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Competition Among Solar Contractors in California

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Abstract

The Dixit-Stiglitz model of monopolistic competition is adapted to generate patterns of firm entry and firm sales distribution seen in the data on solar installations in California. The model is calibrated using the data on installations and the calibrated model is used to evaluate the welfare effect of government subsidies to the purchase of residential solar systems.

Introduction

The prices of installed solar photovoltaic (PV) systems have come down over the last few decades. The declines in prices have been driven primarily by declines in prices of solar modules (panels). Solar modules, however, constituted less that forty percent of the price of installed systems in 2012 (see Friedman et. al). Other factors, including profit margins of contractors (installers), make up the rest of the installed system price. Existing studies of the impact of consumer subsidies on solar penetration and social welfare, have assumed a perfectly competitive market for the solar installation industry. The assumption of perfect competition is at odds with the data on solar installations in California. A model of monopolistic competition of the solar installation industry, adapted from Dixit-Stiglitz (1977), is developed. The model is consistent with some of the observed regularities in the data.

Solar Installation Industry in California

The data on solar installations in California reveal many striking regularities regarding entry and distribution of sales of firms (contractors) involved in the installation of solar systems. These regularities are explored in detail in Pillai (2014), a short summary is included below. In what follows each county is considered as a separate market. The number of contractors operating in a county varies systematically with market size of the county, as measured by the total solar system sales in the county. The relationship in Figure 1 between these two variables shows a strong log-log relationship. Second, within each county the sales distribution of contractors exhibits a very similar pattern. Figure 2 shows the sales distribution for Los Angeles, and the distribution in other counties very similar. The graph indicates that

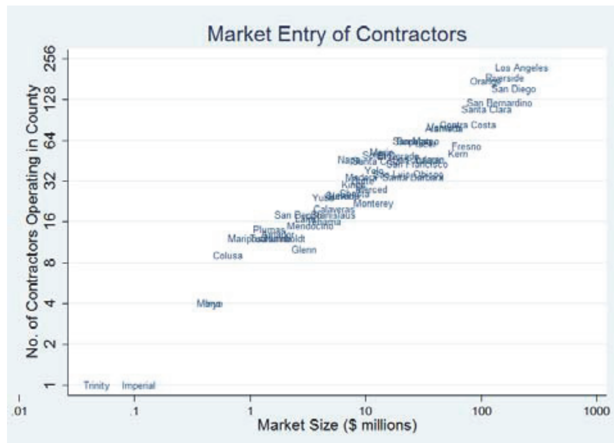

Figure 1

distribution follows a Pareto, with a deviation from the Pareto at the lower end.

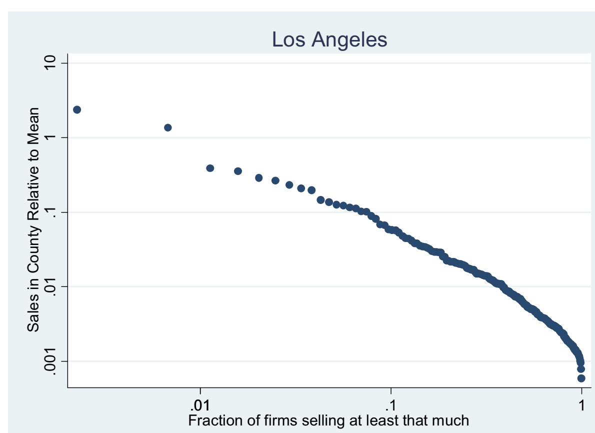

Figure 2

The distribution of prices charged by contractors in a county is also very similar across counties. The reciprocal of the price follow a Pareto distribution, with a deviation from the Pareto at the lower end.

The above regularities regarding entry, sales and price distribution can be generated from a model of monopolistic competition and heterogeneous firms who differ in their productivities. The number of firms that enter the market is restricted by the fixed entry cost. The main entry cost in solar installation industry is the advertising cost, which is modeled according to Eaton, Kortum and Karamarz (2011) and Arkolakis (2010). Firms enter a market as long as they can cover the entry cost, and the marginal firm (the least productive firm that enters a market) makes just enough profit to cover the fixed cost. In larger markets, more firms enter due to the assumption of monopolistic competition. Firms sell slightly differentiated products which gives each contractor some room to charge a price above its cost. To generate the Pareto sales distribution in each county, it is assumed that firm productivities are drawn from a Pareto distribution. Since productivity is an inverse function of cost, and since all firms charge a constant markup above cost in Dixit-Stiglitz type models, the inverse of price also follows a Pareto distribution.

Model Calibration

The three underlying parameters in the model are the parameter of the Pareto distribution which determines the distribution of firm productivities, the advertising parameter which determines the effectiveness of advertising in the industry, and the demand parameter that determines the extent of differentiation among the contractors. The Pareto parameter is estimated directly from the data on prices charged by the contractors. The other two parameters are estimated using simulated method of moments. The parameters are estimated by drawing productivities randomly from the Pareto distribution, and by matching the resulting sales distribution with observed distribution in data. With the estimated parameters, model generated patterns of entry and sales distribution hue closely to the one seen in data.

Simulations

The calibrated model is used to find out the reduction in cost that would have been required to achieve given penetration levels in California in the absence of subsidies. In the absence of subsidies, the price of solar systems would have had to reduce by 40% in order to have reached the penetration level that was achieved in 2012. If the penetration level is to reach 1.5% without subsidies, then cost would have to fall by 88% of its value in 2012. The model is also used to generate the welfare impact of the consumer subsidy. It is assumed that the subsidies are financed through a tax on consumption of electricity. The difference in consumer surplus (with and without the subsidy) is measured using the concept of equivalent variation. The consumer surplus would have been higher by $77 million in the absence of subsidies while the producer surplus would have been lower by $59 million, adding up to a net welfare loss of $18 million from subsidies. Note, however, that the welfare calculations have been made without considering the environmental consequences of replacing polluting generation sources like coal with solar energy systems.

Conclusion

Cost reduction in solar panels has been the focus of most studies related to solar PV industry. The impact of competition and market structure on prices of installed solar systems has received much less attention. The data on solar installations in California has been used to understand regularities in related to market structure of the installation industry in California. A model was developed that was consistent with these regularities, and the model was estimated using the installation data. The estimated model was then simulated to understand the welfare impact of government subsidy offered for the purchase of residential solar systems.

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