

Macroeconomic Variables and Government Bond Yields Listed on the Nairobi Securities Exchange

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Abstract:- The main objective of the study was to determine the relationship between macroeconomic variables and government bond yields listed on the Nairobi Securities Exchange (NSE). The specific objectives were to investigate the impact of the inflation rate, economic growth rate, foreign direct investment (FDI), and exchange rate on government bond yields listed on the Nairobi Securities Exchange (NSE). The study adopted a quantitative research design and utilized secondary data on nineteen, 15-year Kenyan government bonds listed on the NSE from the 1st quarter of 2007 to the 1st quarter of 2023, that is a sixteen-year period. The analysis focused on yearly yield variations over the maturity period of the bonds using data obtained from the Central Bank of Kenya, Kenya National Bureau of Statistics and World Bank. The Vector Error Correction Model technique was employed to identify the long and short run relationships between the macroeconomic factors and government bond yields in EViews. Diagnostic tests included the Augmented Dickey Fuller test and Johansen Cointegration Tests; to test for stationarity and long run relationship between variables respectively. Lag selection was carried out and an optimal lag of 1 was selected based on the Akaike information criterion (AIC) and Schwarz information criterion. VECM was found to be the most suitable model since all the time series data of the variables was found to be stationary upon first difference and there was presence of at least one cointegrating equation. The study established government bond yields were significantly affected by Foreign Direct Investment, Exchange Rate, and Inflation Rate on the long-term while on the short-term the government bond yields were only affected by the inflation rate. The study also established a positive relationship with inflation rates both in the long and short run. The FDI and Exchange Rate exhibited a positive significant impact on the long run only. Economic growth did not exhibit any long run and short run relationships at five percent significance level. The research proposed that it is crucial to prioritize government bonds when developing both monetary and fiscal policies within the nation. Additionally, it suggested that the government should initiate an extensive awareness campaign regarding government bonds and their associated advantages as a strategy to boost bond yields. The primary constraint of the research was its focus on specific macroeconomic variables and bonds. To address this, the study suggested the need for additional empirical investigations into how

other macroeconomic factors, like unemployment rates and government expenditures, impact government bond yields.

Keywords:- Government Bond Yields, Inflation Rate, Economic Growth Rate, Exchange Rate, Foreign Direct Investment, Cointegration, Vector Error Correction Model, Stationarity.

I. INTRODUCTION

A bond is a loan where the issuer is required to repay the capital at maturity and compensate the buyer with one or more future cash flows (Chorafas, 2005). They are responsible for repaying lenders or investors the money borrowed plus interest over a predetermined period (Choudhry, 2006). These cash flow(s) may have a predetermined schedule and magnitude or depend on some economic variable whose value is typically known a priori. Government bonds are types of bonds issued by the federal or national governments of countries to raise funds while rewarding the issuer with annual interest rates over the maturity period (Ślusarczyk et al., 2020). According to McKay and Peters (2019), bond yield refers to interest generated from bond investments over the maturity period(s).

Developing economies in Africa and throughout the world are grappling with mounting budget deficits, rising interest rates, and rising inflation rates. As a result, bond issuance remains a crucial part of Kenya's and other developing countries' deficit finance strategies. For any investment, investors usually look at the level of returns for a given risk premium, in this case, investors who buy government bonds need to understand government bond yields and potential macroeconomic factors that might significantly affect the bond yield. This forms the foundation of this research.

Macroeconomic variables aid investors by providing a convenient method of obtaining more information about the stock market activity as well as determining how businesses perform (Syed Jamaludin et al., 2018). The effectiveness of the security market is greatly influenced by macroeconomic factors. A research study conducted by Adiwibowo and Sihombing (2020) on the macroeconomic factors affecting Indonesian government bonds yields revealed that a variety of factors affect the yield on government bonds, including currency rates, bid-ask gaps, central bank (CB) rates,

overnight rates, credit default swaps (CDS) discrepancies, and oil prices. Security performance is vital for economic growth, according to Olweny and Omondi (2011), since it allows for better allocation of funds to productive economic activity, thereby functioning as a barometer of an economy.

Poghosyan (2014) discovered that the yield on government bonds has a long-term relationship with both the proportion of public debt to GDP and country level of economic growth. In the medium term, sovereign bond rates in many industrialized nations are projected to face significant upward pressure due to budget deficits and public debt (Kumar & Baldacci, 2010). In advanced economies such as the USA, long-term bond yields have a positive correlation with government debt and the long-term yield of US government-issued bonds, both short and long-term (O'Hara & Zhou, 2021). As the amount of public debt rises, the price of government securities declines (Bernal et al., 2016) in the long run, however, Zhou (2021) found a non-linear relationship between the level of government debt and respective bond yields.

Government bond yields, according to Bhattacharyay (2013), are adversely correlated with changes in exchange rate, GDP rate, rates of interest. Economic expansion, according to Senga (2018), is a factor in government bond yields whereby higher rates of economic growth result in less government debt and fewer bond issuances; therefore, debt and bond issuance decline when the economy grows faster.

II. JUSTIFICATION OF THE STUDY

The existing studies on government bond yields in Kenya have shown limitations and a lack of consideration for unique conditions such as the impact of the COVID-19 pandemic on the economy. These gaps in the literature call for further research to address these limitations and provide a more comprehensive understanding of the factors influencing government bond yields in the Kenyan context.

Nyaga (2014) and Balozzi (2017) conducted research on factors affecting treasury bill uptake in Kenya. However, their studies did not directly analyze government bond yields, which are essential in understanding borrowing costs for the government and investment decisions made by individuals and institutions. Furthermore, the use of regression analysis in their research was problematic as it failed to capture the long- and short-term effects of the macroeconomic variables under consideration. By not accounting for these effects, the studies fell short in providing a complete understanding of the relationship between the macroeconomic variables and government bond yields.

In a related study, Fredrick (2014) examined the influence of macroeconomic factors on the growth of the bond market in sub-Saharan Africa but did not specifically consider the impact on government bond yields. This omission is significant because government bond yields directly affect the cost of borrowing for the government, and

understanding the determinants of these yields is crucial for policymakers and investors.

Another study conducted by Ngaruiya and Njuguna (2016) focused on macroeconomic factors affecting bond prices but did not include an analysis of government bond yields. While bond prices and bond yields are related, they represent different aspects of the bond market. Government bond yields are specifically indicative of the return on investment for bondholders, while bond prices represent the market value of bonds. The failure to account for bond yields in their analysis limits the understanding of the factors directly impacting the returns and risks associated with government bonds.

These research endeavors would contribute to the existing body of knowledge, help policymakers in formulating effective fiscal policies, and assist investors in making informed decisions in the Kenyan bond market. Through an analysis of the impacts of macroeconomic factors on government bond yields in Kenya, this study aims to close the knowledge gaps in this area while addressing recent economic developments such as the COVID-19.

III. LITERATURE REVIEW

In a more recent study, Li and Huang (2021) investigated the impact of exchange rate movements on government bond yields in a sample of Asian economies. Their research provided additional insights into the relationship by highlighting a significant positive association between exchange rate volatility and government bond yields. They argued that increased exchange rate volatility heightened the uncertainty and risk perception among foreign investors, leading to higher yields on government bonds.

Subhani and Panjwan, (2009) assessed the nexus between the Consumer Price index (CPI) and bond yields of government in Pakistan between July 2001 and 2009 September utilizing secondary monthly data from the State Bank of Pakistan. The research applied an auto-regressive integrated, moving-average (ARIMA) model for data which was timeseries where the consumer price index was the independent variable, and the government bond yield was the dependent variable. The Autoregressive Integrated Moving Average (ARIMA) model results validated the premise that the Consumer Price Index (CPI) had a substantial relationship with the yield on government bonds.

According to Ammer (2018) who conducted research that suggests a negative relationship between FDI and bond yields on U.S. bond holdings by foreign investors from 31 countries for the period 2003–2016. They found that a 1% increase in FDI in a country is associated with a 0.02% decrease in its bond yield. This implies that higher levels of FDI might lead to reduced borrowing costs for the government, as foreign investors' confidence in the country's economic prospects can drive demand for government bonds and lower their yields.

Matei (2021) examined the consequences of the Covid-19 pandemic on sovereign yield spreads in European Monetary Union countries concerning German government bonds. Moreover, Matei (2021) also argued that economic growth measured by the GDP exerted significant upward pressure on bond yields of government in the 14 European Monetary Union nations, throughout the specified time, both long-run and short-run.

IV. DATA AND METHODOLOGY

This study was guided by a quantitative research design. The Causal-comparative research technique was used to enable the study to specify the type of relationship between macroeconomic factors that is Inflation Rate, Foreign Direct Investment, Exchange rate, and Economic Growth Rate and how they affect the government bond yields. The study's goal was to statistically identify long and short run relationships between the independent variables (macroeconomic factors) and dependent variables (bond yields). The study covered the period of Q₁ 2007 to Q₁ 2023 where the study utilized yearly secondary time series data to determine the impacts of inflation rate, Foreign Direct Investment, Exchange rate, and Economic Growth Rate on government bond yields listed on the Nairobi Securities Exchange in Kenya. The Vector Error Correction Model (VECM) was utilized to analyze the long run and short run relationships. The VECM had the advantage of utilizing non-stationary time series data and allowed cointegrating relationships. The guiding general model would be described as:

$$\Delta BY_t = \beta_0 + \beta_1 \Delta BY_{t-1} + \beta_2 \Delta INF_{t-1} + \beta_3 \Delta FDI_{t-1} + \beta_4 \Delta EG_{t-1} + \beta_5 \Delta EXR_{t-1} + \lambda ECT_{t-1} + u_t \dots \dots \dots (1)$$

Where ΔBY_t is the first-differenced bond yield, ΔBY_{t-1} is the lagged value of the bond yield, ΔINF_{t-1} , ΔFDI_{t-1} , ΔEG_{t-1} , ΔEXR_{t-1} are the lagged first-differenced values of; the inflation rate, FDI, economic growth rate, and exchange rate, respectively. ECT_{t-1} is the lagged error correction term. β_0 is the constant term, β_1 is the coefficient for the lagged first difference of bond yield. β_2 , β_3 , β_4 , β_5 are the coefficients for the first differences of the independent variables (inflation rate, FDI, economic growth rate, and exchange rate, respectively). λ is the coefficient for the error correction term. u_t represents the error term.

➤ *Diagnostic Tests*

The study carried out several diagnostic tests on the study variables. The Augmented Dickey-Fuller Test (ADF) was used to test for stationarity, the Johansen Cointegration Test was performed to test for the presence of cointegration amongst the independent and dependent variables. The lag lengths selection was also performed using the Akaike information criterion (AIC), Schwarz Criterion (SC) and Hannan-Quinn Criterion (HQ) to select the optimal number of lags for the VECM model.

➤ *Empirical Results*

• *Stationarity Test*

The Augmented Dickey-Fuller Test (ADF) was used to test for stationarity.

Table 1 Augmented Dickey-Fuller Test Results

Variable	At Level	At Level	First Difference	First Difference
	(Intercept)	(Trend & Intercept)	(Intercept)	(Trend & Intercept)
Bond Yield	0.0723 (Non-stationary)	0.0645 (Non-stationary)	0.0329 (Stationary)	0.0261 (Stationary)
Inflation Rate	0.8221 (Non-stationary)	0.0937 (Non-stationary)	0.0140 (Stationary)	0.0027 (Stationary)
Economic Growth Rate	0.72010 (Non-stationary)	0.4390 (Non-stationary)	0.0020 (Stationary)	0.0119 (Stationary)
Exchange Rate	0.0848 (Non-stationary)	0.3172 (Non-stationary)	0.0414 (Stationary)	0.0244 (Stationary)
Foreign Direct Investment	0.0573 (Non-stationary)	0.0819 (Non-stationary)	0.0104 (Stationary)	0.0071 (Stationary)

In summary, the ADF test outcomes underscore that all these variables were non-stationary at their initial levels, irrespective of trend inclusion. However, they become stationary when differenced once, with or without a trend. This provides condition provides a clear need for the implementation of the Vector Error Correction Model.

• *Cointegration Test*

Table 2 Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.782720	71.44130	69.81889	0.0369
At most 1	0.706434	47.01620	47.85613	0.0598
At most 2	0.627332	27.40573	29.79707	0.0921
At most 3	0.477295	11.61264	15.49471	0.1765

At most 4	0.074158	1.232834	3.841466	0.2669
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.782720	24.42509	33.87687	0.0249
At most 1	0.706434	19.61047	27.58434	0.3687
At most 2	0.627332	15.79309	21.13162	0.2372
At most 3	0.477295	10.37981	14.26460	0.1882
At most 4	0.074158	1.232834	3.841466	0.2669
Max-eigenvalue test indicates 1 cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

In summary, at a 5% significance level, both the Trace and Max-Eigenvalue tests indicated the existence of one cointegrating equation among the series. This implies that the variables were not moving independently in the long run, but rather, they have a stable, long-term relationship. The presence of Cointegration and the stationarity of the time series data upon first difference necessitated the study to adopt a Vector Error Correction Model (VECM).

➤ *Vector Error Correction Model Results*

The VECM allowed for the analysis of the long and short run relationships by examining their coefficients.

• *Long Run Relationships*

Table 3 Summary of T-Statistic of Long Run coefficients.

Variable	Coefficient	T-statistic(t)	Significance
ECONOMIC GROWTH RATE (-1)	-0.101605	0.84091	Not Significant
FOREIGN DIRECT INVESTMENT INFLOWS USD(-1)	0.611780	-2.20402	Significant
INFLATION_RATE(-1)	0.179496	-2.36526	Significant
USD EXCHANGE RATE(-1)	0.035587	-2.17480	Significant

The derived equation becomes:

$$\begin{aligned}
 \text{BOND_YIELD}_{t-1} = & -3.519003 - 0.101605 * \\
 \text{ECONOMIC_GROWTH_RATE}_{t-1} & + 0.611780 * \\
 \text{FOREIGN_DIRECT_INVESTMENT_INFLOWS_USD}_{t-1} & + \\
 0.179496 * \text{INFLATION_RATE}_{t-1} & + 0.035587 * \\
 \text{USD_EXCHANGE_RATE}_{t-1} &
 \end{aligned}$$

The coefficient of -0.101605 signifies a negative relationship between lagged economic growth and bond yield in the long term. However, with a t-statistic of approximately 0.84091, this relationship is not statistically significant at the 95% confidence level. The coefficient of 0.611780 demonstrates a positive connection between lagged FDI inflows and bond yield over an extended period. The t-statistic for this coefficient, which is approximately -2.20402, exceeds the 1.96 threshold, indicating that changes

in FDI are statistically significant and impact the dependent variable in the long run at a 95% confidence level.

The coefficient of 0.179496 showed a positive association between the lagged inflation rate and bond yield in the long term. With a t-statistic of approximately -2.36526, changes in the inflation rate are statistically significant and are likely to affect the dependent variable in the long run at a 95% confidence level. The coefficient of 0.035587 signifies a positive relationship between the lagged US dollar exchange rate and bond yield over the long term. The t-statistic for this coefficient, approximately -2.17480, exceeds the 1.96 threshold, indicating that changes in the exchange rate are statistically significant and are expected to have a notable impact on the dependent variable in the long run at a 95% confidence level.

• *Short Run Relationships*

Table 4 Summary of T-Statistic of Coefficients

Variable	Coefficient	Standard Error	t-Statistic	Significance (α = 0.05)
Error Correction Term	-0.177673	0.04290	-4.14170	Significant
D(BOND_YIELD(-1))	0.075835	0.07353	1.03137	Not Significant
D(ECONOMIC_GROWTH_RATE(-1))	-0.046970	0.06166	-0.76181	Not Significant
D(FOREIGN_DIRECT_INVESTMENT_INFLOWS_USD(-1))	-0.214591	0.19732	-1.08754	Not Significant
D(INFLATION_RATE(-1))	0.156089	0.07985	1.96475	Significant
D(USD_EXCHANGE_RATE(-1))	-0.003305	0.01991	-0.16602	Not Significant

The derived equation is:

$$\begin{aligned} D(\text{BOND_YIELD}) = & -0.177673 * \text{ECT}_{t-1} + \\ & 0.075835 D(\text{BOND_YIELD}_{t-1}) - \\ & 0.046970 * D(\text{ECONOMIC_GROWTH_RATE}_{t-1}) - \\ & 0.214591 * \\ & D(\text{FOREIGN_DIRECT_INVESTMENT_INFLOWS_USD}_{t-1}) + \\ & 0.156089 * D(\text{INFLATION_RATE}_{t-1}) - \\ & 0.003305 D(\text{USD_EXCHANGE_RATE}_{t-1}) + 0.003539 \end{aligned}$$

The analysis of the equation for bond yield reveals several key findings. First, the coefficient on the Error Correction Term (ECT) is -0.177673, indicating that the system adjusts back to its long-run equilibrium at a rate of 17.76733% per year. This coefficient is not only substantial in magnitude but also statistically significant, with a t-statistic of -4.14170, exceeding the 1.96 threshold for significance at a 5% confidence level. However, the t-statistic for the lagged bond yield is 1.03137, falling below the 1.96 threshold and suggesting that the lagged bond yield may not be statistically significant at the 5% level of significance in explaining the error correction. In practical terms, this means that past values of bond yield might not have a significant impact on the error correction mechanism. Likewise, the t-statistic for the lagged economic growth rate is -0.76181, indicating that this coefficient is not statistically significant at the 5% level. This implies that the lagged economic growth rate may not be a significant factor in explaining the error correction. The t-statistic for the lagged foreign direct investment inflows in US dollars is -1.08754, suggesting that this coefficient is not statistically significant at the 5% level. Consequently, the lagged foreign direct investment inflows may not be a significant contributor to explaining the error correction. In contrast, the t-statistic for the lagged inflation rate is 1.95475, exceeding the 1.96 threshold and indicating that the coefficient for the lagged inflation rate is statistically significant at the 5% level. This implies that the past values of inflation rate play a significant role in explaining the error correction mechanism. The t-statistic for the lagged US dollar exchange is -0.16602, indicating that this coefficient is not statistically significant at the 5% level, suggesting that past values of the US dollar exchange rate may not significantly contribute to explaining the error correction.

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

The coefficient of inflation rate indicated a long-term positive relationship with bond yield, and there was also a short-term association with the lagged inflation rate. These coefficients positively influenced the yield in both the long and short run, indicating that an increase in inflation results in higher yields to compensate investors for inflation. Economic growth rate's coefficient was found to be insignificant in both the long and short run relationships with bond yield. The coefficient was negative for both long and short runs, possibly due to the economic downturn caused by the COVID-19 pandemic. The coefficient of FDI was significant in the long run, showing a positive relationship with bond yield, but it was insignificant in the

short run. This is likely due to the long-term nature of most FDIs, leading to a long-run association with bond yields. The coefficient of the exchange rate is statistically significant in the long run with a positive relationship with bond yield, while the short-term effects are insignificant. This suggests that yields react to long-term changes in exchange rates rather than short-term fluctuations.

Government bonds should be a focal point in the development of monetary and fiscal policies. It is crucial that interest rates associated with government-issued bonds offer attractive yields to encourage higher citizen investment in these bonds, while ensuring that such investments do not negatively impact other securities within the capital market. The government should launch an extensive awareness campaign about government bonds and their benefits. The study also recommends foreign investors to utilize information from this research to better understand how macroeconomic variables affect bond yields for efficient portfolio allocation.

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