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Determinants of Household Electricity Demand in Rural India: A Case Study of the Impacts of Government Subsidies and Surcharges

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ABSTRACT

This paper analyses the determinants of household electricity consumption with the focus to find the impact of government subsidies and surcharges on the demand for electricity services in the rural areas. Using surveyed household data of 332 samples, quantile regression has been employed for checking heterogeneity in electricity demand across different quantile of households. We find government subsidy has enhanced the household demand for electricity consumption with the elasticity ranging from 45 to 65%. Skeptically, electricity consumers of higher quantile tend to consume more even in the presence of outstanding bill while it is the opposite for low quantile group. Surprisingly, income and other socioeconomics variables don't necessarily affect the households demand for electricity. This implies demand for electricity is inelastic to income and selected socioeconomic variables in rural regions. However, electricity demand decreases for households with dwelling characteristics categorized as poorer quantile. Based on our empirical findings implications are drawn for policy makers.

Keywords: Electricity, Determinants, Heterogeneity, Quantile, Subsidies, Surcharges
JEL Classifications: Q4, Q48, R2, R48

1. INTRODUCTION

In India, providing electricity service to every household started as mission in April 2005 naming it as RGGVY (Rajiv Gandhi Grameen Vidyutikiran Yojana) which was later subsumed and renamed as Deendayal Upadhayaya Gram Jyoti Yojana (DDUGJY) in August 2013 (DDUGJY, 2014). Infact in 2018 India had declared that all the villages are electrified which attracted criticisms as some of the remote villages were yet to be electrified. But, quickly in 2019 it was once again declared that all the households in India have access to electricity services barring a few remote areas of Chhattisgarh (Saubhagya, 2019). Today the average hours of electricity supplied to the rural areas in India is around 18 h in a day (PIB, 2019). While India still struggles to provide 24 h of electricity supply to both rural and urban region households along with major disruptions that arises due to weather conditions, load-shedding and often blackouts in peak evening hours due to demand being always higher than the total supply. Assam is no exception, in which some of the households of the region have had the electricity connectivity for just above 5 years or more. Practically, the households in Assam receive around 19 h (PIB, 2019) of electricity supply per day. While it is a well-established fact that the socio-economic benefits of electricity services are profoundly effective; it enables a child to read for longer time for a better educational outcome; increase in business hours, productivity and profit for a firm; and empowerment of women by accessibility to television, radios and cell-phones by cultivating better decision making abilities. Rural electrification also increases labor supply of men and women, schooling of boys and girls, household per capita income and expenditure (Khandker et al., 2014). Electricity service in rural areas is a boon that creates avenues and opportunities for the empowerment of the households. Overall, access to electricity by the households should be an enhancer to their abilities creating better quality of life. However, the electricity bills have become a burden to many of the rural households in Assam due to inefficient and faulty billing mechanism which is adversely affecting the economic condition of the households. The present study is undertaken in remote rural areas of Assam, India, with the objective of exploring the factors that determine a household's electricity consumption level. The recent personal survey in those regions reveal uniquely high amount of electricity bills per month. Ironically the high average bills for different households in rural areas which are endowed with limited electric appliances and equipments raises an alarm for thorough inspection. Along with the socio-economic factors of a household the structure of energy bills has been included to assess all the factors combined. Needless to say, presently the households of the rural areas are not only energy poor but they are overburdened with energy bills.

There is enormous literature on the determinants of residential electricity demand made at aggregate micro and macro level of the households. Most of the earlier studies were done using time series and panel data sets for different countries and regions of the world. They have either used error correction model or panel data econometric analysis technique for identifying the determinants of electricity demand. At the macro level determinants of electricity consumption have been investigated by many researchers such as (Narayan et al., 2007), (Zhou and Teng, 2013) (Cialani and Mortazavi, 2018) (Al-Bajjali and Shamayleh, 2018) by using time series and panel data sets for identifying the factors that determine household electricity demand. At the micro level, associations between socio-economic and dwelling and demographic characteristics were assessed. Studies at micro level such as (Santamouris et al., 2007), (Wassie et al., 2021), (Huebner et al., 2016) have been done for identifying socio-economic, demographic and dwelling characteristics affecting electricity consumption. Specifically for India (Filippini and Pachauri, 2004), (Ramachandra et al., 2000), (Tewathia, 2014) and (Pachauri, 2004) made studies for different parts of India using survey data wherein these studies found that socio-economic, demographic, geographic, family and dwelling attributes influence the total household energy requirements with wide variations in the demand for electricity according to various income groups. Specifically (Pachauri, 2004) using NSSO's household level survey data had found that "total household expenditure or income level is the most important explanatory variable causing variation in energy requirements across households." Additionally, dwelling size of household and age of the head of the household are related to higher energy consumption. Amongst the literature survey made, we find very limited papers that are related to the factors that are core variables for our study i.e. subsidy and surcharges as independent variables affecting the household demand for energy and electricity consumption. But studies related specifically to surcharges to bill defaults is almost nil. Studies done on impact of government subsidies on consumer's electricity demand are also focused mostly on developed countries. A few of them are studies done by (Banfi et al., 2005) on the impact of fuel subsidies, (Rivers and Jaccard, 2011) on the impact of direct subsidy on energy prices, (Mirnezami, 2014) studied the impact of electricity subsidization on electricity consumption in Canada by using household expenditure data. In the most recent comprehensive study done by (Athukorala et al., 2019) found that major determinants of demand for residential electricity are the subsidies, socioeconomic variables and energy saving technology wherein elasticities with respect to subsidy variables are found to be higher than the price variable. As stated earlier there is hardly any study made which is directly or indirectly related to surcharges that are charged by the billing agency due to payment defaults.

For us it has become clear that different authors at different points of time have used different tools and techniques, analysed various aspects of household electricity demand for different countries and regions of the world using different forms of data at both micro and macro levels using mostly secondary data or indirect primary data sets. Above all the basic objective remains the same i.e. to identify the important determinants of residential demand for electricity consumption. We also find there is still a huge vacuum of analysis related to subsidies of different forms for developing countries both at micro and macro level and considerably void in terms of surcharges incurred by consumers. Particularly, our study is focused to identify the impact of government subsidies and surcharges on the electricity consumption at the household level using primary survey data of the households in rural areas of India. Our paper is different and would be a bridge for literature gap, which takes into account of the issue of surcharges incurred recurrently in determining electricity consumption by households across different income groups in the rural areas.

2. MATERIALS AND METHODS

2.1. Data and Variables

The study uses both primary and secondary data. Secondary data on the household's monthly electricity consumption bill was obtained from the Assam Power Distribution Corporation Limited (APDCL) website[1]. The electricity bills accessed also contain information of government subsidy and surcharges amount in it. Notably, APDCL is the sole authority for distribution, trading and supply of electricity in the state of Assam or outside it. Within Assam, primary data was collected from the rural areas of 4 districts of BTR (Bodoland Territorial Region) using stratified random sampling. A total of 332 sample households were selected for collecting primary information related to socioeconomic and dwelling characteristics of the household. Description and type of variables used in our study are given in details in Table 1.

We have used current demand as the dependent variable and the independent variables are categorized into 3 different types: category 1: Subsidies and surcharges; category 2: Socioeconomic characteristics; category 3: Dwelling characteristics.

2.2. Statistical Analysis

For this study we have used the modified Cobb-Douglas model for estimating the household electricity demand. Cobb-Douglas

1 Official website of Assam Power Distribution Corporation Limited: https://www.apdcl.org/website/ViewBill. Monthly household electricity bill are available in the website for maximum of five months including the current month's bill.

Table 1: Description of variables

Variables		
Dependent variable		
Variable	**Definition**	
Current demand	Amount of bill for previous month electricity consumption (in. Rs)[2]	
Independent variables		
Variable	**Definition**	**Related literatures**
1. Subsidies and Surcharges		
Government subsidy	Amount the government bears as a subsidy for a consumer's bill in a month (in Rs)	Few close studies related to government subsidies in fuel subsidies and pricing dynamics with government intervention were done by (Banfi et al., 2005), (Rivers and Jaccard, 2011), (Mirnezami, 2014) and (Athukorala et al., 2019).
Outstanding bill[3]	Total bill accumulated over a period of time due to payment defaults including *surcharges* on outstanding bill (in Rs).	*Relatively none*
2. Socioeconomic variables		
Family income	Amount of money a household earns per month taking all sources of income combined (in Rs)	Several studies done by (Brounen et al., 2102), (Jones and Lomas, 2015), (Weismann et al., 2011), (Yohanis et al., 2008), (Tiwari, 2000), (Bedir et al., 2013), (Cramer et al., 1985) and (Mansouri et al., 1996) found that households with higher income were found to higher consumers of electricity.
Education level	Highest level of education obtained by a member resident of the household(in years)	(Kostakis, 2020), found that level of education of the household has a positive effect on household electricity consumption.
Family size	Total family members residing in the household (number).	Households with more members likely to consume more electricity (Jones and Lomas, 2015), (Bartusch et al., 2012), (Ndiaye and Gabriel, 2011), (Bedir et al., 2013), (Cramer et al., 1985)
School/College going	School and college going students in the household (number).	Households with teenagers more likely to consume more electricity (Brounen et al., 2102)
Retired	Total retired persons in the household(number)	(Jones and Lomas, 2015), (Tiwari, 2000) found households with persons 65+ are likely to consume more electricity.
Minimum Watt	Minimum watt required to run a electric appliance present in the household (watts)[4]	Studies done by (Huebner et al., 2016), (Ndiaye and Gabriel, 2011), (Kavousian et al., 2013), (Weismann et al., 2011), (Yohanis et al., 2008), (Tiwari, 2000), (Bedir et al., 2013), (Cramer et al., 1985) and (McLoughlin et al., 2012) found that households with more number of electric appliances have higher electricity bills.
Area	Housing area (in bigha[5])	(Brounen et al., 2102), (Kavousian et al., , 2013), (Weismann et al., 2011), (Jones and Lomas, 2015), (Yohanis et al., 2008) found that larger floor area is associated with more electricity consumption
Living rooms	Living rooms in the household (number)	Almost identical and similar to studies done by (Huebner, David, Hamilton, Chalabi, & Oreszczyn, 2016), (Brounen, Kok, & Quigly, 2102), (Kavousian, Rajagopal, & Fischer, 2013), (Weismann, Azevedo, Ferrao, & Fernandez, 2011), (Jones & Lomas, 2015), (Yohanis, Mondol, Wright, & Norton, 2008).
3. Dwelling characteristics (dummy)		
Floor of the house	Floor of the house categorized into 3 parts; Pukka(concrete), kutcha(non-concrete) and Mixed	Studies have found that building characteristics have a sizeable impact on electricity consumption (Huebner, David, Hamilton, Chalabi, & Oreszczyn, 2016), (Santin, Itard, & Visscher, 2009), (Steemers & Yun, 2009), (Weismann, Azevedo, Ferrao, & Fernandez, 2011), (Yohanis, Mondol, Wright, & Norton, 2008).
Roof of the house	Roof of the house categorized into 2 parts; Tin and Terrace.	

equation for capturing electricity consumption of a household is given as[2345]

$$ec_i = \frac{\beta_0 y_i^{\beta_1} r_i^{\beta_4} c_i^{\beta_5} el_i^{\beta_6} aa_i^{\beta_7} fm_i^{\beta_8} wt_i^{\beta_9} lr_i^{\beta_{10}} \sum_{j=11}^{12} d_{ji}^{\beta_j}}{gs_i^{\beta_2} ost_i^{\beta_3}} \qquad (1)$$

Where ec_i is the electricity consumed by a household in units, β_0 is the constant term, y_i refers to average monthly income of the household, gs_i is the amount of subsidy (in Rs) given by the government per month for a household, ost_i is the outstanding bill that is accumulated for a household due to non-payment previous months electricity bills (here we have assumed both these variables inversely affects the current electricity consumption for a household i.e., current consumption reduces/increases when the gs_i and ost_i are high/low respectively), r_i is the number of retired personnel (65 years) living in the house; c_i is the number of school college going students in the household, el_i is the highest level of education obtained in the household (in years)[6]; aa_{iis} the housing area of the

2 Current demand = Number of units consumed * Price per unit + electricity duty + current surcharge + fixed charge– government subsidy.

3 Outstanding bill = Arrear principle + Arrear surcharge

4 Watts are calculated as minimum watts required for running electric appliance multiplied by the number of appliances. Standard minimum watts consumed by a appliance accessed from https://letsavelectricity.com/wattagepower-consumption-of-household-appliances/

5 Unit of measurement for land area, 1 bigha = 14,400 sq ft. (NREDC, 2020).

6 According to the standard years required for school, colleges and university

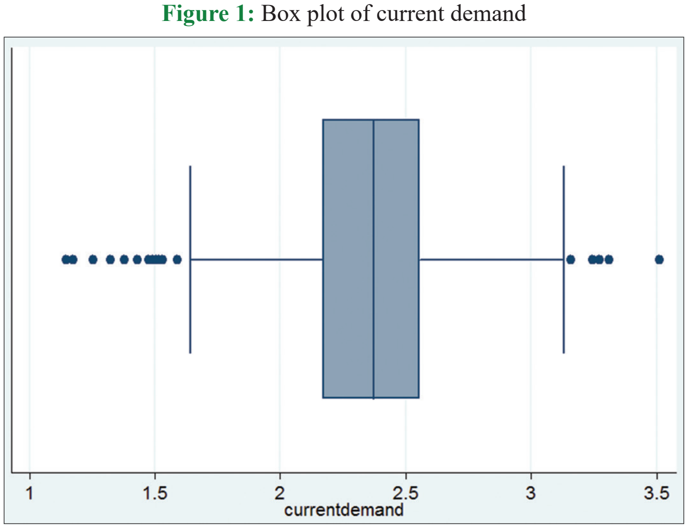
household; fm_i is the total family members in the household, wt_i is the minimum amount of required watts to power up the appliances present in the household, lr_i is the number of living rooms in the household and d_{ji} are set of dummy variables which captures the heterogeneity of household electricity consumption. The parameters β_1, β_2 and β_3 are interpreted as elasticities of electricity consumption for a household's income, government subsidy and outstanding bill respectively. Taking log of Eq. 1 and adding error term ε_i we can estimate it using OLS which yields the marginal effects of the independent variables on electricity demand. But our aim is to find out the heterogeneity that underlies in determinants of electricity consumption i.e. whether the explanatory variables has different impacts across a conditional quantile of electricity consumer households. So, we adopt the quantile regression developed by (Koenker nd Bassett, 1978). It produces more unbiased (Olsen et al., 2012) and robust estimates than the linear regression model when the data sets are large and it contains outliers (Tilov et al., 2020) and (Yeh et al., 2009). Quantile regression approach has been extensively used by (Tilov et al., 2020), (Romero et al., 2016), (Kostakis, 2020), (Athukorala et al., 2019), (Huebner et al., 2016) for detecting and quantification of the effects of determinants on selected quantile for the study concerned. Additionally, the box-plot of the units of electricity consumption of the households in Figure 1 illustrates that its distribution does not follow normal distribution.

As stated above the main objective of this study is to investigate how the effects of socio-economic predictors vary across different levels of electricity consumption of the households. Infact, (Tilov et al., 2020) had stated that QR addresses namely the question of whether an explanatory variable has different impacts across conditional quantiles. Taking logarithms of Eq. 1, quantile regression for analyzing the determinants of electricity consumption across the conditional distribution of dependent variable ec_i is given as

$$\begin{aligned} Lec_i &= L\beta_{\theta 0} + L\beta_{\theta 1} y_i + L\beta_{\theta 2} gs_i + L\beta_{\theta 3} ost_i + L\beta_{\theta 4} r_i \\ &+ L\beta_{\theta} c_i + L\beta_{\theta 6} el_i + L\beta_{\theta 7} aa_i + L\beta_{\theta 8} fm_i + L\beta_{\theta 9} wt_i \\ &+ L\beta_{\theta 10} lr_i + \sum_{j=11}^{12} \beta_{\theta j} d_{ji} + \epsilon_{\theta i} \end{aligned} \quad (2)$$

level studies in Assam, India.

Figure 1: Box plot of current demand



In Eq. 2, "θ" is the quantile in the distribution of household electricity current demand and can take values between zero to unity. "$\beta_{\theta i}$", measures the impact of respective independent variable on the current demand for electricity consumption in different quantiles "θ" chosen. With this we can ascertain whether the households of different electricity consumption levels quantiles will react same or differently according to the exogenous variables chosen for the study. Technically, for 0 <θ <1, with quantile $Quantile_\theta\left(\frac{y}{x}\right) = x_i\beta_\theta$ where y is the dependent variable and x is the set of independent variables and θ is the set of conditional distribution with θ quantiles. The parameters $\hat{\beta}_{\theta i}$ is obtained by minimizing the asymmetric weighted sum of absolute deviations given as

$$\sum_{i:lnec_{i \geq \beta X_i}}^{n} \theta \,|\, lnec - \beta_\theta X_i \,| + \sum_{i:lnec_{i \leq \beta X_i}}^{n} (1-\theta) \,|\, lnec - \beta_\theta X_i \,|$$

Now, $\hat{\beta}_{\theta i}$ can be interpreted as marginal effects for the respective quantile chosen (Angrist and Pischke, 2009)

3. RESULTS AND DISCUSSION

To analyse the association between the current demand for electricity and the three categories of exogenous variables viz. government subsidies and surcharges, socioeconomic variables and dwelling characteristics, we have used the classical OLS and quantile regression analysis techniques. The descriptive statistics of the variables are given in Table 2. The combined results are given in Table 3. We find that there are variations in the coefficients obtained using OLS and quantile regression. Surprisingly we do not find any coefficients for income which is statistically significant in OLS and in all the percentiles though a negative effect is seen for OLS, 10th and 50th quantile while an insignificant positive effect is observed for 25th, 75th and 90th quantile respectively. Results from Table 3 indicate that rural household's current demand for electricity is inelastic to their monthly income. This is partially attributable specifically to the rural areas where the households consume electricity only upto a certain free unit. Thus our study contradicts the findings of (Cramer et al., 1985), (Santamouris et al., 2007) (Zhou and Teng, 2013) and (Haas et al., 1998), (Kostakis, 2020), (Weismann et al., 2011), (Yohanis et al., 2008) and (Tewathia, 2014). However, our result is in line with (Filippini and Pachauri, 2004) and (Athukorala et al., 2019).

Table 2: Descriptive statistics of quantitative variables

Variable	Mean	Std. dev.	Min	Max
Current demand	2.353338	0.3649755	1.1461	3.5099
Income	4.216323	0.3848518	3.4771	5
Govt. Subsidy	1.55006	0.4379701	0	2.3729
Outstanding	1.712554	1.54235	0	4.8064
Members	4.46729	1.50614	2	12
Retired	0.9595016	0.8338044	0	4
Living rooms	3.647975	1.195331	1	8
School/college	1.103125	0.9527997	0	4
Area	0.7076324	0.4157403	0.25	2
Min. watt	2.8033	0.56169	1.0414	3.772
Education	13.86293	2.594447	10	16

Table 3: OLS and quantile regression result

Variables	OLS	Percentiles				
		10	25	50	75	90
Income	−0.021	−0.153	0.010	−0.015	0.011	0.071
	(0.081)	(0.148)	(0.037)	(0.036)	(0.050)	(0.110)
Govt. subsidy	0.310*	0.459*	0.624*	0.634*	0.564*	0.444*
	(0.039)	(0.119)	(0.017)	(0.018)	(0.032)	(0.081)
Outstanding	0.023**	−0.000	0.007	0.016*	0.027*	0.054*
	(0.011)	(0.019)	(0.005)	(.005)	(0.008)	(0.019)
Members	−0.012	−0.015	−0.001	(0.003)	−0.002	0.001
	(0.016)	(0.036)	(0.008)	(0.007)	(0.009)	(0.017)
Retired	0.010	0.003	−0.019**	−0.013	0.009	0.008
	(0.023)	(0.051)	(0.010)	(0.010)	(0.014)	(0.031)
Living rooms	0.002	(0.040)	0.003	0.004	0.004	0.008
	(0.018)	(0.040)	(0.008)	(0.008)	(0.012)	(0.022)
School/college	−0.012	−0.009	−0.007	−0.016	0.001	−0.007
	(0.023)	(0.047)	(0.011)	(0.010)	(0.015)	(0.022)
Area	−0.067	−0.027	−0.012	−0.008	−0.028	−0.045
	(0.042)	(0.069)	(0.017)	(0.020)	(0.030)	(0.058)
Min watt	0.159*	0.163***	0.037	0.038***	0.059**	0.071
	(0.051)	(0.100)	(0.023)	(0.023)	(0.031)	(0.047)
Education	0.010	0.004	0.004	0.006	0.008	0.014
	(0.009)	(0.017)	(0.004)	(0.004)	(0.005)	(0.011)
Kutcha(dum_11)	−0.103***	−0.521*	−0.007	−0.014	Ref	Ref
	(0.056)	(0.105)	(0.026)	(0.025)		
Mix(dum_21)	0.045	(−0.188)	−0.060**	0.017	0.043	0.087
	(0.069)	(0.148)	(0.033)	(0.032)	(0.044)	(0.086)
Pukka(dum_31)	0.103***	Ref	Ref	0.014	0.016	0.076
	(0.056)			(0.025)	(0.035)	(0.056)
Terrace(dum_21)	0.217**	Ref	Ref	0.131*	0.280*	0.229
	(0.103)			(0.046)	(0.064)	(0.146)
Tin(dum_22)	−0.217**	(0.050)	−0.018	−0.131*	−0.280*	Ref
	(0.103)	(0.108)	(0.047)	(0.046)	(0.064)	
_cons	1.561*	1.516*	1.174*	1.220*	1.172*	1.023*
	(0.287)	(0.614)	(0.141)	(0.115)	(0.168)	(0.350)
R^2	0.352					
Mean VIF	1.79					
Breusch-Pagan (H_0:Constant variance)	$Chi^2 = 0.71$					
Pseudo R^2		0.227	0.381	0.435	0.418	0.358

Signs (*), (**) and (***) indicates significance level at 1, 5 and 10% respectively. Standard errors are given in parentheses.

The primary variable of our study, government subsidy is statistically significant and positive at 1% level of significance for both OLS and all the percentiles. The impact of subsidy is found to be the highest (63%) among the median electricity consumers followed by 25th and 75th quantiles with 62% and 56% respectively. Evidently, elasticity of current demand for electricity increases from the 25th quantile upto the median quantile and decreases up the higher quantiles. It implies that government subsidy has increased the current demand for electricity consumption in the rural areas (Table 3). Our results are in line with (Athukorala et al., 2019), (Banfi et al., 2005), (Rivers and Jaccard, 2011) and (Mirnezami, 2014) which shows that government subsidy plays a significant role in household's demand for energy consumption.

Skeptically, we find the outstanding bills has a significant positive impact on the current demand for households of higher quantiles i.e., 50th, 75th and 90th while it is negative though not statistically significant for lowest 10th quantile. It indicates electricity consumer of lower quantile tend to consume less electricity as the outstanding bill accumulate whereas the electricity consumers of higher quantile tend to consume more even in the presence of outstanding bills. This is attributable to the increase in current demand of electricity by the households of higher quantile from their previous demand due to addition of appliances stock (Table 3**)**. Next we find the minimum watt consumed by a household has a positive and statistically significant effect on the current demand for electricity (except for 25th and 90th quartile). Overall, the coefficient value increases in ascending order as we proceed to higher quantiles. For the 5 quantiles of our study this is attributable to increase in addition of more electricity consuming appliances in the households resulting in higher electricity demand. As for the 25th and 90th quartile, one is not in the capacity to add more appliances on the other hand the richer households have almost reached a saturation point for addition of appliances in the household. Intuitively, it implies that households with more number of electric equipments tend to consume more electricity in rural areas. Our results are similar in terms of the positive impact of stock of electric appliances used by a household. Studies done by (Kavousian et al., 2013), (Huebner et al., 2016), (Athukorala et al., 2019) have proven this.

Dwelling characteristics of the household in terms of the floor and roof of a house are important determinants for electricity consumption. With the OLS regression we find that houses with kutcha floors and tin roofs have a significant and negative impact on the current demand for electricity (Table 3). This indicates that poorer households in the rural areas tend to consume lesser electricity than the richer counterparts as synonymously affluent households are assumed to have concrete floor and roof of a house. On the contrary we find households with terrace as roof has a positive and significant impact on the household's current demand for electricity. Overall, dwelling characteristics have a positive impact higher up the quantile while negative effect is observed for households of lower quantiles.

Interestingly we do not find the remaining socioeconomic variables statistically significant viz. total family members in a household, retired persons in a household, number of living rooms in the house, number of school/college going students and the housing area of a household (Table 3). Our study contradicts studies made by (Athukorala et al., 2019), (Huebner et al., 2016), (Kostakis, 2020), (Romero et al., 2016), (Weismann et al., 2011), (Weismann et al., 2011), (Yohanis et al., 2008) and (Kavousian et al., 2013) with exact or similar degree of the variables defined by them.

4. CONCLUSION AND IMPLICATIONS

Our study was conceived with the primary aim to check the impact of subsidies, surcharges and outstanding bills on the current demand for electricity consumption in the rural areas. Based on the results obtained we can draw three main conclusions. Firstly, the government subsidy has enabled the rural households for higher electricity consumption in rural areas which is consistent with studies done by (Athukorala et al., 2019), (Banfi et al., 2005), (Rivers and Jaccard, 2011) and (Mirnezami, 2014). While this increase in demand rises from the lowest to the middle consumer groups (45-63%) and decreases for the higher consumer groups. In case of the outstanding variable it is observed that current demand for electricity also increases due to accumulation of past electricity bills for a household. Usually a well informed household would want to consume less units of electricity when their outstanding bills are high but we do not find it to be so. We are skeptical about this result as it has been found in the survey that the households accumulation of bills (outstanding) is not due to past 2-3 month's bill but it was due to the bill that was produced before them 4-5 months back which was for a whole period from initial connection till the recent month.

Secondly, results suggest that the rural households are less sensitive to electricity bills as the elasticity of income is found to be insignificant for all the quantile groups. Additionally, socioeconomic variables in our study are also found to be practically insignificant. Thirdly, the dwelling characteristics of lower quantile have a negative impact on the electricity demand with the floor and roof type which is typically assigned to poorer segments of the population i.e., kutcha floors and tin roofs. Overall our study reveals that subsidy provided by the government has played a significant role in reducing the burden of electricity bills in rural areas.

For policy implications some decisions can be made based on the results for the households residing in rural areas. We find the demand for electricity is income inelastic along with the socioeconomic characteristics but responsive to the government subsidies in line with (Athukorala et al., 2019). Therefore, the government's efforts to achieve energy sufficiency and also compensate its transmission and distribution losses by increasing the cost price per unit of electricity will prove to be ineffective as demand for electricity is dependent on the amount of subsidies the households receive in the rural areas. So raising the price will reduce the demand which will indirectly affect the well-being of a household. Therefore, the government is encouraged to continue the electricity subsidy for the rural households. On the contrary, for the demand and supply side management, government can distribute basic electricity efficient appliances at a lower cost, stronghold and regulate the electricity saving technological products and industries to bring the cost down and finally spread awareness for electricity conservation at the grassroots level. Lastly, the government can find a way out for amicable solution to the outstanding bills that have been accumulated for the rural households over the years inaudibly.

REFERENCES

Al-Bajjali, S.K., Shamayleh, A.Y. (2018), Estimating the determinants of electricity consumption in Jordan. Energy, 147, 1311-1320.

Angrist, J.D., Pischke, J.S. (2009), Most Harmless Econometrics: An Empiricist's Companion. London: Princeton University Press.

Athukorala, W., Wilson, C., Managi, S., Karunarathna, M. (2019), Household demand for electricity: The role of market distortions and prices in competition policy. Energy Policy, 134, 110932.

Banfi, S., Filippini, M., Hunt, L.C. (2005), Fuel tourism in border regions: The case of Switzerland. Energy Economics, 27(5), 689-707.

Bartusch, C., Odlare, M., Wallin, F., Wester, L. (2012), Exploring variance in residential electricity consumption: Household features and building properties. Applied Energy, 92, 637-643.

Bedir, M., Hasselaar, E., Itard, L. (2013), Determinants of electricity consumption in Dutch dwellings. Energy and Buildings, 58, 194-207.

Brounen, D., Kok, N., Quigly, J.M. (2102), Residential energy use and conservation: Economics and demographics. European Economic Review, 56 (5), 931-945.

Cialani, C., Mortazavi, R. (2018), Household and industrial electricity demand in Europe. Energy Policy, 122, 592-600.

Cramer, J.C., Miller, N., Craig, P., Hackett, B.M., Dietz, T.M., Vine, E.L., Levine, M.D., Kowalczyk, D.J. (1985), Social and engineering determinants and their equity implications in residential electricity use. Energy, 10 (12), 1283-1291.

DDUGJY. (2014), Ministry of Power, Government of India. Available from: https://powermin.gov.in/sites/default/files/uploads/Deendayal_Upadhyaya_Gram_Jyoti_Yojana.pdf

Filippini, M., Pachauri, S. (2004), Elasticities of electricity demand in urban Indian households. Energy Policy, 32, 429-436.

Huebner, G., David, S., Hamilton, I., Chalabi, Z., Oreszczyn, T. (2016), Understanding electricity consumption: A comparative contributionn of building factors, socio-demographics, appliances, behaviours and attitudes. Applied Energy, 177, 692-702.

Jones, R.V., Lomas, K.J. (2015), Determinants of high electrical energy demand in UK homes: Socio-economic and dwelling characteristics. Energy and Buildings, 101(15), 24-34.

Kavousian, A., Rajagopal, R., Fischer, M. (2013), Determinants of residential electricity consumption: Using smart meter data to examine the effect of climate, building characteristics, appliance stock, and occupants' behavior. Energy, 55(15), 184-194.

Khandker, S.R., Samad, H.A., Ali, R., Barnes, D.F. (2014), Who benefits most from rural electrification? Evidence in India. The Energy Journal, 35(2), 75-96.

Koenker, R., Bassett, G. (1978), Regression quantiles. Econometrica, 46(1), 33-50.

Kostakis, I. (2020), Socio-demographic determinants of household electricity consumption: Evidence from Greece using quantile regression analysis. Current Research in Environmental Sustainability, 1, 23-30.

Mansouri, I., Newborough, M., Probert, D. (1996), Energy consumption in UK households: Impact of domestic electrical appliances. Applied Energy, 54(3), 211-285.

McLoughlin, F., Duffy, A., Conlon, M. (2012), Characterising domestic electricity consumption patterns by dwelling and occupant socio-economic variables: An Irish case study. Energy and Buildings, 48, 240-248.

Mirnezami, S.R. (2014), Electricity inequality in Canada: Should pricing reforms eliminate subsidies to encourage efficient usage? Utilities Policy, 31, 36-43.

Narayan, P.K., Smyth, R., Prasad, A. (2007), Electricity consumption in G7 countries: A panel cointegration analysis of residential demand elasticities. Energy Policy, 35, 4485-4494.

Ndiaye, D., Gabriel, K. (2011), Principal component analysis of the electricity consumption in residential dwellings. Energy and Buildings, 43(2-3), 446-453.

Olsen, C.S., Clark, A.E., Thomas, A.M., Cook, L.J. (2012), Comparing least-squares and quantile regression approaches to analyzing median hospital charges. Academic Emergency Medicine, 19(7), 866-875.

Pachauri, S. (2004), An analysis of cross-sectional variations in total household energy requirements in India using micro survey data. Energy Policy, 32(15), 1723-1735.

PIB. (2019), Ministry of Power, Government of India. Available from https://pib.gov.in/PressReleseDetailm.aspx?PRID=1592833

Ramachandra, T.V., Subramanian, D.K., Joshi, N.V., Gunaga, S.V., Harikantra, R.B. (2000), Domestic energy consumption patterns in Uttara Kannada District, Karnataka State, India. Energy Conversion and Management, 41, 775-831.

Rivers, N., Jaccard, M. (2011), Retrospective evaluation of electric utility demand-side management programs in Canada. Energy, 32(4-5), 93-116.

Romero, J.D., Rio, P.D., Penasco, C. (2016), An analysis of the welfare and distributive implications of factors influencing house hold electricity consumption. Energy Policy, 88, 361-370.

Santamouris, M., Kapsis, K., Korres, D., Livada, I., Pavlou, C., Assimakopoulus, M.N. (2007), On the relation between the energy and social characteristics of the residential sector. Energy and Buildings, 39(8), 893-905.

Santin, O.G., Itard, L., Visscher, H. (2009), The effect of occupancy and building characteristics on energy use for space and water heating in Dutch residential stock. Energy and Buildings, 41(11), 1223-1232.

Saubhagya. (2019), Ministry of Power, Government of India. Available from https://saubhagya.gov.in

Steemers, K., Yun, G.Y. (2009), Household energy consumption: A study of the role of occupants. Research on Building Stocks, 37(5-6), 625-637.

Tewathia, N. (2014), Determinants of the household electricity consumption: A case study of Delhi. International Journal of Energy Economics and Policy, 4(3), 337-348.

Tilov, I., Farsi, M., Volland, B. (2020), From frugal Jane to wasteful John: A quantile regression analysis of Swiss households' electricity demand. Energy Policy, 138, 1-11.

Tiwari, P. (2000), Architectural, demographic, and economic causes of electricity consumption in Bombay. Journal of Policy Modelling, 22(1), 81-98.

Wassie, Y.T., Rannestad, M.M., Adaramola, M.S. (2021), Determinants of household energy choices in Rural Sub-Saharan Africa: An example from Southern Ethiopia. Energy, 221, 119785.

Weismann, D., Azevedo, I. L., Ferrao, P., Fernandez, J.E. (2011), Residential electricity consumption in Portugal: Findings from top-down and bottom-up models. Energy Policy, 39(5), 2772-2779.

Yeh, C.C., Wang, K.M., Suen, Y.B. (2009), Quantile analyzing the dynamic linkage between inflation uncertainty and inflation. Problems and Perspectives in Management, 7(1), 21-28.

Yohanis, Y.G., Mondol, J.D., Wright, A., Norton, B. (2008), Real-life energy use in the UK: How occupancy and dwelling characteristics affect domestic electricity use. Energy and Building, 40(6), 1053-1059.