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Subsidies for technology adoption: Evidence from rural Cameroon

**Niccolò F. Meriggi, Erwin Bulte, Ahmed Mushfiq Mobarak,
Julia Liborio**

- This research¹ examines how a short-term subsidy for a new solar lamp affects uptake, usage, and future demand for the product in rural Cameroon.
- The findings suggest that subsidies stimulate uptake of the solar lamps and do not adversely affect subsequent use of the lamps. If subsidies decrease future willingness-to-pay for lamps, this effect is outweighed by increased learning about the benefits of the solar lamps.
- Lowering prices via subsidies also encourages uptake by households who don't use the lamp very much.
- Additionally, information about the benefits of solar lamps does not seem to spread far beyond the source households who purchased the lamp.
- The findings can help policymakers better design subsidy programmes to encourage the uptake and use of clean energy products.

POLICY BRIEF

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¹ This research has been published in the Journal of Development Economics, Volume 153, November 2021. The full article can be accessed [here](#).

Policy motivation for the research

About 789 million people worldwide still lack access to electricity. According to the International Energy Agency (IEA), the electricity access rate in sub-Saharan Africa is only 47%. The majority of these households, especially in rural areas, are unlikely to be connected to the electricity grid in the foreseeable future due to the high costs of grid expansion.

Many economic studies find that price is a primary barrier for adoption of apparently cost-effective technologies such as energy-efficient devices. Given the importance of adopting productive and clean new technologies for inclusive and sustainable growth, guidance on the most effective ways to overcome the price barrier is vital. In that sense, subsidies are the most direct way to address price concerns.

This study looks at the effects of subsidies on the short- and long-run adoption of solar lamps in rural Cameroon, where most people do not have access to on-grid electricity and rely on kerosene lamps for lighting. Solar lamps are a clean, low-cost alternative and provide relatively high-quality lighting.

While many mechanisms to increase uptake such as price and social learning have been examined individually for specific products in separate contexts, one of the contributions of this study is to investigate all these mechanisms jointly for the same product in the same context, to generate a more comprehensive understanding of short- and long-term demand.

This study contributes to the understanding of the welfare costs associated with subsidising access to goods and services for the poor, and ongoing policy debates about subsidising access to electricity for poor households in rural areas.

Overview of the research

The research focuses on the adoption of a portable solar lantern marketed in Cameroon by a joint venture of the for-profit multinational TOTAL and a social enterprise called D. Light. This lamp is called the D. light S20®: a water resistant and durable lantern, characterised by a high-efficiency solar panel. It was advertised as a high-quality alternative to kerosene lanterns.

The study was conducted in the Adamawa region of northern Cameroon with a representative sample of 199 villages, randomly selected from all villages in the 2005 census. Adamawa is a sparsely populated region with approximately one million inhabitants (and five TOTAL gas stations at the time of the study). According to the United Nations Development Programme (UNDP), slightly more than half the population live below the poverty line and Adamawa is the second least-developed and third least-educated region of Cameroon as per data from the IEA. While Muslim Fulbe (Fulani) are the major ethnic group in this region (60%), other ethnic groups are also present, including people of Paleo Sudanese and Bantu origins. The main economic activity in the region is cattle herding.

Very few households in the region had transitioned to battery-powered LED lighting when data was collected. More than 95% of respondents still used kerosene lamps as their main source of lighting, providing light of low quality at relatively high cost, and with adverse environmental and health effects.

A listing and mapping exercise was conducted in the spring of 2013, which included a household questionnaire to collect baseline information. In 27 villages, no villagers proved eligible for the other intervention and so these villages were dropped from the sample. In the remaining 172 villages, several households included in the first wave of data collection satisfied the eligibility criteria.

The data was analysed in two stages to study how short-term subsidies affect demand for the solar lamps and intensity of lamp use. By using a research design that relied on auctioning off solar lamps, the researchers were able to trace out the full demand for the solar lamps at different price levels in the villages. The transaction price for the solar lamp was randomly varied at the village level in Stage 1 of the experiment to explore how these prices affect willingness-to-pay for identical lamps. In Stage 2, the same was done two years later involving a new sample of nearby villagers. The study also examined if prices affected how much the lamps were used and explored how the experiences of early adopters, and the prices they paid, affected willingness-to-pay of nearby villagers who did not participate in the first auction (named 'co-villagers' in this study).

Key findings

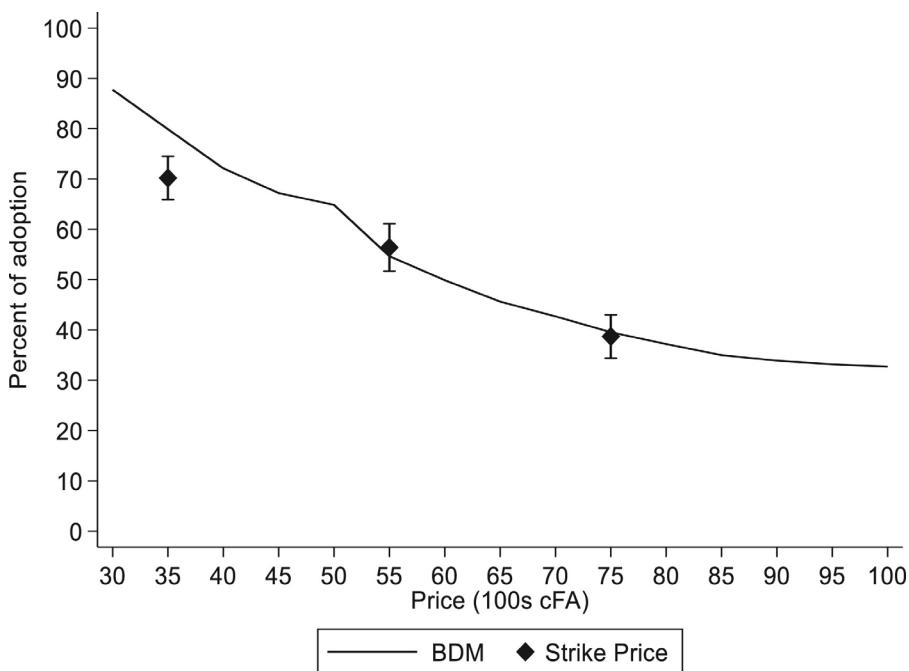
1. Demand for solar lamps drops sharply as prices rise.

The share of study participants bidding higher than the transaction price for the solar lamps drops sharply as prices increase. While 70% of the households indicate that they are willing to pay at least 3,500 FCFA (Central African CFA Francs) – approximately \$6 – for the solar lamp, the adoption rate drops to less than 40% for the high price of 7,500 FCFA (see Figure 1). Such price-elastic demand is consistent with earlier studies on the adoption of new technologies by the poor.

Looking at the stated auction bids, some 30% of the population indicated a willingness-to-pay price matching a best estimate of the lamp's full cost. While lowering the full price from 10,000 to 6,000 FCFA increases the share of adopters by 20%, a smaller discount offered to lower the cost from 6,000 to 3,000 FCFA increases this share by approximately 40%.

The demand curve reveals useful information for policymakers interested in promoting adoption of solar lamps.

Figure 1: Demand for solar lamps (pooled bids).



2. Subsidies greatly increase uptake of solar lamps.

Only a minority of respondents in the sample would purchase a lamp when traded at market prices. The evidence shows how the probability of adoption of solar lamps falls by 14–22 percentage points (depending on specification) when the price increases from 3,500 to 5,500 FCFA and by 31–39 percentage points when the price increases to 7,500 FCFA. The latter treatment effect is large, cutting adoption by 44%. Without subsidies, many poor households use expensive kerosene, or sit in the dark during the evening and night.

3. The prices paid for lamps do not affect how much they are used.

Subjects paying more for the lamp do not seem to use it more intensively. Indeed, there is weak evidence to the contrary: respondents paying the highest price on average use the lamp fewer minutes (at least when recalling use in the last 72 hours). Perhaps this reflects that people who paid a high price treat the lamp more cautiously. This effect is to some extent driven by zero usage. Two years after the sale, about 40% of the respondents reported not using the lamp at all during the past 72 hours. Zero usage could also be due to a worn-down battery.

4. Uptake of the solar lamp, spurred by low prices, positively affects future willingness-to-pay.

Households who have experienced the lamp in their household are willing to pay more than double the amount offered by those who have not adopted the lamp yet. This is consistent with a strong learning effect about the benefits of the solar lamp.

5. There is no evidence of social learning.

While subsidies facilitate a household's own learning about the solar lamp's benefits, there's no evidence of this learning spreading among random

villagers. Information about the benefits of solar lamps does not seem to spread far beyond the source households who purchased the lamp.

Willingness-to-pay in the second stage of the experiment by co-villagers is not correlated with past prices charged locally or with the number of nearby adopters. Indeed, the average percentage of all villagers owning a lamp is twice as high in villages with a low transaction price (6.7%) than in villages with a high transaction price (3.4%).

Policy considerations

If subsidies invite wasteful behaviour or cripple the development of future product markets, then policymakers cannot rely on conventional cost-benefit analyses to assess the efficiency of subsidy programmes. Cost-benefit models would have to be enriched with behavioural considerations. The study's results suggest that, at least for solar lamps and for this study's sample population, this shouldn't be a matter of concern for policymakers.

- Villagers who pay more for the lamp do not seem to use it more intensively. Short-term subsidies increase future demand – once they have a lamp, villagers 'learn' about the benefits of the lamp and are willing to pay more for it in the future.
- Subsidies, however, also attract low-intensity users, which compromises the efficiency of subsidy programmes. Ideally, a subsidy programme should balance the efficiency losses due to potential economic growth and more profitable investment opportunities with efficiency gains from learning.
- In the absence of subsidies, the majority of the target population does not buy solar lamps, hence ambitions to provide universal access to electricity will not be reached by market-based approaches only.
- While learning about the benefits of the lamp increases willingness-to-pay, the majority of the experienced respondents still bid below the full cost of the lamp during the second auction (to obtain a second lamp). If a gap remains between provision cost and willingness-to-pay, even for small-scale and inexpensive solar technologies, it seems highly unlikely that expanding electricity grids into rural areas can be a welfare-enhancing proposition in the near future.
- If the benefits of solar technologies do not cover the full cost, then subsidies for electricity are likely welfare-reducing, unless positive external effects such as increased learning and use of green technologies make up for the gap between price and willingness-to-pay.

This analysis is not meant to be the final word on the welfare effects of short-term subsidies. In the context of this study, respondents are unaware of the product's market price. In other contexts, knowledge about market prices is more widespread, which could matter for the impact of subsidies.