Estimating the TOU Price Elasticity of Power Demand for the Future Adoption of Real Time Pricing

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Overview

In recent years, the electricity market has been reformed and become more dynamic and liberalized than before. From technology side, the development of smart grid network allows the market to exercise demand response programs and integrate distributed energy source such as the rapidly growing renewable energy. With these circumstances, Real Time Pricing (RTP) is needed to provide incentive structure for the consumer, which could not be done with the conventional fixed price system.

In this study a panel type econometrics model is constructed to estimate the hourly price elasticity of demand. This model utilizes the past historical data of hourly consumption of electricity obtained from Korean Electricity Power Company (KEPCO) for the period of 2005-2009. The samples used for this analysis are already under a price structure of three different time zones for each season. The result of the analysis of this time of use (TOU) pricing system would allow the policy maker to design an appropriate incentive program. Further, this study is important in the sense that it provides essential information for designing the effective Real Time Pricing.

Methods

The hourly electricity consumption data obtained from KEPCO is categorized into 35 industries and 36 contract types based on 9th KSIC (Korea Standard Industrial Classification). Since the data is a panel type in nature, least squared dummy variable panel model with fixed effect is constructed. To capture specific characteristics of price elasticity of power demand, several price dummies are added for different industry categories, hours at specific month, weekdays, and holidays. In addition to TOU price of electricity, other additional explanatory variables such as contract size, temperature (represented by Heating Degree Days and Cooling Degree Days), humidity, and production index are also included in the model Some dummies to characterize the electricity consumption for weekdays and day-time are also applied.

The estimation model specified for this study is:

$\hat{\delta}_{\beta}$

where

Variable	Definition	Variable	Definition
y_{it}	Hourly Electricity Consumption	CDD	Cooling Degree Days
P_{it}	Hourly Price of Electricity	HDD	Heating Degree Days
D_k	Dummy of Industries (1-35)	Humd	Humidity
D_{ij}	Dummy of Month-Hours	Prod	Production Index
wd	Weekdays	D_{wd}	Dummy of Weekdays
wdH	Holiday on Weekdays	D_{day}	Dummy of Day-Time (09.00-18.00 = 1)

SH	Special Holidays	α_i	Fixed Effect Dummy
Sz	Contract Size		

Expected Results

The main results of this study are the estimates of hourly price elasticity of demand, which will be utilized as tools of understanding consumer behavior. It should be noted that the hourly price elasticity is composed of price elasticity (β) of the first industry group and partial price elasticity from the price dummies of various kinds as explained above. Thus, we need to examine whether those combinations might produce inappropriate price elasticity with statistical insignificance. The expected hourly price elasticity of demand should have negative sign and statistical significance. In addition to that, other estimates in the model are also expected to have logically correct sign, such as positive coefficient estimates for production index.

Once the above objectives are accomplished, some experiments are conducted by creating several price scenarios to observe the effect of demand response. Additionally, other effect in the model such as that of temperature change to the level of power consumption is investigated.

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