Cost, Contractors and Scale: An Empirical Analysis of the California Solar Market

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Executive summary

The market for rooftop solar has expanded rapidly over the last decade as costs have fallen. In turn solar photovoltaic power has become a viable energy alternative. The rapid fall in solar panel costs has made rooftop solar panel systems profitable for many homeowners and businesses in California and elsewhere. The growth of rooftop solar has implications for electricity market structure and stability, grid infrastructure and operations, and climate change policy. Understanding the drivers of this market becomes an important research objective.

Investment costs in photovoltaics vary greatly and identifying the sources of cost variance is important in understanding the expanding rooftop solar panel market. Global factors such as manufacturing economies of scale and technological change affect costs over time. The distributed nature of photovoltaics also means that local factors affect costs across geographies, demographics, and the structure and strategies of contractors.

However, empirically decomposing the variation in solar costs can be problematic. The global causes of cost variation over time tend to be unobserved and non-linear. At the same time, local observable variables of interest — like the effect of using Chinese panels, installation economies of scale, and cost-inflationary effects of subsidies — can be expected to be correlated with the cost trends over time. A failure to properly control for the non-linear trend will tend to bias the estimated coefficients on the included observed variables.

To decompose the variation in costs and help identify the role of the observable local factors, I use a semi-parametric model. I use a cubic regression spline to account for the general non-parametric shape of the fall of prices over time, while allowing the observable variables to enter the equation linearly.

I find that the use of panels from Chinese manufacturers are associated with costs that are 6% lower. Additionally, I find evidence of local economies of scale. On average an additional 10 MW of capacity installed in a certain year in a given zip code is associated with solar photovoltaic systems that are between 13% and 35% less costly. Evidence is also found for subsidies having an inflationary effect on costs. A $100 increase in subsidies per KW of capacity is associated with an increase in costs of approximately 1%.

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The time period studied was characterized by increasing concentration in the photovoltaic contractor market. However, this trend does not appear to be driven by costs. In fact, contractors with higher market shares are associated with having slightly higher costs. In an extended discussion and case study, I explore non-cost explanations for both increasing concentration in the contractor market as well as for the expansion of the solar photovoltaic market as a whole.

I suggest that the introduction of leasing played a pivotal role. Leasing loosened consumer financing constraints by switching ownership to large contractors with access to multiple sources of financing. Transferring ownership to large contractors may also have allayed concerns about both the complexity of maintaining a solar photovoltaic installation as well concerns about the quality of components.

Exploring solar public policy is not the primary objective of this article, but several implications from the research do emerge. A direct policy implication concerns the design of flexible subsidies. In some US states only homeowners who themselves own the solar system on their roof can collect government production subsidies. On the other hand, the flexibility of California's rules allowed for the introduction of leasing models, which likely helped to expand the market.

Trade policy is also indirectly related to the subject of this article. In 2014, after the period studied, tariffs of at least 30 percent were imposed by the US Department of Commerce on Chinese and Taiwanese solar panels. A full analysis of the merits and fairness of these sanctions is beyond the scope of this article. However, this article clearly shows how competition from Chinese manufacturers helped drive down overall system costs and spurred increased installations. Subsidizing solar systems while at the same time imposing tariffs on imported panels seem like contradictory actions if the aim is to increase renewable energy production.

Keywords Solar power; Solar contractors; Energy investment; Energy subsidies; Economies of scale; Partial linear model.