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Can product demonstrations create markets for sustainable energy technology? A randomized controlled trial in rural India[☆]

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ABSTRACT

The literature on sustainable energy technology sees informational barriers as a major obstacle to technology adoption. In the case of solar home systems, recent studies report positive socio-economic effects on households, but technology adoption remains underwhelming. In collaboration with a local solar technology provider, we conduct a randomized controlled trial in 75 large villages in the state of Uttar Pradesh, India to examine the ability of village solar demonstrations to create markets for solar home systems. We find no effect of such demonstrations on technology sales, awareness, or perceptions of solar technology. Technology adopters report high levels of satisfaction with product quality and service, suggesting that the null finding cannot be attributed to poor technology. These findings suggest that lack of awareness is not a binding constraint on the growth of solar technology markets in the study area. Based on additional surveys, we find evidence suggesting that access to credit from rural banks is an important explanation for variation in sales across villages. These results do not prove that information and awareness are irrelevant in general, but they show that even carefully designed marketing campaigns cannot increase demand for new products in the presence of a binding credit constraint.

1. Introduction

Energy poverty remains prevalent in the developing world. According to the International Energy Agency (2014), in 2012 there were still 1.3 billion people, mostly in Sub-Saharan Africa and South Asia, without basic household electricity access. And yet, the increased availability of household electricity has been shown to increase female participation in labor markets (Dinkelman, 2011), add to non-farm household income (Lipscomb et al., 2013; Chakravorty et al., 2014), improve educational outcomes (Khandker et al., 2012), and contribute to subjective well-being (Aklin et al., 2016).

In recent years, scholars and practitioners have shown considerable enthusiasm for off-grid electricity supply as an alternative to conventional grid extension, with particular interest in solar power (Jacobson, 2007; Wamukonya, 2007; Kirubi et al., 2009; Zerriffi, 2011; Brass et al., 2012; Singh, 2016). Scholars have also proposed that off-grid electricity can increase the reliability of supply when grid electricity is unreliable or of poor quality (Urpelainen, 2014). Although grid extension has historically been the primary driver of household electrification in both industrialized and developing countries (Barnes, 2007), dramatic decreases in the cost of solar technology have raised the possibility that off-grid electricity is a viable option, especially in remote, sparsely populated rural communities. The idea of decentralized renewable energy is also appealing for environmental reasons. According to Alstone et al. (2015, 313), "[w]ith a foundation of super-efficiency and carbon-free generation, supported by new ICT connectivity and applications, expanding access through decentralized power systems could have radically different climate and equity impacts from the incumbent system, challenging the conventional knowledge held by some that one must choose between progress on energy access or climate." Some scholars also emphasize the complementarity of grid extension and off-grid electrification (Urpelainen, 2014). Furthermore, studies, such as Samad et al. (2013), show that solar home systems reduce kerosene expenditures, allow children to study more, and improve the health of household members. At the international level, the United Nations has declared the years 2014–2024 the decade of Sustainable Energy for All, calling for an increased use of renewable energy to eradicate energy poverty.

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At the same time, recent observational studies highlight the behavioral barriers to the widespread use of solar technology in rural communities. Studies from Nicaragua (Rebane and Bradford, 2011) to Eastern Africa (Lay et al., 2013; Smith and Urpelainen, 2014) and Nepal (Mainali and Silveira, 2011) suggest that awareness and information might be important determinants of technology adoption. In Sri Lanka, most knowledgeable villagers also tend to be forerunners in SHS adoption (McEachern and Hanson, 2008). The lack of popular participation in solar technology promotion programs undermines the success of solar market in India and Bangladesh (Wong, 2012). A survey conducted in rural India suggests that awareness of solar technology has a large positive effect on willingness to pay for the technology (Urpelainen and Yoon, 2015). While these observational studies do not offer evidence on the causal effect of information on technology adoption, they do raise the possibility of such an effect.

If solar technology is an effective solution to energy poverty, as the studies cited above suggest, it is possible that informational barriers result in sub-optimal levels of adoption. This article examines the ability of private entrepreneurs to create rural markets for SHS products through informative village demonstrations. Specifically, we conduct a randomized controlled trial to identify the effect of solar technology demonstrations in 75 large villages with a low average electrification rate (44%) in the Unnao district in the state of Uttar Pradesh, India. A local solar technology company, Boond, conducted technology demonstrations in 37 randomly assigned treatment villages; the remaining 38 villages were randomly assigned to a control group without a demonstration. In each demonstration, Boond showed the use of the technology to villagers, provided the details of a financing arrangement that allows villagers to pay for the technology in installments over time, and answered questions. Boond also collected a list of names for interested customers. The demonstration was designed by Boond and previously used in other areas of India. We report results based on Boond's comprehensive sales database over a period of 12 months since the demonstrations began (before the experiment, Boond was not active in the villages).

The results from the experiment cast doubt on the ability of demonstrations to increase sales. The difference between the average number of sales in treated villages and the average in the control villages is substantively small and statistically insignificant. In both control and treatment villages, sales are concentrated in a small number of high-demand villages, and such villages are found regardless of the experimental solar technology demonstrations. Moreover, the solar technology demonstrations do not appear to improve awareness or contribute to positive perceptions of solar technology. In the study area, levels of awareness about solar home systems were already high before the demonstration campaign, suggesting that another area with lower levels of awareness might have made the demonstrations more effective.

In our view, a particularly important explanation for why the demonstrations do not increase sales is the credit constraint. Villages with high sales both in the control and treatment group have unusually active rural bank managers, who generate sales by advertising, offering, and rapidly processing solar product loans for interested customers. Because access to credit relaxes the liquidity constraint and allows households to gain access to a 40% capital subsidy on SHS purchases, it appears to be the binding constraint on greater sales in the area. This finding is consistent with earlier studies suggesting that credit constraints are central to understanding why the spread of solar technology is slow in the rural areas of developing countries (Rao et al., 2009; Mainali and Silveira, 2011; Friebe et al., 2013). As Harish et al. (2013, 697) put it in their survey study of solar sales in Karnataka, the solar “market is…critically dependent on the role that the banks play as intermediaries between consumers and solar firms in rural areas.”

2. Marketing and demand for new technology

Although a new technology holds potential for improving quality of life and livelihoods, these benefits are surrounded by uncertainty (Feder and Slade, 1984; Foster and Rosenzweig, 1995, 2010; Munshi, 2004; Bandiera and Rasul, 2006; Conley and Udry, 2010). In general, studies in economics emphasize both learning from doing and learning by others, following the framework established by Besley and Case (1993) and Foster and Rosenzweig (1995). For example, Conley and Udry (2010) find that, in Ghana, agricultural technology spreads across social networks when farmers learn about successes of their neighbors. Giné and Yang (2009) offer suggestive evidence that farmers in Malawi use informal insurance to deal with risks related to agricultural productivity. Based on a randomized controlled trial, Levine et al. (2012) report that when Ugandan households are offered a trial period in combination with delayed payments, improved cookstove sales increase significantly, suggesting that product risk is an obstacle to creating markets for this sustainable energy technology. Indeed, evidence from the marketing literature suggests that providing information about product quality via advertising and product experience assuages consumers’ concerns about the product (Hoch and Ha, 1986). Potential customers may be uncertain about the magnitude of the benefits promised, the quality and reliability of the product, and potential negative side effects.

In the case of solar technology, these concerns are amplified by the novel nature of the technology (Rebane and Bradford, 2011; Smith and Urpelainen, 2014; Yoon et al., 2016). Because rural households in developing countries are used to a very different lighting source, such as kerosene, they may worry about the quality and reliability of a completely different technology that promises improved lighting at an affordable cost. In a survey conducted in rural Nicaragua, for example, Rebane and Bradford (2011) find that learning about SHS technology from a business or an NGO has a large positive effect on the probability adoption.[1] At the same time, diffused learning through family, friends, or personal observation did not to have such an effect in the Rebane and Bradford (2011) study. In a similar vein, Smith and Urpelainen (2014) report the positive effect of the household head's education, even controlling for household income, on SHS adoption in a nationally representative survey in Tanzania.

The problem of lacking information is further compounded by low institutional capacity in rural areas of developing countries. With the exception of simple lanterns, distributed solar technologies require after-sales services such as maintenance (Friebe et al., 2013; Harish et al., 2013). If a household purchases an SHS and the technology provider promises a warranty of 12 months, the household may worry that the technology provider fails to honor the commitment because of enforcement problems. As Friebe et al. (2013, 767) conclude based on a survey of solar technology companies, “comparatively expensive products must be combined with services such as advisory services, maintenance, finance and capacity building.” In India, for example, Shukla and Bairiganjan (2011, 7) note that the “[a]bsence of modern technological interventions, mass media instruments and platforms (coupled with excessive reliance on social media and opinion leaders) contributes to the information asymmetry that prevents the growth of effective rural markets.” For honest entrepreneurs interested in building a profitable business in the long run, the information asymmetry could be a high barrier to sales. If the rural households do not trust the entrepreneurs, honest businessmen have no incentive to enter the market, as they will not be able to sell their products.

On the other hand, the SHS is a relatively simple technology that provides a basic service of improved lighting, which is familiar to the study population. Using electricity via the SHS is not any more difficult than using grid electricity and maintenance requirements are limited.

[1] They do not test for effects of government awareness campaigns or demonstrations.