SUBSIDIES AND COSTS IN THE CALIFORNIA SOLAR MARKET: AN EMPIRICAL ANALYSIS

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Overview

In this paper, we estimate and analyze cost inflationary effects of subsidies in the context of the California solar PV market. Using a semi-parametric regression technique we model the costs of solar PV installations and analyze the central cost drivers, with focus on subsidies. Furthermore, using machine learning techniques we build a prediction model and use this to simulate costs under different subsidy policies in order to quantify any cost inflationary effects.

Environmental concerns have prompted governments around the world to subsidize renewable energy markets. One of the major risks associated with subsidizing is that it may inflate costs. Thus, understanding the drivers of costs, and specifically how subsidies affect costs is crucial for evaluating and designing good subsidy policies.

We find evidence for significant cost inflationary effects of subsidies. Our simulations suggest that a cut-off in 2012 would not have lead to a substantial jump in costs to end-customers at the cut-off point, and that costs would only be slightly higher for end-customers than with subsidies. The results indicate that an accelerated subsidy down-scaling may be desirable, with minimal adverse implications for end-customers.

We make two main contributions to the existing literature. We improve on existing econometric models of the California solar PV market by enhancing data pre-processing and model identifi- cation. Moreover, we further examine and quantify the cost inflationary effects of the California Solar Initiative policy using machine learning techniques for simulation.

Methods

For our analyses, we use publicly available data from the California Solar Initiative (CSI) of more than 140,000 solar PV system installations across the state of California, from the start of the incentive program in 2007, until mid-2017.

For the descriptive analysis of the costs in the California solar PV market we employ a Generalized Additive Model (GAM), which is a form of semi-parametric regression capable of capturing complex relationships in data while providing descriptive power.

For the simulation analysis, we adopt a deep neural network, a method that has proven useful in out-of-sample predictions in various applications in recent years, like stock market predictions. The neural network regression approach is fully non-parametric, and hence does not provide any direct descriptive power. However, our aim in this part of the study is not to directly interpret the relationships in the data, but rather simulate alternative market scenarios and quantify the effects of cost inflation.

Results

The results of the GAM suggest that a 1% increase in incentives per kW installed, is associated with an increase of nearly 0.1% in costs per kW installed.

Market simulations for zero incentives and for two different cut-off subsidy policies, using the deep ANN, show lower total cost per kW compared to actual costs exhibited under the CSI policy. The cost effect for end-customers (i.e. cost after incentives) is estimated under a 2010 and 2012 cut-off policies. Examination of the cost curves suggest that the 2012 cut-off policy is superior, as costs per kW after incentives do not exhibit any significant jump at the cut-off point, and the costs to end-customers are not notably higher than under the realized scenario. The costs saved by the California government under the 2012 cut-off policy would be US$1.15bn, while the total extra costs imposed on end-customers in our simulation is only US$0.30bn.

Conclusions

In this paper, we estimate and analyze cost inflationary effects of subsidies in the context of the California solar PV market. We find evidence for substantial cost inflationary effects of subsidies.

The results from the simulation analysis suggests that accelerated subsidy down-scaling may be desirable to minimize cost inflationary effects and potentially save the government millions of dollars.

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