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Article

State Borrowing and Electricity Tariff in an Emerging Economy: Post COVID-19 Experience

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Abstract: As the debt stock level of Ghana keeps rising, partly due to the negative impact of COVID-19, a number of new taxes have been introduced in the 2021 budget statement alongside an upward adjustment of electricity tariff. State borrowing may significantly influence electricity tariff, as power generation and distribution are primarily undertaken by state-owned companies whose borrowings constitute a substantial portion of the country' overall debt. Hence, this paper assesses the impact of state debt on electricity tariff in Ghana post COVID-19. The autoregressive distributed lag (ARDL) model and error correction model (ECM) are employed to test for the Granger causality between state debt and electricity tariff. Other variables such as inflation, exchange rate, and net energy import that have the propensity to influence electricity tariff are examined alongside. The results reveal that state debt has both short-run and long-run impacts on electricity tariff. Additionally, inflation rate, exchange rate, and net energy import have only long-run impact on electricity tariff. Meanwhile, exchange rate has short-run effect on state debt. The findings imply that effective debt management policies should be implemented by government to reduce borrowings, particularly when such borrowings are not invested into projects that can repay the debt at maturity. This study demonstrates that all the accumulated debts prior to and during the COVID-19 era are causing an inevitable upsurge in electricity tariff in Ghana. This provides an empirical clue to what the situation is likely to be in other developing countries.

Keywords: state debt; electricity tariff; inflation rate; exchange rate; net energy import

1. Introduction

One possible way to finance state revenue shortfalls is to borrow internally or externally (Owusu-Nantwi and Erickson, 2016). Borrowing to finance government expenditure leads to state debt. Thus, state debt refers to both short-term and long-term loans taken by governments to finance public expenditures due to insufficient tax revenues (Hilton, 2021). While debt financing remains an important fiscal policy decision, studies have shown that the accumulation of debt by many advanced and developing countries post World War II, had led to the economic recession and debt crises witnessed in the early 2000s (Donayre and Taivan, 2017). This situation aroused academic debate on how public debt affects the overall economy and its indicators. For instance, Adom (2016) asserts that building-up state debt to unsustainable levels affect economic indicators. Hilton (2021) also submits that although borrowing to finance public expenditure is not necessarily detrimental, it equally has adverse effect on the economy if not managed effectively. A key sector that is heavily burdened by state debt accumulation is the energy sector where electricity tariff is usually increased in order to offset accrued debts.

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As a developing country, Ghana has a responsibility of managing its debt effectively to avoid negative impact on the economy. Ghana's debt accumulation is attributable to the periods of global economic recessions and debt crises. In 2000, Ghana's debt to GDP ratio was 79.19% and this was classified unsustainable, leading to a declaration of the country as heavily indebted poor country (HIPC) in 2001 and most of the debts were cancelled by the IMF and World Bank (World Bank, 2004; Hilton, 2021). Though Ghana's debt stock reduced drastically to 24.95% in 2008, it rose steadily to 57.12% of GDP in 2016. Prior to COVID-19, Ghana's debt stock stood at 63% of GDP in 2019 but rose to 93.5% as of November 2022 (Ministry of Finance, 2023). The drastic upsurge in the debt stock after 2019 is attributed mainly to the negative impact of COVID-19 (BoG, 2021). The consequences of the unsustainable debt level are dire ranging from inefficient functioning of key state institutions (such as Tema Oil Refinery, Electricity Company of Ghana (ECG), Volta River Authority (VRA), Ghana Cocoa Board, etc., most of which are in the energy sector and generate and distribution electricity power) to poor macroeconomic performance. In 2022, the government declared her inability to repay both domestic and foreign debts. This has necessitated $3 billion IMF bailout deal for a 3-year period, warranting a domestic debt exchange programme, and quarterly upward adjustment in electricity tariff.

Researchers predominantly assessed the impact of these borrowings (domestic and external) on the economic growth (GDP) of Ghana (e.g., Owusu-Nantwi and Erickson, 2016; Adom, 2016; Hilton, 2021). However, there is dearth of research on the impact of the debt accumulation on electricity tariff, which is a critical factor affecting all sectors of the economy and can even stifle economic growth. Electricity generation and distribution companies are state-owned, and their tariffs are determined and regulated by the Public Utilities Regulatory Commission (PURC), which is also a state institution. Based on the neo-Ricardian theory (NRT) (Sraffa, 1960; Robinson, 1962; Pasinetti, 1977), we argue that electricity companies, institutional factors, and distributional consequences play crucial roles in shaping the potential relationship between state debt and electricity tariff. NRT highlights the importance of institutional context, suggesting that state ownership and political considerations influence tariff setting (Acheampong *et al.*, 2021). According to the Ricardian Equivalence Hypothesis (REH), the decision to borrow today is the opposite deferment of imposing more taxes, which will eventually be imposed in the future (Ricardo, 1951). Per the REH, borrowing today can cause corresponding increase in taxes or introduction of new taxes in the future. It follows that continuous rise in state debt may lead to future rise in electricity tariff. While many empirical studies support the REH relative to GDP (e.g., Barro, 1979, 1990; Afzal, 2012, Kourtellos *et al.*, 2013; Onogbosele and Ben, 2016), no direct application was made relative to electricity tariff, which is not tax per se, but a price to pay for consuming electricity and as such may be influenced by debt burdens. For instance, to reduce the negative impact of COVID-19, the government of Ghana provided free electricity and water to some class of consumers and subsequently introduced COVID-19 recovery levy as an indirect tax in 2021. Therefore, this paper assesses the impact of state borrowing on electricity tariff in Ghana.

The findings of this study has empirically established the short-run and long-run causal relationship between state debt and electricity tariff to aid policy decisions regarding debt management, particularly in the energy sector. As the country strives to recover from the negative impact of COVID-19, a lot of credit facilities were acquired including the $1 billion IMF rapid credit. Hence, we believe that it is vital to know how these recent debt accumulations will likely affect electricity tariff over time to provide useful information to governments, industry players and households. Finally, the findings of this paper may be applicable in developing countries with similar situation in their quest of rolling out economic recovery programmes post the global pandemic.

2. Neo-Ricardian Theory

The NRT builds upon the ideas of the REH, which states that government financing through debt or taxes has equivalent effects on the economy (Ricardo, 1951). REH suggests that government debt is seen as future taxation, and consumers and firms adjust their behavior accordingly. The NRT

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provides a more comprehensive framework for understanding the link between state debt and electricity tariff, particularly in the context of state-owned enterprises. Its consideration of institutional, social, and distributional factors offers a more nuanced explanation. For instance, NRT considers the institutional and social factors influencing state-owned enterprises, such as inefficiencies and political pressures; highlights the unequal distribution of tax burdens and benefits among different social classes; acknowledges the role of conflict and power struggles between various interest groups; and captures bounded rationality and imperfect markets (Sraffa, 1960; Robinson, 1962; Pasinetti, 1977).

In the context of state debt and electricity tariff, the REH suggests that state debt financing for electricity generation and distribution will eventually lead to higher electricity tariff (future taxation). Consumers anticipate this and adjust their consumption decisions. It follows that increased state debt for energy sector financing may lead to higher electricity tariff; higher tariff can reduce electricity demand, affecting economic activity; and anticipated future tax burden (tariff increases) influences current consumption and investment decisions. However, the REH assumptions may not hold in reality, as it ignores distributional effects (who bears the tax burden) (Pasinetti, 1977), and overlooks potential inefficiencies in state-owned enterprises. These limitations are addressed by the NRT, which emphasizes the role of institutional and social factors to avoid potential exploitation and inequality.

Based on the NRT, we hold that electricity companies, institutional factors, and distributional consequences play crucial roles in shaping the potential effect of state debt on electricity tariff. Ghana's energy sector debt, primarily financed through state borrowing, has significant implications for electricity tariff. Ghana's energy sector has faced significant challenges, including high debt levels and inefficient electricity companies. The energy sector debt, estimated at GH¢12.2 billion (US$2.1 billion) in 2020 (Energy Commission, 2020), primarily finances electricity companies including ECG and VRA. Subsequently, there have been regular tariff adjustments by the PURC to ensure financial sustainability. Thus, NRT emphasizes the importance of institutional context, suggesting that state ownership and political considerations influence tariff setting (Acheampong *et al.*, 2021). It follows that the principle of tax deferment to borrow to finance state expenditure, due to institutional inefficiencies and political considerations, may cause upward adjustments of electricity tariff in the long-run. From this perspective, the upsurge in electricity tariff can be partly attributed to the continuous rise in state borrowing, which is heavenly induced by energy sector inefficiencies. In other words, the accumulation of debt may have the propensity to influence the changes in electricity tariff. Therefore, it is imperative to empirically test this possibility given that there is no available literature.

3. Electricity Tariff in Ghana

Electricity is essential for quality healthcare delivery, education, transport, effective communication, mineral exploration, and ultimately serves as the pillar for every sector of an economy (Kumi, 2017). Electricity consumption contributes significant to economic growth over long a period (Chirwa and Odhiambo, 2020). Thus, both developed and developing countries pay critical attention to electricity demand and supply. As far back as 1960s, Ghana was committed to universal access to electricity by establishing state-owned institutions such as VRA to generate power; Ghana Grid Company Limited (GRIDCO) to transmit electricity from power generation sources to bulk supply points; and ECG to solely distribute the power to the consumers. Based on successive governments' efforts to expand access to electricity, demand for electricity in Ghana has increased by about 52% between 2006 and 2016. This has necessitated the need to double generation capacity over the same period (Kumi, 2017). In spite of the generation capacity being doubled, the country still suffers from persistent power supply challenges. Coupled with the intermittent power supply, Ghanaians are burdened with high electricity tariff (the price to pay for electricity consumption). In order to ensure a stable electricity tariff, the PURC incorporated an Automatic Adjustment Formula (AAF) with the aim of sustaining the real value of the tariffs by adjusting it, based on variations in factors such as fuel price (light crude oil, natural gas, etc.), exchange rate, inflation rate and generation mix. Electricity tariffs are categorized into six (6): residential, non-residential, special load tariff (SLT)

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– low voltage, special load tariff (SLT) – medium voltage, special load tariff (SLT) – high voltage and special load tariff (SLT) – high voltage – mines (Energy Commission of Ghana, 2016).

The government of Ghana might raise electricity tariff rather than other taxes because tariffs provide a stable source of revenue (IMF, 2019; World Bank, 2020a), and help utilities recover costs (Energy Commission, 2020; PURC, 2020). In terms of fiscal burden, tariff increases shift burden from taxpayers to electricity consumers given that a substantial portion of the state debt is used to finance power generation and distribution costs by the electricity companies (Ministry of Finance, 2020). Thus, tariff revenue funds energy sector investments and debt servicing (World Bank, 2019). Furthermore, higher tariffs ensure financial sustainability of the state-owned utilities (Acheampong *et al.*, 2021). They are easier and efficient to collect than other taxes (Das-Gupta and Mookherjee, 2017). It is worth noting that IMF and World Bank conditionalities also influence Ghana's electricity tariff hikes as part of economic reform packages (IMF, 2019; World Bank, 2020b). A case in point is the recent IMF $3 billion bailout, which required quarterly upward tariff adjustments. Last but not least, for political considerations, tariff increases are less contentious than broad-based tax hikes, as they often target specific consumers (World Bank, 2020a).

4. State Borrowing and Electricity Tariff

Empirical literature on state debt and electricity tariff are scanty. Nevertheless, there are some related empirical studies that suggest possible relationship between state debt and electricity tariff. First, literature shows that state debt has multiplier effect on the economy, which may go a long way to affect electricity tariff. Such studies indicated that state debt crowds out private investment through high cost of capital and consequently chokes the overall economy (Kobayashi, 2015; Anning *et al.*, 2016; Kobayashi and Shirai 2017). On the other hand, some scholars (e.g., Kumi, 2017) discover that electricity tariff has the propensity to influence state debt, suggesting that there could be bi-directional causal relationship between public debt and electricity tariff.

Arguing in favour of the REH, Reinhart and Rogoff (2010), Jalles (2011) and Panizza and Presbitero (2014) empirically held that state borrowing has no causal effect on the economy, meaning that state debt may not have effect on electricity tariff. This is basically in support of the REH that debt has neutral effect on the economy. It follows, therefore, that an empirical study is needed to confirm whether state borrowing would have neutral impact on electricity tariff, because the NRT suggests that due to utilities inefficiencies and distributional effects, it is probable that government debt will influence electricity tariff adjustments.

Lastly, literature suggests that inflation rate, exchange rate, and net energy import may have some controlling effects on electricity tariff (Energy Commission of Ghana, 2016; Kumi, 2017). This is evidenced by the tariff structure of the PURC where inflation rate and exchange rate keenly featured the adjustment of tariffs (PURC, 2020). It is, therefore, important to assess the effect of these variables in addition to state debt.

5. Methods

5.1. Model Estimation

We employed ARDL-based Granger-causality model to test the causal relationships between state debt and electricity tariff. To address the possible situation of omitted-variable-bias, other relevant variables such as, inflation rate, exchange rate, and net energy import were included. The ARDL bounds test prescribed by Pesaran *et al.* (2001) was used to determine cointegration among the regression variables. The error correction model (ECM) was then estimated to establish the Granger causality in the long-run. The ARDL and ECM are more efficient, particularly with small sample size as compared to the Johansen cointegration model which is suitable for large sample size (Hilton, 2021). These estimation models have been successfully utilized in prior empirical studies (Pesaran *et al.*, 2001; Kumar and Woo, 2010; Hilton, 2021; Garedow, 2022).

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5.2. Model Specification

The ARDL model and ECM were estimated on short-run and long-run relationships to support or reject the following hypotheses: (1) causality runs from state debt to electricity tariff (i.e., unidirectional); (2) causality runs from electricity tariff to state debt (i.e., unidirectional); (3) causality runs from and to each other (i.e., bi-directional); and (4) no causality (i.e., neutrality). These hypotheses were tested in both short-run and long-run periods.

5.2.1. Short-Run Model Specification

The ARDL short-run model was specified for all the regression variables (i.e., electricity tariff, public debt, inflation rate, exchange rate, and net energy import) in natural logs. Each variable was estimated as dependent variable in the ARDL model. In total, (5) short-run equations were estimated as follows.

$$\Delta lntariff_t = \alpha_{01} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lntariff_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lnsd_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, lninf_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lnexc_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta lnnetei_{t-1} + \mu_{1t} \quad (1)$$

$$\Delta lnsd_t = \alpha_{01} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lnsd_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lntariff_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, lninf_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lnexc_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta lnnetei_{t-1} + \mu_{1t} \quad (2)$$

$$\Delta lninf_t = \alpha_{01} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lninf_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lntariff_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, lnsd_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lnexc_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta lnnetei_{t-1} + \mu_{1t} \quad (3)$$

$$\Delta lnexc_t = \alpha_{01} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lnexc_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lntariff_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, lnsd_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lninf_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta lnnetei_{t-1} + \mu_{1t} \quad (4)$$

$$\Delta lnnetei_t = \alpha_{01} + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lnnetei_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lntariff_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, lnsd_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lninf_{t-1} + \sum_{i=1}^{q} \alpha_{6i}\, \Delta lnexc_{t-1} + \mu_{1t} \quad (5)$$

where: $lntariff_t$ is the annual tariff rate in period t; $lnsd_t$ is the total public debt in period t; $lninf_t$ is the inflation rate in period t; $lnexc_t$ is the exchange rate in period t; $lnnetei_t$ is the net energy import in period t; α_0 and β_0 are the respective constants; $\alpha_1 - \alpha_5$ and $\beta_1 - \beta_5$ are respective regression coefficients; Δ denotes change; μ_{1t} and μ_{2t} are the mutually independent white-noise residuals; p and q are the lag lengths; and t is the time period.

5.2.2. Long-Run Model Specification

The ARDL bounds test has shown only one cointegration vector (i.e., $lntariff_t$), indicating that there is existence of long-run relationship when $lntariff_t$ is the dependent variable (see Table 2). Therefore, ECM long-run model was specified as:

$$\Delta lntariff_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lntariff_{t-i} + \sum_{i=1}^{q} \alpha_{2i}\, \Delta lnsd_{t-1} + \sum_{i=1}^{q} \alpha_{3i}\, \Delta lninf_{t-1} + \sum_{i=1}^{q} \alpha_{4i}\, \Delta lnexc_{t-1} + \sum_{i=1}^{q} \alpha_{5i}\, \Delta lnnetei_{t-1} + \lambda ECT_{t-1} + \mu_{1t} \quad (6)$$

where: $lntariff_t$ is the annual tariff rate in period t; $lnsd_t$ is the total public debt in period t; $lninf_t$ is the inflation rate in period t; $lnexc_t$ is the exchange rate in period t; $lnnetei_t$ is the net energy import in period t; α_0 and β_0 are the respective constants; $\alpha_1 - \alpha_5$ and $\beta_1 - \beta_5$ are respective regression coefficients;

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Δ denotes change; λ is coefficient of ECT_{t-1}; ECT_{t-1} is the error-correction term lagged once; μ_{1t} and μ_{2t} are the mutually independent white-noise residuals; p and q are the lag lengths; and t is the time period.

5.3. Data

We employed annual time series data from 1998-2020. Though the data predate COVID-19 year (2020), it is important to observe the trend over time since state debt accumulation preceded COVID-19 and the effect might be in both short and long term periods. Data on inflation rate, exchange rate, and net energy import were sourced from the World Bank Development Indicator database (World Bank, 2021), while data on state debt as a percent of GDP was sourced from the IMF fiscal Affairs Department Database and WEO (IMF, 2021) and data on electricity tariff were obtained from the PURC.

6. Results and Discussion

6.1. Unit Roots Test

We employed ADF to test the unit roots. The results in Table 1 show unit root test with intercept and no trend as well as intercept and trend. The results illustrate that all the series variables are integrated of order one as the ADF test statistics are all significant at first difference. Since the ADF confirmed the stationarity of all the series variables at order one, the ARDL model and ECM were estimated.

Table 1. Unit root test result.

	Intercept and no Trend		**Intercept and Trend**	
Variables	**Levels**	**First difference**	**Levels**	**First difference**
$lntariff_t$	-1.287	-3.378**	-1.564	-3.289*
$lnsd_t$	-0.885	-3.642**	-0.945	-3.878**
$lninf_t$	-2.658*	-4.152***	-3.393*	-3.990**
$lnexc_t$	-1.571	-3.475**	-2.610	-3.554**
$lnnetei_t$	-1.390	-3.071**	2.638	-3.778***

Note: *, ** and *** signifies the rejection of the null hypothesis of non-stationarity at 10%, 5% and 1% significance levels, respectively.

6.2. Cointegration Test

To determine the cointegration among the series variables, we carried out the ARDL bounds test. The results in Table 2 depict one cointegration vector, thus the null hypothesis (i.e., no long-run relationships exist) is rejected in this case. ECM could therefore be estimated to establish the long-run Granger causality between $lntariff_t$ and the exogenous variables ($lnsd_t$, $lninf_t$, $lnexc_t$, and $lnnetei_t$). However, we fail to reject the null hypothesis for $lnsd_t$, $lninf_t$, $lnexc_t$, and $lnnetei_t$, meaning that no long-run relationship exists between them and the exogenous variables. Therefore, only ARDL short-run models were estimated for these variables.

Table 2. ARDL Bounds Test.

Dependent Variable	***F*-statistic**	**Cointegration**	**Decision**
$lntariff_t$	6.656257	Yes	Estimate ECM (long-run model)
$lnsd_t$	1.396649	No	Estimate ARDL (short-run model)
$lninf_t$	2.143308	No	Estimate ARDL (short-run model)
$lnexc_t$	2.754151	No	Estimate ARDL (short-run model)
$lnnetei_t$	1.144439	No	Estimate ARDL (short-run model)

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Note: Critical values (I0 Bound) are 2.45, 2.86 and 3.74; and Critical values (I1 Bound) are 3.52, 4.01 and 5.06; critical values are significant at 10%, 5% and 1% respectively.

6.3. Lag Length Selection Criterion

The Akaike information criterion (AIC) was employed to select the lag length for the models. The result demonstrates that $lntariff_t$, $lnpd_t$, $lninf_t$, $lnexc_t$, and $lnnetei_t$ respectively have lag lengths of 1, 2, 0, 1, and 3 (see Table 3). Therefore, the ARDL model and ECM estimations were based on these lag lengths.

Table 3. Lag length selection test.

Dependent variable	Lag length	Akaike information criterion (AIC)
$lntariff_t$	1	3.183147*
$lnsd_t$	2	-0.598639*
$lninf_t$	0	0.890928*
$lnexc_t$,	1	-1.475172*
$lnnetei_t$	3	1.545634*

* indicates lag order selected by the criterion.

6.4. Short-Run and Long-Run Causal Relationships

Table 4 presents the short-run and long-run causal relationships among the regression variables. ARDL short-run model was adopted to test the short-run Granger causality. It can be observed from Table 4 that, a positive short-run causal relationship runs from state debt to electricity tariff [Coef = 3.279; p-value = 0.006], and not vice versa [Coef = 0.029; p-value = 0.617]. It means that, in the short-run, state debt has significant positive impact on changes in electricity tariff, such that, as government(s) accumulates more debts, there is high possibility of a rise in electricity tariffs, ceteris paribus. On the other hand, there is no short-run causal relationship running from inflation rate, exchange rate and net energy import to electricity tariff, and vice versa. Granger causality runs from exchange rate to state debt [Coef = 0.432; p-value = 0.031].

Furthermore, ECM was estimated to test the long-run causal relationship using ECT_{t-1}. Only electricity tariff was estimated as dependent variable based on the cointegration test result. As shown in Table 4 [Coef = 1.057; p-value = 0.035], there is long-run Granger causality running from all the exogenous variables (state debt, inflation rate, exchange rate, and net energy import) to electricity tariff. The coefficient is statistically significant at 5% significance level. This implies that all the explanatory variables have impact on electricity tariff in the long-run. Thus, in the long-run, state debt Granger causes electricity tariff and not vice versa. It follows, therefore, that there is unidirectional impact of state debt on electricity tariff in the long-run as observed in the short-run. This result is consistent with the REH that debt accumulation influences future imposition of tax or tariff in this context.

These empirical results support the assumption behind the REH that borrowing today would cause an increase in tax as government would have to impose more taxes to offset the debt (Ricardo, 1951). But, more importantly, the results underscore the inefficiencies of the electricity companies and political considerations espoused by the NRT to be underlining factors for the rise in debt stock, causing upward adjustments in electricity tariff (Acheampong *et al.*, 2021). Empirically, our findings do not support Kumi's (2017) discovery that electricity tariff has the propensity to influence state debt. Hence, there is no bi-directional causal relationship between state debt and electricity tariff as inferred from Kumi's (2017) study.

It is instructive to note that even though this study is without a precise precedent, it has highlighted the significant impact of state debt on electricity tariff in both short-run and long-run. Additionally, this study has demonstrated that inflation rate, exchange rate and net energy import have significant impact on electricity tariff in the long-run. It follows that a rise in these exogenous variables will likely cause an increase in electricity tariff. Thus, this paper empirically justifies the

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inclusion of inflation rate and exchange rate in the adjustment of tariff (Energy Commission of Ghana, 2016; PURC, 2020). However, net energy import should also be included in the tariff adjustment formula.

Table 4. Granger-causality test results (short-run and long-run causation).

Dependent Variable	**Independent Variables Coefficients [p-value]**					***ECT*$_{t-1}$ [p-value]**
	lntariff$_t$	*lnsd*$_t$	*lninf*$_t$	*lnexc*$_t$	*lnnetei*$_t$	
lntariff$_t$	-	3.279	-0.127	0.904	0.277	1.057
		[0.006]	[0.831]	[0.581]	[0.517]	[0.035]
lnsd$_t$	0.029	-	0.311	-0.451	-0.049	-
	[0.617]		[0.175]	[0.335]	[0.710]	
lninf$_t$	1.910	-4.031	-	-2.530	-7.861	-
	[0.482]	[0.762]		[0.646]	[0.862]	
lnexc$_t$	0.013	0.432	0.049	-	0.045	-
	[0.706]	[0.031]	[0.636]		[0.541]	
lnnetei$_t$	-0.115	-4.475	-0.511	-0.665	-	-
	[0.724]	[0.428]	[0.658]	[0.772]		

6.5. Serial Correlation and Heteroskedasticity Tests

The Breusch-Godfrey serial correlation and heteroskedasticity tests affirm that the models are not serially correlated and there is no heteroskedasticity as the [Prob. F] for the respective variables are not less than 5% significance level (Table 5). It indicates that the findings are valid and reliable to augment existing literature.

Table 5. Serial correlation and heteroskedasticity results.

Dependent variable	**Serial Correlation LM** ***F*-statistic [Prob. F]**	**Heteroskedasticity** ***F*-statistic [Prob. F]**
lntariff$_t$	0.403403 [0.5364]	1.640081 [0.2056]
lnsd$_t$	1.259815 [0.3493]	0.784561 [0.6473]
lninf$_t$	0.122180 [0.7302]	1.473456 [0.2599]
lnexc$_t$	0.534272 [0.4778]	0.657109 [0.6615]
lnnetei$_t$	0.465617 [0.5025]	0.294963 [0.9146]
* lntariff$_t$	0.002599 [0.9602]	2.556428 [0.0736]

Note: * lntariff$_t$ is for the ECT$_{t-1}$.

6.6. Residual and Stability Diagnostics Tests

The stability diagnostic test was conducted using CUSUM. The test was run for lntariff$_t$ in ARDL short-run model and ECM long-run model. The stability is assessed at 5% significance boundary. Figures 1 and 2 show the CUSUM test for lntariff$_t$ in ARDL and ECM respectively. Both models fall within the 5% significance boundary, indicating that they are stable.

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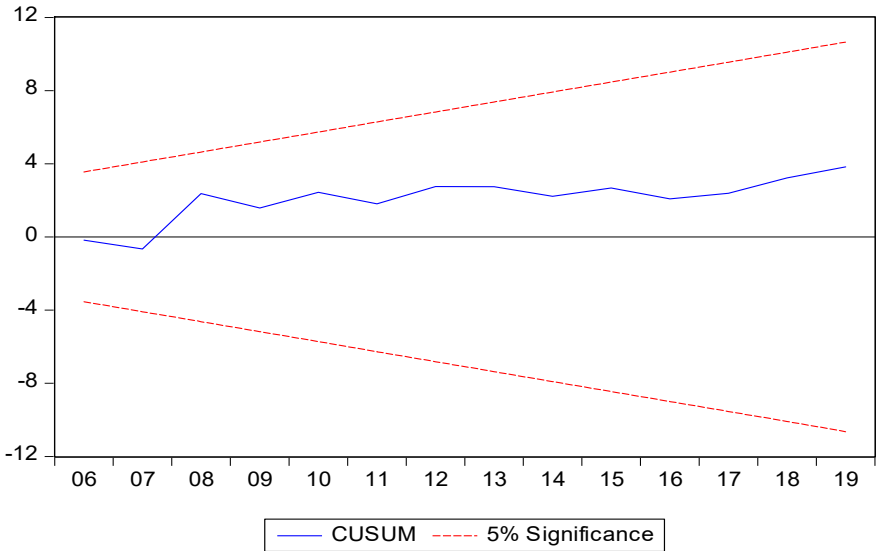

Figure 1. Stability diagnostic result for lntariff$_t$ in ARDL.

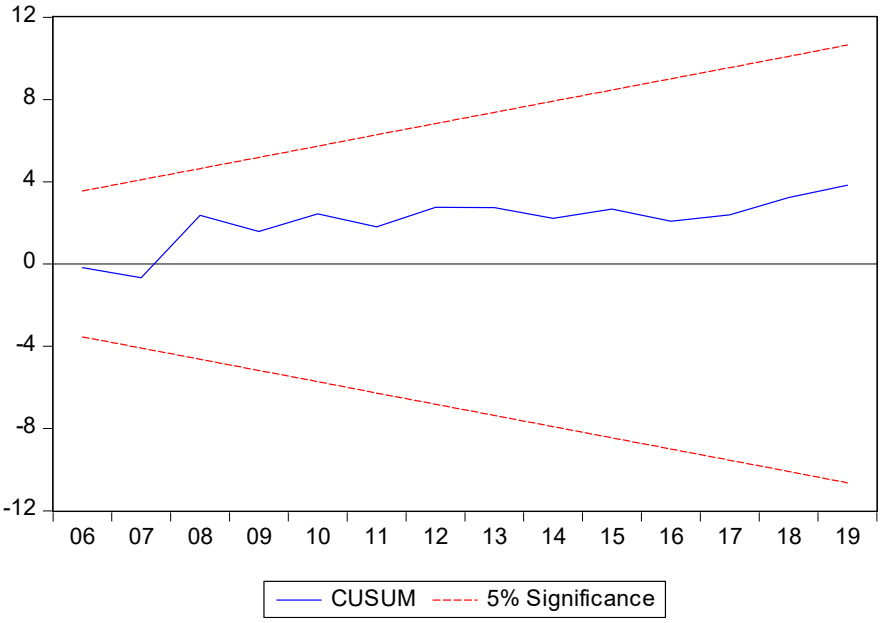

Figure 2. Stability diagnostic result for lntariff$_t$ in ECM.

7. Conclusions

As the debt stock level of government keeps rising, partly due to the negative impact of COVID-19, a number of new taxes have been introduced in the 2021 budget alongside an upward adjustment of electricity tariff. Therefore, we were of the view that debt accumulation may have significant influence on electricity tariff. Hence, we employed ARDL model and ECM to test for the Granger causality between state debt and electricity tariff. The results revealed that state debt has both short-run and long-run impact on electricity tariff. It means that citizens would be required to pay more for electricity consumption in the future in response to rising debt level today. Furthermore, inflation rate, exchange rate, and net energy import have long-run impact on electricity tariff while only exchange rate has short-run effect on state debt. Thus, all the accumulated debts prior to and during the COVID-19 era are causing an inevitable upsurge in electricity tariff in Ghana, providing an empirical clue to what the situation is likely to be in other developing countries where there is poor debt management. These findings imply that effective debt management strategies (e.g., maintaining high fiscal discipline) must be implemented by government to reduce borrowings, particularly when

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such borrowings are not invested into projects that can repay the debt at maturity. Given that government is constrained by budget deficit, borrowings to finance the deficit should be spent on capital stock which will in turn generate income to service the debt. Government may also control budget deficit by reducing consumption expenditure.

This paper significantly augments extant literature but it is limited in the following way. The paper examines the case of one emerging economy without consideration of other economies with similar situation. In jurisdictions where socio-economic factors or governance structures differ, a replication of this study is needed to ensure that same results are achieved to support the implementation of the recommendations in this paper. Future research should examine the phenomenon in selected developing countries to see whether there will be consistency or inconsistency in the findings.

Authors Contribution Statement: Kris Hilton was involved in methods, analysis and interpretation of the data, and the final approval of the version to be published. Vida Essuman was involved in the conception and data collection, Ebenezer Effisah drafted the paper revising it critically for intellectual content by focusing on the introduction while Andaratu Khalid wrote the literature review section and conclusion. We agreed to be accountable for all aspects of the work.

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