Learning by Doing and Product Differentiation in the Solar Panel Installation Industry

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Also performed in conjunction with the Risk Center's SEEDS Project

Introduction

It is generally accepted that the price of residential solar photovoltaic (PV) generation systems will fall over time. This expectation is grounded in the theory of learning by doing; as the industry gains experience the cost to produce and install panels should fall and, in a competitive market, those gains should be passed on to consumers. There are two dimensions on which the solar PV industry might experience learning by doing: the module cost, which represents the cost to manufacture the hardware of the generation system, and the balance of system (BOS) cost, which represents the cost to install the system. A recent study by the U.S. Department of Energy tracks the global module price index and the total price paid by consumers for solar PV system from 1998 to 2011 and find that the both the module price and the total price have fallen consistently (Feldman et al. 2012). However, the difference between the total price and the module price, which represents the BOS, has stabilized. One possible explanation of the DOE's report is that solar installation companies have ceased to innovate. On average BOS contributes more than two thirds of the cost per watt of solar PV so if installation costs have in fact stabilized the outlook is bleak for the solar industry.

We suggest an alternative explanation for the stabilization of installation prices. While learning depresses costs we assert that there is an opposite pressure on price from learning that has been hitherto ignored. Consumers prefer experienced installers, either because consumers interpret experience as a proxy for quality or because they are more likely to have heard of an experienced firm through word of mouth. As a result, service from an experienced firm is differentiated from its less experienced competitors, allowing experienced firms to charge a higher premium for their service. In this paper we empirically measure the effect of this differentiation by learning on installation prices.

Data and Analysis

Our data is comprised of individual consumer level records of applications for state solar subsidies in San Diego, California made available by the Risk Center's SEEDS Project. The data records the size and price of the installed system, the company chosen to do the installation, the dates of the project's initiation and completion, and the addresses of both the consumer and the installer for all residential San Diego installations from 2007 to 2011. We perform our analysis on installations begun in the year 2010 to minimize concern about entry and exit of firms and exclude leased panels from consideration to avoid potential price misreporting issues (see Podolefsky, (2013)). We employ data from years 2007-2009 to construct counts of completed installations by each firm to measure firm experience. We track learning over time through the number of installations completed by each firm in each month of 2010.

We construct a logit choice model over the firms present in the market in 2010. Consumer utility is a linear function of a firm's experience at the time of installation and price. If firm experience is a proxy for quality then estimates of this simple model should not be biased. However, we remain agnostic about the mechanism through which firm experience effects consumer preference (quality versus word of mouth) so we employ a control function to correct for potential endogeneity. Notice that price includes both hardware and installation costs so price varies over individuals based on the size of the system installed. Size of the system is largely a function of a consumer's roof characteristics which we interpret as exogenously given. We therefore include in the control function the system size in addition to the cost shifters distance from installer to consumer and an indicator of whether the installer offers a lease option.

Results and Discussion

Our parameter estimates from the logit model described above indicate that consumers have a positive and significant preference for experienced firms (and a negative and significant preference for price). We assume firms are Bertrand competitors so using the estimated purchase probabilities from the logit model and firm profit first order conditions we back out marginal costs. These costs are weakly decreasing in firm experience and firm margins are increasing in firm experience. So we show that while learning by doing decreases costs, learning also exerts upward pressure on price.

Funding Motivation

I am seeking funding to present this work at the MSOM 2014 and the INFORMS 2014 conferences being held in Seattle and San Francisco respectively. I hope that feedback received at these conferences will push the work forward. Unfortunately my travel budget is insufficient to cover travel to both conferences. For that reason I'm requesting the funds detailed below.

References

David Feldman, Galen Barbose, Robert Margolis, Ryan Wiser, Naim Darghouth, and Alan Goodrich. Photovoltaic (pv) pricing trends: Historical, recent, and near-term projections. DOE Technical Report, 2012.

Molly Podolefsky. Tax evasion and subsidy pass-through under the solar investment tax credit. 2013. Working Paper.