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Electricity Revenue and Tariff Growth in Malawi

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ABSTRACT

In 2011, the Millennium Challenge Corporation, a Washington Based Aid Agency, signed a Compact agreement with the Malawi Government to implement a number of interventions in the power subsector; one of which was power sector reforms. Given that one of the key interventions under the reforms relate to improving the creditworthiness of the existing utility company by advocating for improved financial position (revenue and tariff growth); understanding what drives or impedes power utility growth is important, both in the short- and long-run. The empirical results show that electricity tariffs, electricity generated, and power sector reforms drive revenue growth; while the system losses and inflation impedes revenue growth in the short-run. However, in the long-run, the results show that electricity tariffs and electricity generated drive revenue growth; while system losses and power sector reforms impede revenue growth in the long-run. In terms of tariff growth, the study results show that inflation, real exchange rate (RER) depreciation, electricity revenues, and system losses drive tariff growth; while electricity generated impedes tariff growth in the short-run. However, the long-run results reveal that RER depreciation, revenue growth, and system losses, drive electricity tariff growth; while electricity generated impedes the tariff growth.

Keywords: Malawi, Determinants of Utility Growth, Autoregressive Distributed Lag Models, Power Sector Reforms
JEL Classifications: N17, O43, O55

1. INTRODUCTION

The availability of electricity, like in many African countries, is one the biggest challenges that Malawi faces. A Constraints Analysis study, financed by the Millennium Challenge Corporation (MCC) and completed in May 2010, employed a growth diagnostic framework proposed by Hausmann et al. (2005) and concluded that the poor state of electricity infrastructure in the country was one of the main challenges affecting economic growth in Malawi. The report also ranked Malawi as one of the countries in the world with the lowest level of sophistication and a high degree of non-traditional products affecting the growth of manufacturing output and investment (MCA-Malawi, 2010b, p. 3). Malawi is also one of the countries in the world with the lowest electricity per capita consumption averaging 94 kilowatt hours (kWh) per capita in 2014. Compared to Iceland which is the biggest consumer of electricity in the world with an average of 52,374 kWh per capita, Malawi has a long way to go towards improving access to electricity for both consumption and development. As of 2013, Malawi's per capita GDP at constant 2005 US dollars was estimated at $264 per capita; making the nation to be one of the poorest economies in the world (MCA-Malawi, 2013b; World Bank, 2015).

As of 2015, the current installed generation capacity in Malawi was 351 Megawatts (MW) of which 100% is hydro-generated. According to the Integrated Household Survey of 2010/2011, it was estimated that about 6.48% of households had access to electricity during that period against an installed generation capacity of 287 MW (Republic of Malawi, 2012a). With new installed generation capacity added in 2014 of 64 MW; this increased the installed capacity to the current 351 MW. It is estimated that about 7-9% of households in the country have access to electricity based on this small addition to the generation capacity.

In order to improve the energy situation in the country, on April 11, 2011, the Malawi Government signed a US$350.7 million Compact grant agreement with the United States Government, through the MCC. The aim of the program is to revitalize the power sub-sector in Malawi which has been the most significant constraint towards fostering economic growth. The Compact agreement became effective on September 20, 2013 and will be implemented for exactly 5 years and end on September 19, 2018 (MCA-Malawi, 2013a). The MCC Compact with Malawi is, therefore, seen as a catalyst towards unlocking Malawi's potential to foster high economic growth and poverty reduction in the long-term. There are three important projects that will be implemented under the program in the course of 5 years.

First, the program is expected to add approximately 27% of gross fixed capital formation by investing $257.1 million towards power subsector infrastructure development through the following interventions: rehabilitation works of one of the oldest power plants that was commissioned in 1966; construction of new 400 kV and 132 kV transmission backbone lines expected to increase the grid throughput capacity from 260 MW to 960 MW; and uprate selected transmission and distribution substations and lines in order to increase availability and reliability of electricity as well as reduce system losses to existing and future customers (MCA-Malawi, 2013b). A cost benefit analysis that was conducted by MCC estimates an economic rate of return of 18.7% if the infrastructure development project activities are implemented according to plan (MCA-Malawi, 2013b). The calculated rate of return included one precondition whereby the Malawi Government was expected to increase generation capacity. This was successfully achieved when the power utility commissioned the Kapichira II hydro-power plant in January 2014 by adding 64 MW to the installed generation capacity, thereby fulfilling this condition (MCA-Malawi, 2013a, Annex I-3). Under the infrastructure development project, the benefits are envisaged to contribute towards economic growth and poverty reduction by increasing electricity consumption, raising the profitability and productivity of enterprises, and value-added production in key growth sectors of the economy (MCA-Malawi, 2013b).

Second, the program is investing $25.7 million towards power sector reforms that seek to improve power subsector governance. The goal of the power sector reform project is to create a conducive environment for future expansion. Much as the infrastructure development project will increase the throughput capacity to 960 MW, Malawi will need to increase its generation capacity to fully utilize the improved transmission and distribution grid system. It is estimated that for Malawi to achieve its 2030 goals of increasing access to electricity to about 30%, the economy needs to invest approximately $7 billion to achieve this goal. Government on its own does not have the capacity to attract all these resources, hence the need for power sector reforms. Under the MCC Compact power sector reform project, the strategies put forward aim at strengthening, enhancing regulation and corporate governance of power sub-sector institutions (MCA-Malawi, 2013b).

In order to achieve the agreed strategies the power sector reform project is implementing two main activities. The first activity is called the Electricity Supply Corporation of Malawi (ESCOM) turnaround project with interventions aimed at reforming Malawi's single monopolistic utility company, the ESCOM, which is fully owned by Government. The interventions being implemented under this activity focus on improving ESCOM finances, operations and corporate governance (MCA-Malawi, 2013b, p. 10-11). The second activity focuses on regulatory reforms in the power subsector by focusing on tariff reform, regulatory capacity building, and creation of an enabling environment for private sector participation (MCA-Malawi, 2013b, p. 12).

Third, the program is also investing $25.9 million toward mitigating costly power disruptions caused by weed infestation and sedimentation in the catchment areas where the hydropower plants are located. This project will complement activities being implemented under the infrastructure development project by investing in weed and sediment management equipment and interventions that work with communities living within the Shire River catchment area (MCA-Malawi, 2013b, p. 12-14).

Given that the benefits of the infrastructure projects are yet to be realized and will come after compact implementation in 2018; there is consensus that the benefits of power sector reforms can have both short- and long-term growth effects. One of the key drivers of progress under the power sector reform program is to see whether the utility becomes creditworthy as well as evidence of improved efficiency over time, both in the short- and long-term. This question can only be answered if we understand the key determinants that exhibit a long-run level relationship with either revenue or tariff growth. The focus of this study is, therefore, twofold: to identify the determinants of utility growth; with a special focus on revenue and tariff growth. Second, is to see whether the implementation of power sector reforms under the MCC program with Malawi are bearing fruit. We find these policy goals to be consistent with the power subsector program being implemented by the Malawi Government with support from the MCC.

In order to achieve this, the study employs the recently developed autoregressive distributed lag (ARDL) bounds testing approach to cointegration that was developed by Pesaran et al. (2001) to establish level relationships between the dependent variables and the targeted power sector reform covariates discussed in the next section. The rest of the paper is organized as follows. Section 2 discusses the key interventions implemented through the MCC Malawi Compact from April 2010 under the power market sector reform; from which we draw some of the key drivers that were identified and agreed to be improved. Section 3 establishes the empirical model and methodology to be adopted. Section 4 presents the empirical results. Lastly, section 5 discuss the conclusions arrived from the research and some policy implications based on the study results.

2. FACTORS AFFECTING POWER UTILITY PERFORMANCE IN MALAWI

In April 2010, the MCC, a Washington-based aid agency, hired a Consulting firm, Ernst Young (EY), to undertake a financial and management performance review of the national power utility, the ESCOM. The product of this assignment was to develop a 5 years reorganization plan with eleven recommendations grouped into seven categories. The three major recommendations made were to: Improve billings and collections; reorganize the utility's capital structure; and improve ESCOM's revenue position. Additional recommendations made included: Developing a roadmap for unbundling ESCOM through a power market restructuring study; developing an independent power producer (IPP) framework; improving procurement; and increasing board and management capacity (MCA-Malawi, 2010a).

As in many public utilities, prior to April 2010, ESCOM faced numerous challenges; one of which included the accumulation of arrears both from public institutions and private customers. During ESCOM's fiscal period, July 2009-June 2010, average collection period in days averaged 327 days; while average creditor days stood at 195 days. As a result of ESCOM was unable to service its obligations within the stipulated statute of 30 days (MCA-Malawi, 2015). EY's proposed solutions were grouped into short- and medium-term solutions. The short-term solutions included improving connection times to improve revenue collection; and increasing controls for journal entries and debt collection. In the medium-term the proposed solutions included migration of customers to prepaid meters; and installation of a new billing system (MCA-Malawi, 2010a).

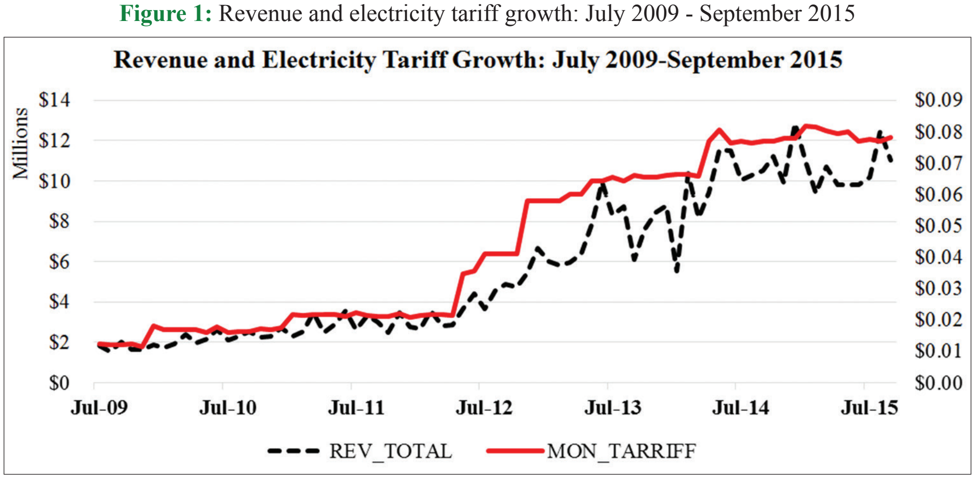
Significant improvements were made to address the short-term solutions in particular improving internal controls; which led to improved receivable days to an average of 76 days as of June 2015. Average creditor days also significantly improved to 65 days as of June 2015 (MCA-Malawi, 2015). To address the medium-term solutions, ESCOM has also made significant progress in migrating existing customers from post-paid to pre-paid meters from 10% in July 2009 to 60% as of June 2015 (MCA-Malawi, 2015). As of June 2009, ESCOM's total debt obligations stood at US$112 million (or MWK15.7 billion) which meant that the Utility was technically insolvent (MCA-Malawi, 2010a). This grossly affected the utility's liquidity ratios. For the quarter ending September 2009, the average long-term debt-equity ratio stood at 1.31; the gearing ratio was 1.45; the acid or quick ratio was 0.03; and the current ratio was 0.38 (MCA-Malawi, 2015).

The recommendation made by EY was for government to write-off ESCOM's debt by restructuring and converting it into equity. The process was successfully completed in June 2014; which resulted in creating a creditworthy utility with zero long-term debt as of June 2015. Other improvements that materialized included a moderate gearing ratio averaging 0.32; the acid or quick test ratio and the current ratio improved to 2.96 and 6.32, against benchmarks of 1.00 and 3.00, respectively (MCA-Malawi, 2015).

Though significant improvements were made in improving ESCOM's finances, ESCOM's revenue position was still low. This required a form of cash injection from the government, development partners and a tariff increase. In July 2012, based on recommendations made by MCA-Malawi, the Government of Malawi injected US$10 million (or MWK2.5 billion) to support ESCOM working capital needs. As of June 2013, Malawi had committed $435 million into the power subsector for capital asset renewal; $350.7 million as a grant committed from MCC; and $84 million commitment from the World Bank (MCA-Malawi, 2015). The other contribution towards improving ESCOM's revenue position was through the base-tariff review process spearheaded by the Malawi Energy Regulatory Authority (MERA) which is done once every 4 years. Figure 1 illustrates trends in ESCOM's revenue and tariff adjustments during the period July 2009-September 2015.

The primary vertical left axis shows revenue growth in millions of US dollars while the secondary right axis shows the growth in electricity tariff expressed in US$ cents per kWh. For comparison purposes, we convert all financial data to constant US Dollar prices using the average exchange rate for the month of December 2014 as the base. In December 2009, MERA approved a base-tariff increase from a real value of $0.01/kWh in July 2009 to $0.02/kWh. The second phase of increasing the base-tariff was in December 2010 that maintained the real value of the electricity tariff at $0.02/kWh. Within the period, April 2012-November 2012, ESCOM benefited from two automatic tariff adjustment mechanisms that takes into account inflation and exchange rate movements within a ±5% rationalization framework (Republic of Malawi, 2012b).

Figure 1: Revenue and electricity tariff growth: July 2009 - September 2015



Source: MCA-Malawi Indicator Tracking Table, December 2015

The application of the automatic tariff adjustment framework (ATAF) led to an increase in the real value of the electricity tariff from \$0.02/kWh to \$0.06/kWh in November 2012. The electricity tariff continued to benefit from automatic tariff adjustments approved by MERA in May 2013 and exchange rate gains raising the electricity tariff to \$0.07/kWh in March 2014 (MCA-Malawi, March 2015). In July 2013, MERA initiated a second base-tariff review and in April 2014, a new base-tariff was approved increasing the tariff to \$0.08/kWh in real terms (Malawi Energy Regulatory Authority, 2014). As illustrated in Figure 1, the trend shows a co-movement between the growth in utility revenue and the growth of average monthly tariffs.

Based on the discussion above, we isolate seven main determinants of revenue growth to be investigated. These include average monthly tariffs, quantity of electricity generated, level of long-term debt, system losses, inflation, the real exchange rate (RER), and a dummy variable for commencement of public sector reforms to measure their impact on revenue growth.

The first set of determinants of revenue growth are associated with MCA-Malawi efforts to advocate for an approval of a cost-reflective tariff (TRIFF) and increased generation capacity (GEN). As a precondition to the implementation of the Compact, the Malawi Government agreed to invest in new generation capacity by completing the construction of Kapichira II hydro-power plant (MCA-Malawi, 2013a). This was completed in December 2013 and the plant was commissioned in January 2014 which added 64 MW of installed generation capacity. In November 2013, MCA-Malawi also engaged EY to develop a Detailed Financial Model to assist ESCOM in applying for a base-tariff review in June 2014. ESCOM successfully applied for the base-tariff and eventually it was approved and became effective on April 1, 2014; increasing the base tariff in real terms to \$0.08/kWh (Malawi Energy Regulatory Authority, 2014). A priori expectations is that we expect a positive relationship between movements in electricity tariffs, generation capacity and revenue growth.

The second set of determinants that affect revenue growth comprise improving financial and operational efficiencies within the utility. The variables considered include reducing total debt (DEBT), and system losses (LOSS). A priori expectation is that financial and operational efficiencies proxied by the accumulation of total debt, and accumulation of system losses, respectively; are negatively associated with revenue growth.

The third set of determinants represent a measure of macroeconomic stability. According to MERA by-laws of 2012, the external factors affecting utility revenue growth include inflation and the RER. We, therefore, investigate the impact of inflation (INF) and the RER on revenue growth. A priori expectation is that high rates of inflation and real exchange rate instability are expected to be negatively associated with revenue growth. Lastly, the impact of power sector reforms during the study period is investigated by including a time-variant dummy variable covering the period of MCC program effectiveness (September 20, 2013) which signifies the fulfilment of conditions precedent.

The same variables being targeted under the MCC Malawi Compact will be investigated as potential determinants of tariff growth. According to the Electricity By-Laws of 2012, the electricity tariff (TRIFF) in Malawi is reviewed every 4 years and subjected to an automatic tariff adjustment mechanism (ATAF) that takes into account inflation and exchange rate fluctuations. Every 4 years, any electricity Utility company is expected to submit an application for a base tariff review that takes into account revenue requirements for the next 4 years. ESCOM has so far applied for two base-tariff reviews that were approved in December 2009 and April 2014 (Malawi Energy Regulatory Authority, 2009, 2014).

The domestic inflation rate triggers electricity tariff adjustments on domestic costs and attracts a 20% adjustment rate. The exchange rate, on the other hand, triggers electricity tariff adjustments on foreign goods and services; and attracts an 80% adjustment rate. Inflation and exchange rate movements are regarded as important determinants of tariff growth in Malawi, and thus will be regarded as state variables in the tariff growth equation. If the automatic tariff adjustment mechanism is implemented correctly, we anticipate the coefficient parameters for inflation and real exchange rate to be positively associated with electricity tariff growth. The inclusion of the other variables aims at determining the role that other efficiency factors play in tariff determination, both in the short- and long-run.

3. EMPIRICAL MODEL SPECIFICATION AND DATA SOURCES

3.1. Empirical Model Specification

The theoretical framework that expresses the long-run dynamic relationship between the two dependent variables of interest and their set of covariates is specified in this section. To my knowledge, I have not come across an empirical paper that has taken this approach and, therefore, it remains the first of its kind. Based on the previous discussion, the empirical growth model for both the revenue and tariff growth equations are assumed as follows:

$$REV_t = f(TRIFF_t, GEN_t, DEBT_t, LOSS_t, INF_t, RER_t, DUM_t) \tag{1}$$

$$TRIFF_t = f(INFL_t, RER_t, REV_t, GEN_t, DEBT_t, LOSS_t, DUM_t) \tag{2}$$

The variables in equations (1-2) are all expressed in logarithmic values and include lags of both the dependent and explanatory variables. In order to estimate these two equations, the study uses the recently developed ARDL model suggested by Pesaran and Shin (1999) and the bounds test to cointegration suggested by Pesaran et al. (2001). The unrestricted ARDL representation of the empirical model with fixed variables included in the empirical specification is given as:

$$lnREV_t = \beta_0 + \beta_1 T_t + \sum_{i=1}^{n}\beta_{2i}\Delta lnREV_{t-i} + \sum_{i=1}^{n}\beta_{3i}\Delta lnTRIFF_{t-i}$$
$$+\sum_{i=0}^{n}\beta_{4i}\Delta lnGEN_{t-i} + \sum_{i=0}^{n}\beta_{5i}\Delta lnDEBT_{t-i} + \sum_{i=0}^{n}\beta_{6i}\Delta lnLOSS_{t-i}$$
$$+\sum_{i=0}^{n}\beta_{7i}\Delta lnINF_{t-i} + \sum_{i=0}^{n}\beta_{8i}\Delta lnRER_{t-i} + \sum_{i=0}^{n}\beta_{9i}\Delta DUM_{t-i}$$
$$+\alpha_1 lnREV_{t-1} + \alpha_2 lnTRIFF_{t-1} + \alpha_3 lnGEN_{t-1} + \alpha_4 lnDEBT_{t-1}$$
$$+\alpha_5 lnLOSS_{t-1} + \alpha_6 lnINF_{t-1} + \alpha_7 lnRER_{t-1} + \alpha_8 DUM_{t-1} + \varepsilon_t \quad (3)$$

$$lnTRIFF_t = \beta_0 + \beta_1 T_t + \sum_{i=1}^{n}\beta_{2i}\Delta lnTRIFF_{t-i} + \sum_{i=0}^{n}\beta_{3i}\Delta lnINF_{t-i}$$
$$+\sum_{i=0}^{n}\beta_{4i}\Delta lnRER_{t-i} + \sum_{i=1}^{n}\beta_{5i}\Delta lnREV_{t-i} + \sum_{i=0}^{n}\beta_{6i}\Delta lnGEN_{t-i}$$
$$+\sum_{i=0}^{n}\beta_{7i}\Delta lnDEBT_{t-i} + \sum_{i=0}^{n}\beta_{8i}\Delta lnLOSS_{t-i} + \sum_{i=0}^{n}\beta_{9i}\Delta DUM_{t-i}$$
$$+\alpha_1 lnTRIFF_{t-1} + \alpha_2 lnINF_{t-1} + \alpha_3 lnRER_{t-1} + \alpha_4 lnREV_{t-1} +$$
$$\alpha_5 lnGEN_{t-1} + \alpha_6 lnDEBT_{t-1} + \alpha_7 lnLOSS_{t-1} + \alpha_8 DUM_{t-1} + \varepsilon_t \quad (4)$$

In equations (3 and 4) the parameters $\beta_2, \ldots, \beta_9$ are the short-run multipliers (elasticities) and α1,…, α_8 are the long-run multipliers (elasticities). The error term is assumed to be independent and identically distributed, denoted ε_t. The ARDL approach to cointegration comes with its advantages. First, the ARDL model include lags of both the dependent and explanatory variables and is a powerful tool to investigate both short- and long-run growth effects (Pesaran and Shin, 1999). Second, the bounds test for identifying cointegrating relationships can be applied irrespective of whether the study variables are integrated of order zero or one (Odhiambo, 2013). Third, the ARDL model can take up a sufficient number of lags that captures the data generating process in a general to specific modelling framework; and given small sample sizes as in the present study of 75 observations, the ARDL approach provides robust results in studies affected by small sample sizes (Narayan, 2005). Finally, the two-stage ARDL bounds testing approach effectively corrects for any possible endogeneity in the explanatory variables (Pesaran and Shin, 1999; Acikgoz and Mert, 2014).

The error correction model associated with equations (3 and 4) are presented as follows:

$$ln\Delta REV_t = \beta_0 \Delta T_t + \sum_{i=1}^{n}\beta_{1i}\Delta lnREV_{t-i} + \sum_{i=0}^{n}\beta_{2i}\Delta lnTRIFF_{t-i} +$$
$$\sum_{i=0}^{n}\beta_{3i}\Delta lnGEN_{t-i} + \sum_{i=0}^{n}\beta_{4i}\Delta lnDEBT_{t-i} + \sum_{i=0}^{n}\beta_{5i}\Delta lnLOSS_{t-i} +$$
$$\sum_{i=0}^{n}\beta_{6i}\Delta lnINF_{t-i} + \sum_{i=0}^{n}\beta_{7i}\Delta lnRER_{t-i} + \sum_{i=0}^{n}\beta_{8i}\Delta DUM_{t-i} + \rho ECM_{t-1} + \varepsilon_t \quad (5)$$

$$ln\Delta TRIFF_t = \beta_0 \Delta T_t + \sum_{i=0}^{n}\beta_{1i}\Delta lnINF_{t-i} + \sum_{i=0}^{n}\beta_{2i}\Delta lnRER_{t-i} +$$
$$\sum_{i=1}^{n}\beta_{3i}\Delta lnTRIFF_{t-i} + \sum_{i=0}^{n}\beta_{4i}\Delta lnREV_{t-i} + \sum_{i=0}^{n}\beta_{5i}\Delta lnGEN_{t-i} +$$
$$\sum_{i=0}^{n}\beta_{6i}\Delta lnDEBT_{t-i} + \sum_{i=0}^{n}\beta_{7i}\Delta lnLOSS_{t-i} + \sum_{i=0}^{n}\beta_{8i}\Delta DUM_{t-i}$$
$$+\rho ECM_{t-1} + \varepsilon_t \quad (6)$$

In equations (5 and 6), the term, ECM, represents the error correction term, which measures the short-run speed of adjustment towards the long-run equilibrium path of the estimated ARDL model (Collier and Goderis, 2012). There are three scenarios that the ECM coefficient can take (Nair et al., 2006). In the first scenario, if the value of the ECM is between 0 and –1, then the convergence towards the long-run equilibrium path is monotonic where the correction of the dependent variable in period t is equivalent to the fraction of the ECM in period t-1. In scenario 2, if the ECM is between –1 and –2, then the convergence towards the long-run equilibrium path represents a dampened oscillation where the correction of the dependent variable takes time to converge towards its equilibrium path. Lastly, in scenario 3, if the ECM is positive or < –2, then the dependent variable will not converge towards its long-run equilibrium path.

The ARDL bounds testing approach requires variables to be integrated of either order one or zero and variables integrated of order two or more make the bounds testing approach to cointegration irrelevant (Odhiambo, 2013). Thus, it is important to conduct unit root tests to validate such an important assumption. Three unit root tests are employed in this study. First, we use the Augmented Dickey and Fuller (1979) unit root test that takes into account the presence of serial correlation in the time series data. Second, the Perron (1990) innovation outlier model is used to investigate the presence of structural breaks in the time series data. Third, the Elliott et al., (1996) Dickey Fuller generalized least squares (DFGLS) unit root test is employed that detrends the time series data.

3.2. Data Sources

The data for the power utility determinants investigated have been obtained from the MCA-Malawi Indicator Tracking Table (MCA-Malawi, 2015) that consolidates data from various sources obtained from the national power utility, ESCOM; the World Bank World Development Indicators (World Bank, 2015), and the Reserve Bank of Malawi (Reserve Bank of Malawi, 2015). These data files comprise of monthly generation statistics and financial statistics obtained from the ESCOM; monetary statistics such as average monthly inflation and nominal exchange rate data obtained from the Reserve Bank of Malawi; annual PPP conversion factor obtained from the World Bank; and an author constructed dummy variable. The period of analysis covers monthly time series data from July 2009 to September 2015; and has a sample size of 75 observations. Table 1 summarizes the variables of interest including their definitions and sources.

Table 1: Definition and source of variables

Variable	Definition	Source
REV	Total actual revenue in December 2014 constant USD prices	MCA-Malawi Indicator Tracking Table, December 2015
TRIFF	Actual average monthly electricity tariff in December 2014 constant USD prices	MCA-Malawi Indicator Tracking Table, December 2015
GEN	Total electricity generated in MWh received by transmission	MCA-Malawi Indicator Tracking Table, December 2015
DEBT	Total debt (long-term, short-term and bank borrowings) in December 2014 constant USD prices	MCA-Malawi Indicator Tracking Table, December 2015
LOSS	System losses calculated as {[(Total MWh sent from generation to transmission+Net imports) - Total MWh billed]/(Total MWh sent from generation to transmission+Net imports)}	MCA-Malawi Indicator Tracking Table, December 2015
RER	Real exchange rate expressed as the ratio of nominal exchange rate (LCU per US$, period average) and PPP conversion factor, GDP (LCU per international $)	World Bank, World Development Indicators, March 2015; and Reserve Bank of Malawi, April 2015
INFL	Monthly inflation, period average	Reserve Bank of Malawi, April 2015
DUM	Dummy variable representing the impact of power sector reforms, 1, 2, 3,…=October 2013 onwards; 0=Otherwise, July 2009 – September 2013)	Author constructed

Table 2: Unit root tests results

Variable name	Stationarity of all variables in levels						Stationarity of all variables in 1st difference					
	ADF		DFGLS		Perron		ADF		DFGLS		Perron	
	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend	Without trend	With trend
log (REV)		–1.91		–7.74***		–1.83		–11.96***				–3.88***
log (TRIFF)		–1.80		–5.86***		–1.94		–10.02***				–9.77***
log (DEBT)		–3.24*		–6.73***		–3.13**		–11.07***				
log (GEN)	–3.97***		–4.94***		–3.92***							
log (LOSS)	–8.69***		–10.38***		–8.72***							
log (INF)	–1.39		–4.34*		–0.82		–3.21**		–6.01***		–2.99***	
log (RER)	–1.25		–7.11***		–0.99		–7.31***				–7.34***	

Note: For all P values: ***1% significance level; **5% significance level; *10% significance level

The study uses two econometric software packages, namely: Eviews 9 to conduct unit root tests; and Microfit 5.0 for the computation of the ARDL empirical results.

4. EMPIRICAL RESULTS

4.1. Unit Root Tests

Figure 2 presents graphical representations of the time series used in this study. A preliminary graphical analysis of the time-series shows that when testing for unit roots, the test equations for total revenue, monthly tariffs, and total debt are trend stationary and should include both an intercept and a trend; while total generation, system losses, monthly inflation, and the real exchange rate time-series should include an intercept only.

Table 2 report the unit root test results for the time-series used in the study. The results in Table 2 show that only the inflation variable is integrated of order one; while the quantity of electricity generated, and system losses variables are integrated of order zero; regardless of the unit root test used. The revenue, real exchange rate, and monthly tariff variables are integrated of order one when the ADF and the DFGLS tests are used; and integrated of order zero when a structural break is considered. The debt variable is integrated of order one when the ADF test is used; and integrated of order zero when the DFGLS and innovation outlier models are used.

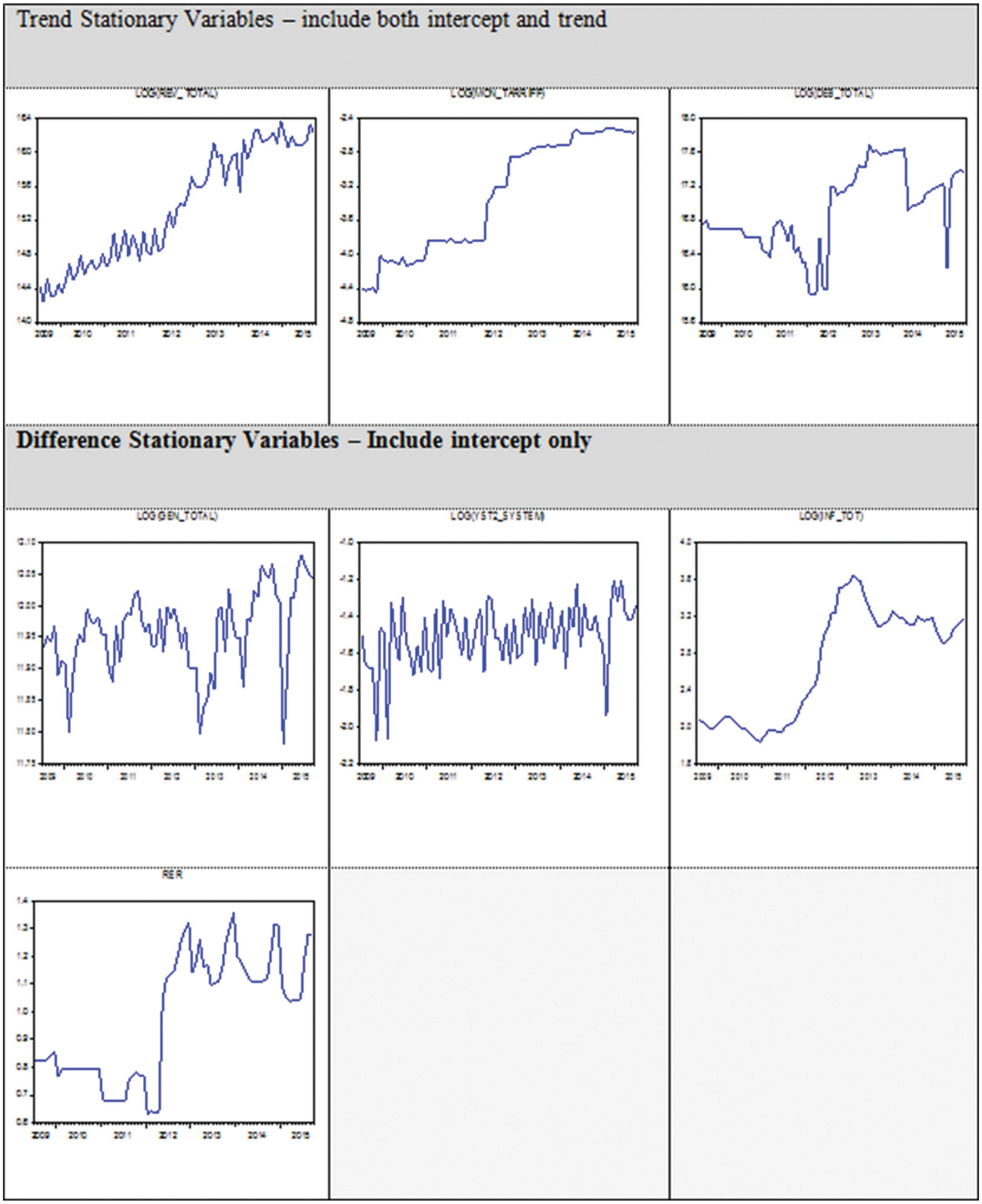
Overall, the unit test results reveal that all variables are either integrated of order one or zero. This confirms that the ARDL bounds-testing approach for establishing cointegrating relationships suggested by Pesaran et al. (2001) can be employed in this study.

4.2. Empirical Analysis of ARDL-Based Error Correction Model

The Akaike Information Criteria (AIC) is used to determine the appropriate lag-length for the estimated ARDL equations. This method is preferred as it tends to over-fit the growth equation. An optimal lag-length of 2 is chosen based on the number of regressors included in the growth model. The results show that optimal model for the revenue equation is ARDL (2, 1, 0, 0, 1, 2, 0, 2) and reports an adjusted R-squared of 0.9675; and the lowest Akaike Information Criterion of –45.31. For the tariff equation, the optimal ARDL model is ARDL (1, 2, 0, 2, 0, 0, 0, 0) with an adjusted R-squared of 0.9872; and the lowest AIC of –79.54. Table 3 reports the Pesaran et al. (2001) bounds test results for the study equations.

Critical values are obtained from Pesaran et al. (2001, p. 301) and as illustrated in Table 3, the computed F-statistic for the revenue equation is 8.12 and is statistically significant at the 1% upper critical bound. The computed statistic for the tariff equation reveals an estimate of 3.99, which is statistically significant at the 5% significance level. In summary, the bounds test to cointegrating relationships using the Pesaran et al. (2001) approach confirms

Figure 2: Data generating processes for selected time series



the existence of long-run level relationships in both equations of interest.

Table 4 presents the estimated short- and long-run multipliers of the revenue growth equation.

Panel 1 Table 4 reports the estimated long-run coefficients; while Panel 2 report the estimated short-run coefficients of the revenue growth equation. As illustrated in Panel 2, the short-run dynamics and the adjustment towards the long-run equilibrium path is measured by the error correction term (ECM) and reports an estimated value of –1.66%, which is statistically significant at the 1% significance level. The reported ECM confirms convergence of the revenue growth equation; however, the convergence shows a dampened oscillation and indicates a slow convergence towards its long-run equilibrium growth path. The underlying restricted ARDL model shows a good-fit represented by an estimated R-squared value of 0.71 and an adjusted R-squared value of 0.63.

The long-run results in Panel 1 reveal that the key determinants that are significantly associated with real monthly revenues include increases in monthly tariffs, increases in generation capacity, system losses, and implementation of power sector reforms. The results show that the relationship between increases in monthly

Table 3: ARDL bounds test results

Dependent variable	Function	Value (F-statistic)	Cointegration status
Utility Revenue	(REV|TRIFF, GEN, DEBT, LOSS, INF, RER, DUM)	8.12***	Cointegrated
Electricity Tariff	(TRIFF|INF, RER, REV, GEN, DEBT, LOSS, DUM)	3.99**	Cointegrated

Null hypothesis: No long-run relationships exist

Asymptotic critical values (Pesaran et al., 2001, Case IV, p. 301)

1%		5%		10%	
I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
3.07	4.23	2.50	3.50	2.22	3.17

Note: ***1% significance level; **5% significance level; *10% significance level, ARDL: Autoregressive distributed lag

electricity tariffs is positively and significantly associated with increases in monthly electricity revenues; and the results are statistically significant at the 1% significance level. The results reveal that a 1% increase in average monthly electricity tariffs leads to a 0.62% increase in real monthly electricity revenues. In addition, increases in generation capacity lead to increases in the long-run level of real electricity revenues, and the results are statistically significant at the 1% significance level. The results reveal that a 1% increase in electricity generated leads to a 0.76% increase in the long-run level of electricity revenues.

On the other hand, the study finds that the relationship between system losses and implementation of power sector reforms under the MCC Compact are negative and significantly associated with the long-run level of real electricity revenue growth; and the results are statistically significant at the 5% and 10% significance levels, respectively. The results show that a 1% increase in system losses lead to a –0.24% decline in the long-run level of real monthly electricity revenues; while a 1% increase in the implementation of power sector reforms leads to a –0.01% decrease in the long-run level of real monthly electricity revenues. The study did found no significant association between increases in total debts, inflation, real exchange rate depreciation, and the long-run level of real electricity revenues.

The short-run results in Panel 2 of Table 4 show that the key determinants that are significantly associated with the growth of electricity revenues include increases in average monthly tariffs, the quantity of electricity generated, system losses, inflation, and implementation of power sector reforms. The results show that the relationship between increases in the growths of monthly average electricity tariffs, electricity generated, and implementation of power sector reforms are positively and significantly associated with the growth of real monthly electricity revenues; and the results are statistically significant at the 1% and 10% significance levels. The results show that a 1% increase in the growth of average monthly electricity tariffs led to a 0.53% increase in the growth of real monthly electricity revenues. In addition, a 1% increase in the growth of electricity generated led to a 1.26% increase in the growth of real monthly electricity revenues. Furthermore, a 1% growth in the implementation of power sector reforms in the previous period led to a 0.27% increase in the growth of real monthly electricity revenues.

On the other hand, the study reveals a negative and significant relationship between the growths of system losses, inflation and real monthly electricity revenues, and the results are statistically significant at the 1%, 5% and 10% significance levels. The results show that a 1% increase in system losses led to a –0.24% decline in the growth of real monthly electricity revenues, and the results are statistically significant at the 10% significance level. The impact of inflation on the growth of real monthly electricity revenues is significant both in the current and previous period. The results show that a 1% increase in the growth of inflation in the current period led to a –1.08% decline in the growth of real monthly electricity revenues and is statistically significant at the 1% significance level; while a 1% increase of inflation in the previous period led to a -0.58% decline in the growth of real monthly electricity revenues, and is statistically significant at the 5% significance level. The study did not find any significant impact between increases in total debt, and real exchange rate depreciation on the growth of real monthly electricity revenues.

Panels 3 and 4 of Table 4 display results of the short- and long-run elasticities for the tariff growth equation, respectively. The results in Panel 4 show that the error correction term (ECM) is estimated as –0.68%, which is statistically significant at the 1% significance level. The reported ECM confirms convergence of the tariff growth equation towards its long-run equilibrium growth path; and the results indicate that the convergence is quick and is corrected in the next period. However, the underlying restricted ARDL model shows a relatively good-fit represented by an estimated R-squared value of 0.50 and an adjusted R-squared value of 0.40.

The long-run results in Panel 3 of Table 4 present some interesting results. The estimated results reveal that the key determinants that are positively associated with the long-run level of electricity tariffs include real exchange rate depreciation, increases in electricity revenues, and system losses; while the quantity of electricity generated is negatively associated with the long-run level of utility tariffs. The results are statistically significant at the 1% and 10% significance levels. The results reveal that a 1% increase in the depreciation of the local currency leads to a 0.36% increase in the long-run level of electricity tariffs, and the results are statistically significant at the 10% significance level. In addition, the results show that a 1% increase in utility revenues leads to a 0.82% increase in the long-run level of utility tariffs, and the results are statistically significant at the 1% significance level. Furthermore, the results reveal that a 1% increase in system losses leads to a 0.35% increase in the long-run level of utility tariffs, and the results are statistically significant at the 1% significance level. On the other hand, a 1% increase in generation capacity results in a –1.15% decrease in the in the long-run level of utility tariffs; and the results are statistically significant at the 1% significance level.

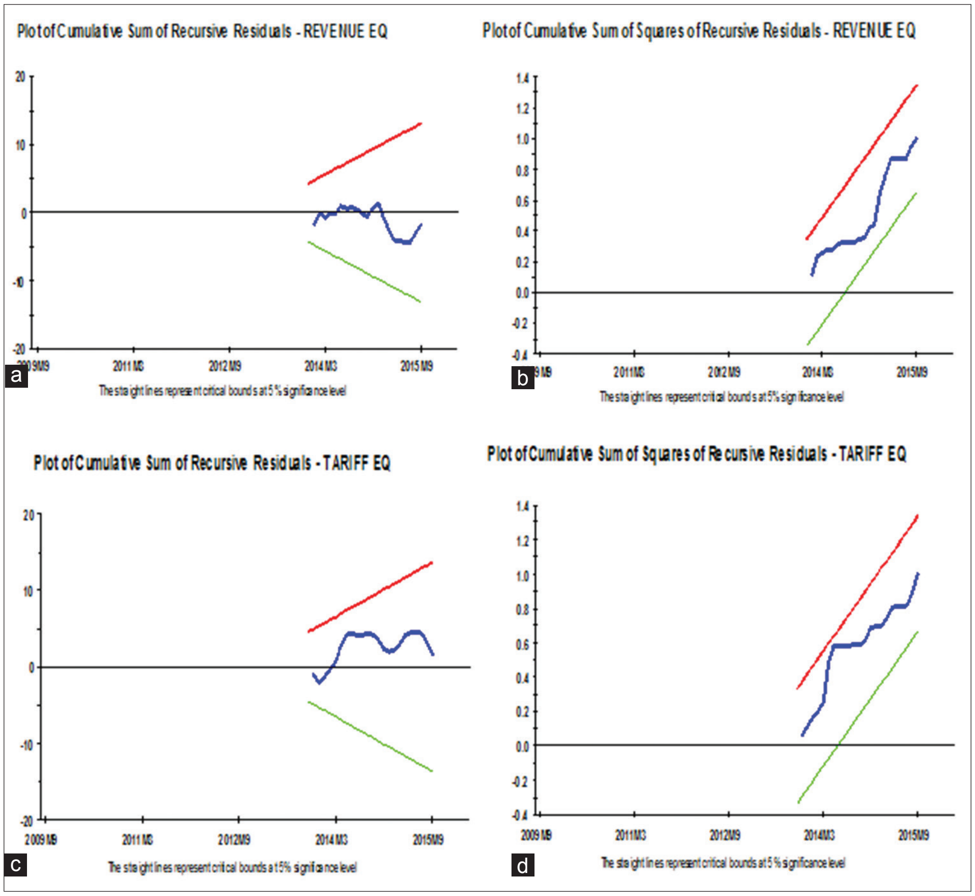
The short-run results in Panel 4 show that the key determinants that are positively and significantly associated with tariff growth include inflation, real exchange rate depreciation, increases in monthly utility revenue, and system losses; while increases in the

Table 4: Estimated empirical results

Regressor	Coefficient	Standard error	t-statistic	Probability
Revenue equation: Panel 1 - Estimated long-run coefficients (Elasticities) [Dependent variable: Log of real monthly revenue, log $(REV)_t$]				
log $(TRIFF)_t$	0.6239***	0.103	6.02	0.000
log $(GEN)_t$	0.7605***	0.226	3.36	0.001
log $(DEBT)_t$	−0.0587	0.036	−1.63	0.110
log $(LOSS)_t$	−0.2436**	0.121	−2.00	0.050
log $(INF)_t$	−0.0147	0.065	−0.22	0.825
log $(RER)_t$	0.1083	0.133	0.81	0.421
DUM_t	−0.0054*	0.002	−1.81	0.076
$TREND_t$	0.0114***	0.003	4.10	0.000
C_t	8.4630***	2.816	3.01	0.004
Revenue equation: Panel 2 - Estimated short-run coefficients (Elasticities) [Dependent variable: Change in log of real monthly revenue, Δlog $(REV)_t$]				
Δlog $(REV)_{t-1}$	0.1878	0.122	1.54	0.130
Δlog $(TRIFF)_t$	0.5260***	0.193	2.72	0.009
Δlog $(GEN)_t$	1.2622***	0.422	2.99	0.004
Δlog $(DEBT)_t$	−0.0975	0.059	−1.65	0.104
Δlog $(LOSS)_t$	−0.2368*	0.135	−1.74	0.087
Δlog $(INF)_t$	−1.0806***	0.258	−4.19	0.000
Δlog $(INF)_{t-1}$	−0.5809**	0.265	−2.19	0.032
Δlog $(RER)_t$	0.1797	0.218	0.82	0.413
ΔDUM_t	−0.1816	0.141	−1.28	0.205
ΔDUM_{t-1}	0.2724*	0.139	1.95	0.056
$\Delta TREND_t$	0.0189***	0.005	3.54	0.001
ECM_{t-1}	−1.6596***	0.206	−8.04	0.000
R-squared	0.7121	R-Bar squared		0.6298
S.E. of regression	0.1177	F-stat (15,26)		11.54 [0.000]
Residual sum of squares	0.7752	DW-statistic		2.11
Akaike info. criterion	−45.314	Schwarz-Bayesian criterion		−25.846
Tariff equation: Panel 3 – Estimated Long-Run coefficients (Elasticities) [Dependent variable: Log of Real Monthly Average Tariff, log $(TRIFF)_t$]				
log $(INF)_t$	0.0569	0.087	0.65	0.516
log $(RER)_t$	0.3559*	0.191	1.86	0.068
log $(REV)_t$	0.8213***	0.175	4.70	0.000
log $(GEN)_t$	−1.1463***	0.320	−3.58	0.001
log $(DEBT)_t$	0.0327	0.054	0.60	0.550
log $(LOSS)_t$	0.3548***	0.102	3.49	0.001
DUM_t	−0.0021	0.004	−0.49	0.627
$TREND_t$	0.0015	0.005	0.27	0.784
C_t	−2.7613	4.314	−0.64	0.525
Tariff equation: Panel 4 – Estimated Short-Run coefficients (Elasticities) [Dependent variable: change in log of real monthly average Tariff, Δlog $(TRIFF)_t$]				
Δlog $(INF)_t$	0.3441*	0.178	1.93	0.058
Δlog $(INF)_{t-1}$	0.2515	0.165	1.52	0.133
Δlog $(RER)_t$	0.2439*	0.124	1.96	0.054
Δlog $(REV)_t$	0.2027***	0.075	2.69	0.009
Δlog $(REV)_{t-1}$	−0.1458**	0.073	−2.01	0.049
Δlog $(GEN)_t$	−0.7857***	0.217	−3.62	0.001
Δlog $(DEBT)_t$	0.0224	0.038	0.59	0.559
Δlog $(LOSS)_t$	0.2432***	0.068	3.58	0.001
ΔDUM_t	−0.0014	0.003	−0.49	0.627
$\Delta TREND_t$	0.0009	0.004	0.27	0.785
ECM_{t-1}	−0.6854***	0.115	−5.95	0.000
R-squared	0.5043	R-bar squared		0.3951
SE of regression	0.0747	F-stat (11,61)		5.46 [0.000]
Residual sum of squares	0.3295	DW-statistic		2.06
Akaike Info. Criterion	-79.541	Schwarz-Bayesian criterion		−63.508

***1% significance level; **5% significance level; *10% significance level

Figure 3: CUSUM and CUSUMQ tests, (a) plot of cumulative sum of recursive residuals REVENUE EQ, (b) plot of cumulative sum of square of recursive residuals REVENUE EQ, (c) plot of cumulative sum of recursive residuals TARIFF EQ, (d) plot of cumulative sum of squares of recursive residuals TARIFF EQ



quantity of electricity generated is negatively and significantly associated with electricity tariff growth. The results show that the current level of inflation is positively and significantly associated with electricity tariff growth at the 10% significance level. The results show that a 1% increase in inflation in the current period increases the growth of tariffs by 0.34%. The growth in the depreciation of the real exchange rate is also positively associated with electricity tariff growth in the short-run, and the result shows that a 1% increase in the growth of the real exchange rate led to 0.24% increase in the growth of electricity tariffs. This result is also statistically significant at the 10% significance level. This also confirms the importance of inflation and the real exchange rate depreciation in determining automatic tariff adjustments by the energy regulator in the short-run (Republic of Malawi, 2012b).

Furthermore, increases in electricity revenues reveal mixed results. The results show that a 1% increase in the growth of real monthly electricity revenues in the current period led to a 0.20% increase in the growth of electricity tariffs; while a 1% increase in the growth of real monthly electricity revenues in the previous period led to a –0.15% decline in the growth of electricity tariffs in the short-run. Overall, the study reveals a positive and significant relationship between the growth in electricity revenues and electricity tariffs in the short-run. The study results also reveal that the growth in system losses is positively and significantly associated with short-run electricity tariff growth; and the results are statistically significant at the 1% significance level. The study results show that a 1% in the growth of system losses in the short-run led to a 0.24% increase in the growth of electricity tariffs. The results imply that customers in Malawi pay for operational inefficiencies and a reduction in system losses would, therefore, lead to a reduction in utility tariffs.

Lastly, the study results show that the relationship between increases in the quantity of electricity generated is negative and significantly associated with tariff growth at the 1% significance level. The results reveal that a 1% increase in the growth of the quantity of electricity generated led to a –0.79% decrease in the growth of electricity tariffs in the short-run. The results reveal the benefits of economies of large scale investments in generation capacity and least-cost option integrated resource planning; which reveal that the adoption of such planning leads to low marginal and average costs. The study results did not find any significant impact between the growths of total utility debts and implementation of power sector reforms on tariff growth in the short-run.

Lastly, the following post-diagnostic tests are reported - the CUSUM and CUSUMSQ test; Breusch-Godfrey serial correlation test; Breusch-Pagan-Godfrey test for heteroskedasticity; Ramsey RESET test; and ARCH test. Figure 3 illustrates the CUSUM and CUSUMSQ results for the estimated revenue and tariff growth equations discussed in this paper.

As illustrated in Figure 3, the CUSUM test for both growth equations reveal parameter instability; while the results of the CUSUMQ test for both equations reveal variance stability. The cumulative sum of recursive residuals as well as the squares of the recursive residuals are both within the 5% critical lines and the results are suggestive of coefficient stability in both growth equations. Table 5 reports post-estimation diagnostic results.

The post-estimation results in both equations reveal that we cannot reject the null hypotheses for all post-diagnostic tests at the 5% significance level. Overall, the results reveal that both the revenue and tariff growth equations are well-specified and the parameter estimates are not biased.

5. CONCLUSION AND POLICY IMPLICATIONS

This paper set out to investigate two important policy issues. First, the study aimed at identifying the key determinants of utility growth; with a special focus on revenue and tariff growth. Second, the study investigated whether the implementation of power sector reforms under the MCC program in Malawi have a positive impact on utility growth. A number of power sector reforms have been initiated and have been implemented with support from the Compact since 2010; and are expected to be completed by September 2018. The study utilized monthly data covering the period, July 2009 - September 2015.

Using the recently developed ARDL bounds-testing approach, the study results show that the main determinants that are positively associated with electricity revenue growth include utility tariffs and electricity generated; while system losses have a significant negative impact on utility revenue growth, both in the short- and long-run. The results showed that inflation has a negative impact on utility revenue growth in the short-run only. The results have also shown that the implementation of power sector reforms since the commencement of the MCC Malawi Compact in September 2013 have mixed results. While the growth in the implementation of power sector reforms shows a significant association with the growth of electricity revenues in the short-run, the results show that the implementation of power sector reforms are negatively associated with electricity revenue growth in the long-run; though the magnitude of impact is more pronounced in the short- than long-run. The study results also found no significant

Table 5: Post-estimation diagnostic tests

Test statistic	Revenue equation	Tariff equation
Breusch-Godfrey test: No serial correlation	0.72 (0.489)	0.54 (0.587)
Breusch-Pagan-Godfrey Test: No heteroskedasticity F (1,71)	0.35 (0.557)	1.49 (0.225)
Ramsey RESET test: Functional form	0.00 (1.000)	0.48 (0.492)
ARCH Test: Heteroskedasticity (no ARCH terms) F (2,54)	1.32 (0.273)	0.25 (0.779)

Note: For all p-values: ***1% significance level; **5% significance level; *10% significance level; otherwise not significant.

relationship between the accumulation of debt, depreciation of the real exchange rate and electricity revenue growth, both in the short- and long-run.

In terms of electricity tariffs, the study results reveal that the depreciation of the real exchange rate, increases in electricity revenues, and increases in system losses are positively and significantly associated with electricity tariff growth, while increases in electricity generated is negatively and significantly associated with electricity tariff growth; both in the short- and long-run. Furthermore, the results reveal that inflation exhibit only short-run and no long-run effects on tariff growth. No significant relationship was found between the accumulation of utility debt, the implementation of power sector reforms, and tariff growth, both in the short- and long-run.

These results have significant policy implications for the growth of the power subsector in the Malawian economy. First, the results reveal that electricity tariffs and increased generation capacity are key determinants of revenue growth in the power subsector, both in the short- and long-run. It is, therefore, recommended that policymakers should continue to implement cost-reflective tariffs as well as increasing generation capacity using least cost options. Second, utility operational inefficiencies have a significant negative impact on revenue growth in the power subsector. This supports the efforts being implemented under the Power Sector Reform Agenda of the MCC Compact with Malawi that seeks to improve operational performance of the national utility (MCA-Malawi, 2013). In particular, strategies that seek to reduce system losses should be pursued and adopted by the national power utility, ESCOM.

Third, the results also show that macroeconomic stability is important for revenue growth and, therefore, policies that control the growth of inflation should be encouraged and pursued. Lastly, the implementation of power sector reforms in improving revenue growth was found to be important for the power subsector. The study, therefore, concludes that the impact of reforms are bearing fruits in making the national utility company, ESCOM, become a creditworthy institution. Thus, the continued implementation of power sector reforms should be encouraged in the short-run. In addition, the negative association between the implementation of power sector reforms and revenue growth also support the importance of reforms in attracting IPP in the electricity sector as well as the importance of lowering marginal costs in the long-run.

On the other hand, the results of the tariff growth equation have also important policy implications especially for the energy regulator, the Malawi Energy Regulatory Authority. The results show that real exchange rate depreciation, increases in electricity revenue, and system losses are positively and significantly associated with tariff growth, while increases in electricity generated is negatively and significantly associated with tariff growth; both in the short- and long-run. The results also show that inflation has a significant impact on tariff growth only in the short-run. From a policy perspective, the results have shown that much as the ATAF is driven by changes in inflation and the real exchange rate depreciation in the short-run; operational inefficiencies such as system losses also increase utility tariffs, both in the short- and long-run. Thus, it is important for policy makers to take into account the impact of operational inefficiencies whenever the base tariff and ATAF is being reviewed. Thus, it is recommended that policy makers should ensure and encourage the national power utility, ESCOM, to focus on reducing operational inefficiencies. In addition, policies that aim at increasing the quantity of electricity generated should be encouraged as the more electricity is supplied, the more real tariffs will decrease due to reduction in long-run average and marginal costs.

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