Peer Effects on the Diffusion of Residential Solar Power Systems: A Dynamic Discrete Choice Approach

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Abstract

Although solar photovoltaic (PV) systems currently produce only a small fraction of the total electricity generated in the U.S., the high growth rate of PV adoption, driven in part by the rapidly decreasing cost of PV systems during the past decade, has positioned this technology as a viable clean energy alternative to fossil fuels. Many countries now consider solar electricity generation to be a strategic component of future energy portfolios. How to reach the goal of widespread residential adoption of this technology? Federal and state and local incentives, as well as declining hardware cost, have propelled the growth.

Moreover, at the individual household level, the space-time dynamics of installations reveal a clear pattern: after a new installation occurs in a neighborhood without adopters, slowly but inevitably other households also begin installing such systems. We study this technology diffusion phenomenon at a micro-level by considering forward-looking household decision makers who consider both economic benefits and other influences.

We propose a dynamic discrete choice model in which households analyze the trade-off between the current return on investment and peer effects due to neighboring installations versus the benefit of waiting for the cost to further decline. To estimate the model parameters, we gathered a novel and detailed data set of PV adoption in Austin, Texas.

Our model differentiates adopters by their wealth and geographic location, and characterizes the influence of previous adopters by distance. For inference, we use a Bayesian method that overcomes the computational burden of classical approaches. The estimated parameters reveal a higher predisposition to adopt not only for mid- to high-income households, but also due to the number and proximity of current installations by other households.

Counterfactual analyses demonstrate that a step-wise decreasing net cost of installation incentivizes more adopters at a lower average rebate per adopter than the observed base case for net installation cost. The estimation of our structural model can be used to project the dynamics of the market, providing insights about where the developers should focus their customer acquisition efforts and what schedule of incentives would stimulate adoption more efficiently.

As a follow-up, we explore the influence of PVs and electric vehicles (EV) diffusion. In the US, several states experience a positive correlation between PV and EV adoption, suggesting that these technologies complement each other from a consumer standpoint. We analyze the PV and EV diffusion patterns and develop preliminary models of the diffusion of complementary technologies.