RESEARCH HIGHLIGHTS

Selection on Welfare Gains: Experimental Evidence from Electricity Plan Choice

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Context

Inefficient energy retail pricing has long been an issue in electricity markets. Around the world, nearly all households pay electricity prices that do not reflect the cost of electricity being generated at that time because energy demand fluctuates depending on the time of day or time of year. Currently, households often consume too much energy during peak demand hours, such as the workday, and too little in off-peak hours, such as the mornings and evenings. With dynamic pricing, or pricing that adjusts to reflect the cost of electricity during peak and off-peak times, consumers could choose to change when and how they consume their electricity—allowing consumers to save money by reducing electricity use during peak times, and ultimately providing a public good by lowering electricity prices and energy consumption. A key problem is that due to political constraints, many countries—including the United States—currently rely on voluntary take-up when it comes to the adoption of dynamic electricity pricing. Such voluntary take-up is also common to other policy domains, including U.S. social welfare programs such as food stamps and disability insurance, and energy efficiency rebates. When policy take-up is voluntary, the key question becomes what types of consumers take up the policy, and to what extend does society benefit from their take up? This study considers this policy question using economic theory and data from a field experiment in electricity plan choice.

Research Design

The researchers conducted a field experiment in the city of Yokohama, Japan from July 2014-January 2015. The experiment was conducted in partnership with the Japanese Ministry of Economy, Trade and Industry, the city of Yokohama, Tokyo Electric Power Company, Toshiba Corporation, and Panasonic Corporation. To recruit as broad of a range of households as possible, the city provided free installations of an advanced "smart meter" and in-home display. The authors chose to study a cohort of 970 households out of more than 3,000 households that participated in the program.

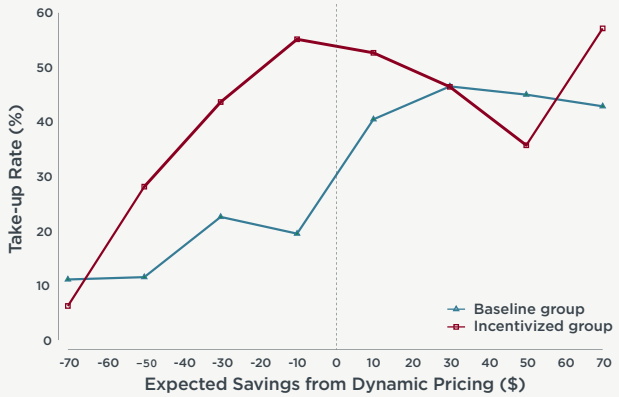
All customers were eligible to switch to dynamic electricity pricing, as opposed to the default flat pricing which was 26 cents per kWh regardless of the time of use. Under the dynamic pricing plan, the price in off-peak hours was reduced to 21 cents per kWh, and the price in peak hours was 45 cents per kWh on regular days. An important innovation in this study is that the authors randomly distributed $60 upfront as an incentive to take up the program. The authors use this financial incentive to study the relationship between the types of consumers who would adopt the dynamic pricing and the social welfare gains that can be obtained from such take up.

Using the smart meters, the researchers collected hourly electricity usage data for each participating household in the pre-experimental period in 2013 and experimental period in 2014 and 2015. During the pre-experimental period, they calculated the expected annual savings consumers would gain if they decided to switch. They then presented this information to consumers when they were asked to switch to the dynamic pricing policy.

Findings

Those consumers who would be expected to save money from adopting dynamic pricing are more likely to opt into the new pricing scheme. Some consumers would be more likely to save money under a dynamic pricing scheme, without any behavioral changes, simply due to how they consume electricity (positive values on the x-axis). These consumers are those who consume more electricity during off-peak hours—such as the early morning or evening—and less during on-peak hours—such as during the workday. The consumers who would be expected to save money were more likely to opt into the dynamic pricing scheme—regardless of whether they were offered a financial incentive to do so (represented by the high take-up rate for both incentivized and baseline groups). The authors find that the take-up rate from these customers (called "structural winners") was nearly

Figure 1 · Heterogeneous Effects of the Take-Up Incentive on Take-Up Rates

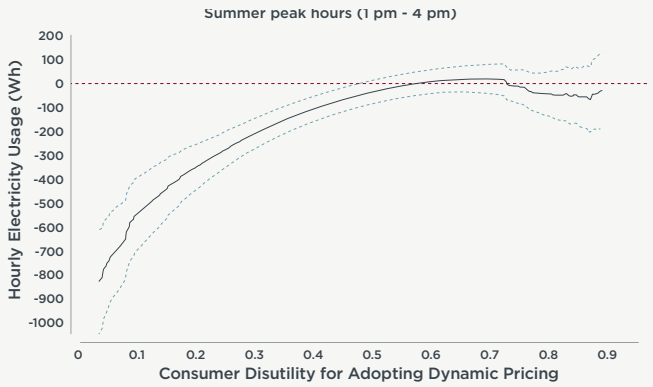


Note: This figure shows the take-up rate for each group by the expected savings from dynamic pricing. The take-up incentive caused different effects on the take-up rates of structural winners and losers.

50 percent. Those consumers who were not expected to save money from opting into the policy (negative values on the x-axis) were more enticed to opt in when given the financial incentive to do so (wide gap between the baseline and incentivized groups). The take-up rate of these customers (called "structural losers") was around 15 percent without the take-up incentive, and the incentive boosted this number to around 30 percent.

Consumers who are eager to join the program are also more likely to respond to fluctuating prices and reduce their electricity during peak times. For the policy to meet its goal of improving social welfare, consumers would need to reduce their electricity consumption after they adopt the dynamic pricing. However, it is not guaranteed that such conservation would occur for all consumers. Some might make a lot of effort to conserve peak-hour electricity, while others might choose not to conserve at all even though they are having to pay higher electricity prices. A key question is whether a consumer's reluctance or eagerness to join the dynamic pricing policy is related to the extent to which they respond to changing prices and conserve electricity. The researchers discover that those who are eager to take up the dynamic pricing (the lower numbers on the x-axis) reduce peak-time electricity usage (the negative numbers on the y-axis). These consumers conserve up to 1 kWh per hour per household each peak-hour day. Those who are reluctant to take up the dynamic pricing (the higher numbers on the x-axis) do not conserve much (hovering around zero on the y-axis).

Figure 2 · Marginal Treatment Effects on Electricity Usage



> "To successfully reduce emissions and transition to clean energy sources, it's critical that we find ways to cut electricity use during peak times One way to do this is to charge consumers more during peak hours along with a reduced price for off-peak hours, encouraging them to respond by using less electricity during peak hours. But not all consumers will behave as we would expect. Our study helps policymakers identify strategies to optimize the success of these programs."
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Providing too high of a financial incentive leads the policy to become less successful at cutting peak-hour electricity because it encourages consumers to join who are less enthusiastic about the program, and therefore less likely to reduce their electricity. The researchers' finding that those eager to join the program are also most likely to reduce their peak-hour electricity use implies that providing a take-up incentive is useful but has limits. Consumers who adopt the dynamic pricing with zero or small take-up incentives are likely to conserve electricity during peak hours, whereas those who adopt the dynamic pricing only with large take-up incentives are likely to conserve less. The researchers test this theory by simulating different policies with varying take-up incentives. They find that providing a financial incentive of $60 (as their field experiment did) improved the take-up rate of the policy from 31 to 48 percent, leading to an improved welfare gain of $18 to $23 per consumer per year. The most optimal take-up incentive design—which they derived by using their model, available consumer characteristics data, and their empirical findings—would boost the welfare gain to $33.1 per consumer per year. Policymakers could use similar methods when designing optimal take-up incentives for their policies.

CLOSING TAKE-AWAY

Households in the United States and many countries now have smart meters at home that record hourly consumption and, therefore, make dynamic pricing technologically feasible. A key challenge is that due to political constraints, many countries—including the United States—currently rely on consumers to voluntary take up dynamic electricity pricing. This study shows how the willingness of consumers to join these programs is related to the degree to which they conserve electricity, as well as how policymakers could design an optimal take-up incentive to target key consumer types and deliver large welfare gains from this policy.

The Energy Policy Institute at the University of Chicago (EPIC) is confronting the global energy challenge by working to ensure that energy markets provide access to reliable, affordable energy, while limiting environmental and social damages. We do this using a unique interdisciplinary approach that translates robust, data-driven research into realworld impacts through strategic outreach and training for the next generation of global energy leaders.