The household effects of very large electricty tariff hikes in Zambia

Mashekwa Maboshe, Akabondo Kabechani and Grieve Chelwa

ERSA working paper 767

November 2018

The views expressed are those of the author(s) and do not necessarily represent those of the funder, ERSA or the author's affiliated institution(s). ERSA shall not be liable to any person for inaccurate information or opinions contained herein.

The household effects of very large electricity tariff hikes in Zambia*

Mashekwa Maboshe†, Akabondo Kabechani‡ and Grieve Chelwa§

November 15, 2018

Abstract

This paper simulates the real household expenditure effects of electricity price increases in Zambia. First, we find that electricity subsidies are highly regressive. Second, our partial equilibrium model simulations of the welfare effects of electricity tariff rises show that poorer households suffer larger percentage losses in real expenditures compared to wealthier households. Naturally, this leads to increases in poverty. We find that removing electricity subsidies and transferring the realised fiscal savings to social cash transfers reduces extreme poverty significantly. This budget-neutral strategy is particularly attractive for Zambia, and other sub-Saharan economies currently facing the challenges of constrained growth, high budget deficits and high poverty rates simultaneously.

1 Introduction

Unendurable power outages and deficits in sub-Saharan Africa pose significant constraints to social and economic development in the region. Around 30-60% of firm productivity losses are due to electricity shortages and an estimated 600 million people have no access to electricity (Trimble et al, 2016). The main cause of the crisis has been under-pricing of electricity resulting in a vicious cycle of poor cost recovery; inadequate investment; and electricity shortages (Independent Evaluation Group [IEG], 2016). Under-pricing is quite prevalent, with nearly 70% of the countries in the region setting electricity prices below the cost recovery rates (Trimble et al, 2016). The economic costs of electricity

*Acknowledgements: We are grateful to Singumbe Muyeba for his critical review of the earlier draft of this paper. We thank Samson Mukanjari, Robert Jenkins, Tabitha Kamoto and Nathan Pumulo for their useful comments.

†Corresponding author. Southern Africa Labour and Development Research Unit (SALDRU), University of Cape Town; Public and Environmental Economics Research Centre (PEERC), University of Johannesburg, South Africa. Email: Mashekwa.Maboshe@gmail.com

‡Graduate School of Business, University of Zambia.

§Graduate School of Business, University of Cape Town, South Africa; Southern African Institute for Policy and Research (SAIPAR), Zambia.

subsidisation are wide, ranging from increased budget deficits to crowding out productive social spending such as health and education (Cockburn et al, 2017).

To turn around the power deficits and set the stage for development, new generation capacity in the region must increase from 2 to 8 GW (gigawatts) per year (IEG, 2016). The World Bank and IMF (International Monetary Fund) generally agree that market pricing would attract investment and increase electric power capacity in Africa (Kojima and Trimble, 2016; IMF, 2013). However, implementing efficient pricing would likely lead to adverse impacts on household welfare as electricity prices increases would raise living costs (Cockburn et al, 2017).

Adopting and implementing electricity price reforms in the region has been very slow, due to concerns about the likely socio-economic hardships and political ramifications of price increases (Kojima et al, 2014). Therefore, understanding the likely welfare implications of electricity price reforms is the region is important in informing energy and development strategy. However, despite the policy relevance of this topic, little empirical evidence exists especially in sub-Saharan Africa.

This paper simulates the household welfare effects of a large increase in electricity prices in Zambia. In 2017, the government increased the top marginal tariffs by an unprecedented 75% as part of a series of ongoing electricity sub-sector reforms aimed at achieving full market-pricing by 2021 (Ministry of National Development and Planning, 2017). Our simulations using a partial equilibrium model shows that real household expenditure falls by an average 4.6% following the price hikes. The poorest household decile suffer the largest welfare loss of 11% compared to only 3.7% for the richest decile. As a result of the welfare losses, extreme poverty increases by about 0.6 percentage points. However, we find that if government allocates the realised fiscal savings to the poorest 50% households, extreme poverty drops by 4 percentage points. These results suggest that efficient electricity pricing can be realised in poor income countries without experiencing the feared economic hardships if appropriate anti-poverty mitigation strategies accompany the price reforms. Most importantly, our results show that this can be achieved even with a budget-neutral social programme.

This paper proceeds as follows: we present a review the relevant literature followed by the study context and methodology. The results are then presented and discussed; followed by the conclusion.

2 Relevant literature

The relevant literature can be classified into two groups: i) studies that describe the distribution of electricity subsidies, and; ii) those that evaluate the welfare impacts of electricity price reforms. Overall, evidence suggests that energy subsidies in general are globally substantially larger than previously thought (6.5% of global GDP); and are overall regressive (Coady et al, 2017; Clements et al, 2014).

In developing economies, the balance of evidence on the distribution of electricity subsidies suggests that richer income groups benefit substantially more than the poor. These results however vary widely from country to country. In Bangladesh and Pakistan for example, the richest household quintiles receive about 6 and 3 times more subsidies than the poorest quintiles (respectively) (Ahmed et al, 2013; Trimble et al, 2011). Similarly, studies in Mexico and China find that the richest household deciles receive more than 4 and 5 times (respectively) the amount of the electricity subsidies provided to the bottom 10% households. (Komives et al, 2009; Wang and Zhang, 2016).

The distribution of electricity subsidies in some sub-Saharan countries is quite regressive. In a study involving 18 countries in the region, Banerjee et al (2008) finds that only 0.5%[1]

of the total electricity subsidies are transferred to the poor households in Rwanda; and only about 9% and 3% of the subsidies were transferred to the poor households in Ghana and Burkina Faso respectively. A recent study in Zambia has shown that the electricity subsidies are also highly regressive with only about 2% of the subsidies going to the bottom 50% of the population (De La Fuente et al., 2017).

Secondly, the literature largely finds that electricity price reforms have a negative effect on real household welfare. A study in Turkey shows that a 50% increase in electricity prices leads to a (three times) larger percentage reduction in the incomes of the poor households relative to the rich (Zhang, 2015). Jiang et al (2015) finds similar results in China, where there the poorest income groups a percentage loss in real incomes that was 2 times larger than the loss in incomes for the richest income group (Jiang et al, 2015). Furthermore, Feng et al (2018) finds that in electricity tariff increases in Latin American and the Caribbean led to larger real incomes losses among the poor compared to the rich in 8 out of 11 countries.

Very few studies have focussed on the welfare effects of electricity price reforms in sub-Saharan Africa. One of the earliest studies conducted in Zimbabwe found that the 95% increases in electricity tariffs during the 1982-84 reforms only resulted in marginal losses in welfare among the urban poor due to very low electricity access rates at the time (Hope and Singh, 1999). More recently, Boccanfuso et al (2009a; 2009b) find that though the electricity price increases only lead to marginal increases in poverty in Mali and Senegal (respectively), the poor suffer the largest indirect general equilibrium welfare losses in some cases even when they are not directly connected to the electricity grid. Other related studies that focus on the fossil fuels sector also find that fuel price increases lead to welfare losses particularly among the poorest households (Andriamihaja and Vecchi, 2007; Siddig et al, 2014, Cooke et al, 2016; Wesseh and Lin, 2017).

Methodologically, standard incidence analysis (Demery, 2000) has been used to assess the distribution of subsidies while partial equilibrium or computable

[1] Banerjee et al (2008) presents incidence scores as the fraction of the proportion of the total electricity subsidies transferred to poor households overt the proportion of the poor in a given country. We estimate the incidence of subsidies reported in this paper using the country specific poverty rates reported in Fosu (2015).

general equilibrium (CGE) models have been used to estimate the direct and indirect effects of price changes. Partial equilibrium models assume static consumer and producer behaviour, while CGE models account for consumer and producer price responses. In contrast to CGE models that are data and computationally intensive, partial equilibrium models usually have minimal data and time requirements.

Based on the above review, we contribute new evidence on the welfare impacts of electricity price increases in sub-Saharan economies. Despite the policy and academic relevance of this topic, very little empirical evidence focusses on the sub-Continent. Existing electricity sector specific studies such as Boccanfuso et al, (2009a; 2009b) are now quite out-dated as they employ data from the late 1990's. More recent studies such as De la Fuente (2017) in Zambia only discuss the distribution of electricity subsidies and do not go deeper to evaluate the direct and indirect welfare effects of electricity prices increases.

This paper uses the popular price-shifting partial equilibrium model developed by Coady (2008) to estimate the direct and indirect welfare effects of electricity price increases in Zambia. Given the assumption of static behavioural responses under this model, the resulting welfare impacts are interpreted as the short-run impacts or the upper-bound estimates of the long-run adverse impacts of the electricity price hikes on household welfare (Coady, 2008; Fabrizio et al., 2016). The model has been widely used in most IMF and World Bank supported price-reform studies especially in data constrained low-income countries. Recent applications of the model include: Peltovuori (2017) in Kiribati; De La Fuente et al (2017) in Zambia; Younger et al (2017) and Cooke et al (2016) in Ghana; and Hill et al (2016) in Ethiopia.

3 The electricity sector and price adjustments in Zambia

Zambia's electricity sector is dominated by hydro power, which accounts for nearly 95% of the national installed capacity of about 2,411 MW (ERB, 2016). The generation, transmission, distribution and supply of power is dominated by a vertically integrated state utility –ZESCO (Zambia Electricity Supply Corporation) while the sector is regulated by the ERB (Energy Regulation Board). While on paper prices are set at market rates, the prices are rarely reviewed and adjusted in practice. Often, electricity prices remain unchanged for years even when the operational, financial and economic costs have substantially increased. Moreover, the ERB rarely grants the state utility (ZESCO) the full tariff increase when tariff adjustments are requested. Figure 1 shows the average electricity price increment applications made by ZESCO against the price adjustments approved by the ERB over the period 1998 to 2017.

As can be seen, full tariff adjustment have rarely been granted in Zambia. Nearly 70% of the applications for price increases by the power utility are either completely rejected or only partially effected by the regulator. Therefore, to the extent that electricity tariffs are not fully adjusted to reflect the cost of service provision, electricity consumption is subsidised. Electricity subsidies can be provided directly through fiscal transfers to power utilities, or indirectly by allowing utilities and governments to incur losses through under-pricing (Kojima et al, 2014). In Zambia, subsidisation has mainly occurred indirectly through under-pricing. The level of electricity subsidies in Zambia is not publicly available, however estimates suggest that Zambia's electricity sector quasi fiscal deficits (or implicit financial losses) could be as high as 3.4% of GDP (IMF, 2013). In context, these subsidy costs are quite substantial given that Zambia's total health expenditure budget was about 5.0% of GDP in 2014 (WHO, 2018).

Residential electricity is billed using an inverted block tariff structure were incremental blocks of electricity usage are charged higher rates. Table 1 presents the electricity tariff schedules for residential, commercial and social services customers in Zambia before and after the 2017 pricing reforms.

As can be seen in Table 1, the top marginal tariffs were increased by about 75% as part of the first changes in a series of energy reforms aimed at ultimately achieving full cost pricing and zero subsidies by 2021 (Ministry of National Development and Planning, 2017).

4 Methodology

This paper evaluates the distribution of residential electricity subsidies and then simulates the direct and indirect household expenditure effects of electricity tariff increases using a partial equilibrium price-shifting model. The paper then simulates impacts of the electricity tariff hikes on poverty and inequality in Zambia are simulated.

4.1 Data

The main source of data for this study is the 2015 Living Conditions Monitoring Survey (LCMS) - a nationally representative survey of household incomes, expenditure and living conditions in Zambia (Central Statistics Office [CSO], 2016; CSO and World Bank, 2017). We use the survey to identify households that are connected to the grid and to obtain the associated household expenditures on electricity. We use household consumption[2] to create household deciles. Using consumption also makes our welfare rankings and poverty estimates comparable to the official estimates reported by the CSO (CSO, 2016). Lastly, we also used the 2010 input output table (CSO, 2017) to estimate the indirect expenditure effects of the electricity price increases.

[2] Consumption is seen as a better measure of long-term welfare compared to income especially in less-developed countries where incomes fluctuate widely (Haughton and Khandler, 2009)

4.2 Estimation of electricity consumption and subsidies

Given that the survey does not directly report electricity consumption in kilowatts, we estimated quantity of electricity consumed by applying the electricity tariff schedule (Table 1) to the reported household electricity expenditures[3] in the survey.

Next, following Lustig and Sean (2013), we define the size of electricity subsidies per kilowatt as:

$$S = P^m - P^s \tag{1}$$

where P^m and P^s are the market and subsidised electricity prices per kWh respectively. The actual total amount of electricity subsidies used in this paper is estimated as the difference between the market value of electricity consumed per household and the (discounted) electricity expenditures reported in the survey. The former is a product of the estimated electricity consumption and the cost reflective electricity price per kWh.

4.3 Estimation of the direct and indirect expenditure effects.

Given that residential households would face a final 75% increase in prices increase once all the subsidies and discounts to electricity are eliminated, it is important to consider both the direct and indirect household welfare impacts of the price increases. The direct effects arise from a reduction in real household expenditure due to increases in expenditure on electricity consumed directly by households (e.g. lighting and cooking). The short-run direct expenditure effect of electricity price increases on household real expenditure is estimated as:

$$\partial logY_{dir} = \sum_{i}^{m} s_i \partial logP_t \tag{2}$$

where $\partial logY_{dir}$ is the direct expenditure effect, s_i represents the budget share of electricity while $\partial logP_t$ is the electricity price change. The indirect effect on the other hand arises when households consume goods and services that use electricity as an inputs (e.g. restaurant services). Identifying the magnitude of the *indirect effect* requires an estimate of the effect of higher electricity prices on the costs of all the other goods and services consumed by the households. This is estimated using an input-output table and a price-shifting model (see appendix III for more details).

4.4 Estimation of the impact on poverty and inequality.

The impact of the 2017 electricity price increases on poverty and inequality is simulated by comparing the poverty headcount rate and Gini coefficient before

[3] We found that 346 out of 4279 households with access to the grid in the sample had missing electricity expenditures. To avoid losing those observations, we imputed the missing electricity expenditure values using a hedonic regression (See Appendices I and II).

and after the electricity price increases. Operationally, the per capita consumption and income after the price increases are adjusted for percentage reduction in real household welfare to take into account the total welfare loss effects due to the electricity hikes. This approach, which adjusts the per capital consumption and income for the real welfare loss is preferred over a simple subtraction of per capita subsidies. In keeping with common convention, we estimate poverty rates using the consumption expenditure per capita amounts while the Gini coefficient is calculated using income per capita.

5 Results and discussion

5.1 Distribution of electricity subsidies

Given that protecting the incomes of the poor has been a justification for the provision of electricity subsidies and for the use of lifeline tariffs in Zambia, we briefly evaluate the extent to which poor households actually benefit from the subsidies. Figure 2 shows the distribution of electricity subsides by household deciles. The first panel shows the shares of subsidies that accrue to each decile, while the second panel shows the cumulative shares of subsidies that accrue to the cumulative population deciles.

Currently, electricity subsidies in Zambia are highly regressive as can be seen in Figure 2. The richest 20% of the income distribution receive more than 60% of the electricity subsidies while the poorest 20% receive less than 1%. A look at the entire distribution actually shows a particularly striking pattern: about 96% of the electricity subsidies accrue to the richest half of the population while the bottom 50% receive less than 4% of the benefits. A quick comparison of these findings with similar studies (Barnerjee et al, 2008; De la Fuente, 2017) confirms the highly unequal distribution of electricity subsidies in the region. Considering why the electricity subsidies are so regressive in Zambia is certainly an important policy question. To answer this, we explore the distributions of household electricity connection rates, electricity usage and expenditure patterns as well as the distributions of household subsidies per capita and per kWh in Table 2.

From Table 2, we firstly observe that electricity connection rates are heavily skewed towards the higher income groups. More than 90% of the households in the richest decile have access to an electricity connection, while only less than 1% of the poorest decile households has access to the grid. Any access to electricity and the associated electricity subsidies are therefore skewed towards richer households. Factors such as the relatively high electricity connection fees and the historical roll out of the main electricity grid along the main rail and road networks have mainly disadvantaged the rural and urban poor in terms of access to the grid.

Furthermore, we observe that poorer households typically consume far much less electricity in comparison to richer households. For example, the richest household decile consumes 3.6 times more electricity per month compared to the poorest decile. Given that all electricity consumption was effectively subsidised before the 2017 changes, higher electricity consumption therefore resulted in higher levels of total electricity subsidies for the richer, heavier consumers of electricity.

Clearly, the residential subsidy policy before the 2017 price changes was ineffective in "protecting the incomes of the poor" by transferring electricity subsidies to the poor. Rather than focus the benefits towards the poorer groups, the majority of the subsidies accrued to the richer and high electricity consuming groups. To assess the extent to which the 2017 price increases and changes helped target subsidy benefits to the poorer income groups, we assume that electricity consumption patterns would at least remain constant immediately after the reforms and therefore use the estimated pre-reform household electricity consumption levels to estimate the subsidies that would accrue to households following the price changes. We then compare the distribution of the subsidies before and after the price increases. The results are shown in Figure 3.

As shown in Figure 3, the new electricity pricing changes have not significantly benefitted the lower income groups. This is due to the fact that the 2017 price reforms did not significantly restrict the levels of subsidies going to the richer households. If anything, we see an increase in the lifeline tariff bands from 100 to 200 kWh units which as effectively only worked to benefit the richer deciles since the lifeline tariffs are not targeted, but universally provided to all households at this point. Figure 3 also suggests that the introduction of market pricing in the top tariff blocks has worked to somewhat reduce the levels of total subsidies going into the richest deciles after the 2017 price changes.

5.2 The direct and indirect impacts on real household expenditure

The increase in electricity tariffs arising from the removal of subsidies is likely to impact real household expenditure both directly and indirectly. The direct effect arises from the increase in electricity expenditure due to electricity price increases. The indirect effects on the other hand arise from the increases in the prices of all other goods and services that use electricity as an intermediate input. To estimate the direct and indirect effects of removing electricity subsidies, we simulate a 75% electricity tariff price increase. This is the required increase in tariffs estimated to make the electricity tariffs cost reflective (Mundende, 2017). Figure 4 shows the direct and indirect real expenditure effects.

The results show that increasing electricity prices results in larger welfare losses among the poorer households relative to the richer ones. For example the lowest household decile experience an average 11.2% reduction in their real household expenditure compared to a welfare loss of only 3.7% for the richest decile. The direct expenditure effects are larger among the poorer decile while the indirect effects on the other hand are somewhat similarly distributed across the deciles. To explain the distribution of the total expenditure effects, we tabulate the electricity budget shares alongside the simulated total household effects by decile as shown in Table 3.

Table 3 shows that household electricity budget shares decline with increasing household consumption levels. The poorest decile spends more than 3 times the share spent by the richest decile. Given that the direct effects of price changes are directly proportional to the budget shares and price changes, poorer households will experience larger direct welfare losses. We also note that the resulting indirect effects are somewhat uniformly distributed across the deciles and particular small (ranging between 0.8 and 0.9%) in comparison to the direct effects. The smaller indirect price effects are mostly a result of the smaller indirect price increases that pass through to the non-electricity sectors following the electricity price increases. Our findings are quite similar to Jiang et al (2015) who find that the direct impacts of electricity price increases were 2 times larger for poorest income group compared to the richest group. That study also finds that the indirect effects are somewhat uniformly distributed across the income distribution and lie in the range 0.6% to 0.7% (Jiang et al, 2015), which is remarkable close to our estimates. Our results are also similar to Cooke et al (2016) who despite focussing on fuel price increases finds that the direct effects dominate the indirect effects in the Ghanaian fuel sector.

5.3 The Impact of electricity price increases on poverty and Inequality

Finally, we assess whether the electricity increases have any impact on household poverty and per capita income distribution in Zambia. To provide some insight, we perform a comparative analysis of the changes in poverty and inequality as described in section 3.4. Table 4 presents the changes in the poverty headcount and Gini coefficient estimates.

The results in Table 4 show that moderate and extreme poverty both increase by about 0.7 and 0.6 percentage points respectively. This translates into an additional 108,000 and 92,000 people falling below the moderate and extreme poverty lines, respectively. We also find that as expected, the poverty gap and poverty severity indicators under both measures marginally worsen. These results imply that average consumption and the intensity of poverty among the poor deteriorate further following the tariff increases. Income inequality on the other hand, as measured by the Gini coefficient marginally reduces from 0.67 to 0.66. The reduction in the Gini is not surprising, given that the subsidies which were initially regressive have been eliminated in the simulation, thereby resulting in a relatively more progressive income distribution in per capital terms.

5.4 Simulating reductions in poverty due to mitigation measures

This section briefly simulates the potential improvements in poverty arising from the channelling of the electricity subsidy savings to the poor. A clear benefit from the total elimination of the electricity subsidies are fiscal savings estimated at US$146 million per annum[4] that could potentially reduce the fiscal deficits in Zambia. An alternative option is to channel the fiscal savings to the poor through cash transfers. The Zambian government is particularly committed to fighting extreme poverty and has rapidly expanded social cash programmes from a coverage of only 60,000 beneficiary household in 2013 to over 535,000 in 2017 (Siachiwena, 2016; UNICEF, 2018). In 2015, the social cash transfer beneficiaries received about K70 (US$ 11) per month per household. In this paper, we simulate two simple allocation scenarios: i) allocating the subsidy savings to the bottom five deciles; and ii) the first scenario plus allocating double the current monthly grant payments to the poorest 50% of the households (given that grant pay-outs in Zambia are a tiny fraction in comparison to the food poverty line and to pay-outs in neighbouring countries such as South Africa (Siachiwena, 2016)). Table 5 presents the simulations of changes in poverty for the two policy scenarios above.

Table 5 considers the mitigation effects of scenario 1 (allocating the subsidy savings to the poorest 50% of the households) and Scenario 2 (Scenario 1 plus allocating double the current monthly grant payments to the poorest 50% of the households) on poverty in Zambia. In both simulations, extreme poverty reduces significantly though the headline (moderate) poverty rate remains unchanged[5]. Simulations show that extreme poverty reduces by 4.2% and 10.7% for scenario 1 and 2 respectively. This translates into an estimated 646,000 and 1,647,000 Zambians escaping food poverty due to implementing mitigation the above mitigation measures following the electricity price increases. On average therefore, we find that the mitigation measures reduce the poverty headcount by a larger margin than was increased by the electricity price hikes in both Scenarios. Although Scenario 2 offers the biggest poverty reduction effect, we would recommend the adoption of Scenario 1 which is budget-neutral yet offers provides decent levels of poverty reduction.

6 Conclusion and policy recommendations

This paper investigated the distribution of electricity subsidies and simulated the real welfare effects of the recent electricity tariff hikes in Zambia. First, we find that electricity subsidies in Zambia are quite regressive, with more than 60% of the subsidies going into the richest quintile households compared to less than 1% which is transferred to the poorest 20% households. Second, the 75% electricity price hike results a 4.6% average decline in real household expenditures. The poorest household decile is the most affected, suffering the largest reduction in household welfare of 11.2% compared to the richest household decile (3.7%).

[4] The monthly estimate is US$12.6million, which is reasonable compared to the US$26 million monthly estimate for total (residential and non-residential) electricity subsidies in Zambia (Smith, 2016).

[5] The fact that moderate poverty remains unchanged is not surprising, given that both the allocated fiscal savings per capital and social grants per capita (K15.9 and K12.3 respectively) are clearly way below the K214 per capital per month moderate poverty line.

Naturally, the welfare losses lead to increases in moderate and extreme poverty which rise by 0.7 and 0.6 percentage points respectively.

The simulation of possible mitigation programmes shows transferring the realised electricity subsidy savings to the poorest half of the households reduces extreme poverty by 4.2 percentage points. A second policy simulation that transfers the electricity fiscal savings as above but doubles the social cash transfer pay-outs to the poorest 50% of the population reduces extreme poverty by 10.7 percentage points. Overall, either simulation results in a net reduction in extreme poverty but the first scenario which is budget neutral is preferred in countries fighting high budget deficits and poverty simultaneously.

Based on the findings in this paper we recommend that the next round of reforms focus on targeting the electricity subsidies to the poor and accelerating the ongoing rural electrification programmes. This would simultaneously help improve access and equity in the distribution of subsidies especially among the poor and at least in the intermediate term. Second, government must consider the budget-neutral option of transferring the electricity fiscal savings to poor households. This policy is particularly useful in countries where authorities are trying to fight the twin problems of high-budget deficits and high poverty rate as is the case in Zambia and most sub-Saharan countries.

References

[1] Ahmed, F., Trimble, C., Yoshida, N., 2013. The transition from underpricing residential electricity in Bangladesh: Fiscal and distributional impacts. Report 76411-BD. Washington DC: World Bank.

[2] Adriamihaja, N., Vecchi, G. (2007). Madagascar: an evaluation of the welfare impact of higher energy prices in Madagascar. Africa Region Working Paper Series No. 106. World Bank.

[3] Boccanfuso, D., Estache, A., Savard, L., 2009a. Electricity reforms in Mali: a macro–micro analysis of the effects on poverty and distribution. *South African journal of economics*, *77*(1), 127-147. https://doi.org/10.1111/j.1813-6982.2009.01205.x

[4] Boccanfuso, D., Estache, A., Savard, L., 2009b. A macro-micro analysis of the effects of electricity reform in Senegal on poverty and distribution. Journal of Development Studies, 45(3), 351-368. https://doi.org/10.1080/00220380802582361

[5] Banerjee, S., et al., 2008. Access, affordability, and alternatives: modern infrastructure services in Africa. Washington DC: Background Paper 2, Africa Infrastructure Country Diagnostic, World Bank.

[6] Clements, B., Coady, D., Fabrizio, S., Gupta, S., Shang, B., 2014. Energy subsidies: How large are they and how can they be re-

formed?. *Economics of Energy & Environmental Policy*, *3*(1),1-18. http://dx.doi.org/10.5547/2160-5890.3.1.bcle

[7] Cockburn, J., Robichaud, V., Tiberti, L., 2017. Energy Subsidy Reform and Poverty in Arab Countries: A Comparative CGE-Microsimulation Analysis of Egypt and Jordan. *Review of Income and Wealth*. https://doi.org/10.1111/roiw.12309

[8] CSO. 2016. 2015 Living Conditions Monitoring Survey (LCMS) Report. Lusaka, Zambia. https://www.zamstats.gov.zm/phocadownload/Living_Conditions/2015%20Living%20Conditions%20Monitoring%20Survey%20Report.pdf

[9] CSO. 2017. 2010 Supply, use and input output tables. Lusaka: Republic of Zambia. https://www.zamstats.gov.zm/phocadownload/National_Accounts/2010%20Supply%20Use%20and%20Input-Output%20Tables%20Report.pdf

[10] [Dataset] CSO, World Bank. 2017. Zambia Living Conditions Monitoring Survey VII 2015. ZMB_2015_LCMS-VII_v01_M. http://catalog.ihsn.org/index.php/catalog/7105/study-description

[11] Coady, D., 2008. The Distributional Impacts of Indirect Tax and Public Pricing Reforms: A Review of Methods and Empirical Evidence, in: Gillingham, R., (Ed). Poverty and Social Impact Analysis by the IMF: Review of Methodology and Selected Evidence. Washington DC: International Monetary Fund.

[12] Coady, D., Parry, I., Sears, L., Shang, B., 2017. How large are global fossil fuel subsidies?. *World development*, *91*,11-27 http://dx.doi.org/10.1016/j.worlddev.2016.10.004

[13] Cooke, E.F., et al., 2016. Estimating the impact on poverty of Ghana's fuel subsidy reform and a mitigating response. Journal of Development Effectiveness, 8(1),105-128. http://dx.doi.org/10.1080/19439342.2015.1064148

[14] De La Fuente, A., Rosales, M., Jellema, J., 2017. The impact of fiscal policy on inequality and poverty in Zambia. Policy Research Working Paper 8246. World Bank: Poverty and Equity Global Practice Group

[15] Demery, L., 2000. Benefit incidence: a practitioner's guide. *The World Bank. Washington, DC.* http://documents.worldbank.org/curated/en/574221468135940764/pdf/351170Benefit0incidence0practitioner.pdf

[16] ERB (Energy Regulation Board). 2016. Energy Sector Report 2015. Lusaka, Zambia.

[17] Fabrizio, M.S., Goumilevski, M.A. and Kpodar, M.K.R., 2016. *A New Tool for Distributional Incidence Analysis: An Application to Fuel Subsidy Reform*. International Monetary Fund.

[18] Feng, K., Hubacek, K., Liu, Y., Marchán, E., Vogt-Schilb, A., 2018. Managing the distributional effects of energy taxes and subsidy removal in Latin America and the Caribbean. *Applied Energy*, *225,* 424-436. https://doi.org/10.1016/j.apenergy.2018.04.116

[19] Fosu, A.K., 2015. Growth, inequality and poverty in Sub-Saharan Africa: recent progress in a global context. *Oxford Development Studies*, *43*(1), 44-59. https://doi.org/10.1080/13600818.2014.964195

[20] Haughton, J., Khandker, S.R., 2009. Handbook on poverty and inequality. Washington DC: World Bank.

[21] Hill R., Inchauste G., Lustig N., Tsehaye E., Woldehanna T., 2016. A fiscal incidence analysis for Ethiopia, in: Inchauste G., Lustig N., (Eds.), The Distributional Impact of Fiscal Policy: Experience from Developing Countries, World Bank, Washington, D.C

[22] Hope, E., Singh, B., 1999. *Energy price increases in developing countries: Case studies of Colombia, Ghana, Indonesia, Malaysia, Turkey, and Zimbabwe*. The World Bank.

[23] Independent Evaluation Group. 2016. Financial Viability of the Electricity Sector in Developing Countries: Recent Trends and Effectiveness of World Bank Interventions. Washington, DC. World Bank. https://openknowledge.worldbank.org/handle/10986/25174 License: CC BY 3.0 IGO

[24] IMF (International Monetary Fund). 2013. Energy Subsidy Reform in Sub-Saharan Africa: Experiences and Lessons. Washington, DC: International Monetary Fund.

[25] Inchauste, G., Lustig, N., Maboshe, M., Purfield, C., Woolard, I., 2015. The distributional impact of fiscal policy in South Africa. Policy Research Working Paper 7194. World Bank Group: Poverty Global Practice Group & Macroeconomics and Fiscal Management Global Practice Group

[26] Jiang, Z., Ouyang, X. and Huang, G., 2015. The distributional impacts of removing energy subsidies in China. China Economic Review, 33, 111-122. http://dx.doi.org/10.1016/j.chieco.2015.01.012

[27] Kojima, M., Bacon, R., Trimble, C., 2014. Political economy of power sector subsidies: a review with reference to Sub-Saharan Africa. Washington DC. World Bank.

[28] Kojima, M., Trimble, C., 2016. Making Power Affordable for Africa and Viable for Its Utilities. Washington DC. World Bank.

[29] Komives, K., Halpern, J., Foster, V., Wodon, Q., Abdullah, R., 2007. Utility subsidies as social transfers: An empirical evaluation of targeting performance. *Development Policy Review*, *25*(6), pp.659-679. https://doi.org/10.1111/j.1467-7679.2007.00391.x

[30] Komives, K., Johnson, T.M., Halpern, J.D., Aburto, J.L., Scott, J.R., 2009. Residential electricity subsidies in Mexico: exploring options for reform and for enhancing the impact on the poor. Working paper no.160. World Bank.

[31] Lustig, N., Higgins, S., 2013. Commitment to Equity Assessment: Estimating the Incidence of Social Spending, Subsidies and Taxes Handbook. CEQ Working Paper No. 1, July 2011; revised January 2013. New Orleans, LA.

[32] Ministry of National Development and Planning, 2017. Seventh National Development Plan 2017-2021. Lusaka: Government of the Republic of Zambia.

[33] Mudende, M V. 2017. 2017 Retail Tariff Application – Media Brief Presentation. Power Point Presentation. ZESCO. Lusaka, Zambia.

[34] Peltovuori, V., 2017. Fossil fuel subsidies in the Pacific island context: Analysis of the case of Kiribati. *Energy Policy*, *111*, pp.102-110. https://doi.org/10.1016/j.enpol.2017.09.021

[35] Policy Monitoring and Research Centre. 2014. Promoting Energy Investment through cost reflective tariffs. Lusaka, Zambia

[36] Siachiwena, H., 2016. Social Protection Policy Reform in Zambia in Zambia during the Sata Presidency, 2011–2014. CSSR Working Paper 377. Cape Town: Centre for Social Science Research, University of Cape Town.

[37] Siddig, K., Aguiar, A., Grethe, H., Minor, P., Walmsley, T., 2014. Impacts of removing fuel import subsidies in Nigeria on poverty. *Energy Policy*, *69*, 165-178. http://dx.doi.org/10.1016/j.enpol.2014.02.006

[38] Smith, G., 2016. Zambia economic brief : beating the slowdown - making every kwacha count (English). Zambia economic brief; no. 7. Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/804591467989562427/Zambia-economic-brief-beating-the-slowdown-making-every-kwacha-count

[39] Trimble, C., et al., 2011. Rethinking Electricity Tariffs and Subsidies in Pakistan. Report number 62971-PK. Washington D.C.: World Bank.

[40] Trimble, C., Kojima, M., Perez Arroyo, I., Mohammadzadeh, F., 2016. Financial viability of electricity sectors in Sub-Saharan Africa: quasi-fiscal deficits and hidden costs. Policy Research Working Paper 7788. Washington D.C.: World Bank.

[41] UNICEF, 2018. UNICEF Annual report 2017 Zambia. UNICEF. https://www.unicef.org/about/annualreport/files/Zambia_2017_COAR.pdf

[42] Wang, F., Zhang, B., 2016. Distributional incidence of green electricity price subsidies in China. Energy Policy, 88,27-38. http://dx.doi.org/10.1016/j.enpol.2015.09.035

[43] Wesseh Jr, P.K., Lin, B., 2017. Options for mitigating the adverse effects of fossil fuel subsidies removal in Ghana. *Journal of cleaner production.141*,1445-1453. http://dx.doi.org/10.1016/j.jclepro.2016.09.2144

[44] WHO (World Health Organisation), 2018. Global Health Expenditure database. https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS

[45] Younger, S.D., Osei-Assibey, E., Oppong, F., 2017. Fiscal incidence in Ghana. Review of Development Economics, 21(4), e47-e66. https://doi.org/10.1111/rode.12299

[46] Zhang, F., 2015. Energy price reform and household welfare: The case of Turkey. *Energy Journal 36*(2), 71-95. http://dx.doi.org/10.5547/01956574.36.2.4

[47] ZESCO. 2018. Current ZESCO Tariffs. http://www.zesco.co.zm/customerCare/tariffs

Table 1: Electricity tariff rates before and after the 2017 price changes

Residential				Commercial		Social	
(1)		(2)		(1)	(2)	(1)	(2)
Block	(K/kWh)	Block	(K/kWh)	K/kWh	K/kWh	K/kWh	K/kWh
0-100	0.15	0-200	0.15	0.31	0.54	0.28	0.49
101-300	0.31	201+	0.89				
301+	0.51						
Fixed charge	18.23		18.23	55.09	96.41	47.91	83.84

Source: ZESCO residential tariff schedules. (1) and (2) are the electricity price structures before and after the reforms respectively. The detailed tariffs schedules for other types of commercial billing is available at ZESCO (2018). kWh refers to kilowatt hour.

Table 2: Household electricity access, usage, expenditure and subsidy rates

Household decile	Electricity connection rates (%)	Average electricity consumption (kWh)	Average electricity expenditure (K/Month)	Average electricity subsidies (K/Month)	Average electricity subsidies per capita	Average electricity subsidies per kWh
Poorest	0.31	133.01	43.46	56.93	8.11	0.43
2	0.68	140.42	47.56	67.28	8.51	0.43
3	2.73	199.65	68.92	90.59	14.81	0.42
4	2.69	208.40	69.71	93.32	12.97	0.42
5	11.86	241.73	79.25	101.34	16.39	0.41
6	24.23	223.07	73.61	94.60	15.80	0.42
7	43.15	264.15	90.87	110.39	19.90	0.42
8	57.30	297.57	105.63	120.99	24.89	0.41
9	78.72	355.75	131.78	138.75	31.67	0.40
Richest	92.59	484.44	193.48	172.68	58.88	0.38
Overall	31.43	354.43	132.34	136.56	35.06	0.40

Source: Own estimates based on the 2015 LCMS. Estimates calculated as averages over the household deciles

Table 3: Budget shares and real expenditure effects

	Budget share of electricity expenditure	Direct effects (%)	Indirect effects (%)	Total effects (%)
Poorest Decile	13.89	-10.42	-0.80	-11.21
2	9.83	-7.37	-0.94	-8.31
3	10.99	-8.24	-0.90	-9.14
4	8.25	-6.18	-0.87	-7.05
5	8.03	-6.02	-0.88	-6.90
6	5.81	-4.36	-0.90	-5.26
7	5.49	-4.12	-0.92	-5.04
8	5.16	-3.87	-0.91	-4.78
9	4.69	-3.52	-0.90	-4.42
Richest Decile	3.79	-2.84	-0.87	-3.72
Total	4.92	-3.69	-0.89	-4.58

Source: Own calculations based on the 2015 LCMS. The direct, indirect and total real expenditure effects indicate the percentage reduction in real household expenditure budgets caused by the increase in residential electricity prices

Table 4: The poverty and inequality impacts

	Before	After	Change
Moderate poverty (1)			
Headcount	60.3 [a]	61.0	0.7***
Gap	32.0	32.4	0.4***
Severity	20.7	20.9	0.2***
Extreme poverty (2)			
Headcount	48.2	48.8	0.6***
Gap	22.8	23.1	0.3***
Severity	13.6	13.8	0.2***
Income Inequality (3)			
Gini coefficient	0.667	0.664	0.003***

Source: Own Estimates based on the 2015 LCMS dataset.

*Notes: (1) and (2) The poverty estimates are based on per capita consumption expenditure using the K214 and 152 poverty lines respectively (CSO,2016) (a) The official poverty headcount is 54.4% which is comparable estimate to the 54.9% we obtain using adult equivalents. (3) The Gini coefficient is based on income per capita. Poverty estimates in percentages (%) *** Differences statistically significant at the 1% level.*

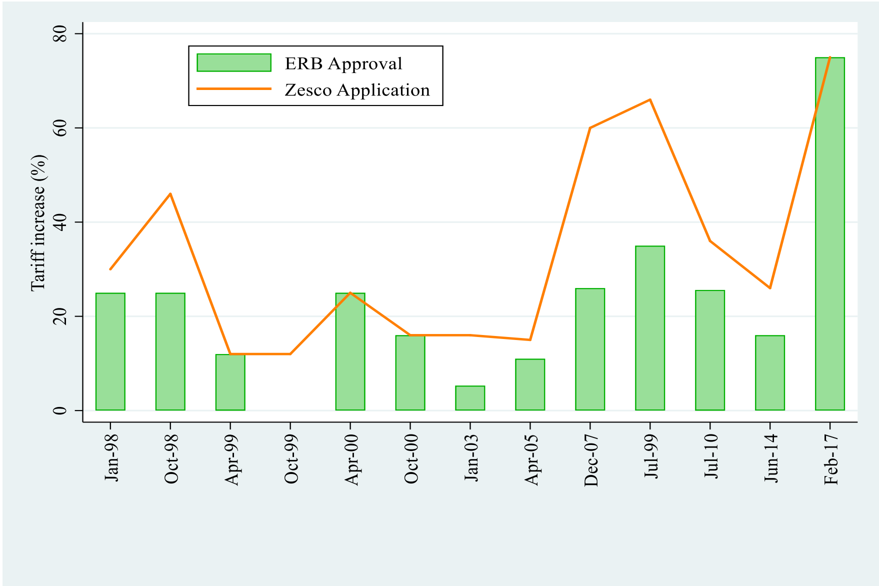
Table 5: Simulations of the changes in poverty

	Headcount	Poverty gap	Severity
Baseline poverty rates:			
Moderate poverty	61.0	32.4	20.9
Extreme poverty	48.8	32.4	13.8
SCENARIO 1:			
Changes in moderate poverty	-	-3.7***	-4.3***
Changes in extreme poverty	-4.2***	-4.9***	-4.3***
SCENARIO 2:			
Changes in moderate poverty	-	-9.5***	-9.9***
Changes in extreme poverty	-10.7***	-11.5***	-9.1***

Source: Own Estimates based on the 2015 LCMS dataset.

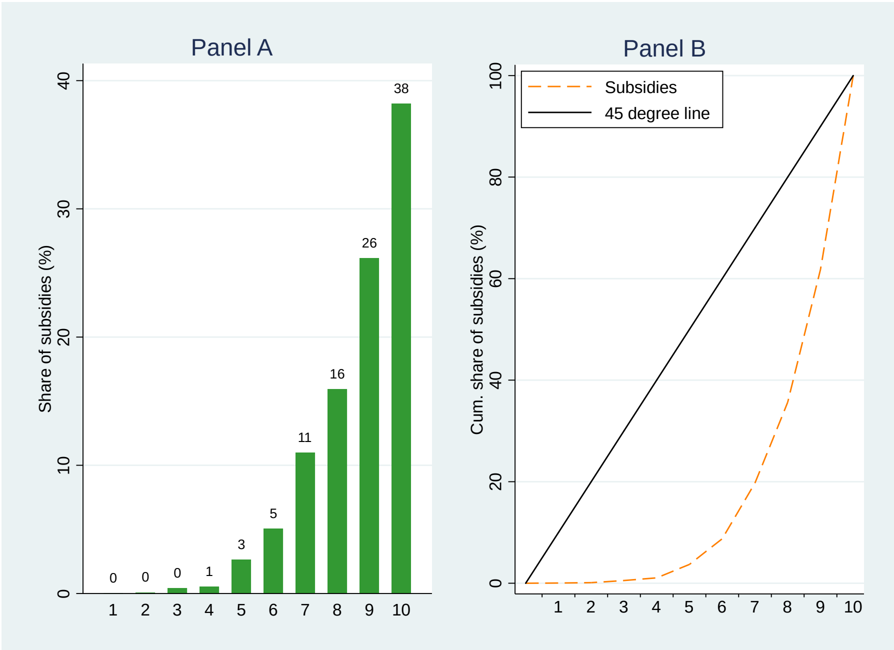
*Notes: Poverty estimates in percentages (%) *** Differences statistically significant at the 1% level.*

Figure 1: Electricity tariff increase applications vs approvals (1998-2017)



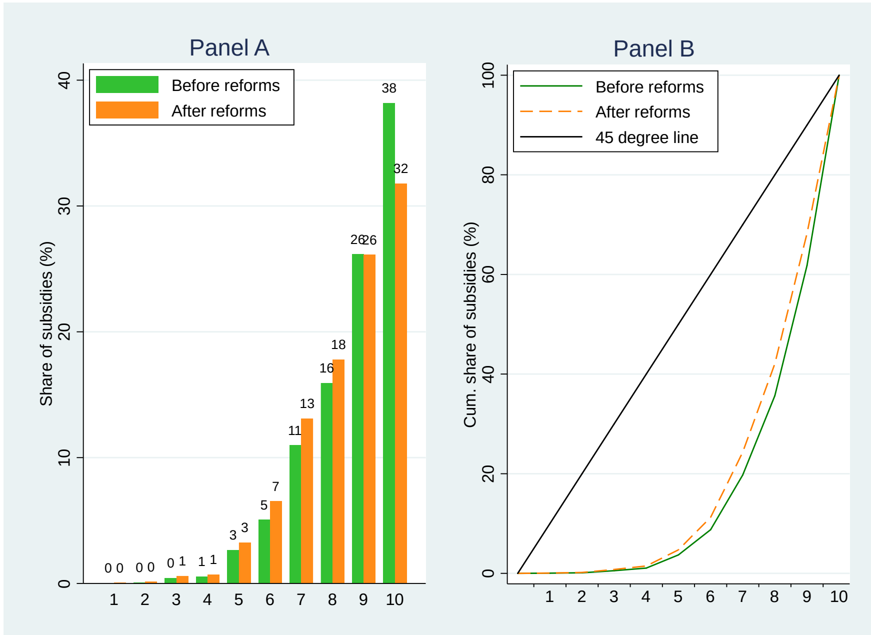
Source: Adapted from Zesco (2017) and Policy Monitoring and Research Centre (2014)

Figure 2: The distribution of electricity subsidies by household deciles



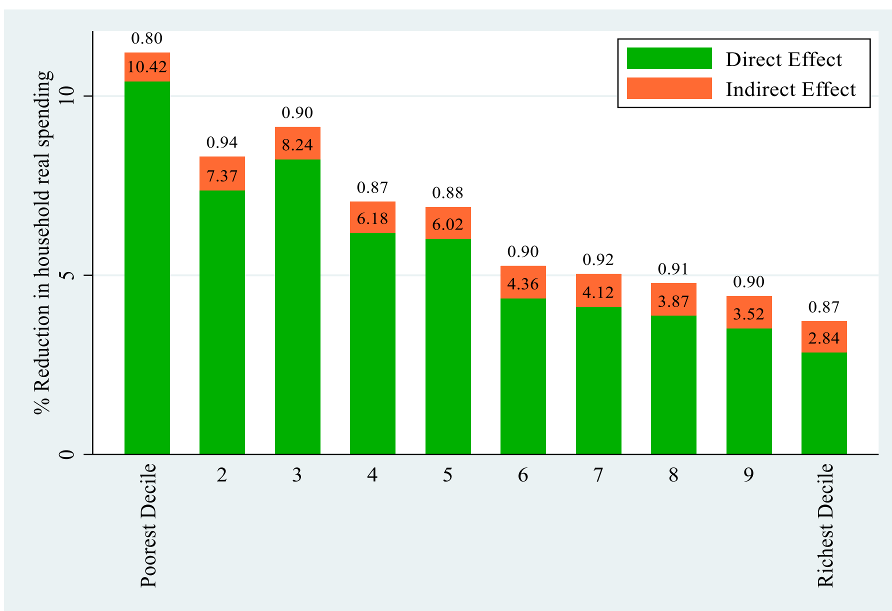
Source: Own estimates based on the Zambia 2015 LCMS dataset.

Figure 3: Distribution of electricity subsidies by household deciles before and after tariff increases



Source: Own estimates based on the Zambia 2015 LCMS dataset.

Figure 4: Direct and Indirect household expenditure effects



Source: Own estimates based on the 2015 LCMS and the 2010 Zambia input-output table

Appendix I; Estimating missing electricity expenditures

Out of the 4279 households who reported having access to the grid, about 346 did not report the corresponding electricity expenses. To estimate electricity expenditure for these 346 households, we applied a standard hedonic regression model to impute the missing values of electricity expenditure[1]. The model regresses the log of electricity expenses for the households connected to the power grid on a set of dependent variables derived from within the household survey. The covariates include; the log of household income, the log of rent expenses (actual or imputed[2]), household size, the material used for roofing, walls and floors, as well as the location of the household (urban or rural area, province and stratum). We follow the Zambian central statistics office and specify the electricity hedonic regression model as follows;

$$lnE_i \;= \beta X_i + \varepsilon_i \; (i = 1,2, \dots, n) \qquad (3)$$

where lnE_i is the log of monthly expenditure on electricity for household i, X_i is a vector of housing and other household characteristics as listed above, while β is a vector of parameter estimates and ε_i is the error term. After estimation, we use the model parameters to predicate values of log of electricity expenditure for each household connected to the grid. To impute the electricity expenses of the 346 households connected to the grid but with missing expenses, we use the anti-log of the predicted log of electricity expenses to obtain the kwacha amounts in level. The output of the imputation regression is presented in Appendix II below.

[1]We follow the methodology in CSO (2016) and Lustig and Sean (2013) in imputing the missing electricity expenditure.
[2]We perform a similar hedonic regression to impute rent for owner-occupied housing.

Appendix II; Hedonic regression results

VARIABLES	Coef.	Std.Error
Log of income	0.054***	(0.007)
Log of rent	0.263***	(0.014)
Household size	0.019***	(0.004)
Number of rooms	0.054***	(0.006)
Type of Wall Material		
Mud bricks	-0.100*	(0.057)
Compressed Mud	-0.057	(0.153)
Compressed Cement/Bricks	0.116***	(0.034)
Concrete blocks/slab	0.006	(0.032)
Cement blocks	0.014	(0.026)
Stone	-0.625**	(0.302)
Iron sheets	0.155	(0.176)
Asbestos /hardboard/wood	-0.083	(0.218)
Pole and dagga/mud	-0.140	(0.210)
Grass	-0.361	(0.369)
Type of Floor Material		
Cement	-0.003	(0.023)
Brick	-0.171	(0.185)
Tiles	0.102***	(0.032)
Mud	-0.163	(0.104)
Wood (not wooden tiles)	0.766	(0.520)
Marble	-0.101	(0.302)
Terrazzo	0.109	(0.199)
Province		
Copperbelt	0.076*	(0.040)
Eastern	-0.055	(0.048)
Luapula	-0.113**	(0.047)
Lusaka	0.053	(0.041)
Muchinga	0.019	(0.047)
Northern	-0.132***	(0.048)
North Western	0.014	(0.047)
Southern	0.025	(0.045)
Western	0.067	(0.053)
Urban	0.144**	(0.062)
Stratum		
Medium Scale	0.404***	(0.102)
Large Scale	1.007***	(0.123)
Non-Agric	0.067	(0.093)
Low Cost	-0.170***	(0.028)
Medium Cost	-0.092***	(0.024)
High Cost	-	
Constant	2.206***	(0.106)
Observations	3,287	
R-squared	0.438	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is log of electricity expenditure, the reference household has walls made of burnt bricks, concrete floors, is located in a small strata rural area in central province.
Source: Own estimates based on the 2015 LCMS (CSO, 2017)

Appendix III; Estimating indirect effects of electricity price increases

The indirect effects on household welfare are estimated using the price-shifting approach of Coady (2008). These effects are estimated as;

$$IE = \sum_{j=1}^{k} w_j . \partial log P_j \tag{4}$$

where *k* is the number of non-electricity goods consumed by the household, w_j the corresponding budget shares, and $\partial log p_j$ the relative price change resulting from the increase in electricity prices. This requires information on the production structure of the economy from the input-output tables. The price-shifting approach implicitly assumes that goods are non-traded, that there are constant returns to scale in domestic production and that demand is price inelastic.

The price-shifting model

Coady (2008) suggest the following three broad categories of commodities according to the relationship between higher production costs and output prices:

- **Cost-Push Sectors:** These consist of sectors where higher input costs are passed on to the final prices paid by households. The relationship between consumer and producer prices in these sectors is given as:

$$p_{cp}^{u} = p_{cp}^{p} + t_{cp} \tag{5}$$

  where, p_{cp}^{u} is the price paid by consumers, p_{cp}^{p} is the price received by producers and t_{cp} is the tax imposed by the government.

- **Traded Sectors:** The trade sectors compete with internally traded goods and output prices are determined by prices on the world market as well as the import or export tax regimes prevailing in the country. Since prices are determined in the world market, higher input costs are not transferred onto output prices and prices are determined as;

$$p_{ts}^{u} = p^{world} + t_{ts} \tag{6}$$

- **Controlled Sectors:** These include industries that are controlled by government and thus government fixes the prices. Any price changes in this sector largely depend on whether government adjusts prices. In the absence of price adjustments, any higher input costs are borne by factor prices, profits or government revenue. To keep the analysis simple, taxes are set to zero.

$$p_{c}^{u} = p^{*} \tag{7}$$

The subscripts *cp*, *ts* and *c* denote cost push, traded and controlled sectors respectively. The changes in consumer prices in the traded and controlled sectors can be computed as:

$$\Delta p_{ts}^{u} = \Delta p^{world} + \Delta t_{ts} \tag{8}$$

$$\Delta p_{c}^{u} = \Delta p^{*} \tag{9}$$

Any changes in Δp_c^u are exogenous and depend largely on price adjustments announced by government. Similarly, $\Delta p_{ts}^u$is exogenously determined through changes in trade taxes and world prices. The changes for the cost-push sectors can be computed as:

$$\Delta p_{cp}^u = \Delta p_{cp}^p + \Delta t_{cp} \tag{10}$$

The term Δp_{cp}^udepends on factor prices of all intermediate goods and can be written as$\Delta p_{cp}^u = f(p)$, where P denotes the price vector of all goods and services.

According to Coady (2008), the aggregate commodity categories are produced with a share of each of the above sectors; that is, cost push, traded and controlled sectors. These shares are given by *α, β,* and *γ*, respectively, and the sum of the shares are equal to one for each sector$(\alpha_s + \alpha_s + \alpha_s = 1; s = 1, \dots S)$. An input-output coefficient matrix *(A)* with unit costs of producing one unit of output j given by a_{ij} for input *i* can be used in capturing the production technology of domestic firms. Given the input-output coefficient matrix and fixed factor prices the change in price of output j can be written as:

$$\Delta p_{cp}^u = \sum_{i=1}^{s} \alpha_i a_{ij}\, \Delta p_{cp}^j + \Delta t_{cp} + \sum_{i=1}^{s} \beta_i a_{ij}\, \Delta p_{ts}^j + \sum_{i=1}^{s} \gamma_i a_{ij}\, \Delta p_c^j \tag{11}$$

Using matrix notation, equation (8) can be written as:

$$\Delta p_{cp}^p = \Delta p_{cp}^p \cdot \alpha \cdot A + \Delta p_{ts} \cdot \beta \cdot A + \Delta p_c \cdot \gamma \cdot A \tag{12}$$

where A is an *n x n* input-output coefficient matrix, p is a vector of prices and *α, β, γ* are n x 1 diagonal matrices. The indirect effect can now be calculated by substituting equation (9) into (7) and using the resulting change in prices in (2) above.

In this paper, we assume that the following standard assumptions generally hold; i)The electricity sector is controlled; ii) All other sectors are cost-push and iii) there is no substitution away from electricity by households. These assumptions not overly restrictive. Given that the interpretation of the estimates here are short-run effects, no major adjustments to consumption of electricity is expected within the short-run. Despite the limitations of input-output analysis – homogeneous output, fixed production technology, absence of scale economies, exogenous inputs and final demand – the approach is easier to implement and requires a lower level of information and data compared to more data and modelling intensive approaches such as CGE models.