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Original Article

Effects of Public Debt on Interest Rates in Selected East African Community Member States

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ABSTRACT

East African Community member states have embarked on various strategies to reduce interest rates in the region to boost investment so as to accelerate economic growth. However, despite the many reforms, the interest rates are far higher than in other countries in Africa, which are more developed. In an attempt to bolster investment, these states have increased public debt rapidly, exceeding the debt ratio of 50 per cent of Gross Domestic Product as provided in their treaty. The main objective of this study was to examine the effects of public debt on interest rates in selected East African Community member states. The study was anchored on the loanable fund model and used a descriptive panel research design. The dataset was drawn from World Development Indicators and Penn World Tables for the period 1980 to 2020. The dataset was drawn from secondary sources: World Bank's World Development Indicators, Penn World Tables, Economic Surveys and Statistical Abstracts for the period 1980 to 2020. The Panel Autoregressive Distributed Lag method was used to analyse the study. The study found that public debt had a positive effect on the long-term interest rate in the five countries combined. Therefore, these governments need to take effective measures to pursue fiscal discipline. Additionally, EAC states can use concessional loans, which have more favourable terms like lower interest rates, deferred repayments, and income-contingent repayments.

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INTRODUCTION

Public debt is inevitable in countries facing a scarcity of capital. Insufficiency of capital is a result of under-savings, which makes it necessary for the countries to look for additional funding normally in the form of foreign borrowing (Adepoju et al., 2007; Essien et al., 2016). Governments typically borrow by issuing securities, government bonds, and bills. They may also borrow directly from supranational organisations such as the World Bank, International Monetary Fund, and other international financial institutions. Additionally, loans can be obtained from bilateral sources.

Public borrowing may allow countries to facilitate growth take-offs by investing in a vital mass of infrastructural projects and in the social sectors. In other words, countries borrow to ensure that investments that have a medium to a long time frame and require large amounts of money are realised (Medeiros & Silva, 2010). Public debt also assists tax smoothing and counter-cyclical fiscal policies, which are important for reducing output volatility. Barro (1979) argued that public borrowing may be an important policy instrument to ensure intertemporal welfare maximisation when public expenditures are stochastic and public taxes are economically inefficient; taxes can be smoothened to reduce the excess lifetime burden of public financing. Moreover, public debt allows an equitable positioning of benefits and costs for long-term projects by reallocating taxation away from the present generations (Gill & Pinto, 2015). Indeed, a government may incur debt because it needs to fill the fiscal deficit, that is, the difference between tax revenue and expenditures to carry out its development function smoothly, particularly investment activities.

Although public debt may finance public goods and consequently increase economic growth and welfare, it has several potential problems. Specifically, the level of economic growth may considerably lose momentum when a country reaches a public debt overhang. This could be through higher interest rates and higher levels of inflation (Boccia, 2013). In terms of interest rates, creditors may be induced to set higher interest rates owing to low confidence in the capacity of the country to service its debt. Consequently, higher interest rates may encourage high debt costs, compelling the government to impose higher taxes (Ncanywa & Masoga, 2018). Higher interest rates may also lead to low investment, resulting in slow economic growth. Subsequently, this may stimulate the current account deficit and reduce economic growth. This induces the country to borrow more and, therefore, increase its debt service obligation (Iyoha, 1999). In addition, with an accumulation of debt, the cost of servicing the debt would have to come from taxes on future production. This may increase the likelihood of economic doldrums, discourage government spending and crowd out private investments (Ncanywa & Masoga, 2018).

Furthermore, the accumulation of debts beyond the threshold may force countries to spend more on servicing debt and less on investment in human (education, health) and physical (infrastructure) capital (Reinhart & Rogoff, 2010). Public debt borrowing and interest payments may also increase income inequality (Barnes., 2008). A high percentage of government stocks and bonds are concentrated among wealthy people. Payment of public debt is mainly achieved through taxation. If the tax system is not progressive, income will be transferred from the low-income groups to the high-income bondholders.

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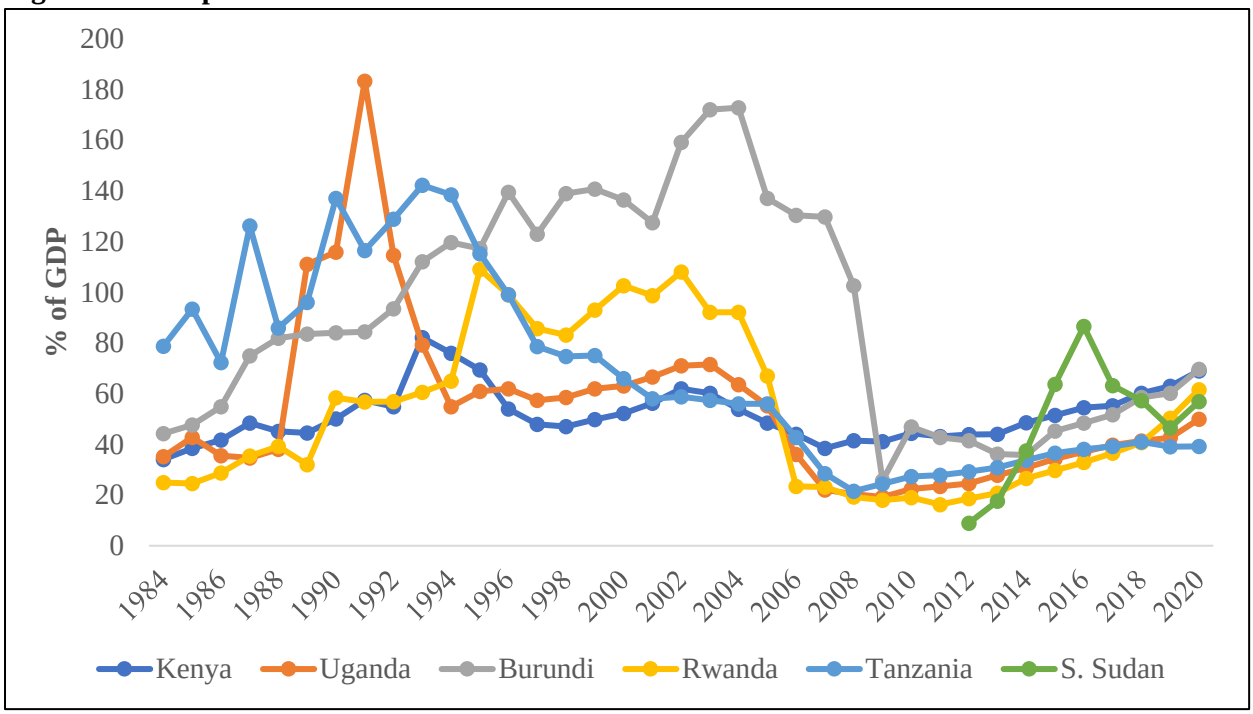
Public Debt in East African Community Member States

Over the years, public debt for the East African Community (EAC) member countries has been increasing, as shown in *Figure 1*.

Figure 1 shows that from the 1980s to the mid-1990s, public debt as a percentage of GDP for most EAC member countries was on the rise. Tanzania had the highest public debt ratio in the EAC, followed by Burundi in this period. Between the mid-1990s and 2010, the public debt-to-GDP ratio for most EAC member countries was on a downward trend. The decline is attributed to debt relief schemes such as Heavily Indebted Poor Countries (HIPC) and Multilateral Debt Relief Initiatives (MDRI) that Tanzania, Uganda, Burundi, and Rwanda benefited from. From 2011, the debt-to-GDP ratio increased drastically. For instance, Rwanda, Tanzania, Uganda, Burundi, and Kenya had their public debts increased from 19 per cent of GDP, 24 per cent, 20 per cent, 25 per cent, and 44 per cent, respectively, in 2010 to 61 per cent, 39 per cent and 44 per cent, 69 per cent and 68 per cent, in 2020. South Sudan's public debt increased from 0 per cent of GDP in 2011 to 57 per cent in 2020. Kenya, Burundi, Rwanda, and South Sudan have already compromised the bid to comply with the region's debt target, which is equivalent to 50 per cent of the GDP and weakened their countries' debt sustainability indicators (IMF, 2021).

Figure 1: Total public debt as a ratio of GDP in EAC



Source: Author's construction from IMF database.

This rapid accumulation of debt by EAC member countries is attributed to the attempt to fund persistent budget deficits and implement mega infrastructure projects against a backdrop of declining revenue collection, putting at risk the region's long-term economic stability. This has raised concern by the IMF over the rate at which these countries are accumulating debt and has warned that this may lead to a debt crisis (IMF, 2019). Kenya and Burundi have the highest debt distress profiles relative to their EAC peers, with their debt-to-gross domestic product (GDP) ratios projected to exceed 65 per cent in 2020 due to the impact of COVID-19 (World Bank, 2020). Burundi has joined a group of nine African countries at a high risk of debt distress, while Kenya's risk of default has increased to moderate from low (IMF, 2019). So far, Kenya, Uganda and Tanzania are among the top 50 countries in the world that are highly indebted to China (World

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Bank, 2021). According to IMF (2019), low revenue collection levels have seen most of these countries spend more than half of their taxable income on debt repayment, curtailing development projects. While struggling with this burden, most of these countries have severally rescheduled their external debts-which, in turn, worsened their external debt problems. The impact of locust invasions, floods and the COVID-19 pandemic exacerbated the debt ratios in 2020, leaving Burundi, Kenya, Rwanda, South Sudan, and Uganda highly exposed to greater rollover and exchange rate risks, according to IMF analysis.

Public Debt and Interest Rate

The variability of short-run and long-run interest rates is a prominent feature in most economies. Interest rates change in response to a variety of economic events, such as changes in federal policy, crises in domestic and international financial markets, and changes in prospects for long-run economic growth and inflation. However, economic events such as these tend to be irregular (Akintoye & Olowolaju, 2008). Changes in interest rates can reflect the basic situation of the operation of the macroeconomy; it also affects all the macroeconomic variables, such as GDP, price level, the level of employment, international balance of payments, the rate of economic growth, and investment, among others. Therefore, a change in interest rates is one of the main factors in judging the macroeconomic situation, and the interest rate trend analysis is the main method to predict the macroscopic economic situation (Albu, 2006). *Table 1* shows the trend of interest rates in EAC member states.

Table 1: Interest rates in Selected EAC member States

Country	1985	1990	1995	2000	2005	2010	2015	2020
Tanzania	12	31	42	21	15	14	16	17
Burundi	12	12	15	15	18	12	15	14
Kenya	14	18	36	22	12	14	16	13
Rwanda	-	-	-	16	15	17	17	16
Uganda	24	38	38	22	19	20	22	19

Source: Author's construction from World Development Indicators database.

EAC member states experienced severe macroeconomic problems towards the end of the 1970s through the 1980s, when output declined substantially in almost all countries as a result of the financial crisis. In response to this deterioration, EAC governments launched policy programmes containing the Structural Adjustment Programmes. Several forms of corrective measures were undertaken, including financial sector reform policy, for example, the interest rate ceiling (Kuteesa *et al.,* 2010). In the late 1980s and early 1990s, there was financial liberalisation in most SSA countries, which was expected to ensure a healthy, competitive, and efficient financial sector (Folawewol & Tennant, 2008). During this period, most EAC interest rates were relatively low, apart from Uganda, which recorded high-interest rates. That is, between 1985 and 1990, Uganda's interest rate averaged 34% compared to averages of 12%, 15 per cent and 18% in Burundi, Kenya, and Tanzania, respectively. This could have been attributed to Uganda suffering a prolonged economic decline from around 1970 through 1980s as a result of mismanagement and intermittent civil war (Harvey & Robinson, 1995)

After the 1990s, most EAC member states moved from a regime of controlled rates to market-driven interest rates (Matete, 2014). This led to a steady rise in interest rates to a high of 15%, 36%,38% and 42% per annum in Burundi, Kenya, Uganda, and Tanzania, respectively in 1995. However, in 2005, most countries moved to the market offered rates that were construed as non-competitive to the introduction of the Central Bank Rate (CBR) (Maina, 2015). In 2016, East Africa's central banks voted to keep their policy interest rates low or unchanged to help bolster their economies amid uncertainty and weaker global growth prospects (IMF, 2019). By 2018, Rwanda, Tanzania, Kenya,

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and Uganda maintained their benchmark lending rates to commercial banks (CBR) at 5.5 per cent, 7 per cent, 9 per cent, and 10 per cent, respectively, to promote increased spending by firms and households and boost economic growth (IMF, 2019). But Kenya, which had capped its interest rates at 4% points above the CBR, faced the difficult task of unlocking credit to the private sector after banks indicated that the capping legislation and their resultant inability to effectively price risk would continue stifling the supply of credit (Kazi, 2019).

The other EAC member states operate a market-driven interest rate regime, allowing banks to adjust their lending rates in line with their respective central banks' policy rates. The reforms in most EAC member states were expected to lead to reduced interest rates, but this was not the case in comparison to other countries in Africa. The interest rates in most EAC member states are far higher than other countries in Africa, which are more developed. For instance, among the ten most developed countries in Africa, South Africa's interest rates decreased from 21% in 1985 to 10% in 2020. Egypt, Algeria, Seychelles, and Botswana had their interest rates decline from 19%, 18%, 15% and 15%, respectively, in 1990 to 11%, 8%, 11% and 6%, respectively, in 2020 (IMF, 2021).

Statement of the Problem

Many EAC member countries focus on improving their growth performance by reducing their interest rate so as to increase the level of investments after undertaking major reforms in the 1980s to shift the orientation of their economies. Moreover, in 2016, East Africa's central banks voted to keep their interest rates low or unchanged to help bolster their economies amid uncertainty and weaker global growth prospects. However, despite the reforms in these countries, the interest rates are far higher than in other countries in Africa, which are more developed.

In an attempt to bolster investment, these states have increased public debt rapidly, exceeding the debt ratio of 50% of GDP as provided in their treaty. However, the borrowed funds have not targeted value-creative economic and social projects, which can potentially outweigh the adverse effects of heavy indebtedness. Moreover, high levels of debt also create uncertainty, deterring investment and innovation (Cordella *et al*., 2005).

Though the levels of public debt have been increasing rapidly in EAC in the past, there is a scarcity of empirical evidence on the impact of public debt on interest rates. Existing works on public debt focus on the impact on economic growth (Were, 2001; Putunoi & Mutuku, 2013) and private investment (Kamundia *et al.,* 2015). Other studies focus on the link between government expenditure and private investment (Njuru *et al.,* 2014). With large levels of public debt as a ratio to GDP, understanding their impact on interest rates is important to provide relevant information for designing policy. Therefore, the purpose of this study is to examine the effect of public debts on interest rates in selected East African Community member states using recent Panel data.

The study covered the period from 1980 to 2020 in order to capture the pre and post-EAC revival period. EAC was originally founded in 1967, dissolved in 1977, and revived in 1999. The study considered five EAC member countries, namely Kenya, Burundi, Uganda, Tanzania, and Rwanda, and excluded South Sudan because of the limitation of the data. South Sudan data run from 2011, the period when the country gained independence.

LITERATURE REVIEW

Theoretical Review

This section reviews theories that lay the foundation for the relationship between public debt and interest rates. The Loanable Fund Model of interest rate is used to determine the effect of public debt on interest rates in EAC member states.

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Loanable Fund Model of Interest Rate

This study will adopt the loanable funds model to describe the impact of public debt on nominal interest rates. This is because the theory enables government borrowing to be included as a direct determinant of interest rate (Burney & Yasmeen, 1989). The loanable funds model has been used to investigate the impact of government deficit or debt on the interest rate (see Hoelscher, 1986; Tran & Sawhney, 1988; Thomas & Abderrezak, 1988; Cebula, 2003, 2005; Correia-Nunes & Stemitsiotis; 1995; García & Ramajo, 2004; Quayes & Jamal, 2007; Barnes, 2008.

Empirical Literature

Using data for the period 1983 to 2003, Pacsani and Kremer (2006) scrutinised whether government debt accumulation affects long-term interest rates in the economies of the USA, Germany, and Italy after controlling for inflation and monetary policy and if there were spillover effects across countries. The study applied a cointegration tests approach to investigate the long-term relationship and structural vector autoregressive (SVAR) model to examine the short-run link between government borrowing and interest rate. The empirical results showed that a continuous accumulation of government debt initiates higher long-run interest rates, at least temporarily. The study also found spillover effects of sustained debt accumulation on higher long-term interest rates from mainly the USA to Germany and Italy.

Kinoshita (2006) applied a dynamic general model on panel data for 19 Organization for Economic Cooperation and Development (OECD) Countries to investigate the association between government debt and long-term interest rates. The theoretical model showed that the impact of debt on interest rate varied with structural parameters of the economy, particularly birth rate and time preference. Empirical results also suggested a small positive effect of the government debt-to-GDP ratio on estimated and simulated long-run interest rates. But, a rise in government consumption and debt led to a significantly larger effect. The study pointed out that even though the interest rate effect of pure crowding out may be small, the economic impact of accumulating government debt should not be ignored.

Applying data for the period 2002:2 to 2009:2, Hsing (2010) examined whether the Greek long-term interest rate was affected by government debt and other related macroeconomic variables. The study employed the ARCH and GARCH model in the loanable funds framework and found that more government debt as a percentage of GDP would raise the government bond yield and a higher real short-term interest rate, a higher percentage in real GDP, a higher expected inflation rate, a higher EY government bond yield, and a higher effective nominal exchange rate would increase the government bond.

In a similar study, Kameda (2011) applied a fully modified OLS estimator on data for the period 1980 to 2000 to analyse the effect of budget deficit and government debt on real long-term interest rates in Japan. The study found that projected budget deficit and public debt expert upward pressure on interest rates. There was also a positive and significant relationship in the long run between the projected deficit to GDP ratio and equity premium and expected inflation. Additionally, results revealed that interest rate responds more to budget deficit than to government debt.

Chen (2011) applied an extended open economy loanable funds model on quarterly data for the period 1972:1 to 2010:3 to scrutinise the effect of government deficit on long-term interest rates in Japan. The author found that a higher ratio of public deficit to GDP led to a lower long-term interest rate. The results also showed that the real money market rate, the GDP growth rate, the expected inflation rate, the world long-term interest rate, and the expected depreciation of the local currency have a positive impact on the long-term interest rate. This study therefore, revealed that inclusion of the world interest rate and exchange rate in the analytical model could better explain the behaviour of long-term interest rates.

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Ogawa *et al.* (2016) contributed to the debate by using the panel VAR model to explore the dynamic interactions among the public debt-to-GDP ratio, the real GDP growth, and the real long-term interest rate, using data from 31 OECD countries. The estimates suggested no causal connection between public debt and GDP growth rate for all levels of public debt. Instead, results suggested a causal link between GDP and public debt. In high-debt countries, the negative effect of growth on public debt was augmented by an increase in the long-term real interest rate, which subsequently reduced interest-sensitive demand and led to a further rise in the public debt-to-GDP ratio.

In a related study, Guex and Guex (2018) empirically tested the relationship between public debt, economic growth, and long-term interest rates in Switzerland using data covering the period 1894 to 2014. The study applied three different approaches to study the relationships: correlations between GDP-weighted variables, correlation between residuals of ARIMA time series models and vector autoregression (VAR) model. These approaches are applied during the whole time period and also during the boom as well as recession phases independently. The estimates suggested that public debt was not negatively related to economic growth and did not increase long-term interest rates.

In the USA, Gamber and Seliski (2019) used a dataset covering the period 1976 to 2017 to investigate the relationship between federal debt and interest rates. The study focused on the long-term association between expected debt and interest rates in order to disentangle the short-term or cyclical effects of interest rates from the long-term effects. In this study, the explanatory variables included debt to GDP ratio, expected inflation, dividend yield and GDP growth rate. The reduced-form regression indicated that expected interest rates react positively to expected current debt as a ratio of GDP. Specifically, for each percentage point rise in the ratio of projected debt to GDP, the expected interest rate would increase by 2 to 3 percentage points. Further, the study attempted to estimate how interest rate response depends on the type of fiscal policy by simulating a dynamic stochastic general equilibrium (DSGE) model. The DSGE simulations indicated that the estimate depends on the type of fiscal policy that produces a percentage point increase in the projected debt-to-GDP ratio. If a fiscal policy boosts the incentive to invest in private capital or supply additional labour, the effect on interest rate would possibly be less than the empirical estimate given that a higher supply of capital or labour would compensate for some of the initial crowding out emanating from higher levels of government borrowing.

MATERIALS AND METHODS

Research Design

A descriptive panel research design was adopted in this study. The design is better because it includes a much larger data set that allows for more variability and less collinearity among the variables than is typical of cross-section or time-series data.

Theoretical Framework

This study adopted the loanable funds model, also known as the neo-classical model of interest rate to describe the impact of public debt on interest rate.

Following Devereux and Saito (2006) and De Santis and Luhrmann (2009), the behaviour of net capital inflow is clarified by the relative interest rate and the exchange rate to measure net capital inflows. Following Hsing (2010), the extended open-economy loanable fund model, allowing for the demand and the supply of loanable funds, may be expressed as follows:

$$LF^{d} = V(R, R^{S}, \pi^{e}, Y, D) \quad [1]$$

$$LF^{s} = X(R, R^{S}, \pi^{e}, Y, R^{*}, E) \quad [2]$$

where LF^{d} is the demand for loanable funds, LF^{S} the supply for loanable funds, R the long-term interest rate, R^{S} the real short-term interest rate, π^{e}

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the expected inflation rate, Y the percentage change in real GDP, D government debt, R^* the World interest rate, and E the nominal effective exchange rate.

Setting LF^d and LF^s equal to the equilibrium loanable fund (LF), the equilibrium long-term interest rate $(\overline{R})$ may be written as follows:

$$\overline{R} = \overline{R}(D, R^S, Y, \pi^e, R^*, E) \quad [3]$$

Taking the partial derivative of $\overline{R}$ with respect to each of the exogenous variables gives the following:

$$\frac{\partial \overline{R}}{\partial D} = \frac{V_D}{|J|} > 0 \quad [4]$$

$$\frac{\partial \overline{R}}{\partial R^S} = \frac{V_{R^S} - X_{R^S}}{|J|} > 0 \quad [5]$$

$$\frac{\partial \overline{R}}{\partial Y} = \frac{V_Y - X_Y}{|J|} \neq 0 \quad [6]$$

$$\frac{\partial \overline{R}}{\partial \pi^e} = \frac{V_{\pi^e} - X_{\pi^e}}{|J|} > 0 \quad [7]$$

$$\frac{\partial \overline{R}}{\partial R^*} = \frac{-X_{R^*}}{|J|} > 0 \quad [8]$$

$$\frac{\partial \overline{R}}{\partial E} = \frac{-X_E}{|J|} < 0 \quad [p]$$

Where $|J|$ is the Jacobian for the endogenous variables and is expected to have a positive value. It is worth to note that in equation 3.24 if $V_Y > X_Y$, $\frac{\partial \overline{R}}{\partial Y} < 0$ and if $V_Y < X_Y$ then $\frac{\partial \overline{R}}{\partial Y} < 0$. Therefore, as demonstrated by equation 3.21 to equation 3.27, the equilibrium long-term interest rate is positively linked to government deficit or debt, the real short-term interest rate, the percentage change in output, the expected inflation rate, the world interest rate/expected exchange rate.

Empirical Model Specification of Effect of Public Debt on Interest Rate

Based on the theoretical framework outlined in section 3.3.3, this study analysed the effect of public debt on interest rates by estimating the following model:

$$LINTR_{it} = \varphi_0 + \varphi_1 DEBT_{it} + \varphi_2 SINTR_{it} + \varphi_3 LYRPC_{it} + \varphi_4 INFL_{it} + \varphi_5 WINTR_{it} + \varphi_6 REER_{it} + \nu_{it} \quad 10]$$

Where $LINTR_{it}$ is the nominal long-run interest rate at the time t, $DEBT_{it}$ the public debt measured as a% of GDP, $SINTR_{it}$ the short-run interest rate, $LYRPC_{it}$ the real income per capita, $INFL_{it}$ the inflation rate, $wINTR_{it}$ the world interest rate $REER_{it}$ denote the real effective exchange rate at the time t and V_{it} is the error term.`

Data Type, Data Source and Data Collection

The study used secondary data from various sources for Kenya, Burundi, Uganda, Tanzania, and Rwanda from the year 1980 to 2020. Data on the level of public debt, openness, Debt service, private investment, and GDP growth was obtained from the World Bank's World Development Indicators (WDI). Data on inflation and real interest rates was gathered from Penn World Tables (PWT 8.0). Data for public debt was obtained by adding the values of external and internal debt for each year. The debt ratio was calculated by dividing the public debt values by the GDP values for each year.

Data Analysis

To test for panel unit roots, the analysis made use of the Levin et al. (2002) (LLC) test, Im et al. (2003) (IPS) test and the Augmented Dickey-Fuller (ADF) Fisher unit root test proposed by

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Maddala and Wu (1999). The null hypothesis for the Levin-Lin-Chu unit-root test is that panels contain unit roots. For the Im-Pesaran-Shin unit-root test, the null hypothesis is that all panels contain unit roots with the alternative that some panels are stationary. The null hypothesis for the Augmented Dickey-Fuller Fisher-type unit-root test is that all panels contain unit roots with the alternative hypothesis that at least one panel is stationary.

Panel-level heteroskedasticity was tested using the Likelihood-ratio (LR) test and modified Wald test with the null hypothesis that there is homoskedasticity (constant variance) in the panels. Additionally, the test for panel-level autocorrelation was done using the Wooldridge test, whereas the test for contemporaneous correlation was done using Pesaran's (2004) test of cross-sectional independence. The null hypothesis for the autocorrelation test is that there is no serial correlation in the panels. On the other hand, the null hypothesis for the contemporaneous correlation test is that the residuals are not correlated across entities (no cross-sectional dependence in the dataset).

The selection of the maximum lag was carried out for each cross-sectional unit (country). Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quin Information Criterion (HQIC) were used to determine the optimal lags for each country.

If panels are not stationary, the study was to perform panel cointegration tests. The main tests for panel cointegration are Pedroni's panel cointegration test (Pedroni, 1999) and Westerlund's (2007) four-panel cointegration test.

Regarding the selection of the regression model, this study applied a panel with a time series dimension (T) greater than cross-sectional units (N). To determine the most appropriate estimation method to apply, this study used the panel cointegration test, the Hausman test, and the random effects test. For the Hausman test, the null hypothesis is that the random effects estimator is more efficient and consistent than the fixed effects estimator and, hence, more preferred. On the other hand, for the random effects test, the null hypothesis is that there is no significant panel effect. That is, there is no significant difference between cross-sectional units. If variables are cointegrated and are all I(1), then the study will use the Panel Vector Error Corrected Model (PVECM). If the variables are a mix of I(1) and I(0), then the study will use the Panel Autoregressive Distributed Lag (Panel ARDL) method. In view of heteroskedasticity and contemporaneous correlation, the Hausman test that is heteroskedasticity consistent and robust to general forms of spatial and temporal dependence will be performed using the *xtscc* program.

RESULTS

Descriptive Statistics

Table 2 presents summary statistics of the variables for pooled country data, and *Table 3* for individual country data.

The macro panel were unbalanced and consisted of five countries, with observations for 37 different years for each country, giving 185 total observations (n) for each variable.

The pooled data results show that debt as a share of GDP had a mean of 63.4955 and a standard deviation of 35.7769. This implies that public borrowing in these countries is relatively high because the debt threshold is 50% in this region. This is a reflection of the country-specific results for most countries. Specifically, average public debt was 50.94, 54.71, 52.48 and 69.46 for Kenya, Uganda, Rwanda, and Tanzania, respectively. Burundi recorded the highest public debt mean and standard deviation, while Uganda recorded the highest maximum value in 1991. The high debt levels in these countries were recorded between the 1980s and 1990s, which could have been attributed to the 1980s global recession, the rise in interest rates in developed countries, and a decline in real net capital inflows, which was largely due to the real negative interest rate in many countries. The lowest values for Uganda, Burundi, Rwanda, and Tanzania were recorded between the 1990s and 2000s when these

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countries received debt relief offered under the heavily indebted poor country (HIPC) and multilateral debt relief initiative (MDRI).

The average inflation rate observed was 8.2906 per cent with a standard deviation of 5.4784 per cent, implying high variability of inflation rate within the EAC. The minimum inflation rate of -6.35 per cent was observed in Rwanda in 1999, while the highest inflation of 19.9751 per cent was recorded in Uganda. This implies that inflation in EAC countries is high. The required inflation rate in this region is supposed to be less than five per cent, implying that EAC countries are yet to achieve the set inflation rate target.

Kenya had the highest mean for real effective exchange rate, while Tanzania had the highest mean for long-run interest rate.

Table 2: Descriptive statistics for pooled country data

Variable	Mean	Std. Dev	Minimum	Maximum
Debt (% of GDP)	63.4955	35.7769	16.2661	183.1458
Real Per-capita income (current US$)	419.1229	320.7776	98.2145	1667.59
Inflation (annual %)	8.2906	5.4784	-6.3509	19.9751
Sintrate (%)	19.14502	6.4066	12	42.0460
REER (%)	19.29862	16.58626	2.27	113.21
Wintrate (%)	5.237714	2.626723	1.65	12.46
Lintrate (%)	9.971634	3.276634	4.112134	18.47119
Real interest rate (%)	7.6964	6.334	-8.009	21.488

Source: Author (2022)

Table 3: Descriptive statistics – country-specific results

Variable	Statistics	Kenya	Uganda	Burundi	Rwanda	Tanzania
Debt	Mean	50.94	54.71	93.53	52.48	69.46
	Std Dev	10.29	34.03	44.04	31.59	37.32
	Min	34.06	19.19	25.69	16.26	21.52
	Max	82.06	183.14	172.73	108.97	142.16
Inflation	Mean	8.77	7.96	8.58	6.37	9.89
	Std Dev	4.47	5.78	6.22	5.81	4.48
	Min	0.93	-3.16	-4.25	-6.35	2.71
	Max	18.89	19.97	18.94	15.62	19.19
Sintrate	Mean	8.06	2.89	4.99	9.52	5.97
	Std Dev	6.61	22.73	7.26	7.09	7.61
	Min	-8.01	-53.44	-16.67	-4.76	-26.71
	Max	21.09	22.99	18.25	24.21	14.67
REER	Mean	19.87	16.94	19.05	18.89	14.09
	Std Dev	16.31	11.69	16.29	15.64	13.56
	Min	2.27	2.96	4.32	2.29	3.25
	Max	96.04	55.42	113.2	84.08	51.08
Lintrate	Mean	11.72	10.69	7.69	7.29	12.24
	Std Dev	2.62	3.03	2.61	1.31	3.13
	Min	7.46	5.22	4.25	4.25	4.11
	Max	16.22	14.38	16.63	10.15	18.47
Real Interest	Mean	7.75	8.98	5.97	8.92	7.76
	Std Dev	6.05	8.29	5.86	5.77	4.36
	Min	-8.01	-5.44	-6.19	-4.76	-1.21
	Max	17.81	21.48	18.15	17.82	16.27

Source: Author (2022)

Panel Unit Root Properties Test

Before the estimation and interpretation of the results, a panel root test was performed to investigate if there was any variable that was non-

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stationary. The presence of a unit root in any variable may lead to spurious regression, where the regression results may be misleading. The variables used in this study were tested for stationarity using the Levin et al. (2002) (LLC) test, Im et al. (2003) (IPS) test and Augmented Dickey-Fuller (ADF) Fisher unit root test suggested by Maddala and Wu (1999) to check for panel unit roots.

The panel unit root test results for the variables used in objective three are presented in *Table 4.*

Table 4: Panel Unit Root Test Results

Variable	Test	LLC Test	IPS Test	Fisher-ADF Test	Conclusion
		Adjusted t-statistic	W-t-bar statistic	Inverse chi-squared (10) Statistic	
Long-run interest rate (*LINTR*)	Levels	-1.1301 (0.1292)	-0.1024 (0.4592)	9.8004 (0.4582)	LINTR is I (1)
	First Difference	-5.6652 *** (0.0000)	-7.2381*** (0.0000)	84.8394*** (0.0000)	
Total debt (*Debt*)	Levels	-0.4979 (0.2545)	0.3422 (0.5240)	7.5193 (0.6757)	Debt is I (1)
	First Difference	-6.4456*** (0.0000)	-7.5037*** (0.0001)	37.5560*** (0.0000)	
Short-run interest rate (*SINTR*)	Levels	-1.7136** (0.0433)	-1.0819 (0.1397)	16.6379* (0.0828)	SINTR is I (1)
	First Difference	-5.2408*** (0.0000)	-5.3719*** (0.0000)	55.5499*** (0.0000)	
Real income per capita *(LYRPC)*	Levels	-0.0616 (0.4755)	2.6308 (0.9957)	2.1661 (0.9949)	RYRPC is I (1)
	First Difference	-5.8134*** (0.0000)	-6.7015*** (0.0000)	77.7037*** (0.0000)	
World interest rate *(WINTR)*	Levels	-6.0211*** (0.0000)	-9.1154*** (0.0000)	111.8786*** (0.0000)	WINTR is I (0)
	First Difference	-13.5187*** (0.0000)	-15.1285 *** (0.0000)	228.1002*** (0.0000)	
Exchange rate (*REER*)	Levels	-15.6262*** (0.0000)	-9.4890*** (0.0000)	87.2113*** (0.00000	EXCR is I (0)
	First Difference	-8.0508*** (0.0000)	-9.6791*** (0.0000)	129.4465*** (0.0000)	
Inflation (*INFL*)	Levels	-7.4437*** (0.0379)	-2.1114** (0.0174)	20.5303*** (0.0246)	INFL is I (0)
	First Difference	-8.4594*** (0.0000)	-10.2567*** (0.0000)	136.3313*** (0.0000)	

*Note: **LLC**=Levin, Lin, and Chu test; **IPS**=Im, Pesaran and Shin test; **ADF** = Augmented Dickey-Fuller – Fisher unit root. The values in the Table are the test statistics: (*), (**) and (***) = the series is stationary at 10%, 5%, and 1% respectively.*

Source: Author (2022)

The results show that private investment as a share of GDP, total public debt as a share of GDP, debt service as a share of GDP and trade openness are all stationary on their first difference, indicating that they are integrated of order one. Further, the results indicate that GDP growth, real interest rate and inflation are stationary at levels.

Multicollinearity Test

This study employed variance inflation factor (VIF) to detect multicollinearity in regression analysis. Multicollinearity is when there's a correlation between predictors (i.e. independent variables) in a model; its presence can adversely affect the regression results. The VIF estimates

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how much the variance of a regression coefficient is inflated due to multicollinearity in the model. A variance of inflation (VIF) was used to determine the degree of correlation between variables so as to avoid multicollinearity, which can adversely affect the reliability of the study estimates. The rule of thumb is that a VIF of 10 or higher may be an indication of the problem of multicollinearity (Williams, 2015; Joseph et al., 2014). *Table 5* shows the VIF results.

Table 5: VIF Multicollinearity Test Results

Variable	VIF	1/VIF
Debt	1.60	0.6260
Lyrpc	3.19	0.3132
Wintrate	2.84	0.3517
Inflation	2.38	0.4204
Exchange rate	2.17	0.4601
Sintrate	2.10	0.4758
Mean VIF	2.38	

Source: Author (2022)

The results suggest that there is a relatively low correlation among the study variables of interest because all scores were less than 10. Therefore, there is no multicollinearity problem.

Panel Cointegration Test

Westerlund's (2007) cointegration test was used to test for panel cointegration. *Table 6* presents Westerlund cointegration results for the models used for analysis. Results are for both group mean and panel statistics. The null hypothesis of Westerlund's (2007) cointegration tests was that there was no cointegration in the cross-section units.

Westerlund panel cointegration test gives both group mean and panel statistics. At a level of significance of five per cent, test statistics for group and panel statistics showed panel cointegration. This implied that there was a long-run relationship in the data series.

Table 6: Westerlund Panel Cointegration Test Results

Statistics	Z-Value	P-Values	Conclusion
Gt	-2.866***	0.003	There is Panel Cointegration
Ga	-11.628**	0.033	There is Panel Cointegration
Pt	-5.845***	0.004	There is Panel Cointegration
Pa	-10.732***	0.001	There is Panel Cointegration

Ho: No panel cointegration; Levels of significance for the test = (*), (**) and (***) imply statistical significance at 10%, 5% and 1% respectively

Source: Author (2022)

Heteroskedasticity Test, Autocorrelation Test and Contemporaneous Correlation Test

The Likelihood-ratio (LR) test, in addition to the modified Wald test, was applied to test Panel level heteroskedasticity. The null hypothesis formulated was that there existed a constant variance in the panels or homoscedasticity. Additionally, panel-level autocorrelation was checked using the Wooldridge test, with Pesaran's (2004) and Breusch-Pagan's LM test of cross-sectional independence used to test for contemporaneous correlation. The null hypothesis for the autocorrelation test was that there was no serial correlation in the panels. On the other hand, the null hypothesis for contemporaneous correlation was that the residuals were not correlated across entities (no cross-sectional dependence in the data series). *Table 7* shows the results for the panel-level heteroscedasticity test, panel-level autocorrelation test and test results for contemporaneous correlation for the model used to analyse the effect of public debt on interest rate.

The Likelihood-ratio test and the modified Wald test were utilised to check whether there is the

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presence of heteroskedasticity in the study panel data. The results rejected the null hypothesis and accepted the alternative that there was no panel heteroscedasticity. Additionally, panel-level autocorrelation was assessed using the Wooldridge test, and the results showed no first-order autocorrelation. Pesaran's test and Breusch-Pagan's LM test of cross-sectional independence were executed to test for contemporaneous correlation. The diagnostic test outcome indicated that there is cross-sectional dependence in the panels. This result was expected, bearing in mind macro panel data for the countries in the same region. Subsequently, there is a likelihood of some comparisons across the countries that form the respective panels, perhaps owing to factors common to all the countries in the region.

Table 7: Heteroskedasticity test, autocorrelation test and contemporaneous correlation test results

Likelihood-Ratio (LR) Test	Modified Wald Test	Conclusion
LR chi2(6) = 11.32 Prob>chi2= 0.1253	Chi2(5) = 7.12 Prob>chi2= 0.2121	There is no heteroskedasticity
Test for Autocorrelation		
Wooldridge Test	F (1,4) = 130.591 Prob>F=0.1673	No First order autocorrelation
Test for Contemporaneous Correlation		
Pesaran's CD Test	Pesaran's test Statistic= -1.735 P-Value = 0.0828	Cross-sectional dependence is present
Breusch-Pagan LM test	Breusch-Pagan LM test statistic = 33.466 P-Value = 0.0002	Cross-sectional dependence is present

Source: Author (2022)

Optimal Lag Selection

The selection of the maximum lag to be applied in the estimation of the model was carried out for each cross-sectional unit (country). Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quin Information Criterion (HQIC) were used to determine the optimal lags for each of the panels. This was done by choosing the smallest values to indicate the best lag length. *Table 8* shows the optimal lag for each of the panels used.

Table 8: Optimal lag selection results

Panel/Country	AIC	SIC	HQIC	Optimal Lag Length
Kenya	3.5460* (Lag=1)	3.9160* (Lag=1)	3.6666* (Lag=1)	1
Uganda	3.0652* (Lag=1)	3.4353* (Lag=1)	3.1859* (Lag=1)	1
Burundi	3.9651* (Lag=1)	4.3352* (Lag=1)	4.0858* (Lag=1)	1
Rwanda	3.1305* (Lag=1)	3.5006* (Lag=1)	3.2511* (Lag=1)	1
Tanzania	4.4648* (Lag=4)	4.9246* (Lag=2)	4.644 (Lag=4)	4

*Note: * indicates the lag order selected by the criterion*

Source: Author (2022)

The maximum lag selection resulting from the three criteria indicates a maximum lag of one for four panels: Kenya, Uganda, Burundi, and Rwanda. Further, the criteria suggest a maximum lag of four for the Tanzania panel. In view of these findings, the study implements a maximum of one lag for the five panels.

Hausman Test and Fixed Effect Test

To determine the most appropriate estimation method to apply to analyse the effect of public debt on the interest rate, this study uses the panel cointegration test, Hausman test and the random effects test. For the Hausman test, the null

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hypothesis is that the random effects estimator is more efficient and consistent than the fixed effects estimator and, hence, more preferred. On the other hand, for the random effects test, the null hypothesis is that there is no significant panel effect. That is, there is no significant difference between cross-sectional units. Given heteroskedasticity and spatial correlation, the study implemented a Hausman test shown in *Table 9* that is heteroskedastic consistent and robust to general forms of spatial and temporal dependence.

Table 9: Selection of the regression model

Test	Test statistic	Conclusion
Spatial correlation robust Hausman test	F (5,34) = 48.09 Prob>F=0.0000	Fixed effects model is preferred over the random effects model
Fixed effects test	Chi2(4) = 61.72 Prob>chi2=0.0000	There is a significant (fixed) panel effect

Note (*), (**) and (***) = the series is stationary at 10%, 5%, and 1% respectively.

Source: Author (2022)

The results from the Hausman test show that the fixed effects regression model is more suitable than random effects. Moreover, the fixed effects results indicate that there are significant panel effects in the panel data, suggesting that the fixed effects estimator is more suitable for fitting the data relative to the pooled ordinary least squares estimator. These findings, the existence of panel cointegration and the varying orders of integration of the variables suggest that panel Autoregressive Distributed Lag (Panel ARDL) is the most suitable estimator for this study. Panel ARDL requires that the variables be integrated into order one or zero (Pesaran *et al.*, 2001). The panel ARDL is employed to analyse long-term and short-term estimates and also to cover the limitations of cointegration (Pedroni, 2004). The panel ARDL is appropriate even with the endogeneity issue of independent variables (Marques et al., 2018).

Panel ARDL method has three estimators. Pooled mean group estimator, mean group estimator and dynamic fixed effects estimator. The pooled mean group model confines long-run coefficients to be the same across the groups that make the panel, while the short-run coefficients, intercepts, and error variances differ across the groups (Pesaran *et al.*, 1999). This approach yields consistent estimates if the estimate on the error correction term is negative and does not exceed negative two, the disturbance term on the error correction model is serially uncorrelated and the regressors not to be endogenous. The mean group estimator proposed by Pesaran and Smith (1995) fails to enforce any restriction. That is, it runs a separate regression for each group in the panel so that all coefficients differ both in the short run and in the long run. However, the estimator may return biased and inconsistent estimates if the data lacks sufficiently large time series dimension and cross-section dimension, say 20 to 30 cross-sectional units.

Given that the study focuses on developing countries within the same geographic area, the East African region, there is a likelihood of homogeneity with respect to public debt and interest rates in the long run across some or all of the countries. Nevertheless, country-specific heterogeneity is expected in the short run. Moreover, the Dynamic Fixed Effect estimator yields more efficient parameter estimates relative to the mean group model under the assumption of long-run homogeneity (Samargandi *et al*., 2014). Thus, the Dynamic Fixed Effect estimator is the most relevant for this analysis.

Additionally, the study applies the Hausman test to identify the most appropriate estimator between the pooled mean group, mean group, and dynamic fixed effect method by testing if there exist significant differences between the estimators. The null hypothesis of the Hausman test is that the difference between pooled mean group and mean group or pooled mean group and dynamic fixed effects method is not significant. In case the null is not rejected, the pooled mean group estimator is

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favoured because it is efficient. A pooled mean group estimator is applied if the P-value is not significant at the 5% level, and if the P-value is significant at the 5% level, the mean group or dynamic fixed effect estimator is suitable (Samargandi *et al*., 2014). Since the P-value is significant, the study applied a Dynamic Fixed Effect Estimator

Empirical Results on the Effect of Public Debt on Interest Rate

To achieve the objective of this study, the Dynamic Fixed Effect estimator was used to analyse the effect of public debt on interest rates using. *Table 10* depicts the Panel ARDL results on the effect of total debt (Debt) on long-term interest rates (Lintrate).

Table 10: Pooled dynamic fixed effect results for the effect of public debt on interest rate

Variable	Long-run estimate	Short run estimate
Debt	0.0478***(0.0109)	0.0231** *(0.0881)
Short-run interest rate	-0.3345***(0.0713)	0.2786***(0.1217)
Real income per capita	-0.0139(0.0013)	0.0024(0.0040)
Inflation	-0.2075 **(0.1069)	-0.0235(0.00198)
World interest rate	-0.5810***(0.1758)	-0.0992*(0.1899)
Exchange rate	-0.1093***(0.0082)	-0.0061(0.0086)
Error correction term		-0.27099***(0.0881)
Constant		4.3228***(2.2748)
Log Likelihood		-282.0194
Number of observations		185

*Note: ***, ** and * show significance at 1%, 5% and 10%, respectively. Robust standard errors are in parenthesis.*

Source: Author's computation

Table 11: Dynamic fixed effect regression results: individual country estimates

Variable	Kenya	Uganda	Burundi	Rwanda	Tanzania
Debt	0.0104**	0.0039	0.0454***	0.0194***	0.0530**
	(0.0407)	(0.0084)	(0.0172)	(0.0133)	(0.0212)
Short-run interest rate	-0.0397	-0.0197***	0.3560	0.8137**	0.2020**
	(0.0858)	(0.0602)	(0.3232)	(0.0223)	(0.1032)
Real income per capita	0.0049**	0.0002***	-0.0145	0.0092***	0.0051
	(0.0042)	(0.0031)	(0.0244)	(0.0034)	(0.0084)
Inflation	-0.0063***	0.0005	0.0024***	0.0159	0.1194***
	(0.0307)	(0.0074)	(0.0402)	(0.0156)	(0.0383)
World interest rate	-0.0557***	0.0451	-0.3364**	-0.3229***	-1.0122**
	(0.2736)	(0.2428)	(0.3498)	(0.0157)	(0.0076)
Exchange rate	-0.6152**	-0.2131***	0.0029	-0.3188**	0.0279***
	(0.0419)	(0.0116)	(0.0231)	(0.0142)	(0.0082)
Error correction term	-0.1676***	-0.0042***	-0.1211***	-0.0008***	-
	(0.0614)	(0.0130)	(0.0727)	(0.0316)	0.8632***
					(0.1409)
Constant	0.1911***	0.2879***	1.1565***	-0.2582**	0.2366***
	(1.1708)	(0.3806)	(0.8251)	(0.4635)	(0.0434)
Log Likelihood					-282.0194
Number of observations					185

*Note: ***, ** and * show significance at 1%, 5% and 10%, respectively. Robust standard errors are in parenthesis.*

Source: Author's computation.

DISCUSSION

The study explored panel data with some variables being differenced to order one. There were 185

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observations of five East African countries with the minimum and maximum observation of 37 for each country. The log-likelihood of -282.0194 suggests that the model fairly fits the data set. Regression results in Table 11 indicate that public debt had a positive effect on the long-term interest rate in the short run and long run, as anticipated. This is revealed by the coefficient of 0.0478, which suggests that in the long run, a one per cent increase in public debt leads to a 0.0478% increase in long-term interest rate. These results are in line with the loanable fund theory of interest rate, which posits that the rate of interest is determined by the demand and supply of loans in an economy. Consistent with this finding is that of Ogawa *et al*. (2016), who established a positive association between public debt and long-term interest rates in 31 OECD countries. The estimation outcome also agrees with Hsing (2010), who found out that in Greece, the long-term interest rate was affected by government debt and other macro-economic variables through a channel that begins with a rise in government bond yield, which later affects short-term interest rates, inflation and the effective nominal exchange rate which would in turn increase government bonds. Finally, the consistency of this result is in the same vein as that of Pacsani and Kremer (2006), who established that an incessant accrual of government debt temporarily initiates a higher long-run interest rate coupled with a spillover effect of sustainable debt accumulation in countries like USA, Germany, and Italy.

The results also found that the long-run coefficient of inflation is negative and statistically significant at five per cent. This implied that a one per cent increase in inflation would lead to a 0.2075% decrease in long-term interest rate. The justification for this association is that when interest rates are reduced, individuals will be able to borrow more money. The outcome is that the public will have more money to invest and spend. This leads to the growth of an economy, which further increases the level of inflation in the long run. It should be noted that the relationship between inflation and interest rates is bidirectional and causal in nature (see Mishkin, 1988; Gibson, 1982). Consistent with this finding is that of Durevall and Ndung'u (1999), who asserted that there is an outstanding relationship between inflation, exchange rate, foreign prices, and terms of trade in the long run, while money supply and interest rates only have a short-term relationship.

Interestingly, the estimated coefficient results suggest that there was a negative effect of world interest rates on the long-term interest rates in the five East African countries. The long-run coefficient was -0.5810. This implied that a one per cent increase in the world interest rate reduced the long-term interest rate by 0.5810 per cent. This finding is supported by Hordahl *et al*. (2016), who established that the international association between world interest rate and long-term local rates in both emerging and developed economies are strong. The study compares interest rates in advanced economies with those in developing economies and conditioned them with the Federal funds rate and world real interest rate as global benchmarks. They posit that in the long run, local interest rates of emerging economies are inversely influenced by world and federal funds rates.

Finally, the study regression results also showed that the exchange rate and short-run interest rate coefficient were statistically significant at a five per cent level. This indicated that there was a negative effect of the exchange rate and short-run interest rate on the long-run interest rate in the five countries. The estimated long-run coefficient of short-run interest rate was -0.3345, and the exchange rate was -0.1093. This suggested that a one per cent increase in the short-run interest rate reduced the long-run interest rate by 0.33%, and a one per cent increase in the exchange rate reduced the long-term interest rate by 0.12 per cent. This result also agrees with that of Sanchez (2005), who found that the correlation between exchange rate and interest rates, conditional on an adverse risk premium shock, is negatively associated with expansionary depreciations in small open economies. Along the same vein, Cavoli and Rajan (2005), in their study of how exchange rates affect interest rates in small open advance economies, confirm that in those emerging

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economies that have unrestrained hard pegs, the fluctuations in exchange rates in itself and with relation to interest rates have significantly changed over the years with an inverse relationship (see also Eichengreen, 2004).

DFE regression for individual country-specific results further confirmed that the coefficients for total debt, inflation, world interest rate, and exchange rate were statistically significant at five per cent. Therefore, total debt, inflation, world interest rate, and exchange rate were found effective in determining the long-term interest rate. However, the signs were different for country-specific variables. Table 12 shows the estimation outcome of the DFE individual country estimate. For instance, public debt positively affects the long-term interest rate in Kenya, Burundi, Rwanda, and Tanzania.

CONCLUSION

The study objective was to determine the effect of public debt on interest rates in selected EAC member states. The study pooled results and found that public debt had a positive and significant effect on the long-term interest rate in the long run, as anticipated. Moreover, in the long run, there was an inverse relationship between short-run interest rate, inflation, exchange rate and world interest rate in the five East African countries combined. The regression results for individual country-specific further confirm that total debt, short-run rate, inflation, world interest rate, and exchange rate are significant in determining the long-term interest rate in EAC. However, the signs are different for some country-specific variables.

The study result implies that if the debt crisis is not solved properly, the cost of issuing government bonds may rise. These governments need to take effective measures to pursue fiscal discipline. To enhance fiscal discipline, the EAC member states, through the East Africa Legislative Assembly (EALA) and in consultation with the legislative assemblies in the individual countries, should enact laws to empower the EAC secretariat to undertake fiscal coordination and monitor the adherence of specific countries to the EAC Treaty's criteria of not exceeding 50 per cent the ratio of government debt to GDP. This is because pursuing the debt-financed expansionary fiscal policy to stimulate the economy would raise the long-term government bond yield, reduce the magnitude of the government spending multiplier, and crowd out part of private spending. In other words, high public debt can negatively affect capital stock accumulation and economic growth via an increase in long-term interest rates. Additionally, EAC states can use concessional loans, which have more favourable terms like lower interest rates, deferred repayments, and income-contingent repayments.

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