Household Appliance Holdings and the Demand for Electricity in Barbados

Prof. Roland Craigwell

Department of Economics, University of the West Indies, Cave Hill Campus, Bridgetown, BB11000, Barbados

November 2009

CONTENTS

1. Introduction

- The Barbados Light and Power Company (BL&P) has recently submitted its application to the Fair Trading Commission (FTC) for a review to its rates and rate structure which have not been changed since 1983.
-
- At the time of this presentation the first round of discussions have been completed but no final decision have been made.

- The BL&P claim that a rate change was required as it was thought that the current rates do not permit the company to maintain its reliability and efficiency as well as to satisfy lenders and attract new capital.

- To help the discussion on these proposed reforms between the (BL&P) and the FTC, it would be useful to have some information on the effects of price revisions on consumption which will largely depend on the price elasticity of demand for electricity. The latter would require knowledge of demand for electricity studies in as much details as possible.

1. Introduction

- This paper estimates a demand for electricity function for Barbados to assess the impact of the proposed rate changes on consumers.
- Past electricity demand studies for Barbados (Durant, 1991; Cox, 1978; Mitchell, 2009) have not addressed policy issues like the one proposed above and have been based on aggregate time series data and have used macro-econometrics techniques.

- For the first time, survey data (micro-level data) on Barbadian households are utilised along with micro-econometrics.

- Micro-level data, which reflects individual and household behaviour more closely, can add detail to an understanding of the nature of consumer responses (see, for instance, Hawdon, 1992; Nesbakken, 1999; Holtedahl and Joutz, 2004; Louw et al., 2008).

- Microeconomic approaches to energy and electricity demand modelling also enable an analysis across different heterogeneous household groups and allow for the incorporation of a wide variety of household characteristics within the estimated equations (see Hawdon, 1992).
-

1. Introduction

- The demand for electricity services is a derived demand where households desire certain energy-using appliances and require electricity to power these durable goods (Dubin and McFadden, 1984).

- Hence, it would be appropriate to model the electricity demand for individual appliances; however, data at this level of disaggregation is not available.

- Electricity demand is therefore modelled as the sum of the electricity used by appliance categories.

1. Introduction

- Like most electricity providers around the world, the price of electricity services supplied in Barbados are non-linear, in that on top of a fixed customer fee a three-tier price schedule is employed.

- This type of household demand function allows for the use of censored regression modelling techniques.

- In this paper, the model is estimated using the Heckman two-step approach (see Cameron and Trivedi, 2005 for details).

- Due to the existence of non-linear pricing, Reiss and White (2005) coefficients on the marginal and average price as well as income variables are calculated.

1. Introduction

- Once the electricity demand function is shown to give reasonable findings, it can be used to project the impact of the tariff changes on the Barbadian consumers, by adjusting the price variables while leaving the other variables unchanged.

- The results imply that the proposed new rate structure is generally not likely to have a significant impact on households demand for electricity.

- In the following section, the background to the rate adjustment is discussed. After that, a brief review of the literature is provided. Then the empirical approach, which consist of the conceptual set up, the econometric methodology and data is presented. Next the statistical results are discussed and the paper closes with a brief conclusion.

2. Background to Rate Application

- BL&P indicated that the present rate application is being made because the present rates are inadequate for the Company to continue to meet its operating and maintenance expenses, satisfy lenders and attract new capital to replace older plant.

- Some of the main objectives of the rate application as outlined by the Company include:
  - The provision of fair rates and to apportion the total cost of service among the different classes of customers in a fair manner, sensitive to any impact on customers.
  - To encourage customers to use electricity more efficiently by, revising the existing rates to more closely reflect the unit cost of serving customers, thereby reducing the inter and intra class subsidies that presently exist;
  - To shift the 2.64 cents per kWh of fuel cost from the base energy rate to the Fuel Clause Adjustment (FCA) so that the full fuel cost is collected through the Fuel Clause Adjustment;
  - To revise the Service Charges so that they may more closely reflect the cost of service; and
  - To lessen the rate impact of the overall revenue increase on customers in the lower income bracket.

2. Background to Rate Application

- The rate application is proposed to affect the structure of all of the Company's existing tariff groups.

- It is proposed that the Domestic Service tariff group which services residential customers should changed its fixed domestic customer fee and the base energy price. Currently domestic service customers are first charged a BDS$3 fixed customer fee, on top of an inclining three-tier price schedule (Figure 1 in hard copy).

- Customers using up to 100 kWh are presently paying BDS$0.176 per kWh. Those customers utilizing in excess of 100 kWh are charged BDS$0.196 for the next 900 kWh and BDS$0.216 for each additional kWh in excess of 1000 kWh.

- The BL&P is therefore seeking permission to adjust the customer charge to one where customers that consume less than 100 kWh will pay BDS$6 monthly, while the customer charge will increase to BDS$10 for those consuming between 101 and 500 kWh and BDS$14 for those customers consuming a monthly twelve month average above 500 kWh.

2. Background to Rate Application

- A four-tier inclining block rate is proposed for the base energy charge that will see the exclusion of 2.64 cents/kWh that presently goes towards the fuel cost being shifted from the base energy rate to the Fuel Clause Adjustment (FCA).
- It is proposed that customers using up to 100 kWh will be charged BDS$0.150 per kWh, while those consumers utilising in excess of 100 kWh would have to pay BDS$0.176 per kWh for the next 400 kWh. Customers using in excess of 500 kWh will be charged BDS$0.200 per kWh for the next 1,000 kWh and BDS$0.224 per kWh for any consumption greater than 1,500 kWh (Figure 1 in hard copy).

3. A Brief Review of the Empirical Electricity Demand Literature

- The demand for electricity is a derived demand in that consumption of electricity does not yield any utility but rather is an input into durable goods that do yield utility.

- Taylor (1975) argues that it is important to understand from the outset the differences between long-run and short-run electricity demand.

- In the short-run, electricity demand generally arises from the utilisation of durable goods, while in the long-run demand can be influenced by the stock of these goods the consumer demands.

3. A Brief Review of the Empirical Electricity Demand Literature

- Taylor (1975) notes that most for the early literature the price and income elasticity of demand for electricity is larger in the long-run than in the short-run and electricity demand tends to be fairly price and income elastic in the long-run. These results were by and large derived from highly aggregated data.

- Given this criticism, Parti and Parti (1980) employ a database of more than 5,000 individual households from the San Diego County in 1975. Noting that the consumption of electricity is derived from the utilisation of appliances, the study first attempts to account for the expected electricity usage given the appliances in the household and then actual usage is explained by the presence of appliances (e.g. air conditioner, electric space heater, electric water heater) , average electricity prices, household income, and other characteristics (see hard copy).

- The results suggest that the short-run price elasticity of demand was about -0.6 and the income elasticity of demand was 0.2. These estimates were quite similar to the earlier papers using aggregate time series data.

A Brief Review of the Empirical Electricity Demand Literature

- Dubin and McFadden (1984) rather than separating the demands for non-durables and electricity separately, develop a unified model of the demand for consumer durables and the derived demand for electricity.

- When this is done, the price elasticity estimates for income fall to 0.02, while that for price elasticity declines to -0.3. Similar lower short-run elasticities are obtained by Munley et al (1990) for multi-family, renter-occupied residences as well as Maddock et al (1992) in the case of Colombia.

A Brief Review of the Empirical Electricity Demand Literature

- Reiss and White (2005) estimate a model of residential electricity demand using a representative sample survey of 1307 California households.
- The survey collects information not only on electricity consumption, but also on household appliances, physical characteristics of the residence as well as demographic household information.
- The reported results suggest that the price elasticities of demand for particular appliances varied significantly. However, air conditioning had the highest price elasticity of demand of the five appliance types considered.
- The income effects were, however, statistically insignificant as these effects may have been captured by choices of appliances rather than utilisation and agree with studies by Parti and Parti (1980) and Dubin and McFadden (1984).
- In terms of household price and income elasticities, Reiss and White report that the mean annual electricity price elasticity for California households was about -0.4, which is within the range reported by previous studies, while the income elasticity was zero.

4. Empirical Approach

- ***4.1 Conceptual Framework***
- It is customary to assume that the household demand for electricity is derived from the demand of the commodity itself (electricity) and the service that electricity provides (i.e. being able to operate domestic appliances, televisions, etc.).

- Therefore, a general household utility function incorporating the household's electricity demand would generally take the form of
- **(1)** $U = u(x\{E, A, F), y, z)$ **s.t.** $m < p_x x + p_y y$

- where x is the energy services consumed by the household, E is electricity, A are appliances, F are other fuels consumed by the household, y are goods and services consumed by the household, z represents the tastes and preferences of the household, m is the income of the household, p_x is the price of energy services and p_y are the prices of the other goods and services consumed.

- Solving the constrained optimisation problem gives the following Marshall Demand function for the household's demand for energy services :
- **(2)** $x = x^* (p_x x, m, z, \varepsilon)$
-
- The household's tastes and preferences (z) are incorporated in the demand function as they form part of the decision process in determining which fuels are used by the household as well as they reflect any externalities that may impact on health and productivity. The stochastic term, ε, is added to the equation for estimation purposes
-

4. Empirical Approach

- ***4.2 Econometric Approach***
- Recall that the price of electricity services supplied in Barbados are non-linear: domestic services are first charged a BDS$3 fixed customer charge, on top of this fee a three-tier price schedule is then employed (Figure 1 on hard copy).

- Given this non-linear pricing schedule, Reiss and White (2005) note that the stochastic term in Equation (3) conveys information about the willingness-to-pay of the consumer, i.e. consumers self-select the marginal price they are willing to pay.

- The demand function for the household under a three-tier pricing schedule leads to a censored regression model that can be estimated using the two-step technique of Heckman (see the hard copy).

4. Empirical Approach

- Recall the demand for electricity services is a derived demand. in this instance, modelling the electricity demand for individual appliances would be preferred; however, data at this level of disaggregation is not available.
- Consequently, electricity demand is modelled as the sum of the electricity used by appliance categories:
-
- (3) $\mathbf{x_i = x_i^*\{p_x x, m, z) + \varepsilon_i}$
-
- where $\beta=\sum d_i \beta_i$ are the slope coefficients that depend on the household's holdings of particular appliances with d_i being a dummy variable that takes a value of 1 if the household holds appliance and 0 otherwise.

- The choice of space cooling and water heating are isolated, while the other appliances are treated as statistically exogenous because : (1) this approach increases the degrees of freedom as a smaller set of interaction terms are employed, and; (2) space and water heating are major consumption decisions that require major retrofitting of the house.

4. Empirical Approach

- ***4.3 Data***
- The empirical electricity demand data employed in this study is taken from the Residential Customer Survey (RCS) of consumers conducted by the Barbados Light and Power in 1997 as part of a larger study.

- The survey collects information on the electricity consumed by the particular household, their portfolio of appliance holdings along with demographic information.

- It provides information on 129 Barbadian households, which is less than 0.2 percent of households on the island. It is a nationally representative probability sample of households, with representative sub samples among usage levels.

- The survey was conducted by in-home interview. Interviewers inventory the household's appliances, assess physical characteristics of the residence, and collect demographic information.

- To minimize measurement error, each household's metered energy consumption data are sourced directly from the electric utility. Approximately one hundred and thirty-three interviews were completed among residential customers, thus representing a response rate of 97 per cent.

Table 1: Description of Variables

Mnemonic	Description	Scale
MONKWH	**Monthly electricity usage of households**	**kWh**
P	**Average price of electricity (monthly electricity bill/monthly electricity usage)**	**Dollars**
MP	**Marginal price of electricity (highest per kWh tier price that the consumer presently pays)**	**Dollars**
INCOME	**Monthly Income of household**	**1 = under $1200; 2 = $1200 - $2399; 3 = $2400-$4399; 4=$4400-$6399; 5=$6400-$10000;6=more than $10000**
NTEL	**Number of televisions**	**Scalar**
PERSONS	**Number of persons in household**	**Scalar**
BEDROOMS	**Number of bedrooms in residence**	**Scalar**
FRIGE	**Household has a refrigerator**	**1 if household has a refrigerator and 0 otherwise**
WASHING	**Household has a washing machine**	**1 if household has a washing machine and 0 otherwise**
DRYER	**Household has a dryer**	**1 if household has a dryer and 0 otherwise**
FREEZER	**Household has a freezer**	**1 if household has a freezer and 0 otherwise**
ELESTOVE	**Household has an electric stove**	**1 if household has an electric stove and 0 otherwise**
TOASTERO	**Household has a toaster oven**	**1 if household has a toaster oven and 0 otherwise**
WALLFAN	**Household has a wall fan**	**1 if household has a wall fan and 0 otherwise**
MULUNT	**Household is a multi-unit property**	**1 if household is a multi-unit property and 0 otherwise**
SELIGHT	**Household has security lighting**	**1 if household has security lighting and 0 otherwise**
ELECHEAT	**Household uses electric water heating**	**1 if household uses electric water heating and 0 otherwise**
AC	**Household has air conditioning**	**1 if household has air conditioning units installed and 0 otherwise**
SOLAR	**Household has solar water heating**	**1 if household has a solar water heater installed and 0 otherwise**

4. Empirical Approach

- In terms of the distribution of electricity usage in Barbados our sample reveals:
- On the whole, most consumers (over 70 percent), tend to consume 100 – 900 kWh on a monthly basis and therefore fall in tier 2 of the Barbados Light and Power three-tier price schedule.
- Of the remainder, just fewer than 20 percent consume more than 900 kWh on a monthly basis
- while a relatively small proportion of Barbadian households (less than 10 percent) consume less than 100 kWh of electricity on a monthly basis.

4. Empirical Approach

- Descriptive statistics for the variables employed in the study suggest that the average Barbadian household uses about 546 kWh per month which translates to about BDS$105, or about BDS$0.19 per kWh.
- The average household sampled had a monthly income of BDS$4,400, lived in three-bedroom house with three individuals in the household.

Table 2: Descriptive Statistics

	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
MONKWH	546.426	2636.000	54.000	449.038	1.749	6.889	147.076*
P	0.190	0.210	0.180	0.006	0.703	5.136	35.139*
MP	0.203	0.220	0.180	0.009	0.484	3.980	10.199*
INCOME	3.124	6.000	0.000	1.541	0.241	2.370	3.386
NTEL	1.085	5.000	0.000	1.250	0.681	2.483	11.417*
PERSONS	3.271	6.000	0.000	1.638	0.319	2.224	5.423
BEDROOMS	3.085	6.000	0.000	1.125	-0.036	4.195	7.707*
FRIGE	0.977	1.000	0.000	0.151	-6.326	41.024	8631.741*
WASHING	0.853	1.000	0.000	0.356	-1.991	4.962	105.882*
DRYER	0.147	1.000	0.000	0.356	1.991	4.962	105.882*
FREEZER	0.488	1.000	0.000	0.502	0.047	1.002	21.500*
ELESTOVE	0.318	1.000	0.000	0.467	0.782	1.612	23.515*
TOASTERO	0.411	1.000	0.000	0.494	0.362	1.131	21.593*
WALLFAN	0.690	1.000	0.000	0.464	-0.821	1.674	23.945*
MULUNT	0.093	1.000	0.000	0.292	2.802	8.853	352.937*
SELIGHT	0.178	1.000	0.000	0.384	1.681	3.826	64.416*
ELECHEAT	0.186	1.000	0.000	0.391	1.614	3.604	57.935*
AC	0.248	1.000	0.000	0.434	1.167	2.361	31.458*
SOLAR	0.318	1.000	0.000	0.467	0.782	1.612	23.515*

5. Results

- ***5.1 Electricity Demand Function***
- The electricity demand function for Barbados is estimated using the Heckman two-step procedure, where the Mills ratios are omitted because their economic interpretation is unclear.

- The second stage of the Heckman estimator was estimated using ordinary least squares (OLS) as well as full information maximum likelihood techniques.

- However, the results from both techniques were quite similar. Consequently, only the findings from the OLS estimation approach are displayed, with the reported standard errors being White heteroskedasticity-consistent standard errors.

- The model is able to account for a large proportion of the cross-sectional variation in electricity consumption, 85 percent. The calculated Jarque-Bera statistic for the model residuals suggested that the null hypothesis of normality could not be rejected at normal levels of testing.

Table 3: Electricity Demand Model Coefficient Estimates – Heckman Two-Step Approach
Notes: (1) White heteroskedasticity-consistent standard errors provided in parentheses, while p-values are given in parentheses. (2) ***, ** and * indicates significance at the 1, 5 and 10 percent levels of significance.

Explanatory Variable	**Baseline Use**	**Interaction Effects**		
		Electric Water Heating	Solar Water Heating	Air conditioning
Constant	1.914	-175.589	9.007	-9.564
	(5.113)	(33.224)***	(4.157)**	(4.015)**
p	-0.183	-1.272	-	-
	(0.0366)***	(0.237)***		
mp	0.061	-0.473	0.055	-0.057
	(0.019)***	(0.092)***	(0.025)**	(0.024)**
income	0.029	-	-0.105	0.135
	(0.042)		(0.064)*	(0.057)**
bedrooms	0.099	-0.145**	-	-
	(0.034)***	(0.061)		
washing	0.259	-	-	-
	(0.112)**			
elestove	0.085	-	-	-
	(0.076)			
mulunt	-0.243	-	-	-
	(0.226)			
persons	-	-	0.086	-
			(0.046)*	
R-squared	0.853			
s.e.	0.335			
Jarque-Bera	0.207			
	[0.901]			

5. Results

- Given that the model is a reasonably adequate representation of electricity demand in Barbados, an analysis of the estimated coefficient estimates is now given.
- The coefficient estimates on the appliance holdings show the proportional change in electricity consumption based on consumers' portfolio holdings (washing and elestove). The other appliances were statistically insignificant and therefore dropped out with the use of stepwise least squares. The coefficient for the existence of a washing machine was positive and statistically significant, suggesting that the presence of a washing machine is noteworthy in explaining the demand for electricity in Barbadian households.
- It was somewhat surprising that the number of bedrooms had a significant positive effect on the demand for electricity while the size of the household effect was insignificant. One would have expected that household size would have positive coefficients as larger families would consume more electricity, as well as utilise more electricity to light and cool or heat the rooms in the house depending on the seasonal requirement.
- Halvorsen (1975) however notes that households with larger numbers may substitute electrical power consumption with the use of natural gas for certain requirements that would be energy intensive. Leth-Peterson (2001) found evidence of such substitution for Danish households.

5. Results

- Due to the existence of non-linear pricing, the coefficients on the marginal and average price as well as income variables cannot be interpreted as elasticities. As a result, Reiss and White (2005) non-linear price elasticity which accounts for the substitution and income effects is estimated.

- The calculated price and income elasticities are provided for all households as well as those with electric water heating, air conditioning and solar water heating.

- The computed price elasticity of demand for Barbadian households was -0.778, which was somewhat lower than that obtained by Houthakker (1951), but in line with studies which also use less aggregated data (Parti and Parti, 1980; Dubin and McFadden, 1984; Munley et al, 1990; Maddock et al, 1992).

- For electric water heating, the price elasticity of demand fell to -0.756, suggesting that these households tend to be less price sensitive relative to the average Barbadian household.

- In contrast, households with solar water heaters were more price sensitive, which might be explain by the fact that these households substitute the electricity demanding water heaters, for the heater that had no reliance on electricity. The price elasticity of households with air conditioning was generally consistent with those obtain for the average household.

5. Results

- The income elasticity of demands was calculated in a similar fashion as the price elasticities.

- The income elasticities estimates were small, suggesting that the demand for electricity is relatively income inelastic.

- As noted earlier, electricity demand is a derived demand that is based on the household's portfolio of appliances. Therefore fluctuations in demand for electricity seem to be more a function of appliance holdings rather than income fluctuations.

- These results are similar to those obtained by Reiss and White (2002). Note that the income elasticity for households with solar water heating was negative reflecting the substitution effect arising from the use of solar power to provide water heating.

5. Results

- We can now disaggregates these price and income elasticites by household income level to further investigate the potential effect of income on household use of electricity.

- How elasticities vary by household income is of interest given that one of the objectives of the proposed rate adjustment was to lessen the impact of a rate increase on low income households.

- In general, the results suggest that middle-income households tend to be more price sensitive, even relative to low income households.

- This result is somewhat surprising, given that low-income households should be expected to make greater adjustments to electricity consumption in order to offset the income effect of changes in the price of electricity.

- This finding, however, may reflect the difference in appliance holdings of the two household groups. The relatively low-income household may have a portfolio of appliances that represents the necessities relative to middle-income households.

- As a result, relatively low-income households may be less price sensitive, since there is little they can do to adjust their electricity consumption. In contrast, the middle-income household may be able to reduce their usage of discretionary appliances.

5. Results

- We can also disaggregate the income elasticity by income group, but there was relatively little difference in the income elasticity estimates.

- An assessment of the price elasticity of demand for electricity based on the intensity of electricity use for Barbadian households can also be done (se Figure 4 in hard copy).

- As should be expected, the price elasticity of demand falls with the intensity of electricity usage. Indeed, the price elasticity of demand for relatively low use customers is almost twice that of consumers using more than 1000 kWh in electricity per month.

5. Results

- ***5.2 Projected Impact of Rates Adjustment on Households***
- The paper now turns to investigating the impact of the proposed new rate structure on households demand for electricity.
- We demonstrate that the proposed changes in the electricity rates would result in a reduction in the mean marginal price of electricity (Table 6).

- Graphically Figure 1 shows that the proposed new price schedule lays below and above existing price schedule depending on the consumption level.

- The proposed four-tier system of prices will see the marginal price of electricity for households within the sample move from $0.198 per kWh to $0.184 per kWh, a decrease of 7%.

- Consumers that have consumption pattern under 500 kWh per month and between 1000 and 1500 kWh per month would benefit most form the changes in the marginal prices.

- Households however, with consumption patterns in excess of 1500 kWh between 500 and 1000 kWh per month will face a higher marginal price.

5. Results

- Table 6 also suggests that the proposed changes in the rate structure will result in an increase in the average price of electricity for households at all consumption levels. This result will occur due to the proposed increase in the monthly customer charge and the shifting of the fuel related $0.0264 from the base charge to the fuel clause adjustment.

5. Results

- The results of the simulation exercises to examine the impact of the proposed rates on household electricity consumption are shown in Table 7.

- Households will generally alter their electricity consumption very little in response to the proposed changes to the four-tier structure and the increase in price.

- The results indicate that the average monthly electricity consumption within our sample will be 5 kWh lower due to marginal price changes offsetting much of the impact of the average price increases.

- Our model predicts that notable reductions in demand will only occur within upper income households. This is confirmed by the 5.6% reduction in demand predicted for households consuming over 1500 kWh per month as households with these consumption levels are normally within the upper income bracket.

- Households with monthly consumption patterns between 500 kWh and 1000 kWh per month are expected to make the greater percentage adjustment in their demand for electricity. These households are expected to reduce their monthly consumption by 6.2%.

5. Results

- The Company indicated that the proposed rate structure is designed to achieve a number of objectives.

- Evaluating how the proposed new pricing structure will achieve those objectives is not very simple; however some inferences can be made from the results.

- The structure of the new pricing system seem likely to achieve its primary objective of raising additional revenue as demonstrated by the across the board increase in the average price.

- The achievement of the secondary objective of minimizing the price impact on the lower income households is also evident. Low income households within our sample consume less than 500 kWh per month and therefore will benefit from a significant reduction in their marginal price.

- The objective of encouraging households to use electricity more efficiently and thus promote energy conservation will also likely be accomplished. The increase in marginal prices for higher levels of consumption will have the effect of lowering significantly the demand for electricity among households within the high and middle consumption bands.

6. Conclusions

- With a review of the rates and rate structure of the Barbados Light and Power Company forthcoming, this paper estimated, for the first time, an electricity demand function using survey data of a sample of 130 Barbadian customers.

- This function is then used to project the impact of the proposed change in the rates and rate structure on Barbadian households. As the demand for electricity services is a derived demand and data for the electricity demand for individual appliances is not available, electricity demand is modelled as the sum of the electricity used by appliance categories.
-
- Following Dubin and McFadden (1984), the choice of space cooling and water heating are isolated in this paper, while the other appliances are treated as statistically exogenous. The non-linear pricing structure in Barbados is set up as a censored regression and estimated utilising the Heckman two-step approach where, due to the existence of non-linear pricing, Reiss and White (2002) coefficients on the marginal and average price as well as income variables are computed.

6. Conclusions

- The reported results suggest that the price elasticities of demand for particular appliances varied significantly, with households with solar water heating more price elastic than air conditioning and electric water heating.

- The income effects were, however, statistically insignificant as these effects may have been captured by choices of appliances rather than utilisation and agree with studies by Parti and Parti (1980) and Dubin and McFadden (1984).

- The income elasticity for households with solar water heating was found to be negative, probably reflecting the substitution effect arising from the use of solar power to provide water heating.

- The database also allowed the authors to breakdown price and income elasticities by individual households and these results suggest that middle-income households tend to be more prices sensitive, even relative to low income households, indicating that the middle-income household may be more able to reduce their usage of discretionary appliances.

6. Conclusions

- The impact of the introduction of the new tariff structure was also analysed and revealed that households with consumption patters under 500 kWh will fear much better than higher consumption households form changes in the proposed rate structure.

- In general households will vary their consumption very little as a result of the introduction of the new rate structure. The more significant reduction in demand for electricity is expected among upper income and upper consumption households.

THANK YOU

- THE END

- THANK YOU FOR LISTENING