HOUSEHOLD CHOICE OF NEW ELECTRICITY SERVICE PLANS AND THE ROLE OF INFORMATION FEEDBACK

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Overview

Equipping electricity consumers with smart meters not only reduces the costs of on-premise meter reading incurred to utility companies but also enables new electricity service plans (ESPs) often based on the dynamic pricing (DP) of electricity (Neenan & Hemphill, 2008). A number of earlier pilot studies have also demonstrated that ESPs have potential to bring a sizeable reduction in peak electricity demand and energy conservation for electricity customers and that the extent of demand response can be influenced by providing smart meter-based information feedback on the price and usage of electricity (Allcott, 2011; Faruqui et al. 2012, 2013; Jessoe & Rapson, 2014).

Understanding the response of electricity customers to DPs has never been more important as it is now due to challenges faced by utility companies and regulators. Utility companies, on the one hand, are required to design and introduce DPs that serve their customers while at the same time addressing increased short-term financial risks. The risks orginate from uncertainties about the customers' choice of and response to ESPs (Gellings & Yeager, 2004) and the influence of the increasing deployment of distributed generation sources. On the other hand, utility regulators are urged to oversee the delivery of ESPs to ensure that the market transition serves economic efficiency and distributional equity and system-level reliability due to increasing grid connection of renewable sources. It is imperative for the regulators to assess whether or not DPs, which require non-trivial investments in metering infrastructures as well as auxiliary information technologies, would pay off in terms of decade-long savings in capacity and generation costs. Therefore, the behavioural response of electricity customers to DPs in general and the response with technology-based information feedbacks in particular should be topics of serious academic inquiry.

Despite such importance, we found that surprisingly little of existing literature examined consumers' preference for the combination of DPs and information feedback, characterized by policy-relevant and readily observable consumer characteristics. In this research, we attempt to fill this gap by solving three research questions: (1) How consumers value the attributes of dynamic pricing plan? (2) What is the role of information feedback for consumers in choosing new ESPs? (3) How households' socio-economic and electricity consumption-related information characterize their preference for new ESPs? To address these questions, we developed a discrete choice experiment (DCE) of 13 questions for 1,504 Korean households, and estimated their preferences using multinomial logit and willingness-to-pay (WTP) space model (Train and Weeks, 2005).

Methods

We constructed a survey with 13 choice questions in the survey to elicit individuals' preference for the new ESPs. In each question, respondents were asked to choose most preferred one out of the three labelled alternatives: the two new ESPs, and the status quo (Figure 1). The new ESP alternatives are independent and D-optimal combinations of different levels of six attributes: four TOU and two information feedback attributes (Table 1). Also, we gathered households, building, and energy consumption characteristics to address consumer heterogeneity. We then estimated individuals' willingness-to-pay to the monthly fee for the new ESPs using the following WTP space model (Train and Weeks, 2005) as it addresses both observed and unobserved heterogeneity of the individuals.

$$U_{ij} = \lambda_i Cost_j + \alpha d_{PeakAlert,j} + \beta d_{Realtime,j} + \gamma p_{CP,j} + \delta p_{OP,j} + \mu d_{TOU,j} + \eta X_j + \varepsilon_{ij}$$

$$\lambda_i = \tilde{\lambda}_0 + \sum_{k=1}^{K} \tilde{\lambda}_k Z_{ik}\,, \quad \tilde{\lambda}_0 \sim N(\mu_\lambda, \sigma_\lambda^2)$$

Here, U_{ij} is the consumer i's utility from choosing ESP j, $Cost_{ij}$ is the monthly service fee, $p_{CP,j}$ and $p_{OP,j}$ are unit electricity price in (critical) peak and off-peak time periods of ESP j, $d_{PeakAlert,j}$ and $d_{Realtime,j}$ are dummy variables of ESP j indicating whether information feedback (peak periods alert or real-time consumption and bill) is included. X_j is a vector of other design variables of TOU (peak duration and timing), and $d_{TOU,j}$ is the indicator of the new ESPs. Finally, Z_{ik} is a vector of household-specific characteristics of the consumer i $(k = 1, \ldots, K)$. As a version of mixed logit formation (McFadden & Train, 2000), parameters of WTP space model can be estimated by maximum simulated likelihood (MSL), which is also available in the statistical software. we used gmnl package in R (Sarrias, 2017) to obtain the model estimates.

Figure 1. Sample Discrete Choice Situation in the Survey

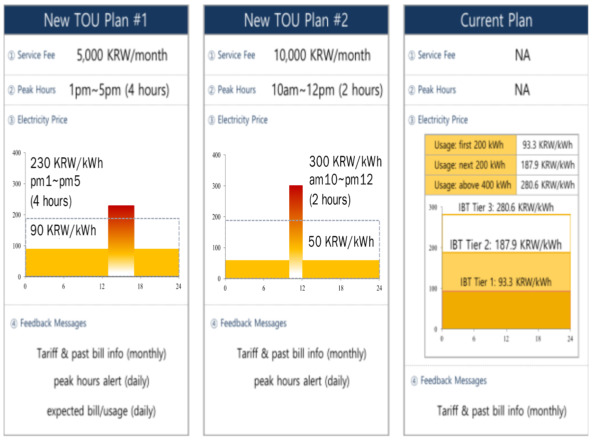

Table 1. List of the Attributes of the New Electricity Service Plans

Attributes	**#Levels**	**Levels**		
		Level 1	Level 2	Level 3
Peak length (hrs.)	2	2 Hours	4 Hours	
Timing of peak	2	Morning (9-13 or 10-12)	Afternoon (14-16 or 13-17)	
Off-peak price*	3	40%	50%	60%
Peak price*	3	150%	200%	250%
Information feedback	3	None	Peak periods reminder	Monthly usage/cost up to date
Service fee (USD/month)	3	0	$5	$10

* % of consumer-specific monthly average under Korean IBT

Results

We found that average consumers perceive positive value about the information feedback through instant messages only when the peak price is sufficiently high relative to off-peak counterpart. We then calculated expected changes in consumer surplus of a hypothetical time-of-use tariff with information feedback that might be plausible under business-as-usual policy scenario in Korea. In this scenario, the new ESP benefits average Korean household with $212. Also, it is households with higher energy expenditure but not necessarily higher income who are more likely to first opt-in the time-of-use tariff.

Conclusions

This study contributes to environmental and energy economics literatures on dynamic pricing and green technology adoption by eliciting individual consumers' preference for new electricity energy service plans. Our study provides holistic understanding of consumers' heterogeneous decision making of residential electricity service plans. To our knowledge, this study is the first one to analyze the role and consumer's preference for the feedback especially in connection with household-specific information: both socio-demographic and energy-consumption characteristics.

For managers and policy makers, our study provides important insights regarding the massive implementation of dynamic pricing programs in terms of ex-ante participate rate and the distributional implications based on readily-accesible consumers' characteristics. This extends the approach of Kaufmann et al. (2013) and Neenan et al. (2016) in promoting nationwide DP and smart meter implementation. We argue that it can be more effective for utilities to provide consumers with smart meter without monthly fee and recover the investment from premium in service charge (e.g. higher-than-revenue-neutral unit prices for peak or off-peak hours) because more than half of the households in our study showed that they wouldn't feel like to pay monthly cost for information feedback. Furthermore, we suggest that it is more cost effective for utilities to promote energy service plans with information feedback preferentially to areas where energy-intensive consumers reside.