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The Impact of Interest Rates and Treasury Bill Yields on Stock Prices in Zambia

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Abstract

The paper analyzes the short-run and long-run effects of interest rates and Treasury bill rates on stock prices on the Lusaka Securities Exchange (LuSE) using semi-annual data between January 2006 and January 2022. ARDL model is used after we proved that there is no ARCH effect on the dependent variable (LNLASI). The findings show that deposit interest rates hada significant but weak negative impact on stock prices in the short run but had a positive impacton the stock prices in the long run, lending interest rates on the other hand had an insignificant positive impact on stock prices but a negative impact on stock prices in the long run. Treasurybill yields were found to have a negative significant impact on stock prices but had an insignificant negative impact on stock prices in the long run. Moreover, we found co-integration between among the three variables which means that there is a long run equilibrium relationship. As a result, the study concludes that, in the long-run, interest rates and Treasury bill rates have a combined effect on stock prices.

Keywords: stock prices, interest rate, treasury bill, Zambia

1. Introduction

Creating and maintaining a stable macroeconomic environment through factors like interest rates, money supply, and exchange rates is one of the most important goals and objectives of governments all over the world. The Central Bank of a country is in charge of determining the interest rates that prevail in an economy based on the macroeconomic environment and variables such asinflation, money demand, and exchange rates, among others. In Zambia, the Monetary Policy Committee (MPC) of the Bank of Zambia is responsible for setting the policy rate in thecountry, this rate is the benchmark interest rate and is simply the rate at which commercial banks borrow from the central bank. The MPC meets every quarter to decide the policy rate and the decision is mainly based on the levels of inflation in the economy since the policy rateis the main tool that the Bank of Zambia uses to try and maintain inflation at its target rate of 6% to 8% per annum.

Stock market and economic performance are related. The performance of the stock market, which is viewed as the economy's barometer, is used to determine the success or failure of macroeconomic policies aimed at stabilizing the aforementioned variables, particularly in developed countries. Therefore, monetary policy has an impact on financial asset prices through interest rates, which further affects the economic decisions and economic growth (Assafa et al., 2019). Consequently, several researchers have investigated the relationship among macroeconomic variables and the performance of the stock market (Aydemir & Demirhan, 2009). However, most studies have primarily focused on developed countries such as the United States, Canada, and Germany; however, according to Engel and Rangel (2005), emerging economies such as Zambia have the most volatile stock markets. Furthermore, emerging stock markets are more reactive to things like changes in the level of economic activity and political stability.

Individual and institutional investors have a choice between buying stocks, buying Treasury bonds, and making other investments, which is reflected in the demand on asset markets. On the supply side, firms make decisions on dividends, new issues, share repurchases, and borrowing to set the supplies of stocks and corporate bonds. Treasury bill and bond supplies are determined by monetary policy, budget, and debt management policies of the government. According to Fama (1965), the stock prices reflect all pertinent market information in an efficient market hypothesis. This basically means that since stock prices are already at their intrinsic value, no investor can outperform the market and make abnormal profits. Since investors have all the information in the market,

including knowledge on other alternative investments like treasury bills, the theory suggests that market participants will move their resources around in order to achieve maximum returns and as a result of this portfolio balancing, stock prices will fluctuate around their true value while also representing all the relevant market information.

This study sought to understand the impact of interest rates and yields on Treasury bills have on the Zambian stock market, as well as the type of relationship that exists between those factors and how it affects stock markets over the short-run and long-run.

The rest of the study is organized as follows. The literature from Zambia and other developing nations is briefly covered in the next section. Section 3 describes our data, definition of variables used, and the model. Our findings are presented in Section 4, and a discussion of the results is covered in Section 5. Section 6 finally concludes.

2. Review of the Literature

Macroeconomic variables like interest rates and treasury bills play an important role in the performance of stock market returns. Returns on the stock market are helpful indicators of the state of the economy going forward, including its financial and economic status. According to Simpson (2014), interest rates and stock prices are inversely related. This is because, for instance, if interest rates are high, it is more expensive for a business to borrow money for expansion, which slows down the company's growth and negatively affects earnings, stock prices start to decline as investors become alarmed. According to Smithson (2014), Treasury bills are short-term government debt obligations with a maturity of one year or less. The government of a nation raises money via these money market instruments.

Numerous studies have been conducted on the impact of macroeconomic data on the stock market. In an efficient market, current stock prices completely represent all pertinent information regarding changes in the macroeconomic environment, according to Fama's (1970) Efficient Market Hypothesis, therefore investors cannot make excessive profits in such a market. Assafa et al (2017) used a panel data analysis to examine the relationship between quarterly stock returns and interest rates of 21 developed countries and 19 developing countries. They found contrasting effect of interest rates changes on stock returns between developed and developing countries which can be attributed to the fact that the economies differ in monetary policies and financial systems. For developed countries there exist statistically significant negative effects of interest rates on stock returns. On the other hand in the developing countries they found no significant relationship as the "… macro determinants are not "priced in" stock returns of developing countries".

The stock market returns in developing countries are affected by domestic and external macroeconomic policies. Exchange rates affect stock markets not only in developed economies but also in developing ones. Musawa and Mwaanga (2017) examined the relationship that exists between interest rates and stock prices in Zambia by analyzing monthly data from 2004 to 2016. Using the Johansson Cointegration test, it was determined that interest rates and stock prices are co-integrated with one another, indicating a long-term relationship between the two variables. The impact of Treasury bill yields and interest rates on stock returns in Ghana was examined by Sunzuoye and Addo in 2013. In their analysis they used the Johansen's Multivariate Co-Integration tests and a Vector Error Correction Model (VECM) on monthly data from January 1995 to December 2011. The findings demonstrated that first, Treasury bill yields and interest rates both have an insignificant negative relationship with stock market returns. Additionally, there is a long-term connection between the two variables. Similarly, Kamal (2018) analysed the impact that Treasury bill yields and interest rates have on the Egyptian stock market. The study made use of monthly data collected from November 2004 to November 2017. Econometric models, specifically Cointegration tests and error correction models were used to examine the link that exists between Treasury bill yields, interest rates and stock market returns, the results concluded that the variables are co-integrated and that there is a significant negative short and long run relationship that exists between them. Further analysis showed that interest rates and Treasury bill yields have a joint impact on the Egyptian stock market.

From the preceding review of literatures, we can observe that stock markets operate differently because their stock returns react differently to internal and external macroeconomic variables. The majority of studies established evidence of impact of certain macroeconomic variables on stock price indices. There is very little literature concerning the Zambian Equity Market. To the best of my knowledge, this study will be among the first studies to consider the dynamics between the Zambian stock market returns, interest rates and Treasury bill yield rates in both the short and long terms.

3. Data and Empirical Model

The data used for this study are semiannual data from January 2002 to January 2022. The stock price indices are collected from Lusaka Securities Exchange All Share Index (LuSE ASI). The 91-day Treasury bill yields, lending interest rates, deposit interest rates, and inflation are collected from The Central Statistics Agency and from Bank of Zambia. The methodological design employed in this study consists of unit root tests; Johansen cointegration test, VECM based Granger causality, variance decomposition analysis and impulse response analysis.

The following ARDL regression model is used:

$$lnY_{it} = \beta_0 + \beta_1 X_1 + \beta_2 X_{1_{t-1}} + \beta_3 X_2 + \beta_4 X_{2_{t-1}} + \beta_5 X_3 + \beta_6 X_{3_{t-1}} + \beta_7 X_4 + \beta_8 X_{4_{t-1}} + \beta_9 lnY_{t-1} + \varepsilon_i$$

Where: β_0= Intercept of the regression line

$\beta_0,\ \beta_1,\ \beta_2,\ \beta_3,\ \beta_4,\ \beta_5,\ \beta_6,\ \beta_7,\ \beta_8$= slopes of the regression equation

X_1 = 91-day Treasury bill rate as measured by the Bank of Zambia

X_2 = deposit interest rate as measured by the Bank of Zambia

X_3 = lending interest rate as measured by the Bank of Zambia

X_4 = Semi-annual inflation as measured by the central statistics

$X_{1_{t-1}}$= lagged value of the 91-day Treasury bill yield rate

$X_{2_{t-1}}$= lagged value of the deposit interest rate

$X_{3_{t-1}}$= lagged value of the lending interest rate

$X_{4_{t-1}}$= lagged value of the semi-annual inflation

lnY_{t-1}= lagged value of the natural log of LuSE ASI

ε_i = is the error term

4. Results

4.1 Descriptive Statistics

Table 1 below presents the descriptive statistics for the variables LASI, DIR, INF, LIR, and TBR. The deposit interest rate had a maximum of 13%, mean of 8.77%, median of 8.62% and minimum value of 6% while inflation had a mean value of 5.21%, median of 3.98%, maximum of 17% and the minimum was 2.19%. The lending interest rate had a maximum value of 29.4%, minimum of 16.25% median of 25.1% and a mean value of 24.4%.

Table 1. Descriptive statistics on DIR, INF, LIR, LNLASI and TBR

	LASI	DIR	INF	LIR	TBR
Mean	4219.418	8.776551	5.210836	24.41620	11.54127
Median	4048.160	8.617272	3.982694	25.13339	11.30480
Maximum	6172.030	13.02400	17.07285	29.40976	21.00030
Minimum	1482.870	6.000000	2.192879	16.25000	4.892700
Std. Dev.	1228.222	1.821782	3.265153	3.873435	4.165849
Skewness	-0.209628	0.527240	2.046452	-0.939699	0.409375
Kurtosis	2.332732	2.642294	7.169298	2.898777	2.523457
Jarque-Bera	0.828030	1.653175	45.51322	4.723175	1.196595
Probability	0.660991	0.437540	0.000000	0.094270	0.549747
Sum	135021.4	280.8496	166.7468	781.3185	369.3206
Sum Sq. Dev.	46764433	102.8856	330.4980	465.1084	537.9832
Observations	32	32	32	32	32

The graph below shows how the returns of the Lusaka Securities Exchange has been trending from July 2006 to January 2022.

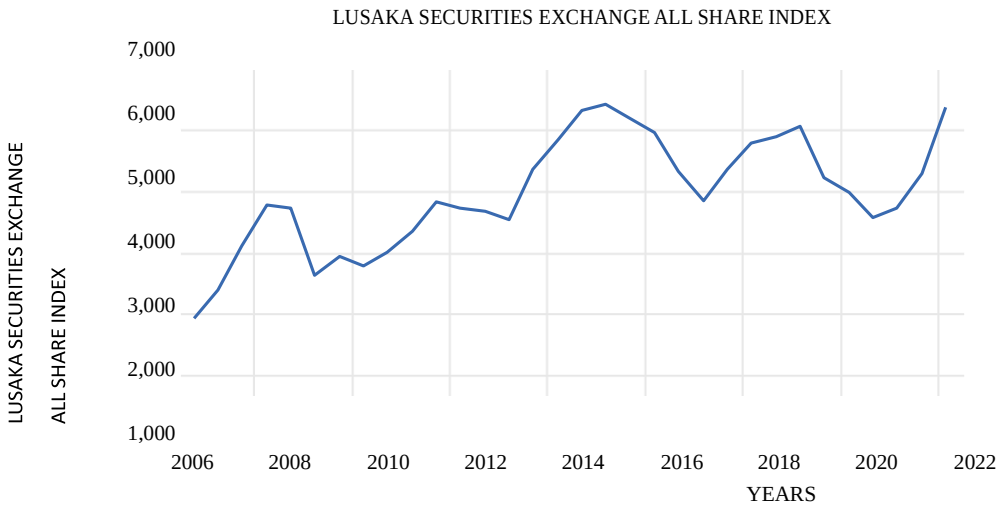

Figure 1. Graphical overview of the LASI at level

The period from 2009 to 2015 shows the longest period of increases in stock prices. This might be because the country and the world at large were recovering from the global financial crisis of 2008 which led to an increase in business activity. In this same period, GDP growth rate averaged about 6.64% per year. This high GDP growth rate is an indication that output was growing at a high rate implying that businesses were more profitable which could have resulted in higher profits and as a result higher stock prices.

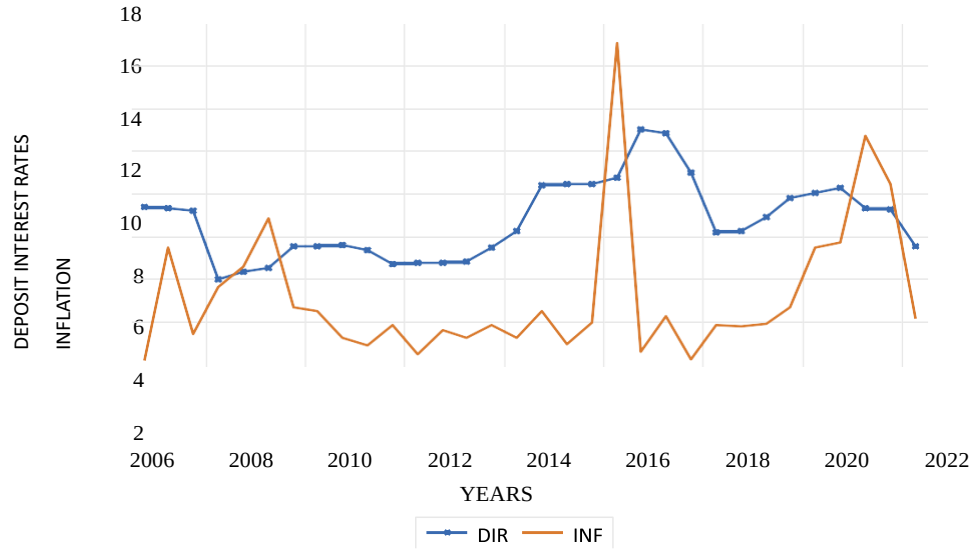

Figure 2. Trend between deposit interest rate and inflation at level

The deposit interest rates were at their lowest point for the period under observation in 2008 and began to rise steadily from 2008 and reached their peak in 2016 at around 13%. This is because the Bank of Zambia policy rate had been increasing steadily from 2008 to 2016 when it reached a peak of 15.5% in 2016. As noticed above, inflation in 2016 reached a new high for the period under observation. This caused the Monetary Policy Committee (MPC) to raise the policy rate in order to reduce total spending in the economy, this is because the nature of inflation was believed to have been demand pull inflation.

4.2 Unit Root Test

The researchers conducted unit root tests on each of the variables in order to determine whether they are stationary at levels or whether they need to be differenced to make them stationary. The Augmented Dickey fuller (ADF) test for stationarity used and we conclude that Natural log of the Lusaka Securities Index (LNLASI), DIR and TBR should be run with both constant and trend. INF and LIR o the other hand has Prob values greater than 0.05 on the trend indicating that the Trend is not statistically significant. After determining whether the

Constant and or trend were significant, the researchers conducted ADF test for stationarity and obtained the following results. The results obtained from the ADF test indicate that LNLASI, DIR, LIR and TBR are integrated of order 1, meaning the variables needed to be differenced once to make them stationary. Inflation on the other hand was integrated of order 0 meaning that Inflation was stationary at levels.

Table 2. ADF – Unit root test results

Variables	Levels form		First difference		Integration Order
	T statistic	**Prob**	**T statistic**	**Prob**	
LNLASI	-3.39997	0.07030	-4.56342	0.00580	1
DIR	-2.57329	0.29400	-3.93126	0.02300	1
LIR	-2.58769	0.10650	-3.51259	0.01460	1
INF	-4.68394	0.00070			0
TBR	-2.71773	0.08280	-4.26726	0.00230	1

4.3 Model Estimation

Gujarati (2009) explains that financial time series including data analyzed in this research report like stock prices, interest rates and inflation often exhibit a problem known as volatilityclustering. This means that there may be periods in which the data may exhibit wild swings and in other periods, data may be relatively stable. This particular characteristic of financial time series makes it more volatile and this volatility suggests that variances of such data vary over time and as a result an Autoregressive Conditional Heteroscedasticity (ARCH) model developed by Engle may be the best model to run.

As the name suggests, the ARCH model, may have an autoregressive structure in that, the heteroscedasticity observed over different periods may be Autocorrelated. This means that variances observed in one-time period depend on the variances in the past, this is called conditionally heteroscedastic. Therefore, the data has to be tested for the presence of ARCH effects. The researchers first estimated a mean equation of the Natural log of the Lusaka Securities Index (LNLASI) as a measure of volatility with AR(1) and MA(1) characteristics. The results of the mean equation are presented below:

Table 3. Mean equation

MEAN EQUATION		
VARIABLES	**T Statistic**	**Prob**
C	25.17629	0.00000
AR(1)	7.71136	0.00000
MA(1)	1.62946	0.11440

From the table above we can conclude that the Natural log of the LASI is Autoregressive since the p value of the AR(1) is less than 0.05. However, the variable does not have a moving average since the p value of the MA(1) is greater than 0.05 and therefore not statistically significant.

Then a test to determine if ARCH effects were present in the model run and yielded the following results:

Table 4. Test for ARCH Effects on the dependent variable

Heteroskedasticity Test: ARCH			
F-statistic	1.152572	Prob. F(1,29)	0.2919
Obs*R-squared	1.184965	Prob. Chi-Square(1)	0.2763

Since the P value was greater than 0.05 we conclude that ARCH effects are not present and that there is no need to run an Autoregressive Conditional Heteroscedasticity (ARCH) model.

The researchers then decided to run the following Autoregressive Distributed Lag Model (ARDL):

Table 5. ARDL(1,0,1,2,0) regression estimates

Variable	Coefficient	Std. Error	T Statistic	Prob*
LNLASI(-1)	0.507443	0.128434	3.950985	0.0007
INF	-0.009373	0.008203	-1.142654	0.2660
LIR	0.007080	0.013939	0.507941	0.6168
LIR(-1)	-0.032263	0.015065	-2.141627	0.0441
DIR	0.002496	0.028376	0.028376	0.9307
DIR(-1)	0.014328	0.033632	0.426010	0.674400
DIR(-2)	0.060184	0.025214	2.386944	0.026500
TBR	-0.017111	0.009339	-1.832294	0.081100
C	4.317270	1.098424	3.930424	0.000800
R- squared= 0.834066	F-statistic = 13.194570		D-W Stat = 1.912331	
Adj R- squared = 0.770853	Prob(F- statistic) = 0.000001			

The results from the ARDL model presented above indicate that the model is a good fit. Since The P value of the F-statistic is 0.000001 and less than 0.05 it is an indication that the overall model is statistically significant. The goodness of fit (R squared) of the model is 0.834066, this means that 83.4% of the variation in stock prices can be explained by variations in previous stock prices, lending interest rates, deposit interest rates, inflation and the 91-day treasury bill rate but the rest of the 16.6% of variation in stock prices are explained by other factors not included in the model but explained by the errors like information asymmetry. The Durbin-Watson statistic of 1.912331 is a strong indication that the model does not suffer from auto-correlation or the model is correctly specified or both.

4.3.1 Test for Cointegration

Bound tests for Cointegration were run in order to determine whether the variables had an equilibrium long run relationship. The null hypothesis of no Cointegration was tested against the alternative hypothesis and the following results were recorded:

Table 6. Bound test for cointegration

Test Statistic	Value	Significance	I(0)	I(1)
F Statistic	4.651863	10%	2.20	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Since the computed F statistic (4.651863) is greater than the I(0) and I(1) at all levels of significance, we reject the null hypothesis and conclude that all the variables are Co-integratedand that they have an equilibrium long run relationship. As a result, an error correction modelwas estimated.

4.3.2 Long-Run Estimates

The following long run estimates of the model were estimated:

Table 7. Levels equation

Variable	Coefficient	Std Error	T Statistic	Prob
INF	-0.019029	0.016819	-1.131417	0.2706
LIR	-0.051127	0.013985	-3.655786	0.0015
DIR	0.156342	0.045332	3.448814	0.0024
TBR	-0.034739	0.022581	-1.538449	0.1389
C	8.765011	0.392334	22.340700	0.0000

Since the estimates of the lending interest rate and deposit interest rate is statistically significant, we can conclude that the lending interest rate has a negative long run effect on stock prices while deposit interest rate have a long run positive relationship on stock prices. The estimates of the 91-day Treasury bill yield and the inflation both have a long run insignificant negative impact on stock prices.

4.3.3 Short-Run Estimates

The estimates of the short term equilibrium relationship with the variables are shown in the table below:

Table 8. Error Correction Model (Restricted Constant and No Trend)

Variable	Coefficient	Std Error	T Statistic	Prob
D(LIR)	0.001990	0.011114	0.179091	0.8601
D(LIR(-1))	0.012752	0.013598	0.937839	0.3623
D(TBR)	-0.022042	0.008519	-2.587319	0.0198
D(TBR(-1))	0.014968	0.008221	1.820729	0.0874
D(INF)	-0.004341	0.006191	-0.685017	0.5031
D(INF(-1))	-0.007659	0.007029	-1.089622	0.2920
D(DIR)	-0.012437	0.024637	-0.504801	0.6206
D(DIR(-1))	-0.079769	0.026824	-2.973811	0.0090
CoinEq(-1)	-0.434517	0.072415	-6.000342	0.0000

The results above give an indication that previous values of the deposit interest rate and currentvalues of treasury bill rate have a significant negative relationship with stock prices in the shortrun while the lending interest rate in the both the previous and current period have an insignificant positive impact on stock prices and inflation in both the previous and current periods has an insignificant negative impact of stock prices and finally the previous treasury bill yields were found to have an insignificant positive impact on stock prices.

The error correction term is statistically significant, negative and less than 1 as expected. The value -0.434517 means that 43.45% of the discrepancy between the long term and short term Natural log of stock prices is corrected within 6 months.

4.3.4 Diagnostic Tests

The effectiveness of the estimated Autoregressive Distributed Lag model that was estimated was tested by diagnostic tests for Serial Correlation, Heteroscedasticity, Normality, Model Specification and Stability.

Table 9. Diagnostic tests

Diagnostic Tests	Specific Tests	Probability
Model Specification	Ramsey's Reset Test	0.742000
Serial Correlation	Breusch Godfrey Test	0.977800
Heteroscedasticity	Breusch - Pagan - Godfrey Test	0.330200
Normality	Jarque-Bera	0.573759

4.3.5 Serial Correlation

The null hypothesis that there was no serial correlation up to 2 lags was tested against the alternative hypothesis was tested and the results obtained are shown below, since the P value (0.9778) was greater than 0.05 we accept the null hypothesis and conclude that there was no serial correlation detected in the model.

Table 10. Breusch-Godfrey Serial Correlation LM Test

Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.022465	Prob. F(2,19)	0.9778
Obs*R-squared	0.070775	Prob. Chi-Square(2)	0.9652

4.3.6 Heteroscedasticity

The null hypothesis that there was no heteroscedasticity (Homoscedasticity) was tested against the alternative hypothesis of heteroscedasticity was tested and the results obtained are shown below, since the P value (0.3302) was greater than 0.05 we accept the null hypothesis and conclude that there was no serial correlation detected in the model.

Table 11. Heteroskedasticity Test: Breusch-Pagan-Godfrey

Null hypothesis: Homoskedasticity			
F-statistic	1.229854	Prob. F(8,21)	0.3302
Obs*R-squared	9.571212	Prob. Chi-Square(8)	0.2964
Scaled explained SS	6.865559	Prob. Chi-Square(8)	0.5512

4.3.7 Model Specification

The null hypothesis that the fitted model was correctly specified was tested against the alternative hypothesis of model misspecification was tested and the results obtained are shown below, since the P value (0.7420) was greater than 0.05 we accept the null hypothesis and conclude that the model was correctly specified.

Table 12. Ramsey RESET TestEquation: UNTITLED

Omitted Variables: Squares of fitted values Specification: LNLASI LNLASI(-1) INF LIR LIR(-1) DIR DIR(-1) DIR(-2) TBRC	Value	df	Probability
t-statistic	0.333839	20	0.7420
F-statistic	0.111449	(1, 20)	0.7420
Likelihood ratio	0.166709	1	0.6831

4.3.8 Stability Test

The researchers conducted stability tests on the estimates using the Cumulative Sum of Recursive Residues (CUSUM) and the Cumulative Sum of Squared Residues (CUSUM SQ) tests for stability. Both tests suggest that the model is stable since the CUSUM and CUSUM SQ statistic is between the critical bounds at the 5% level of significance. Therefore, from the graphs of both the CUSUM and CUSUM-SQ tests conclude that both the long and short runs estimates obtained by the model are stable and lack structural breaks. This leads us to believe that the results of the estimated model are reliable and efficient.

5. Discussion of Findings

The major objective for this analysis was to determine the impact that interest rates and Treasury bill yields have on stock prices in Zambia. The study used an Augmented Dickey Fuller (ADF)test to determine the stationarity of the variables and an Autoregressive Distributed Lag (ARDL) model was used for analysis. The bounds test was used to determine whether or not the variables had a long run equilibrium relationship. Once Cointegration was confirmed, an error correction model was estimated.

The results of the study indicated that The Natural log of the stock market index (LNLASI), deposit interest rates (DIR), lending interest rates (LIR) and the 91-day treasury bill rate (TBR)were integrated of order 1, meaning the variables needed to be differenced once to make them stationary. Inflation on the other hand was stationary at levels.

The short run estimates suggest that the deposit interest rate and current values of treasury bill rate have a significant negative relationship with stock prices in the short run while the lending interest rate in both the previous and current period have an insignificant positive impact on stock prices in the short run while inflation in both the previous and current periods has an insignificant negative impactof stock prices in the short run and finally the previous treasury bill yields were found to have an insignificant positive impact on stock prices in the short run.

Furthermore, the long run estimates suggest that the lending interest rate has a negative long run effect on stock prices while deposit interest rate have a long run positive relationship on stock prices. The estimates of the 91-day Treasury bill yield and the inflation rate have a long run insignificant negative impact on stock prices.

6. Conclusion

The main objective of this research was to determine the impact that interest rates and treasurybills have on stock prices in Zambia. Analysis of data indicated that Deposit Interest rates hada significant but weak negative impact on stock prices in the short run but had a positive impacton the stock prices in the long run, lending interest rates on the other hand had an insignificantpositive impact on stock prices but a negative impact on stock prices in the long run. Treasury bill yields were found to have a negative significant impact on stock prices but had an insignificant negative impact on stock prices in the long run.

In addition, the study also investigated the influence that inflation has on the stock prices and the analysis indicated that inflation has an insignificant impact on stock prices in both the shortand long run.

As a result of the Cointegration among the variables, there are possibilities for investors to earnexcess returns. This is because, it would take time for stock prices to react to new informationon interest rates and treasury bills and thus give investors more time to balance and rebalance their portfolios in a way that maximizes returns. In

contrast, if the markets were efficient, investors would not be able to earn any abnormal returns because the security prices will adjustrapidly to the arrival of new information, thus the current prices reflect all information about the security.

Treasury bills and interest rates both have a negative relationship with stock prices, thus as interest rates decline, investors will be strongly motivated to boost their investments in Zambian stock markets. Instead of making risk-free investments that would yield lesser returns, investors will refocus their attention on generating higher positive real returns. Additionally, when production costs decrease due to falling interest rates, investors will be more motivated to grow their businesses and increase profits. As a result, stock prices would sharply increase in the Zambian stock market.

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