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THE IMPACT OF 2022 ELECTRICITY TARIFF INCREASES ON HOUSEHOLD ELECTRICITY CONSUMPTION: AN ECONOMETRIC ANALYSIS OF KALMUNAI MUNICIPAL COUNCIL

Aafrin Sahnas., M. I., Washima., M. N. F. and Rinosha., K. F.
South Eastern University of Sri Lanka

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Abstract

Electricity tariffs aim to promote efficiency, equity, and financial stability. Ceylon Electricity Board increased the tariffs after making losses in 2022. The research is meant to establish whether there is any correlation between electricity tariffs and consumption. Data were collected over three years, from 2022 to 2024, using 101 households in each year. The same number of households were observed in each year, totaling 303 samples (101 households × 3 years). This research examines any changes in households' electricity consumption using the data collected over these three years. Random Effects regression analysis model has been used to analyze the data collected using Stata software. According to the results of the analysis, electricity consumption is associated with electricity tariffs and electricity expenditure. From the data collected, it is clear that there is a correlation between household electricity consumption and electricity tariff, income, and number of appliances. There is a positive correlation between electricity tariff and consumption. This is contrary to expectations but can be attributed to economic performance in the post-COVID era, increases in income levels, and use of appliances during the sample period. However, the application of modern technology, like solar panels, shows an inverse relationship with the use of electricity. This research recommends that the government and private sectors consider proper planning, both in the short and long term, to tackle this problem. Proposed measures include providing subsidies and incentives to encourage the adoption of renewable energy resources and implementing programs that reward consumers for using more electricity during off-peak hours.

Keywords: Municipal Council, Electricity Tariff, Consumption, Electricity bill, Random Effect Model, Renewable Energy

1. Introduction

Electricity consumption, measured in kWh, depends on income, appliances, house size, and usage patterns *(Repsol, 2023; Chariot Energy, 2023).* Electricity tariff is an important tool used to improve the efficiency of the economy, promote social equity, and maintain financial stability. The electricity tariff also determines the viability of many manufacturing industries

Corresponding email: athemlebbeaafrin@Gmail.Com

in Sri Lanka. The use of electricity for lighting and cooling systems is increasing. The electricity tariff also affects the operating costs of businesses and households.

In Sri Lanka, electricity is generated using various sources such as hydro, coal, thermal oil, and solar energy. The tariff for electricity generated in this way is determined based on the cost of different raw materials. However, these costs are not fully taken into account. This causes losses to the government of crores of rupees. In Sri Lanka, the Electricity Board faced a loss of 50 billion in 2017 and 100 billion in 2018 *(Karunarathna & Athukorala, 2019).*

The hike in electricity rates was enacted despite widespread opposition from numerous individuals. It increases the electricity expenditure of the general public. As a result, people are facing various hardships, such as insufficient income, increased family expenses, and students are unable to carry out their learning activities effectively, which increases their desire to purchase energy-efficient technologies. According to Kanchana Wijesekera, the Minister of Power and Energy, 1 million customers on the island experienced disconnections of their electricity services in the past year as a result of non-payment of their bills *(Ram, 2024).* This research will focus on examining any changes that might have occurred in terms of electricity consumption among households of the Kalmunai Municipal Council of Ampara District due to increased rates of electricity tariffs.

Sri Lanka, like other developing nations, has faced economic problems and budget deficits, which influence the behavior of its household sector. Due to the increase in electricity tariffs, it is important to examine the patterns of electricity consumption to mitigate the impact on consumers. Technological advancements mean that electrical appliances are now common in most social classes, leading to increased tariffs. Electricity consumption differs from one household to another depending on income levels, climatic conditions, family size, and standard of living.

The rise in electricity tariff in 2022 had a significant effect on the cost of living of the average household in Sri Lanka. The purpose of this study is to find out how higher electricity tariff affect how much electricity households use. It aims to determine the correlation between household electricity usage and electricity tariffs.

There have been other studies in Sri Lanka that looked at electricity demand using macroeconomic data, but not many that looked at the effects of higher tariffs on a micro level. In particular, little is known about how income, appliance ownership, and energy-saving

technologies jointly influence electricity consumption at the household level. Therefore, this study analyzes the impact of the 2022 electricity tariff increase using panel data from households in the Kalmunai Municipal Council area.

2. Theoretical Background and Empirical Studies

2.1. Theoretical framework

2.1.1. Energy Demand Theory

Energy demand is a derived demand that arises for satisfying some needs that are met through the use of appliances. Hence, demand for energy then depends on the demand for energy services and the choice of energy-using processes or devices. End-use service demand is affected by the cost of energy but also by other factors such as climatic conditions, affordability (or income of the decision-maker), preference for the end-use service, etc. Similarly, demand for end-use appliances depends on the relative prices of the appliances, relative cost of operation, availability of appliances, etc.

The dynamics of energy demand are influenced by the inertia of appliance stocks, which leads to limited flexibility. At any given time, any consumer would possess a stock of some particular devices with specific operating characteristics.

Electricity demand increases with appliance use. Short-term responses to price changes mainly involve adjusting current appliance usage, as appliance stock cannot change immediately. Customers may find it advantageous to upgrade or replace their appliances over an extended period of time, and new purchases will reflect their preferred features given the state of the market. As a result, long-term responses gradually build up as appliance stocks adjust, but short-term responses are only partial. As a result, energy demand theory contributes to the understanding of how shifts in energy prices affect consumer behavior and consumption patterns over time.

2.1.2 Income and Substitution Effects

The income effect is how changes in income affect how much people buy. People buy more things when they have more money and buy fewer things when they have less money. The income effect does not determine the types of goods consumers will purchase. They may buy less expensive items or cheaper items, depending on the situation and their own preferences.

When someone has money and the prices of different products change, they may decide to buy one instead of another. This is called the substitution effect. This means moving out cheaper

things for more expensive ones, or the other approach around. If an investment pays off well, a person may choose to buy a revised version of an older item, like a car or a phone.

This theory is important to the study since, through it, one will be able to identify the effects of variations in the level of income within a household and tariffs on energy demand.

2.1.3 Price Elasticity

Elasticity is the extent to which consumers adjust their purchases in response to price changes. When demand is elastic, people buy a lot more or a lot less when the price changes. When demand is inelastic, consumers continue to purchase nearly the same quantity despite price fluctuations, much like an elastic rubber band. Due to their necessity and lack of suitable alternatives, goods like gasoline have inelastic demand. Other goods are elastic because consumers can easily adjust their consumption of them. The price elasticity of demand may be calculated quite simply by taking the percentage change in quantity demanded compared to the percentage change in price. Such a theory assesses household responsiveness to price changes, and this property explains how households modify electricity consumption in reaction to tariff increases. The theory concerns whether the 2022 tariff rise led to meaningful reductions in consumption or just a minor behavioral response, because even for a price increase, electricity can be somewhat price-inelastic.

But in some situations, this increase may be seen in observed electricity consumption with increasing tariffs due to confounding factors. These include concurrent increases in household income, increased ownership of electrical appliances, post-COVID recovery, and rebound effects (the more efficient a device is, the more we use it). Furthermore, in developing economies with subdued tariffs historically, observing a positive correlation between price and consumption can occur through their rise during an economic expansion. This paper takes those options into account and adjusts for income, owners of appliances, and the rest in a broader econometric model.

2.2 Empirical review

2.2.1 Price Elasticity of Electricity Demand

Additionally, research findings indicate that households alter their behavior of using electricity based on changes in peaking prices. For instance, earlier studies such as (Berman et al., 1971; Griffin, 1974) indicated that an increment in price results in a drop in electricity usage,

especially among the affluent class. More recent studies, such as Al-Bahrani et al. (2011), which considered extensive data and an advanced econometric model, also noted that the short-run price elasticity of electricity is between -0.86 and -0.66. Conversely, in studies conducted in developing nations, there exists a more rigid view; for example, a very high rebound effect was recorded in China by Lin & Liu (2013), amounting to 165%. This implies that the increase in efficiency would result in an increase in consumption levels.

Sri Lankan studies consistently show low price elasticity of electricity demand, with urban households more responsive than rural ones (Athukorala & Wilson, 2010; Karunarathna & Athukorala, 2019; Athukorala et al., 2019).

Similarly, low price and income elasticities were also confirmed by Athukorala et al. (2019), which indicates that tariff revisions lead to marginal changes only in household consumption. On the whole, studies related to Sri Lanka indicate a weak price responsiveness, citing the influence of income, appliance ownership, and differences between urban and rural populations.

2.2.2 Household Determinants of Electricity Demand

Beyond price, socio-economic and structural factors have a strong influence on household consumption patterns. Income as a factor regularly predicts electricity use since it allows households to buy more electrical appliances (Athukorala & Wilson, 2010; Shareef, 2013). Other important housing features include dwelling size, the number of rooms, and appliance ownership (Aslam et al., 2015; Edward & Johannes, 2019). Additional substitution effects play important factors in energy choices, for example, kerosene and LPG interact as substitutes for electricity in Sri Lanka (Athukorala & Wilson, 2010), and there is evidence that the movement from traditional to modern fuels follows the Energy Ladder Hypothesis (Rajmohan & Weerahewa, 2010). These studies reveal that electricity use is a complex behavior influenced by income, technology access, the types of appliances owned, and socio-economic factors.

2.23 Sri Lankan Case Studies

Sri Lankan studies provide useful insights into electricity demand, highlighting low price elasticity and the influence of income, device ownership and household size. However, most research is limited by a narrow geographical focus, outdated data or macro-level aggregation,

and there is only one district-level cohort study. This leaves a gap in understanding micro-level consumption dynamics and household heterogeneity at the municipal level.

Overall, existing studies confirm that electricity demand is influenced by both economic and structural factors; however, there is limited micro-level panel evidence in the Sri Lankan context, particularly at the municipal level.

2.3. Research gap

Although there is a large amount of literature in the world on household reactions to the change of electricity tariffs, these results are frequently inapplicable to the specific socio-economic background of Sri Lanka. The available literature in Sri Lanka is mostly based on socio-economic and structural predictors of electricity use instead of behavior in response to tariff reforms (Karunarathna & Athukorala, 2019; Naingolan, 2023). Moreover, the majority of the research is based on national time-series data, which is why it puts a significant gap in the household-level cross-sectional research, especially in the period 2022, and even municipal. As a result, the research on the household heterogeneity, price and income elasticities in low-income households, and the interaction of the price, income, and ownership of appliances with consumption patterns is still limited.

The paper fills these gaps using original household-level cross-sectional data to determine the combined effect of income, appliance ownership, household composition, education, and energy sources on electricity consumption. We will use a combination of price signals and income effects, appliance penetration, and socio-demographic variables together in a single analytical framework to estimate product-specific elasticities and model behavioral reactions to possible tariff reforms. This micro, localized strategy defeats the drawbacks of aggregate or industry-based research and offers evidence that presents direct relevance in the design of equitable and effective energy policies in Sri Lanka.

3. Research Methodology

3.1 Data Collection

This study has used primary and secondary data to achieve its objective of this study. Primary data was collected through the structured questionnaire, and secondary data on the electricity consumption of households was collected from the Electricity Board.

The survey instrument included data collection regarding household characteristics (address, meter number, house area, room numbers, family size, income, employment, education) from 2022 to 2024, consumption patterns (meter reading, substitute commodities, behavioral changes), timings of usage (peak/off-peak), conservation measures (energy-efficient equipment, e.g., inverter equipment), knowledge about tariff increases, acquisition of new technology, and measures of reduction like avoiding air conditioners, fans, and refrigerators.

The population of this research will be the households of the Kalmunai Municipal Council. Sample size was calculated using Yamane's Formula to maintain a 10% margin of error (*Public Utilities Commission of Sri Lanka Estimation of the Cost of Energy Not Served in Sri Lanka*, 2024).

$$n = \frac{N}{1 + N(e)^2}$$

$$n = \frac{38{,}011}{1 + 38{,}011(0.1)^2}$$

$$n = 101$$

Here,

n = total sample size, N = population, e = error (10%).

The research uses a panel data approach where the same 101 households were observed for three years (2022-2024) from two regions within the Kalmunai Municipal Council. Each household was assigned a unique 4-digit alphanumeric code (e.g., MC-001 to MC-101) during the baseline survey in 2022, which was used to re-identify the same household in subsequent waves. Field enumerators verified continuity using household rosters. No replacements were added for attired households. The final balanced panel comprises 101 households × 3 years = 303 observations.

This study has employed the stratified random sampling method to collect the data. Households divided into strata based on the area as Kalmunai and Sainthamaruthu. This study determined the sample size within stratum using the proportionate stratified random sampling method.

$$n_h = \frac{N_h}{N} n$$

Where,

n_h = Sample size using the proportionate stratified random sampling

N_h = Total stratum population

N = Total Population

n = Sample size calculated using Yamane's Formula

Table No. 3.1 Number of Households (Families) in the Divisional Secretariats under Kalmunai Municipal Council (2023)

District Secretariat	Total Population	Sample	Total Sample with Time
Kalmunai (Muslim, Tamil)	28,176	75	N x t = 101 x 3
Sainthamaruthu	9,835	26	
Total	38,011	101	303

Source: Kalmunai, Saindamaruthu Divisional Secretariat Report - 2023, 2024

In this regard, Simple random sampling was used to select 101 households out of 38,011 households under the Kalmunai Municipal Council. The data were collected for a span of three years (2022-2024). This resulted in 303 observations for panel data. This will enable robust econometric modeling for changes in electricity consumption for individual households.

3.2 Operationalization of Variables

Table No. 3.2 Variables

Variables	**Description**	**Measurement**
Dependent Variable		
Electricity Consumption (Y_{it})	The yearly average units of electricity usage of the household	kWh per year
Independent Variables		
Electricity tariff (T_{it})	Average tariff rate paid by household per year	Rs Per kWh

Electrical appliances(APP_{it})	Number of electrical appliances used per year	Number
Yearly Income (I_{it})	Yearly income of the household	Rs / per year
Area of the house (HA_{it})	Area of the house	Square feet
Family Members(FM_{it})	Number of family members	Numbers
Education (EDU_{it})	Dummy - 01	Higher education - 1 Otherwise - 0
Substitution (SUB_{it})	Dummy - 02	Gas -1, otherwise - 0
Saving Appliances (SAV_{it})	Dummy - 03	Solar panels -1, otherwise -0
u_i : Items with unique variables and in the analysis, Unobserved factors		
μ_i : Unique invariants and unobserved factors in the analysis		
$_{it}$: Error term		
i indexes households (1,…,101), t indexes years (2022, 2023, 2024)		
β_1, β_2, β_3, β_4, β_5, δ_1, δ_2, δ_3: Parameters		

Source: Author compilation, 2024

3.3 Conceptual Framework

This study has developed a conceptual framework based on identified variables.

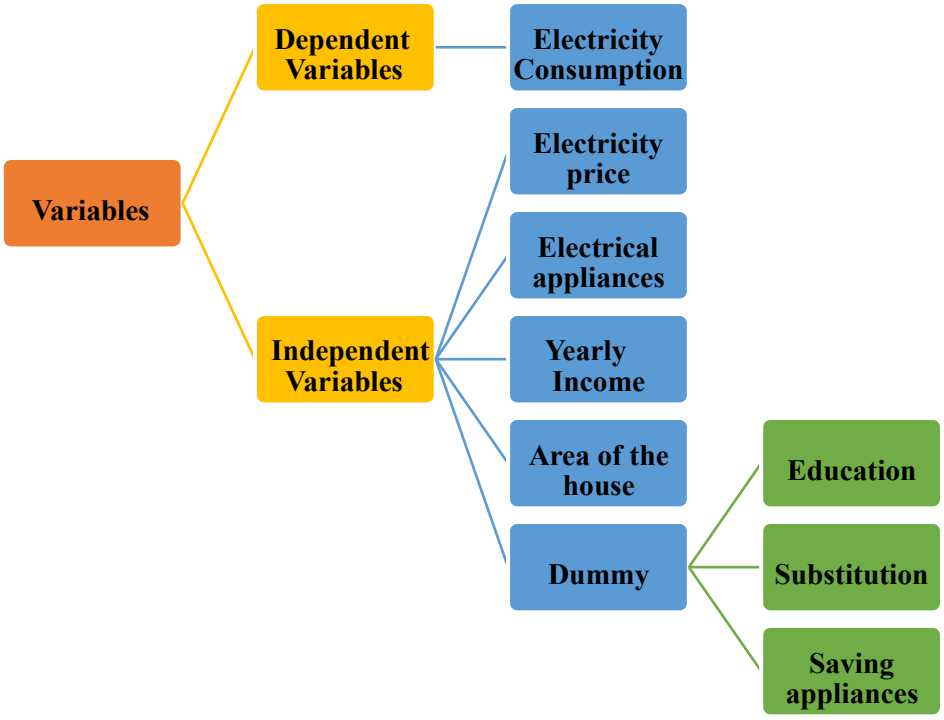


Figure No: 3.1

Source: Author compilation, 2024

Based on the conceptual framework & operationalization table, the following hypotheses were developed.

Null Hypothesis ($\boldsymbol{H_0}$) : There is no relationship between electricity tariff increases and household electricity consumption.

Alternative Hypothesis ($\boldsymbol{H_1}$): There is a relationship between electricity tariff increases and household electricity consumption.

3.4 Methodology

Given the panel structure of the data (households observed repeatedly over three years), either a fixed effects (FE) model or a random effects (RE) model is appropriate (Karunarathna & Athukorala, 2019). The FE model controls for time-invariant unobserved household heterogeneity by allowing each household to have its own intercept, but it cannot estimate coefficients for time-invariant variables. The RE model assumes that household-specific effects are uncorrelated with the explanatory variables and is more efficient.

The equation for the random effects model is shown below.

$$Y_{it} = \beta_0 + \beta_1(\mathrm{T}_{it}) + \beta_2\,(APP_{it}) + \beta_3\,(I_{it}) + \beta_4\,(HA_{it}) + \beta_5\,(FM_{it}) + \delta_1(EDU_{it}) + \delta_2\,(SUB_{it}) + \delta_3(SAV_{it}) + u_i + {}_{it}$$

The equation for the fixed effects model is shown below.

$$Y_{it} = \beta_0 + \beta_1(\mathrm{T}_{it}) + \beta_2\,(APP_{it}) + \beta_3\,(I_{it}) + \beta_4\,(HA_{it}) + \beta_5\,(FM_{it}) + \delta_1(EDU_{it}) + \delta_2\,(SUB_{it}) + \delta_3(SAV_{it}) + \mu_i + {}_{it}$$

Furthermore, the software STATA has been used to obtain the results of these statistical operations.

4. Results and Discussion

Kalmunai Municipal Council located in the Ampara District of Sri Lanka, is a council with well-developed infrastructure. It has reliable electricity facilities, telecommunications facilities, transportation, and public services such as education that are widely available. The area is also a residential area with many houses built of stone, including simple and multistorey houses.

4.1 Demographic Characteristics of the Sample

The analysis of the profile of the household includes variables such as electricity consumption, area of the house, number of family members, number of rooms in the house, yearly income, number of family members engaged in full-time work, and educational level of the households selected for the study based on the Kalmunai Municipal Council.

Table No. 3.3 Analysis of the characteristics of samples

	Electricity Consumption	**Number of Households**				**Percentage**
Analysis of Electricity Consumption of the Households	**Categories (%)**	**2022**	**2023**	**2024**	**Total**	
	0-50 kWh	15	17	12	44	15
	50-100 kWh	24	26	27	77	25
	100-150 kWh	42	40	43	125	41
	150-200 kWh	15	13	13	41	14
	More than 200 kWh	5	5	6	16	5
	Lowest Value	1				
	Highest Value	243				

Analysis of the area of the house	**Area of the house (measured in square feet).**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	
	100–300	18	16	13	47	16
	300–500	20	21	21	62	20
	500–700	20	20	22	62	20
	700–900	19	19	18	56	18
	900–1,100	24	25	27	76	25
Analysis of Family Members	**Number of Family members**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	
	1 – 3	18	20	20	58	19
	3 – 6	56	57	60	173	57
	6 – 9	27	24	21	72	24
Analysis of Rooms in Households' Houses	**Number of rooms**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	
	0 – 3	18	16	13	47	16
	3 – 6	50	57	57	164	54
	6 – 9	33	28	31	92	30
Analysis of Household Income	**Income (Rs)**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	
	0 – 20,000	0	0	0	0	0
	20,000 – 100,000	23	23	25	71	23
	100,000 – 180,000	45	40	37	122	40
	180,000 – 260,000	21	28	29	78	26
	260,000 – 340,000	12	10	10	32	11
Analysis of full-time working members in the household	**Number of workers**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	
	0	3	3	1	7	2
	1	40	45	53	138	46
	2	25	25	24	74	24
	3	33	28	23	84	28
Analysis of the educational level of household members	**Educational Level**	**Number of Houses**				**Percentage**
		2022	**2023**	**2024**	**Total**	

	Secondary	42	38	39	119	39
	Tertiary	59	63	62	184	61

Source: Field study, 2024

Panel data (2022–2024) show that most households consume 100–150 kWh, 25% use 50–100 kWh, 15% use 0–50 kWh, and 19% use over 150 kWh.

Regarding the housing of households, the data shows that 25% of the houses use 900-1,100 square feet. This indicates large houses. The data further shows that 20% of the houses use 300-500 square feet and 500-700 square feet. Moreover, 18% of the houses use 700-900 square feet. Only 16% of the distribution of the number of family members shows that 57% have 3-6 members, followed by 24% having 6-9 members, and 19% having 1-3 members. This also shows the prevalence of medium-sized families.

Similarly, 54% of the households have 3-6 rooms, followed by 30% having 6-9 rooms, and 16% having 0-3 rooms. This also shows the prevalence of medium-sized houses.

The income earned by the households also shows that 40% of the households earn 100,000-180,000 Rs annually, followed by 26% earning 180,000-260,000 Rs, 23% earning 20,000-100,000 Rs, and 11% earning more than 260,000 Rs.

The distribution of the households according to the number of earning members shows that 46% have one full-time earner, while the majority have more than one earner. Similarly, 61% of the population has a tertiary level of education.

4.2 Analysis to determine the impact of the electricity tariff increase on the electricity consumption of Kalmunai Municipal Council households.

4.2.1 Hausman Test

The Hausman test is a statistical test used to determine which statistical model is most appropriate for the data being analyzed. It is particularly useful in group data analysis to compare fixed-effects and random-effects models and select the most appropriate model.

H_0 : Random-effects model is appropriate.

H_1 : The fixed-effects model is appropriate.

Table No: 3.4 Hausman Test

	(b) Fixed	(B) Random	(b-B) Difference	SE
Log tariff	1.86986	1.853721	0.0161742	0.0105492
Log income	0.2005078	0.1866445	0.0138633	0.008887
Log appliances	0.2132822	0.2253189	-0.0120367	0.372834
Log house area	-0.612092	-0.0682098	0.0070006	0.401474
Log no of family members	0.1390608	0.1612363	-0.0221755	0.0156815
Log education level	-0.3351635	-0.3345708	-0.0005927	0.0152414
Log substitute goods	-0.4836261	-0.4953851	0.011759	0.0202126
Log use of energy-saving devices	-1.938001	-1.938618	0.0006174	0.0103491
Chi 2 (2)	2.50			
Prob> chi2	0.2865			

Source: Estimated by the researcher, 2024

The results from the Hausman test have a chi-square value of 2.50 with a probability value of 0.2865. This is larger than the 5% level of significance. Since the value obtained is less than the critical value $\chi^2_{0.05,2}$ (5.99), the null hypothesis cannot be rejected.

The random-effects model is appropriate since it is efficient and consistent, provided that the specific effects are not correlated with the regressors.

4.2.2 Model Results

Table no: 3.5 Analysis of log-log model

Variables	**Co-efficient**	**P value**	**Z Value**	**95% confidence interval**
Intercept	**-4.412508 (0.8025978)**	0.000	-5.50	-5.98557 – -2.839445
Log electricity tariff (T)	**1.853722 (0.1095365)**	0.000	16.92	1.639034 – 2.068409
Log Income (I)	**0.1866438 (0.690571)**	0.007	2.70	0.0512947 – 0.3219929
Log appliances (APP)	**0.2253197 (0.1300172)**	0.083	1.73	-0.295077 –0.4801471
Log house area (A)	-0.068209^{NS} (0.1148767)	0.553	-0.59	-2.933632 – 0.156945
Log no of family members (M)	0.1612365^{NS} (0.2049737)	0.432	0.79	-0.2405045 – 0.56297
Log education level (EDU)	-0.3345714^{NS} (0.4547642)	0.462	-0.74	-1.225893 – 0.556750
Log substitute goods (SUB)	-0.4953854^{NS} (0.4629836)	0.285	-1.07	-1.402817 – 0.412045
Log use of energy-saving devices (SAV)	**-1.938618 (0.4777953)**	0.000	-4.06	-2.87508 – -1.002157
The value of the robustness coefficient of the regions of the model (r^2)				0.9215
The value of the robustness coefficient between regions of the model (r^2)				**0.9110**
The value of the overall robustness coefficient of the model (r^2)				0.9204

(Here, indicates significance at the 1% level, indicates significance at the 5% level, indicates significance at the 10% level, and NA indicates non-significance.)

Note: The robust standard error is shown in brackets. This is used to mitigate the issue of autocorrelation and heteroscedasticity.

The value of the robustness coefficient according to the above table shows that 91.1% of the variation in the dependent variable can be explained by differences between regions. The logarithmic model was selected based on the study of the researcher Nainggolan (2023).

Among the variables identified to determine the relationship between electricity bills and household electricity consumption, household yearly electricity bill, number of electrical appliances used, household yearly income, and use of energy-saving devices were identified as variables that significantly influence electricity consumption, while house area, number of family members, education level, and use of substitute goods were identified as variables that did not significantly influence electricity consumption.

According to the random effect model study, the random effect model equation for the yearly electricity consumption of the household sector is as follows:

$$\log Y_{it} = -log4.413 + log1.854\ (P) + log0.187\ (I) + log0.225\ (APP) - 1.939\ (SAV) + u_{it}$$

The analysis of factors determining electricity consumption among households in the Kalmunai Municipal Council area reveals several key findings.

The probability value of 0.000 denotes a statistically significant positive relationship between the annual electricity consumption and electricity tariff at the 1% significance level, suggesting that an increase of 1% in electricity tariff results in an increase in consumption by 1.853%. This counterintuitive result likely reflects the block tariff structure, income growth, and increased appliance ownership rather than a causal increase in demand. The results are supported by existing theories and studies, which confirm that such a trend exists due to the presence of the developed municipality of Kalmunai in the Ampara District, with high electricity consumption due to the widespread availability of electrical devices. The increase in tariff does not reduce demand, but it remains stable or constant, as the electricity demand in households and factories is inelastic to changes in price (Kim, 2020). Limited alternatives for heating and cooling, along with low awareness of energy conservation, further sustain high usage (Battistini et al., 2022; Yizhang, 2013).

The positive association between electricity tariff and usage does not necessarily mean that increased tariffs lead to higher electricity demand. There are several reasons why this is the case. To begin with, the positive correlation between electricity tariff and consumption may have been caused by some structural problems associated with Sri Lanka's block tariff structure. Under the block tariff, the increase in electricity consumption results in a higher electricity tariff. In addition, in the time frame considered in this study (2022-2024), higher tariffs coincided with rising income and the purchase of more devices, resulting in increased consumption. Post-COVID economic growth reinforced the trend further. Additionally, the historically low rates of tariffs had led to prior adjustment by consumers to the existing level of prices. Thus, the positive coefficient cannot be considered as a deviation from the law of demand; on the contrary, it is an illustration of how structural pricing systems function.

According to the log-log random effect model, the income elasticity of demand coefficient is 0.186, with its probability value being 0.000, which suggests a strong and significant positive correlation at 1% between the electricity consumption and annual household income of 0.186%.

This association is caused by the income elasticity of demand concept, which is used to establish how consumer income affects demand. Increased income levels will motivate individuals to consume more, including electricity consumption. Increased income results in bigger housing, increased electrical appliance usage, and modernization, which increases electricity demands. Improved standards of living through increased incomes also lead to urbanization, increasing energy demands (Shabur & Ali, 2024).

The examination of the electricity consumption trends by various households in the Kalmunai Municipal Council reveals a statistically positive relationship (p-value = 0.083) between the number of electrical appliances and the quantity of electricity consumed in one year at a 10% significance level. In particular, a 1% change in the number of appliances results in a 0.225% change in electricity consumption. Electricity consumption is currently high because of old and inefficient electrical appliances and the emergence of advanced electrical devices (Arcadia, 2024; Electric, 2022). Important appliances such as refrigerators and air conditioners operate throughout the day, while technological advancements and increased purchasing power make it easier to purchase more appliances.

However, there are some important relationships that were discovered during the investigation of electricity consumption patterns among households. In spite of being statistically insignificant, the relationship between house size and electricity consumption is positive; this means that for every 1% increase in house size, the electricity consumption rate decreases by 0.068%. There are several reasons why such a relationship exists, including the fact that the bigger the house size, the fewer rooms are occupied within the household. Furthermore, people who live in spacious houses usually have fewer members in their families, which results in less electricity consumption. According to Abubakar et al. (2024), poor families living in spacious houses usually have lower electricity consumption levels.

Family size, which had a coefficient value of 0.161 in the log-log transformation model, was not statistically significant at p = 0.432. Education level was not statistically significant (P = 0.462). Substituted goods are not statistically significant (P = 0.258). These mean there are no reliable interpretations for this definition.

Since the probability value is 0.000, there exists a negative relationship between electricity consumed annually and the usage of energy-efficient devices at a 1% significance level. This means that a rise in the usage of energy-efficient technologies will result in a fall in electricity consumed annually by 1.939% with each additional 1% adoption of such technologies. The main cause of the decrease in the consumption of electricity is the substitution effect. The use of these innovations leads to a significant reduction in electricity consumed by households. Energy-saving innovations offer households increased freedom and control over the use of energy. This freedom allows households to lower their dependence on electricity from the grid while still benefiting from higher levels of energy utility. Being able to produce one's own energy is advantageous to consumers for various reasons. Ecological factors are critical in promoting this shift. Utilization of sustainable energy alternatives assists in resolving ecological issues and lowering energy bills. Moreover, the use of energy-saving equipment installed in these devices contributes to further energy savings. The efficiency of solar panels depends on how well they harness energy from the sun. More efficient solar panels can produce more electricity, thereby lowering household dependence on conventional energy sources.

From the analysis, the probability value for the association between the annual electricity usage and the tariffs is 0.000. At the 1% significance level, the outcomes show that there exists a

significant positive correlation. Hence, we can conclude by rejecting the null hypothesis in favor of the alternative hypothesis.

5. Conclusion

This research analyzed the effect of an increase in electricity tariff in 2022 on consumption behavior in Kalmunai Municipal Council using panel data analysis on 101 households (2022-2024) using a random effects model. The findings reveal that electricity tariff, household income, and number of electrical appliances have significant positive correlations with consumption, while energy-saving devices (solar panels, generators) show a strong negative relationship.

The positive tariff and consumption coefficient (1.85%) appear counterintuitive but are explained by the post-COVID economic recovery, rising incomes, increased appliance ownership, and Sri Lanka's block tariff structure. A 1% increase in income raises consumption by 0.187%, and a 1% increase in appliances raises consumption by 0.225%. On the other hand, for every 1% increase in energy-saving devices, consumption drops by 1.94%.

This research demonstrates that raising tariffs cannot be an adequate strategy for reducing electricity consumption among residential customers. Other measures like the establishment of efficient appliances, promotion of renewable energy sources, and financial assistance for underprivileged citizens are indispensable for effective energy management.

6. Recommendations

Based on the empirical findings, four recommendations for policymakers have been proposed. The first recommendation is to sustain progressive tariffs with high tariffs for high consumption brackets but offering electricity subsidies to poor households through the Aswesuma system. Secondly, initiate appliance exchanges to allow individuals to swap old appliances with new appliances that have 5 star ratings in refrigerators, air conditioners, and fans by reducing tariffs on efficient appliances. The third recommendation is to encourage the use of energy-efficient devices through the provision of low interest loans and net metering of rooftop photovoltaics. The fourth recommendation is not to depend on increasing tariff levels because of inelastic consumption.

7. Suggestions for future research

Further studies need to build upon and confirm the findings made in this study through the implementation of the same techniques in various socio-economic and geographical areas of Sri Lanka, especially by comparing results from urban and rural locations. This will help to ascertain the general applicability of the findings. It is important to analyze the behavioral aspects of technology adoption and why households hesitate to adopt energy-efficient technologies despite having incentives available to encourage investment in these solutions. In addition to that, there needs to be an emphasis on longitudinal studies that can monitor changes over time in the relationship between electricity tariff, income, and electricity usage. The final point to address in further studies would be to formulate customized policies on the basis of the above findings.

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