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Incentive pass-through in the California Solar Initiative – An analysis based on third-party contracts

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ABSTRACT

Many utilities and states have implemented incentives for residential solar to reduce the high upfront cost. There is a growing body of literature evaluating the extent of this corresponding price reduction, termed 'incentive pass-through', typically finding nearly complete path-through for host-owned systems. However, few studies hitherto had the data to reliably estimate path-through for third-party owned systems, which comprise most of new installations over this period. This study evaluates incentive pass-through for third-party owned systems in California between 2010 and 2014. The estimation results show path-through rate is around 62%, suggesting that unlike host-owned systems, a portion of the incentive reduced the contract price of the system and the rest of the incentive was retained by the installer. This study has important implications for future subsidy program design in the presence of different ownership types in the market.

1. Introduction

High first cost has historically been a large barrier to the adoption of solar photovoltaic (PV) (Margolis and Zuboy, 2006). Direct subsidies are a common policy tool to alleviate this burden, thereby encouraging solar adoption. Federal investment tax credits are perhaps the most enduring form of upfront subsidies for solar energy technologies, established in 2005 through the Energy Policy Act. Simultaneously, many utilities and states have implemented additional incentives in the form of tax credits, buy-downs and loan programs in order to further incentivize solar adoption locally.[1] Indeed, there is strong theoretical and empirical support that incentive programs (both federal and state-level) increase solar adoption (Durham et al., 1988; Sarzynski et al., 2012; Rogers and Sexton, 2014; Hughes and Podolefsky, 2015; Gillingham and Tsvetanov, 2017; Li and Li, 2017). More specifically, several studies have evaluated the mechanism by which up-front incentives work, empirically evaluating the reduction in capital costs faced by consumers as a direct result of the incentive level (most notably, Dong et al., 2018). This research question is termed 'incentive pass-through' or 'subsidy pass-through,' and provides a method to evaluate incentive program success, since the intent of incentive programs is to directly reduce the upfront cost to adopt solar.

All research on this question, to date, has focused on host-owned systems. In the case of host-owned systems, the customer authorizes the installer to apply for incentives and then, in theory, receives a discount on the system cost equivalent to the incentive level. However, over the past several years, most consumers have elected third-party ownership (TPO), where they either lease a solar system (termed a 'lease') or purchase only the electricity provided by the system (termed a 'Power Purchase Agreement', or a 'PPA') from an installer/financer.[2] According to a GTM Research (2015) research report, TPO has accounted for the most common ownership structure in key solar markets. For example, TPO has gained more than 90% of New Jersey's residential solar market share since 2013. In 2014, more than 50% of New York's distributed generation systems were third-party owned, and in California, Arizona and Colorado, 69–81% of installed distributed generation systems were third-party owned. Installed capacity by ownership types in California can be seen from Fig. 1.

Though third-party owned systems have been included in previous studies, the reported transaction cost between the installer and the financer has been used as a proxy for customer costs since studies did not have access to customer contracts. However, Davidson et al. (2015) illustrated that this cost does not correlate with contractually-stipulated terms (monthly payments, upfront payment, etc) and as a result,

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[1] Current incentives can be found at the Database of State Incentives for Renewables & Efficiency (http://www.dsireusa.org/).

[2] Myriad structures exist, though often the system owner in a TPO transaction is an institutional investor, or in some cases, a company with both installing and financing capabilities, termed a solar integrator. For simplification, the remainder of the paper refers to the system owner as the installer.

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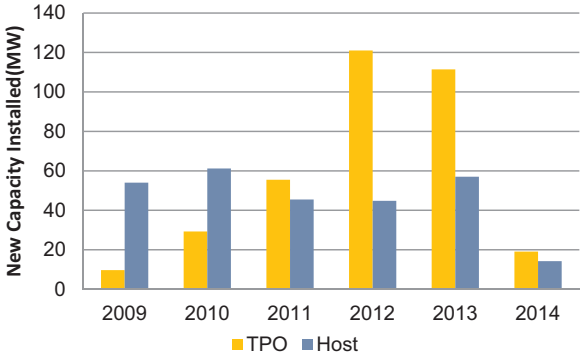

Fig. 1. Installed capacity by ownership type under CSI (2009–2014).

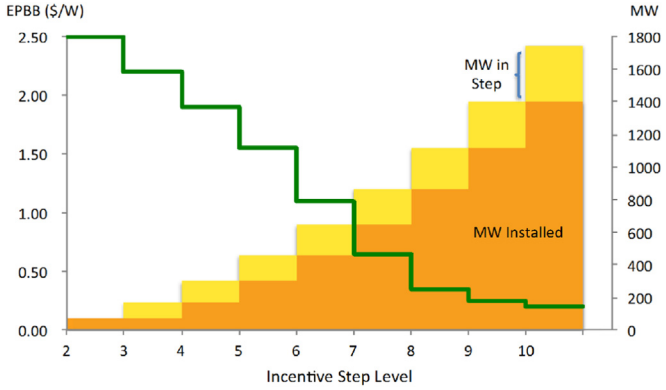

Fig. 2. Incentive amount step down schedule as a function of cumulative installed capacity targets.

provides a poor proxy. Without access to TPO contracts, previous studies have not been able to reliably estimate incentive pass-through for a majority share of the residential solar market. Further, it is quite possible that this dynamic may be different for TPO customers than host-owned customers, and that extending takeaways from host-owned pass-through rates may mischaracterize the actual result.

Theoretically, since the owner receives an additional revenue stream derived from the incentives, the installer can provide the solar customers with a discount on their solar payments, and still meet a desired return on the project. However, since payments for a third-party system are not necessarily one upfront sum—payments are often spread over the lifetime of the project and/or can contain escalator clauses[3]—it is less obvious to consumers whether their payments have been directly reduced because of the incentive levels.

This study evaluates the incentive pass-through, based on detailed data extracted from customer contracts, for third-party owned systems that received a California Solar Initiative (CSI) upfront incentive payment. The CSI incentive scheme provides an ideal natural experiment since the program incentive amounts incrementally stepped down over time as the program reached cumulative capacity targets (Fig. 2). Unlike many other incentive programs with constant incentives over time, the CSI step-down design provides discrete changes around the incentive amount over a period where other relevant factors can be assumed to remain constant, such as installed costs and customer demand.

Further, the CSI is the largest non-federal incentive program, offered to rooftop solar owners in the state's three investor-owned utilities (IOUs): Pacific Gas and Electric Company, Southern California Edison, and San Diego Gas and Electric. The CSI's objective was to stimulate the installation of nearly 2 GW of new solar capacity over the program duration (2007–2016). As shown in Fig. 2, at the beginning of the CSI in 2007 (step 2), a typical residential PV system could receive an upfront rebate of $2.5/W based on system capacity, whereas the system installation price was on average around $10/W. Within each of the three largest IOU service territories, the rebate level then decreased stepwise once a certain capacity goal for each step had been achieved. The CSI established nine steps for the entire process, with the final rebate level at $0.2/W, after which the program ended. The three IOUs administer this rebate program in their own territories with different capacity goals, and they have generally moved at different paces along the rebate ladders. Information on the then-current rebate level and the remaining capacity goals before the step changes has been constantly updated at CSI website for each IOU.

Although the CSI program has met capacity targets in all customer segments, the question of pass-through has important implications for future subsidy design. This analysis, by focusing on the third-party owned segment, sheds light on how incentives may impact ownership models differently. This analysis has important implications for developing incentives that can still meet program objectives in the context of a dynamic and growing industry.

Section 2 reviews the literature on incentive pass-through. Bear in mind that previous studies are all about host-owned segment of the industry and this analysis is focused on TPO segment because of the unique dataset. The dominance of the TPO model makes this analysis even more important. The empirical specification and data are discussed in Section 3 and the estimation results are presented in Section 4. Section 5 concludes the paper and discusses future research.

2. Literature review

The cost pass-through, which measures the change in prices resulting from a cost shock, is an important concept in various economic fields. In Industrial Organization, the analysis of pass-through has been used to evaluate merger (Jaffe and Weyl, 2013), quantify cartel damages (Verboven and van Dijk, 2009); in International Economics, whether exchange-rate fluctuations are passed through to the prices of imported goods has been discussed extensively (Goldberg and Knetter, 1997). In public finance, researchers have used pass-through to study tax incidence and subsidy pass-through (see e.g., Jenkin, 1872; Poterba, 1996; Marion and Muehlegger, 2011; Weyl and Fabinger, 2013).

In program evaluation, however, incentive pass-through rate is also a key indicator to measure how subsidies or taxes change the prices. There is a growing body of literature evaluating the incidence of incentive pass-through in the U.S. residential solar market. To date, most studies have relied on installer reported prices to evaluate incentive pass-through for third-party owned systems, rather than the payment terms stipulated in the contract between the installer and the customer. First, I discuss this existing literature to illustrate the existing theoretical foundation, data sources and methodologies that have been employed to estimate incentive pass-through. Second, I discuss research that illustrates concerns related to using installer-reported prices to proxy third-party contract prices.

Existing literature has estimated pass-through rates ranging from 17% to over 100% depending on the incentive evaluated, the data, and the model specification. Podolefsky (2013) evaluates Federal Investment Tax Credit (ITC) incentive pass-through by evaluating prices before and after the removal of the $2000 cap, estimating a 17% ITC pass-through. A small body of literature has evaluated incentive pass-through specifically as it pertains to PV systems installed under the California Solar Initiative; these coefficient estimates ranged from 45% to over 100%. The first effort to estimate pass-through in California markets was Wiser et al. (2006), based on California Energy Commission incentives and associated system data. Relying on a reduced form

[3] An escalator clause in a solar lease or PPA contract is a provision allowing for an annual increase in leasing payments or electricity prices. In the sample, around 30% of the contracts have an escalator clause and the annual escalation rate on average is 3%.