

The Great Fall: Local vs. Global Economies of Scale in the California Solar Power Market

Johannes Mauritzen, NHH Norwegian School of Economics, +47 90 56 64 62, johannes.mauritzen@nhh.no

Overview

Solar power is the worlds fastest growing form of electricity production. In some areas with high solar irradiation it is already a competitive generation resource, even without subsidies. Much attention has been focused on the global producers of solar panels, where prices plunged by more than 60% between 2010 and 2013 as economies of scale and increased competition - especially from China - pushed prices down.

However, globally produced solar panels now make up only one third of the total costs of a system in the US market. Costs associated with the permitting and installation of a solar system make up well over half the cost and can account for a large amount of the variation in system cost. For example total system costs in Germany, which developed a relatively early market for solar power due to generous subsidies, had median system costs per watt that were quoted at less than half the average cost of US systems.

Using a detailed data set of 134,000 solar power installations installed in California between 2007 and early 2014 and using a multi-level bayesian regression model, I find that local contractors account for a majority of the price variation of installations within a year. More so I find that in counties with high market penetration of solar power systems, prices fell more than in counties with low market penetration. I also find that larger integrated seller/contractors have higher prices on average, however the price differences have narrowed as the market has matured.

Methods

The primary goal of this paper is to estimate the slope of the system cost over time and to explore to what extent the fall in costs can be attributed to global returns to scale from photovoltaic manufacturing or from local factors including contractor returns to scale and competition. In order to do this I attempt to estimate the system cost slope over time within both industrial and spatial group levels. However this presents a challenge for classical regression modeling. Estimating the slope at the county level would introduce 85 parameters - one for each county. Estimating the slope within contractors introduces hundreds of parameters to the model, some based only on a few observations.

A solution is to use a Bayesian Multilevel Models. Here group-level parameters are introduced as prior distributions in the full model with a posterior distributions being iteratively estimated for all parameters simultaneously. Intuitively, the within group parameters of the slope of the cost-over-time coefficient of the model are estimated as a weighted sum of the total variation and the within-group variation. Implementation of the model is done using the Bayesian probabistic programming language Stan (Stan Development Team 2014) .

Results

The analysis shows that as the market for solar power systems grew and prices came down a process of consolidation took place and a few companies garnered a significant amount of market share. The market share for any one company was never more than 5% in any given year, however it could be considerably higher at the county level. The distribution of system costs also changed markedly over the period studied. As the market started to heat up in 2007-2009, the variance of prices increased substantially. However as the market matured, system prices converged and variance in prices was reduced considerably.

Initial regressions show that counties with larger number of installations saw prices fall more than counties with lower number of installations. This was especially true for residential installations. However contractors with high

market share tended to have higher costs. However, high market-share contractors also had steeper declines over time.

Conclusions

I find strong evidence that local economies are at least equally important for the fall in California solar power costs between 2007 and 2014 as global economies of scale in the photovoltaic manufacturing industry. However a careful analysis of the data shows several interesting subtleties about the growth of the local solar panel industry. While counties with high market penetration of solar power tended to see steeper price drops and lower costs, contractors with high market share tended to have higher prices. Market power is an unlikely reason for this as even the largest contractor had under 5% of the market share. A likely explanation is that the dominant installers use their economies of scale not to necessarily be the lowest cost installer but instead to overcome the informational challenges and complexity of the market. Several of the largest contractors offer all-in-one solutions – dealing with financing, permitting, installation and monitoring. In return they can charge slightly higher prices than less vertically integrated contractors.

References

Stan Development Team,. (2014). *Stan: A C++ Library for Probability and Sampling, Version 2.2*. Retrieved from <http://mc-stan.org/>