, a unit change in 91-day Treasury bill rate influence the exchange rate volatility by 2.5790 units in the same direction and at the same time changes the level of exchange rate return by 1.5696 units. Therefore, increasing 91-day Treasury bill rate increases the volatility of the monthly Kenya shilling to US dollar returns and appreciates Kenyan shilling against the US dollar.

Key Words: treasury bill rate, exchange rate level, volatility.

I. INTRODUCTION

Exchange rate volatility refers to when exchange rate drift up or down from the average long run exchange rate due to changes in demand and supply of the currencies involved. It is the channel through which international prices pass through to domestic prices (CBK, 2015). Just like prices of goods and services, exchange rate is determined by supply and demand of foreign exchange in a free foreign exchange market that causes the exchange rate movements, that is, to appreciate or depreciate. According to Hakim, Bakhtiar, Syarifuddin, and Achsani (2014), the supply and demand of foreign exchange is kindled by economic fundamentals such as productivity, inflation rates, real interest rates, government trade policy, consumer preference, and market sentiments like traders’ opinion about future exchange rates and news about future market fundamentals. Volatility introduces uncertainty that negatively affects business decisions and plans. The increase in exchange rate volatility has negative effects on international trade and capital flows, thus having an adverse impact on domestic economy (Clark, Tamirisa, & Shang-Jin, 2004). Unpredictable changes in exchange rates may reduce international trade by increasing the risks of importing and exporting. Equally, by increasing the risk of investing in foreign assets, exchange rate volatility may retard the flow of capital between the countries.

Treasury Bills are debt obligations issued by the Central Bank of Kenya, on behalf of the government and are sold at a discounted price to reflect investor’s return and redeemed at face (par) value (CBK, 2016). The Treasury bills are purchased through competitive bidding and the interest rate applicable to these securities is the Treasury bill rate. At a discount means the instrument is sold to an investor, at below the face value. The difference between the discounted price and the face value determines the interest earned. 91-day Treasury bill rate represent government securities’ interest rate in open markets operations (Moki, 2014). Open Market Operations involves the sale or purchase of government securities (Treasury bills/bonds) with the aim of influencing liquidity conditions in the financial system (CBK, 2016). When the Central Bank sells securities, it reduces the supply of money and when it buys securities it increases the supply of money in the market (CBK, 2015). The 91 Treasury bill rate is considered to be the short term interest rate and money market rate (Corozon, 2014). It influences monetary policy through the sale of short term government securities and forms the basis for the setting of commercial bank lending rates (Cheruiyot, 2012). When the TB rate goes up, interest rates on any loans or corporate bond tied to it also go up.
II. LITERATURE REVIEW

Zettelmeyer (2004) examine the impact of monetary policy on exchange rate; evidence from three small open market economies which were Australia, Canada and Zealand during 1990s. The three countries have a high degree of openness both in terms of trade and capital flows; floating exchange regime in the sense that no particular level of exchange rate was targeted by policy makers and they use formal inflation targets. The study used three month Treasury bill rate as a measure of policy shocks. The study established that a contractionary shock will appreciate exchange rate. Also, Cheng (2006) uses VAR techniques to analyze the monetary transmission mechanism in Kenya. The study examined how variations in the short-term interest rate (Treasury bill rates and interbank rates) account for fluctuations in output, prices, and the nominal effective exchange rate. The study used monthly data for the period 1997 to 2005. The study found that variations in the short-term interest rate account for significant fluctuations in the nominal exchange rate and prices, while accounting little for output fluctuations. Moreover, Tobias (2011) used GARCH model to test the effect of short term interest rate on the volatility of the foreign exchange rate using Treasury bill rates from August 1991 to December 2007. The findings revealed that there exists a link between short term interest rates and the volatility of foreign exchange rate in Kenya.

Keynesian Theory: According to Keynes, interest rate channel is the main channel for monetary policy transmission. A contractionary monetary policy will result to an increase in interest rates leading to crowding out of local investments. This increases unemployment and lowers aggregate demand due to low consumption levels (Mishkin, 1996). Keynes also supports monetary policy transmission through exchange rate channel with adoption of expansionary monetary policy interest rates fall this leads to capital outflows since domestic interest rates are lower than foreign interest rates thus causing a depreciation of the local currency (Walsh, 2010). The depreciation makes local goods competitive in the world market since they become cheaper and thus an appreciation of the exchange rate.

The Mundell-Fleming Model and Monetary Policy: According to Mankiw(2006) and Blanchard(2006), Mundell-Fleming model is an economic model first set forth by Robert Mundell and Marcus Fleming. The model is an extension of the IS-LM model. In the IS-LM, interest rate is the key component in making both the money market and the good market in equilibrium. Under the Mundell-Fleming framework of small economy, interest rate is fixed and equilibrium in both markets can only be achieved by a change of nominal exchange rate. Mundell (1968) and Fleming (1962) argue that the exchange rate enters the macroeconomic framework of interest and output determination because changes in exchange rates affect competitiveness. Under a system of floating exchange rates, the exchange rate is set by market forces and is allowed to fluctuate in response to changing economic conditions. An increase in money supply shifts the LM curve downward. This directly reduces the local interest rate and in turn forces the local interest rate lower than the global interest rate. This depreciates the exchange rate of local currency through capital outflow. (Hot money flows out to take advantage of higher interest rate abroad and hence currency depreciates.)

The depreciation of the currency follows from the interest rate parity condition. The depreciation makes local goods cheaper compared to foreign goods and increases export and decreases import. Hence, net export is increased. Low interest rate also leads to increase in investment. Increased net export and investment leads to the shifting of the IS curve to the right resulting to increase in equilibrium income. This shift continues to the right until the local interest rate becomes as high as the global rate. At the same time, the BOP is supposed to shift too, as to reflect depreciation of home currency and an increase in current account or in other word, the increase in net export. These increase the overall income in the local economy. A decrease in money supply causes the exact opposite of the process (Young &William, 2004). To conclude, these theories support a relationship between exchange rate, interest rate differentials and inflation differentials. This again, justifies why they should be included in the analysis model. Mundell-Fleming model also supports the influence of exchange rate through unsterilized intervention, that is, monetary policy channel.

III. METHODOLOGY

To test for the effect of 91-day Treasury bill rate on the level and volatility of the exchange rate, monthly data on Kenya shilling to US dollar exchange rate returns and 91-day Treasury bill rate was used. To account for other macroeconomic variables affecting exchange rate data on inflation rate, net foreign exchange intervention and central bank rate was added as moderating variables. The data ran from January 1997 to June 2016. The main sources of the data included: The Monthly Economic Reviews of the CBK and the Economic Surveys of the Kenya national bureau of statistics. Some data was also extracted from CBK and KNBS database on their websites. The data was then saved in Excel spreadsheet which was then imported to Eviews.
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**Model Specification**: To measure the impact of 91-day Treasury bill rate on the level and volatility of the Kenya shilling to US dollar exchange rate, a generalized autoregressive conditional heteroscedasticity (GARCH) model was used with 91-day treasury bill rate, net FOREX intervention data, central bank rate and inflation rate in both the conditional mean and variance equations as proposed by Engle (1982) and Baillie and Bollerslev (1986).

The model is as follows:

$$ ERT_t = \alpha_0 + \alpha_1 \ln TB_t + \alpha_2 \ln INV_t + \alpha_3 \Delta \ln CBR_t + \alpha_4 \Delta \ln INF_t + \epsilon_t. $$  

**conditional mean equation (1)**

Where,

$$ \epsilon_t | \Omega_{t-1} \sim N(0, h_t). $$

$$ h_t = b_0 + b_1 \Delta \ln TB_t + b_2 \ln INV_t + b_3 \Delta \ln CBR_t + b_4 \Delta \ln INF_t + \alpha \epsilon_{t-1}^2 + \beta h_{t-1}. $$  

**conditional variance equation ... (2)**

Where,

$$ b_0, \alpha, \beta > 0 \text{ and } \alpha + \beta < 1. $$

Equation (1) represents the mean equation in which measures the effect of 91-day Treasury bill rate (TB) on the level of exchange rate while equation (2) is the conditional volatility equation which depends on the same set of determinants as that of the mean equation (i) plus two more determinants; past disturbance $\alpha \epsilon_{t-1}^2$ and the lagged variance $\beta h_{t-1}$.

**IV. RESULTS AND DISCUSSIONS**

**Unit root and normality test**: The presence of unit roots for all the variables in the mean equation were tested by applying Augmented Dickey Fuller (ADF) and Philips Perron (PP) tests. All variables were found to be stationary at 5% level of significance after taking the second difference. The use of standard ARCH/GARCH model requires testing the distribution of the dependent variable. If the series is not normally distributed then GARCH model is found to be applicable in analyzing the data. Histogram-stat test for normality was applied where descriptive statistics of the exchange rate return including skewness and kurtosis measures were computed. The exchange rate return series was found to be positively skewed. This shows the presence of volatility in the return series implying that depreciation in the exchange rate occurs more often than appreciation. The probability of JB statistic rejected the null hypothesis that the series is normally distributed was rejected. The non-normality of the return series justifies the use of ARCH and GARCH model.

**Arch Effects and Volatility Clustering Test**: Before estimating ARCH and GARCH model it is necessary to test for the residuals of the mean equation to check whether they disagree with the assumptions of the OLS. ARMA equation was estimated by an econometric model which was built by applying OLS technique after which the estimated residuals are obtained. The assumptions underlying the GARCH model are that the time series under consideration must exhibit heteroscedasticity as well as autocorrelation. It is expected that there will be heteroscedasticity in financial time series data since in financial data some periods are riskier than others, that is, the expected value of error terms at some times is greater than others (arch effect). Moreover, these risky times are not scattered randomly across quarterly or annual data but riskier periods may be followed by other riskier one and less risk period followed other less risk periods (Volatility Clustering).

Ljung-Pierce Q-statistic of the squared deviations ($Q^2$) and Lagrange Multiplier ARCH test (ARCH-LM test) were employed. The Ljung-Box Q-statistic for squared residuals as well as the ARCH-LM test confirms the presence of ARCH effect since their F-probabilities (0.00) are less than 0.05; hence the null hypothesis of zero ARCH effect in the residuals is rejected. Again, a line graph for exchange rate return residual was plotted to verify the presence of volatility clustering. Both the test revealed that there is heteroscedasticity, autocorrelation and volatility clustering in the exchange rate return series and that it follows a non-normal distribution. Once ARCH has been found in the investigated data, it justifies the use of GARCH models. The inverted AR root for mean equation was 0.24 which is inside the unit circle, that is, between -1 and 1. Therefore, the mean equation is well defined.

**Estimated GARCH (1, 1) Model**: After the confirmation of the arch effect GARCH model was estimated. It is expected that estimating GARCH(1,1) specification to be sufficient to eliminate ARCH-effects from the residuals. Again for a well specified GARCH (1,1) model, the Wald test should show that the sum of ARCH coefficient $\alpha$, and GARCH coefficient $\beta$ to be less than one for the overall model to be stationary. The ARCH-LM test F-probability was 0.640451 which is greater than 0.05 and that of Ljung-Box Q-statistic for squared
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residuals was 0.403 which is also greater than 0.05. Therefore, the null hypothesis of no further ARCH effect in the estimated GARCH model was accepted.

To assess the degree of volatility persistence, the Wald test was used. The null hypothesis for this test is that the sum of ARCH coefficient (α) and GARCH coefficient (β) is equal to one; that is, H₀: α + β = 1, to mean that the error variance is integrated or non-stationary against the alternative H₁: α + β < 1, that is, error variance is stationary. This means that volatility will not take long time to revert to mean as α + β < 1. Again the constant term in variance equation, ARCH and GARCH term should be greater than zero and significant. From table 10, it is seen in that the coefficient of the ARCH term (α) is 0.5733, coefficient for GARCH term (β) is 0.2566 and constant term for the variance equation is 0.2566. These coefficients are all positive and significant as required since their Z probabilities are less than 0.05. The sum of ARCH and GARCH coefficients, α + β = 0.8299, which is lower than unity. The null hypothesis of non stationarity was rejected. This confirms the stationarity of the variance to display that volatility will not take long time to revert to mean.

The GARCH (1,1) model is shown in Table 1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>Z- Statistics</th>
<th>P-Value</th>
</tr>
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<tbody>
<tr>
<td>Mean Equation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>1.5315</td>
<td>1.2739</td>
<td>1.2022</td>
<td>0.2293</td>
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<tr>
<td>LNINV</td>
<td>-0.9863</td>
<td>0.5006</td>
<td>-1.9702</td>
<td>0.0488</td>
</tr>
<tr>
<td>ΔLCBR</td>
<td>0.0715</td>
<td>0.89023</td>
<td>0.0803</td>
<td>0.9360</td>
</tr>
<tr>
<td>ΔLNTB</td>
<td>-1.5696</td>
<td>0.6074</td>
<td>-2.5842</td>
<td>0.0098</td>
</tr>
<tr>
<td>ΔLNINF</td>
<td>0.2464</td>
<td>0.3294</td>
<td>0.7479</td>
<td>0.4545</td>
</tr>
<tr>
<td>AR</td>
<td>0.2565</td>
<td>0.0688</td>
<td>3.7265</td>
<td>0.0002</td>
</tr>
<tr>
<td>Variance Equation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>4.3853</td>
<td>1.7319</td>
<td>2.5321</td>
<td>0.0113</td>
</tr>
<tr>
<td>ARCH(1)</td>
<td>0.5733</td>
<td>0.1081</td>
<td>5.3008</td>
<td>0.0000</td>
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<tr>
<td>GARCH(1)</td>
<td>0.2566</td>
<td>0.0744</td>
<td>3.4470</td>
<td>0.0006</td>
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<tr>
<td>LNINV</td>
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<td>0.1379</td>
<td>-2.2060</td>
<td>0.0274</td>
</tr>
<tr>
<td>ΔLCBR</td>
<td>1.3515</td>
<td>2.2060</td>
<td>0.6126</td>
<td>0.5401</td>
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<tr>
<td>ΔLNTB</td>
<td>2.5790</td>
<td>1.2708</td>
<td>2.0300</td>
<td>0.0424</td>
</tr>
<tr>
<td>ΔLNINF</td>
<td>1.2159</td>
<td>0.3728</td>
<td>3.2620</td>
<td>0.0011</td>
</tr>
</tbody>
</table>

The conditional mean equation and variance equation are thus specified as follows:

\[ ERT_t = -0.9863 LNINV_t - 1.5696 TB_t + 0.2565 GARCH(1) + \epsilon_t \]  
\[ h_t = 4.3853 - 0.3042 LNINV_t + 2.5790 TB_t + 1.2159 LNINF + 0.5732 \epsilon_{t-1}^2 + 0.2566 h_{t-1} \]  

Parameter estimates: From conditional mean equation, the coefficient for 91-day Treasury bill rate was -1.5696 and significant since its p-value is 0.0098 < 0.05. This implied that an increase in TB by one unit leads to a decrease in mean return of foreign exchange rate by 1.5696 units. Meaning that, a decrease in 91 treasury bill rate by one unit increases the mean exchange rate return by 1.5696 holding other things equal. This follows that a decrease (increase) in 91-day Treasury bill rate depreciates (appreciates) Kenya shilling against the US Dollar.

Also, the TB coefficient in variance equation was 2.5790 with a P-value of 0.0424 < 0.05. Meaning that, increasing (decreasing) 91-day Treasury bill rate by one unit increases (lowers) the volatility of the monthly Kenya shilling to US dollar returns by 2.5790 holding other things equal. This is in consistence with empirical study of Zettelmeyer (2004) about the relationship between exchange rate volatility and interest rate.

Therefore, holding other things equal, 91-day Treasury bill rate is seen to be more effective in reducing the exchange rate volatility since a unit change in 91-day Treasury bill rate influence the exchange rate volatility by 2.5790 units and at the same time change the level of exchange rate return by 1.5696 units while a unit change...
in INV influences the volatility and level of exchange rate by 0.3042 and 0.9863 units respectively. The 91-day Treasury bill rate affects the exchange rate through an indirect method.

The indirect intervention traverses from open market operations to change the domestic money supply, to changes in domestic interest rates, to changes in exchange rates due to new rates of returns. The problem with this method is that it may take several weeks or more for the effect on exchange rates to be realized because the low interest rate has to increase investment and net export returns which will result to increased domestic money supply and hence depreciation of the Kenya shilling. A second problem with indirect method is that to affect the exchange rate the central bank may need to change interest rates away from what it views as appropriate for domestic concerns at the moment.

Also, volatility appears to be affected significantly by both foreign exchange intervention and inflation but central bank rate has no significant effect on both exchange rate level and volatility. Increasing net foreign exchange intervention would reduce volatility of exchange rate and at the same time appreciates Kenya shilling while inflation has a negative impact on exchange rate volatility. These factors have a significant policy implication in controlling exchange rate volatility.

V. CONCLUSIONS AND RECOMMENDATIONS
The main aim of this study was to evaluate the effect of 91 day treasury bill rate on exchange rate level and volatility. The results from GARCH model confirmed 91-day Treasury bill rate has a significant effect on both the level and volatility of exchange rate in Kenya. The results revealed that CBR has no significant effect on the mean and variance of exchange rate return. It was also found that foreign exchange intervention and inflation have significant effect on exchange rate volatility. Since 91 day treasury bill rate affect the volatility of exchange rate policy makers should make adjustments that ensures stable exchange rates by stemming out any excessive volatility in the exchange rate to avoid further depreciation and fluctuation on exchange rate. This is recommended since stable exchange rates will ensure certainty, helping investors to make accurate planning and reduce operational risk. At the same time, competitive exchange rates will help to ensure that the goods remain competitive relative to foreign markets. A combination of a stable exchange rate environment and a competitive currency will attract investment, increase aggregate output and expand country's economic prosperity.

REFERENCES