THE SOCIAL VALUE OF MANDATORY TIME-OF-USE TARIFFS

Bowei Guo, Renmin University of China, +8613166307524, b.guo@ruc.edu.cn
Ao Sun, Renmin University of China, +8618813109870, sunao@ruc.edu.cn
Feng Song, Renmin University of China, +8615010547873, songfeng@ruc.edu.cn

Overview

When the marginal costs of a good varies over time, the application of marginal cost pricing to such good is usually considered to be the most efficient pricing strategy. In such business, prices and consumption instantaneously adjust to cost fluctuations, achieving real-time economic efficiency. Electricity markets are good examples — as the cost of electricity generation varies with demand and renewable supply, implementing dynamic tariffs to end-users could improve efficiency especially when demand is elastic and buyers are fully informed (Allcott, 2011; Joskow and Wolfram, 2012).

Besides improving efficiency, dynamic tariffs may also bring other benefits such as lowering (usually underinvested) capital investments required on "peaking" generation capacity, bring environmental benefits due to the reduced greenhouse gas emissions (Holland and Mansur, 2008), reducing the cost of balancing the system and so on.

In this article, we focus on the social value of mandatory time-of-use (TOU) pricing policy, which mainly include the saved cost from electricity generation, the value of the reduced need for peaking plants, the social value of saved greenhouse gas emissions, as well as reduced network losses and ancillary services. The first step is to estimate the impact of the TOU tariff on the electricity load pattern of the society. Next, using the robust estimate of price elasticities, we then construct a counterfactual load pattern reflecting a scenario where the TOU tariff was not implemented, and the social value is determined by the difference between the counterfactual and the actual load pattern, as well as other parameters, indices, or factors. Finally, we construct an optimization model where the social welfare is a function of electricity load as well as other parameters, indices and factors from earlier steps, to find the optimal TOU tariff rates that maximise social welfare.

Methods

To estimate the impact of the TOU tariff on the electricity load pattern of the society, we first adopt regression approaches to estimate the load shifting effects triggered by the TOU rates, namely the inter-period elasticities of substitution. Next, using an instrumental variable (IV) approach, we estimate the conservation impact of TOU tariffs, namely the overall price elasticity of demand.

To estimate the social value of the existing TOU tariffs, we develop a data-driven methodology to quantify the social value which includes the saved cost of electricity generation, the value of the reduced need for installed capacity, the social value of the saved greenhouse gas emissions, as well as reduced network losses and ancillary services.

To find the optimal TOU tariff rates that maximise social welfare, we construct an optimization model where the social welfare is a function of electricity load as well as other parameters, indices and factors from earlier steps. We then estimate the welfare improvement from a policy change that switches from the existing price ratio to the one that maximises social welfare.

Results

Our results from diagnostic tests and robustness checks confirm the validity of our estimates. We find statistically significant inter-period elasticities of substitution whilst the IV estimates fail to find evidence for a significant conservation effect of TOU tariffs. This is consistent with the conventional wisdom that energy conservation effect of TOU tariffs is rather limited (Faruqui et al., 2015; Qiu et al., 2018).

[The results for the social value of the existing Tou tariffs and the optimal TOU tariff rates that maximise social welfare is in progress, and will be available by the IAEE European Conference.]

Conclusions

[Conclusions are in progress, and will be available by the IAEE European Conference.]

References

[1]. Allcott, H. (2011). Rethinking real-time electricity pricing. *Resource and Energy Economics*, 33(4):820–842.

[2]. Faruqui, A., Sergici, S., Lessem, N., and Mountain, D. (2015). Impact measurement of tariff changes when experimentation is not an option—a case study of Ontario, Canada. *Energy Economics*, 52:39–48.

[3]. Holland, S. P. and Mansur, E. T. (2008). Is real-time pricing green? the environmental impacts of electricity demand variance. *The Review of Economics and Statistics*, 90(3):550–561.

[4]. Joskow, P. L. and Wolfram, C. D. (2012). Dynamic pricing of electricity. *American Economic Review: Papers & Proceedings*, 102(3):381–85.

[5]. Qiu, Y., Kirkeide, L., and Wang, Y. D. (2018). Effects of voluntary time-of-use pricing on summer electricity usage of business customers. *Environmental and Resource Economics*, 69(2):417–440.