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TIME-OF-USE RATES AND RESIDENTIAL ELECTRICITY COSTS: A LOGIT AND QUANTILE REGRESSION APPROACHES

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OVERVIEW

The production and supply of electricity are faced with the problem of peak load demand, which consists of different demand loads at different moments throughout the day. In order to avoid shortages in electricity supply, production must set in motion sources of power generation with high cost, resulting in very high production costs in these phases. The literature studying this problem (e.g. Faruqui and George, 2005; Herter and McAuliffe, 2007; Herter, 2007; Faruqui et al., 2009), known as peak load pricing, has essentially three perspectives: 1) Critical Peak Pricing (CPP); 2) Real-Time Pricing (RTP); and 3) Time-of-Use (TOU) rates. The CPP predicts for changes in electricity prices over time. These prices reflect production costs that are higher during periods of increased consumption. The Real-Time Pricing (RTP) forecasts price changes in real time. The TOU rates connote to pay a higher price per kWh consumed during peaks or by contrary to pay a lower price in off-peak periods. Since this system does not incorporate seasonal variations and individual demand and the fact that the price changes occur only with the change of the rate, which can take months or years, such rates are static (Herter et al., 2005).

The literature study the CPP system through the use of monitor usage in homes (e.g. Matsukawa, 2004) through partnerships with local suppliers of electricity. In Portugal, this pricing system is not yet in operation, but its implementation is expected to occur in the short to medium term. Nowadays, the pricing system running in Portugal is the TOU rates. In our paper we study the TOU rates, in particular we analyze the factors influencing the choice by the different rates compared to undifferentiated price (flat rate). Besides studying the profile of the residential consumer in the choice of rates, we analyze the sources of further reducing monthly costs given a change in the electricity rates. We conclude studying the determinants of the costs related with the consumption of electricity (by residential spending level), allowing us to bring some enlightment light over the effects of chosen variables and their intensities for different profiles of consumption, not just for the average consumer but also for consumers who are located in tails of the distribution, i.e., consumers with very low monthly expenses and those whose electricity bill is very high.

In the absence of available data we proceed to collect data through the questionnaire techniques conducted by random sampling from the target population that are consumers of electricity in private households in mainland Portugal (with contracted power of 2.3 kVA to 20.7 kVA). The sample size was selected regarding geographic representation, i.e., the number of customers by region. We have a high representative sample of 2569 observations, and in accordance with the literature we consider variables of economic, social, idiosyncratic, physical characteristics of the local consumption, behavior and knowledge.

METHODS

This paper uses two techniques: binary outcome models and quantile regression approach. Firstly we use logit models to study the choice of a flat rate against different electricity rates depending on the TOU rate. Secondly, we estimate the factors influencing the reduction of

electricity costs, given a change at the choice of rates. We end our appreciation looking for the monthly costs with electricity's consumption by the use of quantile regression.

RESULTS

For the electricity choice of rates the results show: 1) The probability of an average consumer to choice for TOU rate is 41.6, in opposition to 58.4 for a flat rate; 2) The effect of income at tariff option is positive and statistically significant; 3) Contrary to the expected, the marginal effect of monthly cost of electricity is weak (0.0062); 4) The variables' effects: children's (0-18 years old), number of appliances, air conditioning, and use of efficient equipment are positive and significant; and 5) The behavioral and knowledge effects contribute to the choice to accept different prices according the TOU rate. Cost savings resulting from the change on choice of rates is influenced by: 1) Positively by the TOU rate, by changing consumer habits (switching), by income level and by household size; and 2) The use of oven and electrical cooking devices has a negative impact on the save of electricity.

The results also suggest that: 1) The factors affecting the cost with monthly electricity consumption have different magnitude depending on the level of cost; 2) The effects of age, household's size, standby, and air conditioning are consistently positive and statistically significant throughout the conditional distribution of the monthly cost of electricity - these variables are correlated with high levels of electricity consumption; and 3) Either apartment and consciousness of being a knowledgeable consumer contribute to a reduction in the monthly cost of electricity - this effect is consistent and statistically significant for all the conditional distribution of the cost.

CONCLUSIONS

We contribute to the debate on peak load pricing problem studying Portuguese reality. Through the use of binary regression estimation and quantile regression technique, we test the factors influencing the choice of rates of electricity residential consumers. We compute the probabilities of the choice of rates, for different consumer's characteristics. We control the conditions allowing electricity cost savings in residential consumption. For different levels of consumption, we also control the factors influencing electricity monthly costs.

The results reveal great consistency and robustness and the signs of the estimates are in general coincident with the expected. A small number of years in school affects negatively the choice TOU rates. The variables: percentage of children's (0-18 years old) in household, the consumption made at off-peak, and income, both have an significant incentive the choice for different electricity prices according to the time of consumption. We also verify that when the consumer has acknowledged about electricity market and the fact that it is by himself considered efficient, both variables contribute positively to TOU rates choice. The results support the air conditioning effect such as suggested by the literature. The monthly cost has an incentive to accept the different electricity prices, but its marginal effect is lower than the expected.

The results suggest the importance of consciousness campaigns, since consumers demonstrate knowledge and skills to adapt to the market, they are prone to save in their monthly electricity bill. Likewise, when a consumer can change consumption habits, this allows an increase of about 33% in the chances of costs saving.

From the analysis of monthly electricity costs assessed at different levels, we conclude that the effect of electrical heat water is significant, positive, and greater in magnitude for higher quantiles. The consciousness of being an efficient consumer of energy, causes a lowering effect on consumption, as expected. This former effect has a tiny magnitude for very low levels of consumption and it is quite constant for the most of the conditional distribution. We

conclude that physical characteristics of the place of consumption (the size of residence), affects positively the consumption only for intermediate monthly costs.