Unreliable and inadequate electricity supply is one of the major challenges affecting Uganda’s economic growth and development. “Frequent power outages cause significant losses, equivalent to 6 percent of turnover on average for firms in the formal sector, and as much as 16 percent of turnover for informal sector enterprises” (Eberhard & Shkaratan, 2011). Electricity in Uganda is highly unreliable because of the dilapidated distribution and transmission network infrastructure. Eberhard & Shkaratan (2011), about 15 percent of installed ca-

capacity in Sub-Saharan Africa is not operational because of inadequate maintenance of the existing facilities.

According to the World Bank (2000:224) Ugandan firms lose an average of 91 days a year because of power outages. The implication is that Uganda and Africa must not only address the challenge of electricity reliability but also ensure that the price of electricity is affordable to attract investment into the country. According to Maweije (2013), business executives perceive the cost of electricity as the biggest hindrance to doing business in Uganda. In order to address the challenges of unreliable electricity supply and high tariffs, in 2003, the Government of
Uganda made a strategic decision to liberalise and unbundle the Electricity Supply Industry (ESI). Before 2003 electricity generation was the sole responsibility of government but liberalisation encouraged private sector participation, increased investment, reduced inefficiency and reduced dependence on government financing. In addition, liberalisation also changed the operation of the electricity sector in Uganda.

Since the liberalisation of the electricity supply Industry, there are more operators with diverse financing structures for generation projects (Electricity Regulatory Authority (ERA), 2013) and use of debt financing by utility firms has been an increasing trend. According to the Uganda Electricity Transmission Company Limited (UETCL) (2013), in 2012 about 55 percent of the energy was generated by Independent Power Producers (IPPs) compared to five percent in 2005. The UETCL report further indicates that since 2003, the number of private electricity generation facilities selling power to the National Grid increased from four to twelve in 2012. This inflow of private sector capital in electricity generation created competition, diverse capital structures and therefore different generation electricity tariffs for the generation plants (ERA, 2013). The prospective developers submitted proposals to ERA under a competitive framework with optimal cost structures in order to be issued a license.

The World Bank (2000) stated that electricity tariffs in Africa are high compared to other regions of the world, mainly because of cost and policy differences. According to Umeme Limited (2011), the Uganda Electricity generation segment has the largest contribution to the retail tariff, contributing 68 percent of the total electricity sector costs. Cornille and Dossche (2006) stated that the major determinants of prices are quantity demanded, quality supplied and cost of production. Since investment in generation companies requires significant upfront cost, we hypothesise that the capital structure, for electricity generation companies may be one the major drivers of the generation tariff. It is expected that if the cost of capital directly influences the costs of production, it will be transmitted to the prices of commodities. This study will look at the generation tariff and how capital structures of generation plants influence the generation tariff in Uganda.

Overview of the Ugandan Electricity Supply Industry and the Capital Structure of Operators

Uganda’s electricity supply industry started with the commissioning of the Owen Falls dam in 1954 and establishment of the Uganda Electricity Board (UEB). At the time of Uganda’s independence in 1962, it was clear that the energy future of the country was very bright. The national demand was low and generation was high. Uganda was generating adequate electricity to meet the national demand, and the rate of industrialisation and economic growth was stimulated by the existence of a generation facility that supplied adequate electricity.

The Uganda Electricity Board was a vertically integrated fully state-owned enterprise that was responsible for generation, transmission and distribution of electricity in Uganda. Like in other countries in Sub-Saharan Africa (SSA) at the time, Uganda Electricity Supply Industries experienced challenges of inadequate investment amidst competing government priorities, poor maintenance, unreliable and expensive
electricity. According to Eberhard & Shkaratan (2011), SSA is experiencing a power crisis with unreliable, inadequate, expensive electricity infrastructure and limited access to electricity with less than three in every ten people living in SSA having access. Eberhard & Shkaratan (2011) further stated that power supply in SSA is unreliable, with 15 percent of the installed capacity not operational mainly as a result of aging plant and inadequate/irregular maintenance with average electricity tariffs in SSA twice the tariffs in other parts of the developing world. Additionally, the World Bank (2011) states that SSA is experiencing an infrastructure financing gap of US$ 31 billion per year resulting from the required additional investment for new infrastructure and addressing inefficiencies in the existing infrastructure. SSA governments do not have the ability to finance the required investment amidst a constrained resource envelope, thus there is a need to encourage partnership with the private investors to bridge the financing gap.

In 2004, the Government of Uganda decided to encourage participation of the private sector in the ESI. The purpose of encouraging private sector participation was to increase investment in the sector, increase generation capacity, reduce power losses, and improve collection rates and efficiency. Since liberalisation of the ESI in 2004, there has been increased generation capacity installed in Uganda. The electricity generation capacity has increased from 425MW in 2004 to 868 MW in 2013 (ERA, 2013). The number of companies generating electricity and selling to the national grid increased from four in 2003 to twelve in 2012 (UETCL, 2013). According to UECTL (2013), electricity generation increased from 1,887GWh in 2005, when the Government of the Uganda was the main generator of electricity, to 2,857GWh in 2012 after encouragement of private sector participation. As private sector participation increased, there was a need to ensure a cost recovery mechanism (including capital costs, financing costs and operating costs), accordingly the weighted average generation tariff increased from US$ 0.02/KWh in 2005 to US$ 0.13/KWh in 2011. The participation of the private sector led to the existence of a diversity of capital structures for investors in the ESI, especially in the Generation segment where there is more private sector participation (ERA, 2013). The capital structures of companies operating in the ESI include debt composition ranging from 100 percent: 0 percent, 80 percent: 20 percent, 70 percent: 30 percent, 65 percent : 35 percent, to mention but a few (ERA, 2013).

Review of Relevant Literature and Theoretical Framework

From the theoretical framework it should be noted that apart from the capital structure, there are other factors affecting the generation tariff including:- the operations & maintenance costs, the technology used, the installed capacity of the generation facility among others. The theoretical framework can be conceptually summarised as in Figure 1. Accordingly, Figure 1 can be explained by moving from the right-hand to left. That is, at macro-level, the generation tariff is affected by two major factors: the volume of electricity generated and the cost of generation.
The volume of electricity generated depends largely on the type of technology employed or fuel used such as hydropower or thermal-power deployed; the installed capacity of the plant; and other factors (for example climatic factors such as hydrology, solar intensity). In this study, the full cost pricing theory is considered appropriate in describing the generation tariff determination process. According to the microeconomic theory, the typical approach of determining the price (P) under this method is to estimate the average variable cost (AVC) and to add a fair margin of profit (Dwivedi, 2003). That is:

\[ P = AVC + AVC(m) \] (1)

Where P is the price (which in our case is the generation tariff), AVC is average variable cost, and m is mark-up percentage of profit that is fixed to cover average fixed cost (AFC) and a net profit margin (NPM). Thus:

\[ P = AVC + AFC + N \] (2)

Figure 1: Conceptual framework of effect of debt-equity structure on electricity tariffs of generation project

From the theory of costs (Koutsoyiannis, 1978), the average cost (AC) is an aggregation of AVC and AFC; and AC is the ratio of total costs (TC) to total output (Q). That is:

\[ AC = AVC + AFC \] (3)

\[ AC = \frac{TC}{Q} \] (4)
Substituting Equation 4 into Equation 3 implies that the electricity generation tariff \( (P_E) \) is a function of total cost of production, output produced and the net profit margin for owners or equity providers for generation plants. This is presented in Equation 3.5 as:

\[
P_E = \frac{TC}{q} + NPM
\]  

(5)

In the electricity industry literature, the right-hand side of Equation 3.5 is referred to as the revenue requirement, which is composed of the operating and maintenance costs, invested capital and profit margin.

According to Bauer (2004:4), the capital structure is determined by the size of the firm, profitability of the firm, growth prospects / opportunities, existing tax shield and the industry in which the firm operates. From a project finance perspective, Gatti (2013:138) stated that project sponsors prefer to commit as limited equity as possible. Gatti (2013: 138) further stated that the basis for the debt to equity ratio is: economic soundness of the project, the acceptance level of risk for the lenders, and precedent in the financial markets.

Harris and Raviv (1991:334) stated that many studies have been conducted to provide guidance on how specific characteristics of firms and industries determine their capital structure. Hatfield, Cheng & Davidson (1994:2) noted that firms operating in the same industry will have generally similar financing structures. However, other researchers such as Boquist and Moore (1984) found weak evidence to support this theory. Electricity generation firms in Uganda have diversified financing structures despite operating in the same industry (ERA, 2013).

Bauer (2004:4) agreed with other researchers that determinants of capital structure in include the size of the firm, profitability of the firm, growth prospects / opportunities of the firm, existing tax shield, tangibility of the firm and the industry of operation. Bauer (2004) stated that more profitable firms are expected to have higher debt in their capital structure because they have income to shield from taxes. Bauer (2004) further argued that companies with more tangibility have more access to credit/debt because of their ability to use their assets as collateral to obtain debt financing. Mark and Clifford (1992), however, found no evidence to support the finding of Bauer (2004) in respect of factors that influence the capital structure of firms.

Some researchers, such as Huang and Song (2006), Rajan and Zingales (1995) and Friend and Lang (1988) concluded that there is a positive relationship between size and capital structure. Song (2005) agreed with Bauer (2004) that the determinants of the capital structure include tangibility (asset structure), non-debt tax shield, profitability, size, expected growth, uniqueness and income variability. Titman and Wessels (1988), argue that firm’s choice of the capital structure is influenced by the costs and benefits of using debt or equity.

Researchers such as Kester (1986), Kim and Sorensen (1986) and Titman and Wessels (1988) however disagree and conclude that there is a negative relationship between size and the capital structure. According to Oolderink (2013), the pecking order theory of capital structure states that in circumstances where external financing is needed, firms prefer debt financing to equity financing. Johnson (1998) stated that there is no predetermined rule for determination of capital structure as every company experiences unique risks, threats and opportunities. He
further noted that although the traditional view is that any company has an optimal capital structure the determination of this optimal structure is subjective and complex. Scannella (2012: 85), like Johnson (1998), noted that there is no universally acceptable rule for choosing the capital structure of a firm. Scannella (2012: 85) noted that typical projects have 70–75 percent debt and 25–30 percent equity. The National Renewable Energy Laboratory (2008: 4-1) stated that between 35 and 45 percent equity is standard for commercial projects. Berger (2011:6) stated that electric power projects in Europe have typical debt to total capital range of 60–70 percent.

Clarke, Wilson, Daines and Nadauld (1988:167) noted that a study by Scott and Johnson concluded that there is a target capital structure for very large American companies that guides decisions regarding financing. He further noted that while this target capital structure varies between 26 and 40 percent there is no consensus on the exact percentage and every company uses its own.

The capital structure is key as it determines the cost of capital. Johnson (1998) noted that the value of the firm/company increased as the weighted average cost of capital reduced. Firms’ costs reduce as the weighted average cost of capital reduces up to the optimal capital structure. As the portion of debt in the capital structure increases, the weighted average cost of capital reduces, increasing the value of the firm. As the portion of debt further increases, the cost of both debt and equity increase to cater for increased financial risk. When the debt portion increases beyond the optimal capital structure, the increase in cost of equity offsets the benefit of lower cost of debt. Leland and Toft (1996) noted that there is a need to balance the tax advantages of debt with the risks of bankruptcy and high agency costs in the determination of the optimal capital structure. Puwanenthiren (2011:1) stated that the capital structure is the most significant discipline in the operations of any company, and concluded that there is a negative relationship between the capital structure and the financial performance of any company. Like Puwanenthiren (2011:1), Dhankar and Boora (1996: 29) stated that the capital structure is the most important decision for a firm. The capital structure affects the profitability of the company, the cost of capital, earnings per share, dividends and liquidity position of the company. Duca (2010:523) concurs with Chowdhury and Chowdhury (2010), and Mark & Clifford (1992) that the capital structure decision is one of the most fundamental premises of the financial framework of a corporate entity. According to Chowdhury (2010:112), the decision in respect of how much debt and equity to employ is aimed at ensuring an optimal financing structure that maximises shareholder returns.

Many other researchers agree that the financing structure has an impact on firm’s costs and profitability. Mohammed Omran (2001) studied 69 Egyptian firms privatised between 1994 and 1998 that started using debt financing. The study concluded that firms that were privatised and used debt financing increased in profitability, operating efficiency, capital expenditure and dividends.

Pirashanthini and Nimalathasan (2013) studied the capital structure of manufacturing companies in Sri Lanka and concluded that the debt to equity ratio is positively and strongly linked to the profitability ratios of gross profit margin and net profit margin. According to Russo, Weatherspoon, Peter-
son and Sabbatini (2000: 27), excessive leverage leads to financial distress, increases the firm’s costs in terms of high transaction costs and forgone profit opportunities and therefore influences prices. Russo et al. (2001:34) stated that there is a positive correlation between the cost of financing and the portion of equity in the capital structure.

When interest rates increase, the cost of debt financing increases and makes equity financing more attractive than debt. Financing more assets using equity reduces the risk brought about by operating leverage and increases profitability. The National Renewable Energy Laboratory (NREL) (2012) states that firms whose financial structure is fully debt-financed generally yield a lower levelised cost of energy (LCOE) than those that rely purely on equity capital.

Empirical results from a study by Dhankar and Boora (1996) on the capital structure of companies in India showed that there is no definite relationship between change in the capital structure and the value of a firm but 81 percent of the companies showed a negative relationship between the capital structure and the cost of capital. Cost of capital reduces as debt levels in the capital structure increase because cost of debt is cheaper than cost of equity as interest rate payments are allowable deductions for tax purposes. Chowdhury and Chowdhury (2010:112) argued that increasing debt financing within the capital structure would increase the firm’s value up to a point where any further increase in debt financing increases the overall cost of capital.

The Brattle Group (2005: 5) stated that the amount of debt in the capital structure influences the cost of equity. Debt financing results in financial risk which equity shareholders incorporate when pricing the cost of equity. Scannella (2012:85), and Chowdhury and Chowdhury (2010:111) agreed that firms dedicate operating cash flows to debt service before paying returns / dividends to shareholders. Debt financing ensures that the company benefits from interest expenses, which is an allowable expense for tax purposes, but too much debt makes debt issuers become nervous regarding the company’s ability to pay. On the other hand, Modigliani and Miller’s findings in 1958 concluded that the decision in respect of the company’s capital structure is not important because of the existence of frictionless markets and homogeneous expectations. Modigliani and Miller (1958) argued that all firms experience the same risk, their expectations are similar, there is absence of growth, agency costs and bankruptcy costs and the risk-free rate can be applied for lending and borrowing by individuals.

Puwanenthiren (2011:2) explained that Modigliani and Miller’s (1958) relevance theory reveals that no capital structure is better than another, the benefits of increasing debt financing is offset by the higher risk incurred. Some researchers agree with Modigliani and Miller’s (1958) findings that the decision in respect of the company’s capital structure is not important. Brigham and Gapenski (1990) in their study of the effects of capital structure on utilities’ cost of capital and revenue requirement concluded that decisions regarding capital structure have a negligible effect on firms’ revenue requirements.

Data and Methodology

Data type and sources
The data used in this study is secondary data, obtained from ERA, Uganda’s ESI regulator. The data was obtained for companies
that have obtained or are about to obtain licenses and permits from ERA to develop, own and operate electricity-generating facilities in Uganda.

**Econometric model**

Based on the theoretical framework presented in section three, the empirical model to estimate the relationship between the capital structure and the tariff of electricity generation projects in Uganda can be stated in a general functional notation as:

\[ T_G = \beta_0 + \beta_1 DE + \beta_2 FC + \beta_3 ROE + \beta_4 OM + \beta_5 GT + \beta_6 PC + \epsilon \]  

(6)

According to Gujarati (2003), Equation 6 can be written as an econometric equation as follows:

\[ T_G = \beta_0 + \beta_1 DE + \beta_2 FC + \beta_3 OM + \beta_4 ROE + \beta_5 GT + \beta_6 PC + \epsilon \]  

Where \( \beta_0 \ldots \beta_7 \) are unknown parameters to be estimated and \( \epsilon \) is the error term representing other unknown variables that may affect the generation tariff.

**Estimation Procedures and Model Diagnostics**

Data used in this study is from various companies and therefore cross-sectional in nature. According to Gujarati (2003), in order to get efficient estimates from cross-sectional data, the data of the dependent variable should be normally distributed and the explanatory variables should not be highly linearly correlated (multicollinear). In case the dependent variable is not normally distributed, Gujarati (2003) suggested that such data can be transformed such as into natural logarithms, squared, squared root, etc., so as to make the data normally distributed. Ordinary least squares (OLS) was used to estimate regression parameters. Since our sample was limited we used robust standard error with bootstrap option in order to get reliable test statistics.

To improve the skewness and relationship patterns among the variables, the following variables were log transformed: DE (portion of debt in the capital structure), OM (operation and maintenance costs), PC (installed capacity), DC (Development costs). In the analysis, the transformed explanatory variables were used in the econometric analysis.

Bivariate linear regression models were estimated with each dependent variable. Then, a forward and backward selection approach was used manually to estimate the final full model. Cook’s Distance was used to detect the influential outliers using a cut-off point of \( 4/n \) which is 0.134 in our case (\( n=29 \)). Three observations were identified as influential and were left out during the analysis.

Based on the correlation matrix there was significant association between development cost and installed capacity (\( r=0.98 \)). To avoid multicollinearity only one of the variable installed capacities was included in the model.

After the selection of the final model, we used robust standard error bootstrap option with 1000 iterations and seed of 1. Bootstrap was used in order to achieve correct inferences given a small sample size (Guan, 2003). Only the results from the final model with bootstrap option will be used for interpretation and discussion purpose. The analysis was done using STATA SE 12 Statistical Program.

**Estimation of the Model and Reliability of the Estimates**

To identify the relationship between the capital structure of electricity generation projects and electricity tariffs in Uganda, Equation 5 was estimated using econometric multiple linear regression analysis. Similar stud-
ies that have used OLS include ECME Consortium (2010) to estimate the functioning of retail electricity. The econometric analysis involves running one OLS regression; in which the projects will be the observations, the Generation Tariff will be the dependent variable, and debt to equity ratio, return on equity, debt financing costs, operation and maintenance costs, technology employed, development costs and installed capacity will be the explanatory variables.

As mentioned earlier, given that the sample for this study was relatively small and there are more than five variables, the analysis can lead to inefficient estimates (Deaton, 2003). To enhance efficiency and reliability of the estimates involving a relatively small sample, Efron (1979) introduced the bootstrapping technique. The bootstrap is a statistical technique that artificially increases the sample size through replication (producing a large number of “copies”) of a sample statistic, computed from bootstrap samples at five percent confidence interval (Boos & Munahan, 1986). In this study, the bootstrap technique is used to improve the efficiency of the estimates.

### Results and Discussions

#### Descriptive Statistics

Table 1 describes the data used in the analysis. In Table 1, $T_g$ is the generation tariff which is the dependent variable measured in US$ per KWh. The figures in the table indicate that the average generation tariff is US$ 0.105/KWh and ranges from US$ 0.053/KWh to US$ 0.243/KWh. The type of technology was coded 1 if the technology was renewable and 0 if it was non-renewable.

From Table 1, it can be observed that 89.7 percent of the generation technology is renewable energy that includes hydro, biomass and bagasse co-generation. Operation and maintenance costs average US$ 0.031/KWh. On average, debt contributes 70.7 percent to the capital structure of electricity generation projects, and the average cost of debt is 7.9 percent per annum. The average return on equity is 16.8 percent. Project development costs range from US$ 4 million to US$ 755 million and average US$ 67.7 million, and the average installed capacity is 25.7MW with a maximum installed capacity of 250MW.

<table>
<thead>
<tr>
<th>Table 1: Description of the data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>$T_{g1}$</td>
</tr>
<tr>
<td>$T_g$</td>
</tr>
<tr>
<td>GT</td>
</tr>
<tr>
<td>Om</td>
</tr>
<tr>
<td>De</td>
</tr>
<tr>
<td>Roe</td>
</tr>
<tr>
<td>dc_100</td>
</tr>
<tr>
<td>pc_100</td>
</tr>
</tbody>
</table>
Testing for reliability of the data
Testing for reliability of the data was undertaken using the approaches below.

Testing for multicollinearity
Table 2 below shows the pairwise correlation of the variables to check for any possible multicollinearity. When there is a perfect collinearity, the result is 1, when there is no relationship between the variable the result is zero. According to Gugarati (2003), if the variables are perfectly collinear, then one of these should be dropped out of the analysis. Table 2 shows that there is almost perfect collinearity between installed capacity and development cost. Development cost was omitted from the regression analysis to avoid the problem of multi-collinearity.

Table 2: Pairwise correlation of the variables

<table>
<thead>
<tr>
<th></th>
<th>TG</th>
<th>GT</th>
<th>Om</th>
<th>de</th>
<th>Fc</th>
<th>roe</th>
<th>dc_100</th>
<th>pc_100</th>
</tr>
</thead>
<tbody>
<tr>
<td>TG</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GT</td>
<td>-0.9596</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Om</td>
<td>0.7388</td>
<td>-0.7187</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>de</td>
<td>0.2443</td>
<td>-0.2523</td>
<td>-0.075</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fc</td>
<td>-0.2221</td>
<td>0.2618</td>
<td>-0.1169</td>
<td>-0.2459</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roe</td>
<td>-0.3582</td>
<td>0.3057</td>
<td>-0.243</td>
<td>-0.1923</td>
<td>0.2707</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>dc_100</td>
<td>0.0062</td>
<td>-0.0166</td>
<td>-0.1883</td>
<td>0.3681</td>
<td>-0.2675</td>
<td>-0.0483</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>pc_100</td>
<td>0.1527</td>
<td>-0.1774</td>
<td>-0.0722</td>
<td>0.4325</td>
<td>-0.2815</td>
<td>-0.0723</td>
<td>0.9789</td>
<td>1</td>
</tr>
</tbody>
</table>

Regression Results
Table 3 below shows the results of the regression using the OLS method with the bootstrapped standard error technique to improve efficiency and robustness. The bootstrap included 948 replications. The results of the regression are robust given that the Wald chi² statistic (70.18) is statistically significant at less than 1 percent level. The adjusted R_Square is 79.2 percent, implying that the model describes up to 80 percent of the relationship between the generation tariff and explanatory variables.

From Table 3, two variables, that is GT (Generation Technology) and installed capacity (log_pc_100), are found to have a significant effect on the generation tariff (gt), while the portion of debt in the capital structure (log_de) is found to have a positive but not statistically significant effect on the generation tariff (gt). Details of the analysis are provided below.

Capital structures of generation projects
Debt-equity (DE): Table 5.4 illustrates that there is a positive relationship between the debt portion of the capital structure and the generation tariff of electricity generation projects. The results in Table 5.4 indicate that a one percent increase in the portion of debt in the capital structure results in a 15.4 percent increase in the electricity generation tariff. When the outliers are excluded, a one percent increases in the portion of debt in the capital structure results in a 24.7 percent increase in the electricity generation tariff. The result is however not statistically significant. Studies such as Russo et al. (2001) also concluded that there is a positive
relationship between the portion of debt in capital structure and prices, explaining that a high proportion of debt in the capital structure leads to financial distress and high costs therefore increasing prices/tariffs.

Table 3: Multiple Regression Results

| Variable     | Observed Coefficient | Bootstrap Std. Err. | Z    | P>|z| |
|--------------|-----------------------|--------------------|------|------|
| GT           | -1.024***             | 0.167              | -6.150 | 0    |
| log om       | 0.034                 | 0.051              | 0.660 | 0.509 | 0.223 | 2.550 | 0.011 |
| log de       | 0.154                 | 0.342              | 0.450 | 0.653 | 0.247 | 0.540 | 0.592 |
| Fc           | 0.701                 | 2.021              | 0.350 | 0.729 | 0.108 | 0.040 | 0.968 |
| Roe          | -0.657                | 0.893              | -0.740 | 0.462 | -1.346 | 0.900 | 0.369 |
| log dc_100   | 0.122                 | 0.104              | 1.170 | 0.240 | -0.066 | -0.380 | 0.702 |
| log pc_100   | -0.168*               | 0.091              | -1.850 | 0.064 | 0.117 | 0.690 | 0.487 |
| _cons        | -1.369                | 0.224              | -6.120 | 0    | -0.968 | -1.930 | 0.054 |
| N            | 29                    |                    |      |      | 29.000 |
| R_Square     | 0.844                 |                    |      |      | 0.538 |
| Adj R-squared| 0.792                 |                    |      |      | 0.4115 |
| Wald chi2(7) | 70.180***             |                    |      |      | 9.580 |
| Root MSE     | 0.155                 |                    |      |      | 0.260 |
| Replications | 948                   |                    |      |      | 1000 |

In order to further understand further why the relationship between the portion of debt in the capital structure and the generation tariffs was positive but not statistically significant, a polynomial graph of the relationship is plotted in Figure 1.

Figure 1: Illustration of relationship between debt portion in the capital structure and generation tariffs
Figure 1 shows a slight inverse relationship when the portion of debt in the capital structure is low and later a positive relationship as the portion of debt in the capital structure increases. Because of this mixed relationship, it is indeed clear that it cannot be statistically significant. However other studies, such as that of Pirashanthini and Nimalathasan (2013), found that high debt composition in the capital structure leads to a lower tariff but nonetheless not significant.

**Technology of generation projects**

Technology (GT): Table 3 shows that there is a negative and statistically significant (p<0.01) relationship between the generation technology and the electricity generation tariff. To further understand why this may be the case, a comparison was done in respect of the average generation tariff for renewable and non-renewable generation technologies in Uganda. The generation tariff for renewable generation technology is about US cents 10.7 per KWh compared to about US cents 23 per KWh for the generation tariff for non-renewable technology. The likely reason why the generation tariff for non-renewable generation is high in Uganda is due to the high costs of fuel utilised in non-renewable electricity generation.

**Installed Capacity**

Installed Capacity (PC): Table 3 shows that installed capacity is a statistically significant variable in the determination of generation tariffs at 6.4 percent. The table further shows that there is a negative relationship between the installed capacity of the generation plant and the generation tariff of the respective plant. A 16.8 percent increase in installed capacity results in a 1 percent reduction in the generation tariff. The results are consistent with Dwivedi (2003) who concluded that a large installed capacity implies that costs are recovered over more units therefore reducing the generation tariff. When the installed capacity is small, the generation tariffs are high and increase as the installed capacity increases up to a certain level, beyond which an increase in the installed capacity leads to reduction in the generation tariff.

**Development costs of generation projects**

Development costs (DC): Table 3 shows that there is a positive relationship between the development costs and the generation tariff and that the development costs variable is significant. Table 5.4 shows that for a one percent increase in development costs, the tariff increases by 12.2 percent. This finding is supported by Ragwitz et al. (2012) who concluded that there is a positive relationship between development costs and the tariff (i.e. an increase in development costs leads to increase in the generation tariff).

**Operation and Maintenance costs (OM)**

Table 3 shows that there is a positive relationship between the operation and maintenance costs and the generation tariff. For a 3.4 percent increase in the operation and maintenance costs, the generation tariff increases by one percent. The variable is significant because it is dependent on the units generated as it is measured in USS/KWh. Literature on the relationship between the operation and maintenance costs and tariffs/prices indicates that the effect of the operation and maintenance costs on prices of commodities depends on the proportion of operation costs to the total costs. A high portion of operation and maintenance costs in the total cost structure will have a higher effect on the tariff / prices.
 Costs of debt

Debt financing costs (FC): The results in Table 3 indicate that there is a positive relationship between the costs of debt and the generation tariffs, although the table further shows that debt financing costs are not statistically significant in the determination of the generation tariff. An increase in the debt financing costs by one percent results in a 70 percent increase in the generation tariff. The results are in line with findings by Russo et al. (2001) that a high interest rate increases the generation tariff.

Return on equity

Return on equity (ROE): The results in Table 5.4 indicate that there is a negative relationship between return on equity and generation tariffs. When the return on equity reduces, the generation tariff increases. An increase in return on equity by one percent leads to a reduction in generation tariff by 65.7 percent. This result is not consistent with findings of the Brattle Group (2005), which concluded that a high return on equity has a positive effect on the generation tariff.

Conclusion and Recommendations

The objective of this study was to examine the relationship between the debt-equity capital structure and the electricity generation tariffs in Uganda. The study found a positive but not significant relationship between the debt portion in the capital structure and the generation tariff of electricity generation projects.

There is a negative and statistically significant relationship between the generation technology and the electricity generation tariff. The generation tariff is high for non-renewable technology and low for renewable technology. Installed capacity is a statistically significant variable in the determination of generation tariffs and there is a negative relationship between the installed capacity of the generation plant and the generation tariff of the respective plant. The study has identified that generation tariffs are low for electricity generation plants using renewable technology and high for electricity generation plants using non-renewable technology. Government of Uganda and Electricity Regulatory Authority should prioritise licensing and development of renewable technology generation projects in order to keep the generation tariffs low.

It is instructive to note that generation projects with small /low installed capacity tend to have higher generation tariffs. The Government of Uganda and Electricity Regulatory Authority should prioritise development of bigger projects and ensure fully optimisation of the project capacities in order to ensure lower generation tariffs. Also the level of development costs is a major determinant of electricity generation tariffs in Uganda. Measures should therefore be implemented to minimise development costs in order to ensure lower electricity generation tariffs.

References


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