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QUALITY SIGNALING AND DEMAND FOR RENEWABLE ENERGY TECHNOLOGY: EVIDENCE FROM A RANDOMIZED FIELD EXPERIMENT

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Quality Signaling and Demand for Renewable Energy Technology: Evidence from a Randomized Field Experiment

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ABSTRACT

Solar technologies have been associated with private and social returns, but their technological potential often remains unachieved because of persistently low demand for high-quality products. In a randomized field experiment in Senegal, we assess the potential of three types of quality signaling to increase demand for high-quality solar lamps. We find no effect on demand when consumers are offered a money-back guarantee but increased demand with a third-party certification or warranty, consistent with the notion that consumers are uncertain about product durability rather than their utility. However, despite the higher willingness to pay, the prices they would pay are still well below market prices for the average household, suggesting that reducing information asymmetries alone is insufficient to encourage wider adoption. Surprisingly, we also find that the effective quality signals in our setting stimulate demand for low-quality products by creating product-class effects among those least familiar with the product.

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1. Introduction

Many goods and services markets are characterized by imperfect and asymmetric information. One common problem is that low-quality products are observably indistinguishable from high-quality products at the point of purchase, leading to a "market for lemons" (Akerlof 1970). The result is an inefficient outcome in which high-quality products are pushed out of the market since consumers that would otherwise be willing to purchase them are unwilling to pay the appropriate premium when their quality is unknown. This issue is especially germane in low-income countries, where institutions to ensure product quality are limited and goods are purchased from itinerant vendors with limited reputational capital at stake. Many theoretical and empirical studies have examined different quality-signaling approaches[1] to overcome these challenges (for literature reviews, see, for example, Riley 2001; Dranove and Jin 2010; Heiman and Hildebrandt 2018). While a variety of quality signals have been useful in correcting quality perceptions across diverse empirical settings, no studies compare the ability of different signaling interventions to address different aspects of the asymmetric information problem in one setting. Moreover, the evidence base for the effects of various signaling approaches on actual consumer demand is quite uneven.[2] We fill this void by running a randomized field experiment to compare the impacts of several popular and empirically understudied quality-

[1] Following quality-signaling theory, we use the term *quality signal* to encompass all potential mechanisms to overcome information asymmetries about product or service quality between buyers and sellers. Examples of quality-signaling mechanisms are the product price (for example, Wolinsky 1983; Milgrom and Roberts 1986), advertising (for example, Nelson 1970; Schmalensee 1982), warranties (for example, Spence 1977; Grossman 1981), and certification (for example, Auriol and Schilizzi 2015; Chatterjee 2020).

[2] The effects of third-party disclosure have been empirically examined in a range of settings including report cards for education and health services (for example, Dranove et al. 2003; Hastings and Weinstein 2008), hygiene scores for restaurants (for example, Dai and Luca 2020), certification for sports-card traders (Zhe Jin, Kato, and List 2010), buyer-satisfaction scores for online sellers (Klein, Lambertz, and Stahl 2016), certification of fertilizer quality (Michelson et al. 2021), and press releases about employers found to be violating safety and health standards in a recent inspection (Johnson 2020). In contrast, there is little empirical evidence on quality signaling through assurance mechanisms, despite their prominent role in quality-signaling theory (for example, Spence 1977; Grossman 1981; Gal-Or 1989). One example is provided by Roberts (2011), who analyzes the effect on overall market prices of the introduction of a market-wide buyer-satisfaction guarantee. Another example is Lewis (2011), who examines the effects of warranties on demand by comparing products for which the warranty period has ended with products with an active warranty.

signaling interventions on consumer demand for renewable energy technology in a market setting in sub-Saharan Africa.

Decentralized solar technologies are associated with significant private and social returns in developing countries.[3] A wide range of service levels is available, allowing households to dynamically scale and address varying electricity demands. Moreover, with grid electricity either not (yet) available, too expensive, or unreliable (for example, Lee et al. 2020; Aarakit et al. 2021; Deutschmann et al. 2021; Valickova and Elms 2021), they have emerged as low-cost and clean alternatives—particularly in rural areas (Deichmann et al. 2011; Grimm et al. 2020). However, despite potential benefits and decreasing prices due to declining production costs (for example, Glemarec 2012), households still appear to underinvest in solar technology in terms of scale and quality. Several market imperfections have been identified as potential barriers. Credit and liquidity constraints significantly inhibit households from purchasing high-quality solar technologies, but alleviating these constraints is currently insufficient to raise the willingness to pay to reach cost-covering prices (Abdul-Salam and Phimister 2019; Grimm et al. 2020; Sievert and Steinbuks 2020). In addition, providing accurate information during the sales process (Mahadevan et al. 2023) and information about the technologies' private and public benefits (Mekonnen et al. 2023) has not been found to significantly increase demand for high-quality products.

In this paper, we examine whether information asymmetry concerning product quality may contribute to the low willingness to pay for solar technology. Markets for off-grid solar products are largely unregulated and dominated by highly affordable products without quality verification that may break easily, harming the environment through avoidable electronic waste (Kinally et al. 2022) and eroding confidence in the technology (Lighting Global 2020).[4] While

[3] Evidence suggests that relative to other lighting sources such as battery-driven flashlights or kerosene-driven lamps, solar lamps substantially reduce household energy expenditures and improve educational outcomes for children (Bensch et al. 2012; Hassan and Lucchino 2016; Grimm et al. 2017; Lemaire 2018). Moreover, reducing consumption of dry-cell batteries plausibly leads to environmental benefits (Grimm et al. 2017; Stojanovski et al. 2017; Wagner et al. 2021), while reduced kerosene lamp usage has potential health benefits (Lam et al. 2018; Kudo et al. 2019).

[4] VeraSol (formerly Lighting Global Quality Assurance; https://verasol.org/about-quality-assurance/) is the world's most widely recognized quality-assurance framework for pico-solar technologies. Its webpage discloses laboratory test results and is mainly tailored to an audience of sector experts. While some products are designed

information asymmetries are frequently mentioned as a barrier to adoption (Chowdhury and Mourshed 2016; Urpelainen 2016; Stojanovski et al. 2017; Aklin et al. 2018; Balls 2020; Groenewoudt et al. 2020; Samarakoon 2020; Wassie and Adaramola 2021), quality-disclosure and -assurance programs aimed to overcome the problem have not been analyzed.

We contribute to the literature by providing the first empirical evidence on the effect of three quality-signaling mechanisms in Senegal on the demand for solar lamps:[5] third-party certification, warranties, and money-back guarantees (MBGs). These three treatments aim to either disclose or assure quality to potential consumers (Dranove and Jin 2010). A certificate is defined as an effort to systematically measure and disseminate verifiable information about product quality. The quality is frequently disclosed to the consumer through a reputable independent third-party provider, which makes the information (more) credible (Auriol and Schilizzi 2015; Stahl and Strausz 2017; Zapechelnyuk 2020). Warranties and guarantees convey information to the consumers about the quality of a product for a different reason: seller costs are increased if product quality is low (Spence 1973). They are typically provided by the private sellers themselves and, thus, require product quality to be sufficiently high to be economically feasible (Kuksov and Lin 2010; McWilliams 2012). Warranties are designed to insure against product performance failure and durability risks (Spence 1977; GalOr 1989; Padmanabhan and Rao 1993; Heiman and Hildebrandt 2018), while MBGs are designed to insure against a poor fit between consumer preferences and product features by allowing

and manufactured well, others fall short of expectations with regard to quality (that is, safety, durability, and performance). For instance, a test was conducted among a group of top-selling non-quality-verified solar products in five domestic markets across Africa and South Asia in 2017. The results showed that almost all products have one or more deficiencies affecting product durability (Lighting Global 2018). Moreover, Groenewoudt et al. (2020) analyze the Ugandan off-grid solar product market and identify three market segments: high-quality, low-quality, and no-quality products, with the latter comprising junk and fake products. They conclude that of all market segments, the high-quality products will offer the most reliable, high-quality energy access. However, we acknowledge that the quality differences between quality-verified and nonverified solar lighting products is currently somewhat debated in the literature (Girardeau et al. 2021). A few studies suggest that the quality differences are small. For instance, Bensch et al. (2018) explain that nonverified solar products (more specifically solar home systems) in Burkina Faso have similar service levels compared to quality-verified systems and calculate that they incur lower costs under the assumption of a lifespan of at least two years. However, the authors also report a disadvantage of nonverified solar products in terms of subjective user-satisfaction ratings.

[5] The lamps come with a solar panel that charges the battery by producing electrical energy from sunlight. They provide basic lighting and phone-charging capabilities, meeting the first level of energy access (Tier 1) defined by the World Bank's multitier framework (Bhatia and Angelou 2015).

consumers to experience the good for a certain amount of time (Moorthy and Srinivasan 1995; Heiman et al. 2015; Heiman and Hildebrandt 2018). By directly contrasting, for the first time, various individual approaches in terms of their impact on actual consumer decision-making in a single experiment, we elucidate which of the theorized mechanisms drive the inefficiencies in markets for products with asymmetric information of this nature (for example, Matthews and Moore 1987).

More specifically, our field experiment provides potential consumers in rural Senegal with the option to buy a high-quality solar lamp or a solar lamp of relatively low quality (to which we refer, for brevity, as a low-quality lamp). We hypothesize that the inability of households to differentiate between low- and high-quality lamps may lead to uncertainty about the lamps' durability and usefulness for the household once purchased. This uncertainty can lead consumers to avoid large investments in solar lamps even though, in expectation, relative to a low-quality solar lamp, high-quality products bring lower lifetime costs at higher performance levels and therefore are likely to provide a higher return on investment.

Our randomized interventions are largely scalable. In fact, the third-party quality-assessment scheme was established by the World Bank Group's Lighting Africa Program with the explicit aim of overcoming purchase uncertainty and, by doing so, accelerating market growth of high-quality solar products to help achieve low-carbon energy-access targets (Murphy and Sharma 2014; Lee et al. 2020). The studied warranty was initiated by the implementation partner, Total Senegal. Our analysis of the demand effects of such a warranty scheme allows us to shed light on the incentives for private sellers to invest in this type of quality-signaling tool in a lower-income-country setting, where it is much less common than in advanced economies.

The quality difference between the lamps used in the experiment is unobservable by visual inspection. Accordingly, households reveal no preference for one or the other at baseline. We measure demand for both products by eliciting the participants' willingness to pay (WTP) using the approach developed by Becker, DeGroot, and Marschak (1964). This elicitation method is a real-purchase bidding game, which allows us to elicit revealed WTP. When assessing the demand for the high-quality lamp, we randomly assign the participants either to receive one of the three quality signals—third-party certification, a two-year warranty (2YW), or a six-week MBG—or to participate in the control group.

We find positive effects on WTP for high-quality lamps presented with the certificate or warranty. In contrast, we observe no effect on WTP for products offered with the MBG. These findings are consistent with the notions that the consumers' uncertainty is largely about the product's durability rather than its utility and that both quality disclosure and warranty are effective approaches for conveying information about product durability. However, while this lack of information can partially explain the low demand for high-quality solar lamps, signaling product durability only partially closes the gap between WTP and market prices. The substantial increase in WTP of about 12–14 percent observed for high-quality solar lamps presented with certification or the 2YW is in the range of effect sizes that have been observed for interventions aimed to ease credit and liquidity constraints (for example, Grimm et al. 2020). This implies that the impacts of the quality signals that were observed to be effective in our experiment also fall short of shifting the average WTP beyond the full market price. However, given recent VAT exemptions and reductions in import tariffs on quality-compliant products in Senegal (Lighting Global 2022a), we estimate that the Lighting Global certification (LGC) and the 2YW have the potential to lift WTP above the new effective market price for around 15 percent of the sample. Thus, our quality signals are expected to affect demand for high-quality solar lamps under these new circumstances.

Surprisingly, we find that although the treatment only applies to the high-quality lamp, the certification and warranty treatments also increase WTP for the low-quality lamp—that is, a competing product of inferior quality with similar observable characteristics. Thus, quality signals appear to change perceptions about the entire product class and not solely the specific product at which they are targeted (Ackerberg 2001). We probe this result by examining the role of consumer experience with solar lamps and find that the observed increase in WTP for the low-quality lamp is concentrated among inexperienced consumers.[6] Taken together, our results suggest that quality-signaling treatments for experienced consumers yield the classical prediction of a separation of low- and high-quality demand curves (Akerlof 1970), while the same intervention for inexperienced consumers appears to convey information about solar lamps more generally. It is also only among the former that we find a separation in the quality perceptions between the two lamps. Among inexperienced consumers, the quality-signaling

[6] Various studies in the quality-signaling literature find heterogeneous consumer responses to third-party information based on consumer experience with the product (Jin and Sorensen 2006; Wedig and Tai-Seale 2002; Dutta et al. 2022) and consumer familiarity with the product (Dafny and Dranove 2008).

treatments seem to serve as a general information campaign that drives up demand for both types of lamp.

Certification and (to some extent) warranties have broader applicability to markets in which product quality is variable and difficult to infer upon initial inspection, such as those for agricultural inputs, food, and repair services (Bai 2021; Michelson et al. 2021). Our results seem most relevant for rural areas in low-income countries across the globe where vendors typically go from one place to another selling products of unknown quality. By demonstrating the applicability of well-established economic theory to experienced consumers in a natural-experiment field setting (Harrison and List 2004), our results strengthen the case for applying this theory to other market settings (List 2020). However, our results also underscore important differences in the treatment effects between experienced and inexperienced consumers with welfare implications that represent an important area for future research.

The remainder of the paper is structured as follows. In Section 2 we introduce the study design, which includes a description of the solar lamps in the experiment, the quality-signaling treatments, and the method for eliciting WTP. Section 3 presents and discusses our empirical strategy. We provide our core results in Section 4 and discuss them in Section 5. Section 6 explores underlying mechanisms, and Section 7 concludes.

2. Study Design and Data

We conducted a randomized field experiment in the Fatick region of Senegal and elicited revealed WTP for low- and high-quality solar lamps. From September to October 2018, we visited 960 households in forty remote villages without access to grid electricity. Under the supervision of a field coordinator, eighteen enumerators implemented a door-to-door campaign[7] to run the WTP elicitation exercise for the solar lamps, provide the quality-signaling treatment for the high-quality solar lamp, and issue a short survey. The study was introduced to participants with the goal to learn about energy usage in rural Senegal to inform the World Bank's project work. Figure 1 summarizes the study design. In each village, twenty-

[7] Solar lamps are sold not only in conventional markets but through door-to-door campaigns in which salespeople market the lamps at consumers' homes.

four compounds[8] were selected after a rapid assessment of the village population conducted with the help of traditional authorities (that is, village heads). All selected compounds willing to comply with the rules of the WTP elicitation exercise were eligible to participate. To limit information spillovers regarding the quality-signaling treatments, only one household per compound was interviewed.

[Insert Figure 1 near here]

When a household agreed to participate, enumerators began a survey with the household head to capture basic socioeconomic characteristics and energy consumption patterns. A randomization procedure embedded in the electronic questionnaire then assigned respondents to (i) a lamp-presentation order (that is, low- or high-quality solar lamp first) and (ii) one of the three quality-signaling intervention groups.[9] A fourth group was the control group, for which the high-quality solar lamp was offered without any quality-signaling intervention. In total, 960 participants took part in the survey and the subsequent elicitation exercise; 479 participants were presented with the low-quality lamp first, and the remaining 481 participants were shown the high-quality lamp first. The different quality-signaling groups and the control group were roughly the same size (that is, one-fourth of the total). The treatment was delivered by the enumerator when eliciting WTP for the high-quality solar lamp. The enumerators explained to participants that the respective treatment only applied to the high-quality solar lamp but did not directly communicate information about its quality. Moreover, study participants were informed in advance that they would be asked to state their WTP for both lamps but that only one lamp would be offered to them at the end of the WTP elicitation exercise. The lamp offered was determined with a random draw. In the remainder of the section, we describe the two types of lamps and provide a short overview of the solar technology market in Senegal. We then present the three quality-signaling intervention treatments and briefly describe the bidding game for eliciting WTP.

[8] Compounds are well-defined groupings of typically two to five related households that share common areas within a clear geographical boundary.

[9] Treatment- and control-group assignment was done with simple randomization stratified by village.

2.1 Solar Lamps Offered in the Experiment

We partnered with Total Senegal to offer households the option to purchase a high-quality solar lamp. The d.light s20 solar lamp can illuminate a single room for four hours once fully charged, has a life expectancy of five years, and costs approximately XOF 8,500 (approximately USD 15) at Total Senegal shops located at high-traffic points along the road network. In our study areas, the lamp is not otherwise readily available at village markets. The s20 lamp was certified by the third-party organization Lighting Global after undergoing a series of laboratory tests to assess its quality on multiple dimensions.[10]

In comparison, lamps of lower quality (including those offered in our experiment) are more commonly found in local markets. They cost approximately XOF 2,500 (around USD 4) and have a life expectancy of approximately six months. They are observationally similar to the high-quality lamp (see Figure A1 in Appendix A). Among the control group—to which the high-quality lamp was not presented with any quality signal—the two lamps were indeed valued at similar prices.[11]

The rural electrification rate in Senegal is still under 40 percent (Diouf and Miezan 2021), and where the grid is available, the service is characterized by low reliability and high prices (Signify Foundation 2019). Yet rural households in Senegal have high demand for electricity—in fact, Deutschmann et al. (2021) find that both households and businesses are willing to pay a premium over current tariffs to receive quality electricity service without outages. Therefore, until reliable and affordable grid connections are available, off-grid solar technologies will offer a convenient option for meeting electricity needs in rural Senegal. However, quality standards are insufficiently enforced and only a handful of local retailers invest in signaling quality. Recently (after the experiment was conducted), Senegal ramped up efforts toward creating a more favorable environment for high-quality solar companies. In 2020, Senegal joined other sub-Saharan African countries in providing VAT or duty exemptions for solar energy kits and components. Moreover, Senegal fully adopted the globally recognized International Electrotechnical Commission standards in January 2021, which contain quality standards for solar kits developed by the Lighting Global program (Lighting Global 2022a).

[10] For more details on quality standards by Lighting Global, see https://www.lightingglobal.org.

[11] The difference in the WTP between the high-quality and low-quality solar lamps is not statistically significant conditional on having experience with the technology (see Table 4).

2.2 Quality-Signaling Treatments

We tested and compared three interventions designed to address information asymmetries and risk associated with purchasing a new and potentially low-quality product: (1) third-party certification, (2) 2YW, and (3) MBG.

Third-Party Certification

In the certification intervention, an enumerator explained to the participant that the d.light s20 solar lamp's quality was certified by Lighting Global. The enumerator presented a certificate that verified the quality and included the Lighting Global and World Bank logos (see Figure A2 in Appendix A). While the LGC applies to all d.light s20 solar lamps, the certification information is only available on the Lighting Global website, meaning that few, if any, of the customers in our sample were previously aware of its existence. Lighting Global systematically measured different durability and performance features of the lamp, and it reports the lamp's quality on the certificate. Hence, while the certificate may not insure against durability and performance risk (Heiman and Hildebrandt 2018), it serves as a quality signal by disclosing information (on the lamp's durability and performance) delivered by an independent third party (Dranove and Jin 2010; Auriol and Schilizzi 2015).

Two-Year Warranty

The warranty intervention assured participants that the solar lamp comes with a 2YW that allows the participant to replace the lamp if it breaks during the warranty period. Replacements are only possible in Total Senegal shops. The product also comes with a two-year manufacturer warranty; however, in practice, this information is not salient, as customers do not have a viable way of contacting the manufacturer (in China) in case the lamp fails. For these reasons, Total Senegal initiated its own warranty scheme for the product (see Figure A3 in Appendix A). The warranty signals quality by assuring customers they will be aided in the event of mechanical failure and by reducing durability and performance risk (Spence 1977; Heiman and Hildebrandt 2018). This matters because these product features are often hard to assess at the time of purchase (Emons 1989; Boulding and Kirmani 1993; Padmanabhan and Rao 1993).

Money-Back Guarantee

The MBG assures participants they will be able to return the product for a full refund at a Total Senegal shop within a six-week period if they are unhappy with it for any reason. This intervention was created specifically for the study to test whether uncertainty is connected to the fit between the product and the consumer. In contrast to the 2YW, the short period of the MBG would not be sufficient for households to assess durability since a breakdown was unlikely to occur within six weeks. In choosing the length of the MBG, we followed the typical length of a thirty- to sixty-day period (Moorthy and Srinivasan 1995). By offering a costly MBG and allowing the user to experience the product, the issuer of this guarantee signals high product and brand quality (Kuksov and Lin 2010; McWilliams 2012). Hence, the MBG reduces performance and fit uncertainties by allowing consumers to experience the good for a certain amount of time (Heiman et al. 2001; Heiman and Hildebrandt 2018). For MBGs to work, the consumer has to perceive them as believable (Jeng et al. 2014); for this reason, the guarantee coupon carries both the World Bank Lighting Africa label and the Total Senegal logo (see Figure A4 in Appendix A). Both institutions are among the most reputable in the market, and we thus expected people to be familiar with them as reliable players in the market.[12]

2.3 Elicitation of Willingness to Pay

Our WTP elicitation process followed the Becker-DeGroot-Marschak (Becker, DeGroot, and Marschak 1964), or BDM, elicitation method. Respondents first participated in a practice round in which they were asked to make a price offer for a small bar of soap.[13] They were told that a random price (within a range that approximates actual market prices) would be drawn and, if the price turned out to be higher than their offer, they would not be able to purchase the item.[14] If the price turned out to be lower than their offer, they would be required to purchase the item at the drawn price. Bidders had to commit to paying for the solar lamp on the day of the

[12] We do observe relatively high trust levels toward the World Bank and Total Senegal among our study sample (see Table 1); around 70 percent indicate (very) high trust toward the World Bank and around 65 percent toward Total Senegal.

[13] In the practice round with soap, participants were not obliged to buy the soap. Moreover, participants were not endowed with a participation fee.

[14] No concrete price range was given to participants.

enumerator's visit. Once the practice round was completed and the enumerators were assured that the participant understood the procedure, the same process was followed to elicit offers for the low- and high-quality lamps.

We selected the BDM process because it is an incentive-compatible approach for eliciting revealed WTP (Berry, Fischer, and Guiteras 2020) and overcomes many of the biases associated with other forms of elicitation (for example, Blumenschein et al. 2008).[15] Each surveyor was required to follow a standardized script on their tablet and to never indicate the quality of the different lamps. The script included the BDM rules, a description of the lamps, and, when applicable, the details of the quality-signaling intervention. This helped to ensure that the offer was provided consistently across households and that participants judged the quality of the product on their own.

3. Empirical Strategy and Descriptive Statistics

To estimate the impact of each intervention, we use the following specification:

$$(1) \qquad logWTP_i = \alpha + \sum_{j=1}^{3} \beta_j T_{ji} + \epsilon_i$$

Here, WTP_i is the outcome of interest for participant i (namely, the WTP for the solar lamp in log form),[16] $j = \{1,2,3\}$ represents each of the three treatment arms, T_{ji} is a dummy variable equal to 1 if participant i is assigned to receive treatment j and 0 otherwise. β_j is the estimate of the average effect of intervention j. We estimate Equation 1 for both solar lamps separately and look at the difference in WTP between the high- and low-quality lamps as a third outcome to test whether there is a separation of demand curves.

Table 1 summarizes the key sociodemographic characteristics of the participants; their trust levels toward the World Bank, Total Senegal, and nongovernmental organizations in general; and their past experience with solar lamps. It indicates that the average monthly available income amounts to XOF 42,758 across both groups. About 60 percent have a monthly

[15] If the participants overstated their real reservation prices, they would have to buy the product at a price higher than their actual valuations. However, by understating their real reservation prices, they might miss a purchase opportunity at a price less than or equal to their valuations.

[16] Because of some large outliers, we winsorize the participants' WTP using a conservative cutoff at the two lower and upper percentiles.

available income allowing them to purchase the high-quality solar lamp with a market price of XOF 8,500. Moreover, Table 1 shows that randomization into treatment and control groups was generally successful, with only one unbalanced characteristic: participants in the control group are slightly more willing to take risks (p-value = 0.077). The magnitude of this statistically significant difference is small. More detailed balance tests on each treatment and control group are shown in Table B1 in Appendix B and reveal that between each of the groups, there are further small significant differences in selected characteristics. We estimate Equations 1 and 2 with and without these control variables to explore whether our findings are sensitive to any bias induced by the small imbalances between each treatment and the control group.

[Insert Table 1 near here]

4. Results

Among the 960 participants in our survey, 515 placed a successful offer (that is, they stated a WTP equal to or above the drawn price) and were offered the lamp that was designated during the random draw. Of the 515 participants, 31 (or 6 percent of successful bidders) did not follow through with the purchase. The main reason was liquidity constraints coupled with overconfidence in being able to secure the money before the surveyors' departure.[17] The remaining 484 participants were able to pay for the offered solar lamp in full on the day the experiment took place. The high follow-through supports the argument that the BDM approach successfully elicits real demand.

Another convenient feature of the BDM method is that it allows us to trace a detailed demand curve by eliciting exact point-of-purchase prices. As our primary outcome of interest, the next subsection starts with the demand for the high-quality d.light s20 solar lamp measured through WTP elicited using the BDM approach.

[17] The thirty-one decliners were relatively equally distributed among the three treatment arms: nine decliners were in the control group, ten in the LGC group, four in the 2YW group, and eight in the MBG group. However the thirty-one decliners are less equally distributed among the two types of lamps: twenty-eight were among those that were assigned to receive the high-quality lamp and three were among those that were assigned to receive the low-quality lamp. Yet the allocation logarithm was overall skewed toward assigning the high-quality lamp (that is, 90 percent of the overall sample were assigned to the high-quality lamp).

4.1 Demand for the High-Quality Solar Lamp

To visually portray the effect of each quality-signaling intervention on the demand for the high-quality solar lamp, Figure 2 shows separate demand curves for all three treatment groups and the control group.

[Insert Figure 2 near here]

The blue line depicts the demand for the high-quality solar lamp when no quality signal is presented with it. While the MBG (orange line) does not lead to a significant increase in WTP, we observe an upward shift of the demand curves among participants who received the LGC or the 2YW. Thus, the treatments that reduce durability and performance risk either through disclosing information or through an insurance scheme lead to a statistically significant increase of XOF 303–42 (approximately USD 0.50).

We observe the same pattern when estimating Equation 1. The results are presented in Table 2. The effect of each treatment is indicated (with and without controls) in Columns (1) and (2). Since we observe a positive effect for the LGC and the 2YW, we pool these two treatments in Columns (3) and (4) and exclude participants who received the MBG. Observing no significant effect for the MBG but significant effects for the other two treatments gives credence to our experimental setup, as we would expect broader impacts in the presence of, for instance, experimenter demand effects or halo effects stemming from reputation gains resulting from the presentation of the logos of highly reputable institutions (the World Bank and Total Senegal). The World Bank logo appears on the LGC and the MBG, and the Total Senegal logo is imprinted on the 2YW and the MBG. Given that we observe significant positive effects for the LGC and the 2YW but not the MBG, neither the World Bank logo nor the Total Senegal logo seems to be driving our results.

On average, the WTP for the high-quality lamp increases by approximately 12–14 percent when the participant is presented with a quality signal about durability. This finding is consistent with the notion that the consumers' uncertainty is largely about product durability rather than product utility. All effects of the durability signals on WTP for the high-quality lamp are significant with and without adjusting for multiple hypothesis testing, when conducting randomization inference, when measuring WTP in levels, and with different levels of winsorization (see Appendix C).

In terms of effect size, our findings are comparable to the results of other studies addressing barriers to solar technology adoption. Grimm et al. (2020) find that relaxing liquidity constraints increases WTP for different solar kits by at most 13 percent in Rwanda. Yoon et al. (2016) analyze whether a trial period and postponed payments increase WTP for solar lamps in India. They observe that the postponed payment increases WTP by about 17 percent. In line with our findings for the MBG, they find no evidence for the effectiveness of a trial period. Both studies conclude that the observed increases in WTP are not enough to reach cost-covering prices, as do we. With a market price of XOF 8,500, the average WTP of around XOF 2,700 when the high-quality solar lamp is presented with the LGC or the 2YW—though higher than when presented without any quality signal—is insufficient for the participants to purchase it at prevailing prices. Hence, while information asymmetries about product quality seem to be a relevant barrier to adoption, other barriers, such as credit and liquidity constraints but most importantly lack of affordability, factor in as well.

As mentioned in Section 2, VAT exemptions and reductions in import tariffs on quality-compliant products have effectively lowered prices for consumers since 2020 (Lighting Global 2022a). Assuming a VAT of around 18 percent and import tariffs of around 23 percent, the market price of the high-quality lamp is expected to fall to approximately XOF 5,000. Thus, while average WTP still remains below market prices, the LGC and the 2YW each have the potential to lift WTP above this new market price for around 15 percent of the sample (see Figure 2).

[Insert Table 2 near here]

4.2 Demand for the Low-Quality Solar Lamp

Akerlof's (1970) model predicts a separation of the demand curves for low- and high-quality products when the latter are presented with signals that allow customers to distinguish their quality. In our experiment, we indeed observe a small but positive shift of the demand curve for high-quality lamps with the LGC and 2YW. To assess the impact of quality signaling for high-quality lamps on the demand for low-quality lamps, we further elicited the WTP for a relevant competing product of inferior quality.

We estimate Equation 1 with revealed WTP for low-quality lamps as an outcome; the results are presented in Table 3. While we hypothesized that the quality-signaling treatments would

have a negative or null effect on WTP for low-quality lamps, we instead observe that the interventions significantly *increase* demand for these lamps. On average, participants receiving either the LGC or 2YW for the high-quality lamp increase their WTP for the low-quality lamp by approximately 10–11 percent.[18] Appendix C shows that the effects of the durability signals on WTP for the low-quality lamp remain significant after adjusting for multiple hypothesis testing, when conducting randomization inference, and with different levels of winsorization.

[Insert Table 3 near here]

We conclude that these quality-signaling treatments appear to change perceptions about the entire product class and not solely the specific product they are attached to. In the rest of this paper, we denote this finding as a "product-class effect," which we now explore by examining the role of consumer experience with solar lamps.

5. Role of Consumer Experience

Various studies in the quality-signaling literature find heterogeneous consumer responses to quality signals based on experience with a good or service (Wedig and Tai-Seale 2002; Jin and Sorensen 2006; Dutta et al. 2022) and familiarity with it (Dafny and Dranove 2008). Differentiating between high- and low-quality products is already challenging in a market in which consumers are fairly familiar with the product class, but it could be exacerbated when the entire product class is relatively new to potential consumers. In this case, quality-signaling interventions might convey information not only about one product's quality but about the entire product class. In an explorative analysis, we empirically test this by differentiating effects between experienced and inexperienced customers.

With more than half of the survey participants having no solar kit experience (see Table 1), we can consider solar lamps to be a relatively new product class to this subsample of consumers and consequently a little-known alternative to commonly used lighting sources such as candles, battery-run flashlights, and kerosene lamps. Among inexperienced consumers, the randomized interventions referring to the high-quality lamp may convey information about solar lamps more generally, turning them into general information campaigns that (a) put solar lamps on

[18] Consistent with the notion of a product-class effect, these effects are concentrated among participants randomly presented with the high-quality lamp first. See Appendix D.

the map as a viable lighting source and (b) highlight certain quality dimensions that traditional lighting sources do not perform well on.

To assess these new hypotheses, we estimate Equation 1 separately for participants with and without prior solar lamp experience.[19] We consider the same two outcomes as before plus one additional outcome: (a) log WTP for the high-quality lamp, (b) log WTP for the low-quality lamp, and (c) the difference in log WTP between the high- and low-quality lamps. As the two durability-signaling treatments have similar effects, we pool the LGC and 2YW treatments and omit the sample receiving the MBG. As indicated in Columns (3) and (4) of Panel B in Table 4, the product-class effects are solely driven by participants without prior solar lamp experience. In the experiment, the inexperienced participants are introduced to a new product class. Without having any benchmark, they seem to increase their WTP for both the high- and low-quality lamps—considering either of them as a practical alternative to other lighting sources.

[Insert Table 4 near here]

As presented in Columns (5) and (6) of Panels A and B in Table 4, we detect a small positive effect on WTP for high-quality lamps and a slightly negative effect on WTP for low-quality lamps among the experienced participants, though both effects are insignificant. To assess whether the latter effect is strong enough to induce a separation of the demand curves, we turn to Columns (5) and (6) in Panel C. The displayed coefficients indicate that the LGC and 2YW treatments lead to a significant separation of demand curves among participants with prior solar lamp experience. All effects presented in Table 4 remain significant after adjusting for multiple hypothesis testing, when conducting randomization inference, when measuring WTP in levels, and with different levels of winsorization (see Appendix C).

Figure 3 visualizes this separation by graphing the two demand curves for the low- and high-quality lamps among experienced participants. Both treatments based on signaling durability induce a WTP gap of around XOF 500 (approximately USD 0.80).

[Insert Figure 3 near here]

[19] See Table B2 in Appendix B for a balance test between respondents with and without solar lamp experience.

6. Mechanisms: Quality-Perception Updating

While we observe a separation of the demand curves for low- and high-quality solar lamps among experienced participants in line with Akerlof's (1970) prediction, we see a positive shift in demand for both solar lamps among inexperienced ones. We next further investigate these different responses to quality signals by turning to the underlying mechanisms.

After eliciting the WTP, participants were asked to rate the quality of each lamp on a five-point Likert scale: 1 (very poor), 2 (poor), 3 (acceptable), 4 (good), or 5 (excellent). To examine whether the treatments convey product-quality information to the consumers that leads to increased WTP, we use this variable as an outcome and estimate the following specification:

$$(2)\ EQ_i = \alpha + \beta_j T_{ji} + \epsilon_i$$

Here, EQ_i is a binary measure of the expected quality of the lamp; it takes on the value of 1 if participant i rates the respective lamp to have good or excellent quality and 0 if participant i rates the respective lamp to only have acceptable, poor, or very poor quality. As before, we pool the LGC and 2YW treatments (indicated by T_{ji}) and omit the sample receiving the MBG. Table 5 presents the results of estimating Equation 2 for experienced and inexperienced participants separately; Panel A indicates the effects on perceived quality for the high-quality lamp and Panel B for the low-quality lamp, while Panel C indicates the effects on the difference in quality perceptions between the two lamps.

[Insert Table 5 near here]

We begin by noting that the constant term is large, positive, and statistically significant. This may reflect cultural norms whereby respondents feel compelled to make positive statements in response to direct questioning about a particular experience, person, or object (DeMaio 1984). Moreover, given the ex post quality assessment, respondents may state quality perceptions to justify their revealed WTP.

As a result, the variation with which to identify the impacts of the treatment on quality perception is quite limited, constraining our ability to fully explore the mechanisms that may be driving our demand effects. Nonetheless, Columns (5) and (6) show that participants with prior solar lamp experience who received the LGC or 2YW treatment exhibit a marginally significant 8 percentage-point higher likelihood of rating the offered high-quality lamp as good

or excellent (see Panel A). Though the result is insignificant, they are also less likely to rate the low-quality lamp as good or excellent (see Panel B), thereby generating a significant separation in quality perception (see Panel C).

The results are less pronounced among participants without prior solar lamp experience (see Columns [3] and [4] in Table 5). The durability-signaling treatments lead to positive but insignificant increases in good and excellent ratings for the high-quality lamp but similar effects (albeit somewhat smaller after adding controls in Column [4]) for the low-quality lamp. Thus, at least the point estimates here paint a picture of product-class effects that are consistent with our earlier results, yielding no significant separation of quality perceptions among inexperienced consumers.

7. Conclusion

We examined the effect of three quality-signaling interventions on the demand for high-quality solar lamps. The solar lamp market in rural Senegal—as in other rural areas of sub-Saharan Africa—exhibits patterns that are consistent with the common asymmetric information problem, in which consumers are unable to distinguish between low- and high-quality products at the point of purchase, leading to underinvestment in high-quality lamps despite their greater cost-effectiveness. In a context of low grid coverage and highly unreliable grids, off-grid solar technologies offer a sustainable option for meeting electricity demand—especially in rural Senegal.

Our study illustrates that quality signals that either credibly inform consumers about a product's durability, such as third-party certification, or assure durability through a (two year) warranty significantly increase demand for high-quality lamps. Further analysis underscored the importance of differentiating between experienced and inexperienced consumers when analyzing the impact of quality-signaling interventions. Among inexperienced consumers, we observed product-class effects, in which the two significant quality-signaling interventions induce an increased demand for not only high-quality lamps but low-quality lamps, to which the quality signals are not attached. For this group of consumers, the interventions seem to function as a general information campaign, driving up the demand for the entire product class, irrespective of quality. Only among experienced consumers do the quality-signaling treatments yield the classical prediction of a separation of low- and high-quality demand curves (Akerlof 1970). The observed separation is induced by an overall increase in perceived quality

of high-quality solar lamps conveyed through the two above-mentioned quality-signaling interventions.

However, these effects might not be enough to translate into actual purchases by the average household, because the difference between the WTP for the high-quality solar lamps and their prevailing market price is substantial. Among experienced consumers, for instance, the average WTP (approximately XOF 2,700) for high-quality solar lamps among respondents receiving a quality signal is still less than one-third of the market price (XOF 8,500). This suggests that additional relevant barriers to adoption persist, such as credit and liquidity constraints (for example, Abdul-Salam and Phimister 2019; Grimm et al. 2020; Sievert and Steinbuks 2020). Studies that examine the effect of relaxing these constraints in rural Senegal and India find similar effect sizes to those reported in our study, at around 13–17 percent, which are not enough to reach cost-covering prices in their settings either. The remaining affordability barrier may likely require subsidization schemes. According to Grimm et al. (2020), subsidies for solar technologies can be justified as policy instruments from a social planner's perspective to achieve universal access to energy and alleviate poverty. Hence, to generate meaningful demand for higher-quality solar lighting products among poor rural households and to address environmental risks posed by the growing volume of electronic waste from (low quality) solar products (Kinally et al. 2022), a combination of subsidies, credit, and quality signaling may be needed.

Additionally, declining production costs of solar panels and LED lights (Glemarec 2012; Apostoleris et al. 2019; Valickova and Elms 2021) and favorable policies for high-quality-lamp manufacturers such as VAT exemptions and changes in import tariffs are lowering prices for the consumer (Lighting Global 2022b). In our setting, we calculated a reduction of the market price of the high-quality lamp from XOF 8,500 to 5,000 since the experiment was conducted. At this lower price, the LGC and the 2YW each have the potential to lift the WTP of 15 percent of the sample beyond the critical threshold—that is, to increase sales by about 30 percent together.

The effectiveness and scalability of the third-party certificate and (to some extent) the warranty potentially give the interventions appeal for retailers in a wide range of markets in which product quality is variable and difficult to infer upon initial inspection. Third-party certification is likely to be the dominant intervention among those tested here. Although it does not insure against early breakdown, it can be provided at relatively low cost to both the supplier and the

buyer.[20] The warranty, in theory, offers more comprehensive coverage of quality uncertainty by providing insurance against possible breakdown but comes at an additional cost to the supplier by potentially inducing moral hazard (that is, more risky usage; see, for example, Lutz and Padmanabhan 1998) and to the buyer since they bear a transaction cost in traveling to the supplier to request an exchange. Additionally, given the low increase in WTP in relation to the market price, warranties might not be an economically viable option for the suppliers because they require risky and labor-intensive efforts.

When testing generalizations from a widely used economic theory in a relevant market setting in which it should hold, we find that the theoretical predictions are valid for experienced customers only. This is a highly relevant finding for two main reasons. First, it suggests that future theoretical research on quality signals should develop extensions to nascent product markets. Second, from the perspective of suppliers, the product-class effects among inexperienced consumers are concerning. If a product class is novel or knowledge about it is not broadly disseminated, private firms will have little incentive to invest in quality-disclosure and quality-assurance efforts. In these situations, public interventions may be welfare enhancing but only if any potential welfare losses associated with the boost in demand for low-quality products is more than offset by gains due to increased sales of high-quality ones. The conditions under which product-class effects of this sort exacerbate or ameliorate the lemon problem are likely context specific and represent an important area for future research.

[20] This might not apply to all third-party certification services. Yet in the case of the Lighting Global certificate, the service is free and the only cost that may fall on the retailer is the one-time cost of changing the lamps' packaging to include information on the certification.

References

Aarakit, Sylvia Manjeri, Vincent Fred Ssennono, and Muyiwa S Adaramola. 2021. Estimating Market Potential for Solar Photovoltaic Systems in Uganda. *Frontiers in Energy Research* 9 (602468): 1–10.

Abdul-Salam, Yakubu, and Euan Phimister. 2019. Modelling the impact of market imperfections on farm household investment in stand-alone solar PV systems. *World Development* 116: 66–76.

Ackerberg, Daniel A. 2001. Empirically Distinguishing Informative and Prestige Effects of Advertising. *RAND Journal of Economics* 32 (2): 316–33.

Akerlof, George A. 1970. The market for lemons: Qualitative uncertainty and the market mechanism. *Quarterly Journal of Economics* 84: 488–500.

Aklin, Michaël, Chao Yo Cheng, and Johannes Urpelainen. 2018. Social acceptance of new energy technology in developing countries: A framing experiment in rural India. *Energy Policy* 113: 466–77.

Apostoleris, Harry, Sgouris Sgouridis, Marco Stefancich, and Matteo Chiesa. 2019. Utility solar prices will continue to drop all over the world even without subsidies. *Nature Energy* 4: 833–34.

Auriol, Emmanuelle, and Steven GM Schilizzi. 2015. Quality signaling through certification in developing countries. *Journal of Development Economics* 116: 105–21.

Bai, Jie. 2021. Melons as Lemons: Asymmetric Information, Consumer Learning and Seller Reputation. CID Faculty Working Paper No. 396, International Development at Harvard University, Cambridge, MA.

Balls, Jonathan N. 2020. Low-cost, adaptable solutions sell: Rethinking off-grid solar diffusion at the bottom of the pyramid in India. *Energy Research and Social Science* 70: 101811.

Becker, Gordon M, Morris H DeGroot, and Jacob Marschak. 1964. Measuring utility by a single-response sequential method. *Behavioral Science* 9 (3): 226–32.

Bensch, Gunther, Michael Grimm, Maximilian Huppertz, Jörg Langbein, and Jörg Peters. 2018. Are promotion programs needed to establish off-grid solar energy markets? Evidence from rural Burkina Faso. *Renewable and Sustainable Energy Reviews* 90: 1060–68.

Bensch, Gunther, Jörg Peters, and Maximiliane Sievert. 2012. How Access to Electric Lighting Affects Security Attitudes and Nighttime Activities in Rural Senegal. Ruhr Economic Papers 369, RWI, Essen.

Berry, James, Greg Fischer, and Raymond Guiteras. 2020. Eliciting and Utilizing Willingness to Pay: Evidence from Field Trials in Northern Ghana. *Journal of Political Economy* 128 (4): 1436–73.
Bhatia, Mikul, and Niki Angelou. 2015. Beyond Connections: Energy Access Redefined. ESMAP Technical Report 008/15, World Bank, Washington, DC.
Blumenschein, Karen, Glenn C Blomquist, Magnus Johannesson, Nancy Horn, and Patricia Freeman. 2008. Eliciting willingness to pay without bias: Evidence from a field experiment. *Economic Journal* 118: 114–37.
Boulding, William, and Amna Kirmani. 1993. A Consumer-Side Experimental Examination of Signaling Theory: Do Consumers Perceive Warranties as Signals of Quality? *Journal of Consumer Research* 20: 111–23.
Chatterjee, Swagato. 2020. Signalling Service Quality through Price and Certifications. *Global Business Review* 21 (1): 279–93.
Chowdhury, Shahriar Ahmed, and Monjur Mourshed. 2016. Off-grid electrification with solar home systems: An appraisal of the quality of components. *Renewable Energy* 97: 585–98.
Dafny, Leemore, and David Dranove. 2008. Do report cards tell consumers anything they don't already know? The case of Medicare HMOs. *RAND Journal of Economics* 39 (3): 790–821.
Dai, Weijia, and Michael Luca. 2020. Digitizing Disclosure: The Case of Restaurant Hygiene Scores. *American Economic Journal: Microeconomics* 12 (2): 41–59.
Deichmann, Uwe, Craig Meisner, Siobhan Murray, and David Wheeler. 2011. The economics of renewable energy expansion in rural Sub-Saharan Africa. *Energy Policy* 39: 215–27.
DeMaio, Theresa J. 1984. Social desirability and survey measurement: A review. In *Surveying Subjective Phenomena*, ed. Charles F. Turner and Elizabeth Martin, 2:257–82. New York, NY: Russell Sage Foundation.
Deutschmann, Joshua W, Agnieszka Postepska, and Leopold Sarr. 2021. Measuring willingness to pay for reliable electricity: Evidence from Senegal. *World Development* 138: 105209.
Diouf, Boucar, and Ekra Miezan. 2021. The limits of the concession-led model in rural electrification policy: The case study of Senegal. *Renewable Energy* 177: 626–35.
Dranove, David, and Ginger Zhe Jin. 2010. Quality Disclosure and Certification: Theory and Practice. *Journal of Economic Literature* 48 (4): 935–63.

Dranove, David, Daniel Kessler, Mark McClellan, and Mark Satterthwaite. 2003. Is more information better? The effects of “Report Cards” on health care providers. *Journal of Political Economy* 111 (3): 555–88.
Dutta, Sujay, Somak Banerjee, Aaron Johnson, and Abhijit Biswas. 2022. Overcoming the challenge of low familiarity: Can a weakly familiar brand signal quality with exceptionally strong warranty? *Journal of Business Research* 141: 737–54.
Emons, Winand. 1989. The Theory of Warranty Contracts. *Journal of Economic Surveys* 3 (1): 43–57.
GalOr, Esther. 1989. Warranties as a Signal of Quality. *Canadian Journal of Economics* 22 (1): 50–61.
Girardeau, Hannah, Alicia Oberholzer, and Subhrendu K Pattanayak. 2021. The enabling environment for household solar adoption: A systematic review. *World Development Perspectives* 21: 100290.
Glemarec, Yannick. 2012. Financing off-grid sustainable energy access for the poor. *Energy Policy* 47: 87–93.
Grimm, Michael, Luciane Lenz, Jörg Peters, and Maximiliane Sievert. 2020. Demand for Off-Grid Solar Electricity: Experimental Evidence from Rwanda. *Journal of the Association of Environmental and Resource Economists* 7 (3): 417–54.
Grimm, Michael, Anicet Munyehirwe, Jörg Peters, and Maximiliane Sievert. 2017. A first step up the energy ladder? Low cost solar kits and household’s welfare in rural Rwanda. *World Bank Economic Review* 31 (3): 631–49.
Groenewoudt, Aleid C, Henny A Romijn, and Floor Alkemade. 2020. From fake solar to full service: An empirical analysis of the solar home systems market in Uganda. *Energy for Sustainable Development* 58: 100–111.
Grossman, Sandford J. 1981. The informational role of warranties and private disclosure about product quality. *Journal of Law and Economics* 24 (3): 461–83.
Harrison, Glenn W, and John A List. 2004. Field experiments. *Journal of Economic Literature* 42 (4): 1009–55.
Hassan, Fadi, and Paolo Lucchino. 2016. Powering Education. CEP Discussion Paper No. 1438, Centre for Economic Performance at the London School of Economics, London.
Hastings, Justine S, and Jeffrey M Weinstein. 2008. Information, school choice, and academic achievement: Evidence from two experiments. *Quarterly Journal of Economics* 123 (4): 1373–1414.
Heiman, Amir, and Lutz Hildebrandt. 2018. Marketing as a Risk Management Mechanism

with Applications in Agriculture, Resources, and Food Management. *Annual Review of Resource Economics* 10: 253–77.
Heiman, Amir, David R Just, Bruce P McWilliams, and David Zilberman. 2015. A prospect theory approach to assessing changes in parameters of insurance contracts with an application to moneyback guarantees. *Journal of Behavioral and Experimental Economics* 54: 105–17.
Heiman, Amir, Bruce McWilliams, and David Zilberman. 2001. Demonstrations and moneyback guarantees: Market mechanisms to reduce uncertainty. *Journal of Business Research* 54: 71–84.
Heß, Simon. 2017. Randomization inference with stata: A guide and software. *Stata Journal* 17 (3): 630–51.
Jeng, Shih-Ping, LiShia Huang, Yu-Jen Chou, and Ching-I Teng. 2014. Do Consumers Perceive Money-Back Guarantees as Believable? The Effects of Money-Back Guarantee Generosity, Store Name Familiarity, and Perceived Price. *Service Science* 6 (3): 179–89.
Jin, Ginger Zhe, and Alan T Sorensen. 2006. Information and consumer choice: The value of publicized health plan ratings. *Journal of Health Economics* 25: 248–75.
Johnson, Matthew S. 2020. Regulation by Shaming: Deterrence Effects of Publicizing Violations of Workplace Safety and Health Laws. *American Economic Review* 110 (6): 1866–1904.
Kinally, Christopher, Fernando Antonanzas-Torres, Frank Podd, and Alejandro Gallego-Schmid. 2022. Off-grid solar waste in sub-Saharan Africa: Market dynamics, barriers to sustainability, and circular economy solutions. *Energy for Sustainable Development* 70: 415–29.
Klein, Tobias J, Christian Lambertz, and Konrad O Stahl. 2016. Market Transparency, Adverse Selection, and Moral Hazard. *Journal of Political Economy* 124 (6): 1677–1713.
Kudo, Yuya, Abu S Shonchoy, and Kazushi Takahashi. 2019. Short-Term Impacts of Solar Lanterns on Child Health: Experimental Evidence from Bangladesh. *Journal of Development Studies* 55 (11): 2329–46.
Kuksov, Dmitri, and Yuanfang Lin. 2010. Information Provision in a Vertically Differentiated Competitive Marketplace. *Marketing Science* 29 (1): 122–38.
Lam, NL, G Muhwezi, F Isabirye, K Harrison, I Ruiz-Mercado, E Amukoye, T Mokaya, M Wambua, and MN Bates. 2018. Exposure reductions associated with introduction of solar lamps to kerosene lamp-using households in Busia County, Kenya. *Indoor Air* 28: 218–27.
Lee, Kenneth, Edward Miguel, and Catherine Wolfram. 2020. Experimental Evidence on the Economics of Rural Electrification. *Journal of Political Economy* 128 (4): 1523–65.

Lemaire, Xavier. 2018. Solar home systems and solar lanterns in rural areas of the Global South: What impact? *Wiley Interdisciplinary Reviews: Energy and Environment* 7 (e301): 1–22.
Lewis, Gregory. 2011. Asymmetric Information, Adverse Selection and Online Disclosure: The Case of eBay Motors. *American Economic Review* 101 (4): 1535–46.
Lighting Global. 2018. Quality Matters. Technical Notes, Issue 27, Lighting Global.
———. 2020. Off-Grid Solar Market Trends Report 2020 (Report Summary). World Bank, Washington, DC.
———. 2022a. Off-Grid Solar Market Trends Report 2022: State of the Sector. World Bank, Washington, DC.
———. 2022b. Off-Grid Solar Market Trends Report 2022: Outlook. World Bank, Washington, DC.
List, John A. 2020. Non Est Disputandum De Generalizability? A Glimpse into the External Validity Trial. NBER Working Paper Series No. 27535, National Bureau of Economic Research, Cambridge, MA.
List, John A, Azeem M Shaikh, and Yang Xu. 2019. Multiple hypothesis testing in experimental economics. *Experimental Economics* 22: 773–93.
Lutz, Nancy A, and V Padmanabhan. 1998. Warranties, extended warranties, and product quality. *International Journal of Industrial Organization* 16: 463–93.
Mahadevan, Meera, Robyn Meeks, and Takashi Yamano. 2023. Reducing information barriers to solar adoption: Experimental evidence from India. *Energy Economics* 120: 106600.
Matthews, Steven, and John Moore. 1987. Monopoly Provision of Quality and Warranties: An Exploration in the Theory of Multidimensional Screening. *Econometrica* 55 (2): 441–67.
McWilliams, Bruce. 2012. Money-Back Guarantees: Helping the Low-Quality Retailer Bruce. *Management Science* 58 (8): 1521–24.
Mekonnen, Alemu, Sied Hassen, Marcela Jaime, Michael Toman, and Xiao Bing Zhang. 2023. The effect of information and subsidy on adoption of solar lanterns: An application of the BDM bidding mechanism in rural Ethiopia. *Energy Economics* 124: 106869.
Michelson, Hope, Anna Fairbairn, Brenna Ellison, Annemie Maertens, and Victor Manyong. 2021. Misperceived quality: Fertilizer in Tanzania. *Journal of Development Economics* 148: 102579.
Milgrom, Paul, and John Roberts. 1986. Price and Advertising Signals of Product Quality. *Journal of Political Economy* 94 (4): 796–821.

Moorthy, Sridhar, and Kannan Srinivasan. 1995. Signaling Quality with a Money-Back Guarantee: The Role of Transaction Costs. *Marketing Science* 14 (4): 442–66.
Murphy, Daniel, and Arsh Sharma. 2014. Scaling Up Access to Electricity: The Case of Lighting Africa. Live Wire 2014/21, World Bank, Washington, DC.
Nelson, Phillip. 1970. Information and Consumer Behavior. *Journal of Political Economy* 78 (2): 311–29.
Padmanabhan, V, and Ram C Rao. 1993. Warranty Policy and Extended Service Contracts: Theory and an Application to Automobiles. *Marketing Science* 12 (3): 230–47.
Riley, John G. 2001. Silver Signals: Twenty-Five Years of Screening and Signaling. *Journal of Economic Literature* 39 (2): 432–78.
Roberts, James W. 2011. Can Warranties Substitute for Reputations? *American Economic Journal: Microeconomics* 3: 69–85.
Samarakoon, Shanil. 2020. The troubled path to ending darkness: Energy injustice encounters in Malawi's off-grid solar market. *Energy Research and Social Science* 69: 101712.
Schmalensee, By Richard. 1982. Product Differentiation Advantages of Pioneering Brands. *American Economic Review* 72 (3): 349–65.
Sievert, Maximiliane, and Jevgenijs Steinbuks. 2020. Willingness to pay for electricity access in extreme poverty: Evidence from sub-Saharan Africa. *World Development* 128: 104859.
Signify Foundation. 2019. Mapping the Off-Grid Solar Market in Senegal.
Spence, Michael. 1973. Job Market Signaling Michael. *Quarterly Journal of Economics* 87 (3): 355–74.
———. 1977. Consumer Misperceptions, Product Failure and Producer Liability. *Review of Economic Studies* 44 (3): 561–71.
Stahl, Konrad, and Roland Strausz. 2017. Certification and Market Transparency. *Review of Economic Studies* 84: 1842–68.
Stojanovski, Ognen, Mark Thurber, and Frank Wolak. 2017. Rural energy access through solar home systems: Use patterns and opportunities for improvement. *Energy for Sustainable Development* 37: 33–50.
Urpelainen, Johannes. 2016. Energy poverty and perceptions of solar power in marginalized communities: Survey evidence from Uttar Pradesh, India. *Renewable Energy* 85: 534–39.
Valickova, Petra, and Nicholas Elms. 2021. The costs of providing access to electricity in selected countries in Sub-Saharan Africa and policy implications. *Energy Policy* 148: 111935.
Wagner, Natascha, Matthias Rieger, Arjun S Bedi, Jurgen Vermeulen, and Binyam Afewerk

Demena. 2021. The impact of off-grid solar home systems in Kenya on energy consumption and expenditures. *Energy Economics* 99: 105314.
Wassie, Yibeltal T, and Muyiwa S Adaramola. 2021. Socioeconomic and environmental impacts of rural electrification with Solar Photovoltaic systems: Evidence from southern Ethiopia. *Energy for Sustainable Development* 60: 52–66.
Wedig, Gerard J, and Ming Tai-Seale. 2002. The effect of report cards on consumer choice in the health insurance market. *Journal of Health Economics* 21: 1031–48.
Wolinsky, Asher. 1983. Prices as Signals of Product Quality. *Review of Economic Studies* 50 (4): 647–58.
Yoon, Semee, Johannes Urpelainen, and Milind Kandlikar. 2016. Willingness to Pay for Solar Lanterns: Does the Trial Period Play a Role? *Review of Policy Research* 33 (3): 291–315.
Zapechelnyuk, Andriy. 2020. Optimal Quality Certification. *American Economic Review: Insights* 2 (2): 161–76.
Zhe Jin, Ginger, Andrew Kato, and John A List. 2010. That's news to me! Information revelation in professional certification markets. *Economic Inquiry* 48 (1): 104–22.

Tables

Table 1: Balance test between control and treatment groups

	Control (C)		Treatment (T)		C−T	
	(1)	(2)	(3)	(4)	(5)	(6)
	Mean	SD	Mean	SD	Diff.	p-value
Age (years)	47.96	15.46	49.05	15.24	-1.09	0.335
Female	0.32		0.33		-0.01	0.672
No education	0.62		0.59		0.03	0.377
Primary school	0.19		0.23		-0.04	0.231
Secondary school	0.12		0.10		0.02	0.474
Higher education	0.01		0.02		-0.01	0.432
Other: Koranic school/Daara	0.06		0.06		0.00	0.804
Finished roof [a]	0.64		0.69		-0.05	0.131
Household size (members)	12.80	7.25	13.07	7.19	-0.27	0.617
Monthly available income (XOF) [b]	37,459.87	52,798.25	44,613.70	82,711.12	-7,153.83	0.202
Willingness to take risks (scale 0–10) [c]	4.95	3.50	4.49	3.55	0.46	0.077
Trust in World Bank [d]	0.70		0.72		-0.02	0.522
Trust in Total Senegal [d]	0.63		0.66		-0.03	0.450
Trust in NGOs [d]	0.60		0.64		-0.04	0.212
Solar lamp experience [e]	0.47		0.49		-0.02	0.498
Village-level solar lamp penetration rate [f]	0.49		0.48		0.01	0.334
Observations	249		711			

Note: The table presents baseline balance comparison using data collected during the household survey prior to making the solar lamp offer. Columns (1) and (3) report the mean values for the households assigned to control and treatment groups, respectively. All three treatments are combined in Column (3). Columns (2) and (4) report the respective standard deviations. Column (5) shows the difference between the control and treatment means and Column (6) the p-values for the test of equality of means. The joint null of equal means is not rejected at standard levels ($F(14, 943) = 0.991$, p-value = 0.462).

[a] Binary variable taking the value of 1 if the main material of the roof is concrete, cement, tile or slate ("finished"), and 0 if zinc, thatch, straw, or clay ("rudimentary").

[b] The monthly available income consists of the sum of self-reported monthly available farm income, nonfarm income, remittances, benefits, wages, and rental income.

[c] Response to question "How do you see yourself in general: are you a person who is generally willing to take risks, or do you try to avoid taking risks? Please use a scale from 0 to 10, where 0 means you are 'completely unwilling to take risks' and a 10 means you are 'very willing to take risks.'"

[d] Binary variable taking the value of 1 if the response to the statement "I trust the World Bank/Total/NGOs" was strongly agree or agree, and 0 if disagree, strongly disagree, or neither agree nor disagree.

[e] Binary variable taking the value of 1 if the household owns a solar kit, and 0 otherwise.

[f] The village-level solar lamp penetration rate is calculated using the average number of households owning a solar kit within the surveyed sample within each village.

Table 2: Treatment effects on WTP for high-quality solar lamp

	(1)	(2)	(3)	(4)
	Log WTP for high-quality solar lamp			
LG certification	0.13	0.14		
	(0.06)	(0.06)		
2-year warranty	0.14	0.12		
	(0.06)	(0.06)		
Money-back guarantee	-0.01	-0.04		
	(0.06)	(0.06)		
Durability signaling (LGC, 2YW)			0.14	0.12
			(0.05)	(0.05)
Constant	7.56	7.48	7.56	7.48
	(0.04)	(0.13)	(0.04)	(0.14)
Control-group mean WTP	XOF 2,355.42			
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.01	0.06	0.01	0.07

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, and household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, and trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village, and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatments and those in the control group.

Table 3: Effects of treatments for high-quality lamp on WTP for low-quality solar lamp

	(1)	(2)	(3)	(4)
	Log WTP for low-quality solar lamp			
LG certification	0.09	0.11		
	(0.06)	(0.06)		
2-year warranty	0.12	0.10		
	(0.06)	(0.06)		
Money-back guarantee	-0.01	-0.03		
	(0.06)	(0.06)		
Durability signaling (LGC, 2YW)			0.10	0.10
			(0.05)	(0.05)
Constant	7.44	7.49	7.44	7.52
	(0.04)	(0.12)	(0.04)	(0.14)
Control-group mean WTP	XOF 2,090.16			
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.01	0.05	0.01	0.05

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, and household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, and trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village, and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatments and those in the control group.

Table 4: Treatment effects on WTP, by level of experience

	Full sample		No experience		Solar lamp experience	
	(1)	(2)	(3)	(4)	(5)	(6)
(A) Log WTP for high-quality solar lamp						
Durability signaling (LGC, 2YW)	0.17	0.16	0.17	0.17	0.10	0.09
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)
Solar lamp experience	0.03	0.05				
	(0.08)	(0.08)				
Treatment × experience	-0.07	-0.08				
	(0.10)	(0.10)				
Constant	7.55	7.46	7.55	7.37	7.58	7.58
	(0.05)	(0.14)	(0.05)	(0.18)	(0.06)	(0.24)
Observations	729	727	382	381	347	346
R-squared	0.01	0.07	0.02	0.08	0.01	0.09
(B) Log WTP for low-quality solar lamp						
Durability signaling (LGC, 2YW)	0.21	0.21	0.21	0.22	-0.01	-0.02
	(0.06)	(0.07)	(0.06)	(0.07)	(0.08)	(0.08)
Solar lamp experience	0.12	0.17				
	(0.08)	(0.08)				
Treatment × experience	-0.22	-0.23				
	(0.10)	(0.10)				
Constant	7.39	7.45	7.39	7.35	7.51	7.71
	(0.05)	(0.14)	(0.05)	(0.20)	(0.06)	(0.22)
Observations	729	727	382	381	347	346
R-squared	0.01	0.05	0.03	0.07	0.00	0.08
(C) Difference in log WTP: high-quality minus low-quality solar lamp						
Durability signaling (LGC, 2YW)	-0.04	-0.05	-0.04	-0.05	0.11	0.11
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
Solar lamp experience	-0.09	-0.12				
	(0.06)	(0.06)				
Treatment × experience	0.15	0.16				
	(0.07)	(0.07)				
Constant	0.16	0.00	0.16	0.03	0.07	-0.13
	(0.04)	(0.10)	(0.04)	(0.13)	(0.05)	(0.17)
Observations	729	727	382	381	347	346
R-squared	0.01	0.04	0.00	0.05	0.01	0.06
Controls	NO	YES	NO	YES	NO	YES

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. The sample consists of only the participants receiving the LGC and 2YW treatments (= "Durability signaling") and those in the control group. Individual and household controls are age, gender, education, finished roof, and household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, and trust in NGOs. We furthermore control for solar lamp penetration rate in the village and the order of lamp presentation.

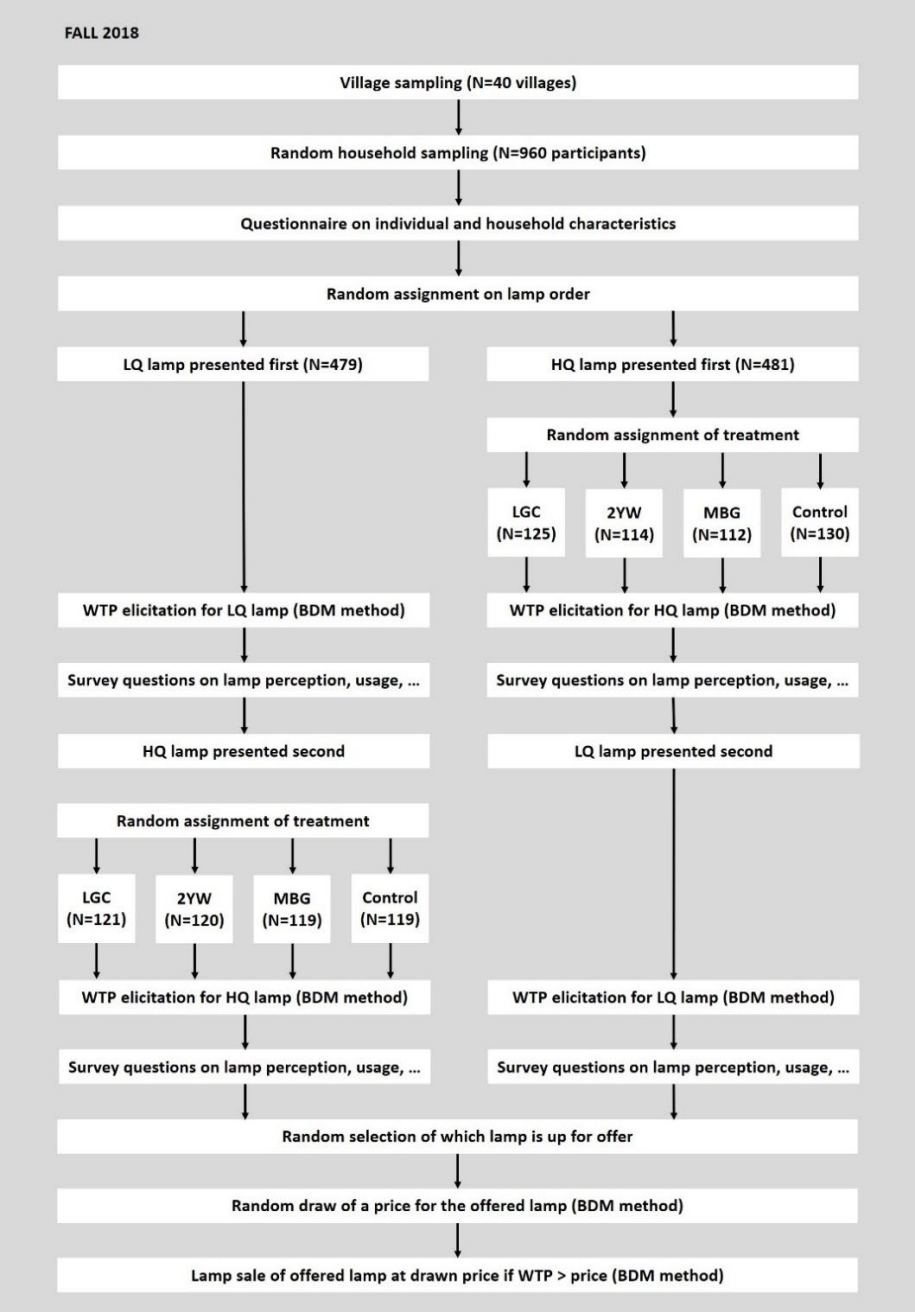
Table 5: Treatment effects on quality perception, by level of experience

	Full sample		No experience		Solar lamp experience	
	(1)	(2)	(3)	(4)	(5)	(6)
(A) Good/excellent expected quality for high-quality solar lamp						
Durability signaling (LGC, 2YW)	0.04	0.04	0.04	0.03	0.08	0.09
	(0.04)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)
Solar lamp experience	-0.05	-0.04				
	(0.05)	(0.05)				
Treatment × experience	0.04	0.03				
	(0.06)	(0.06)				
Constant	0.83	0.75	0.83	0.61	0.77	0.89
	(0.03)	(0.09)	(0.03)	(0.12)	(0.04)	(0.13)
Observations	691	689	358	357	333	332
R-squared	0.01	0.04	0.00	0.10	0.01	0.07
(B) Good/excellent expected quality for low-quality solar lamp						
Durability signaling (LGC, 2YW)	0.04	0.03	0.04	0.02	-0.05	-0.05
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Solar lamp experience	-0.01	-0.01				
	(0.06)	(0.06)				
Treatment × experience	-0.08	-0.08				
	(0.07)	(0.07)				
Constant	0.77	0.67	0.77	0.57	0.76	0.81
	(0.04)	(0.10)	(0.04)	(0.13)	(0.04)	(0.15)
Observations	678	676	350	349	328	327
R-squared	0.01	0.06	0.00	0.09	0.00	0.08
(C) Difference in good/excellent expected quality: high-quality minus low-quality solar lamp						
Durability signaling (LGC, 2YW)	0.01	0.03	0.01	0.03	0.12	0.13
	(0.05)	(0.05)	(0.05)	(0.05)	(0.06)	(0.06)
Solar lamp experience	-0.03	-0.01				
	(0.06)	(0.06)				
Treatment × experience	0.10	0.09				
	(0.08)	(0.07)				
Constant	0.05	0.15	0.05	0.07	0.02	0.16
	(0.04)	(0.12)	(0.04)	(0.16)	(0.05)	(0.19)
Observations	669	667	347	346	322	321
R-squared	0.01	0.04	0.00	0.04	0.01	0.09
Controls	NO	YES	NO	YES	NO	YES

Note: Quality expectation is a binary variable taking the value 1 if the respondent expects good or excellent quality and 0 if the respondent expects very poor, poor, or acceptable quality. Robust standard errors are in parentheses. The sample consists of only the participants receiving the LGC and 2YW treatments (= "Durability signaling") and those in the control group. Individual and household controls are age, gender, education, finished roof, and household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, and trust in NGOs. We furthermore control for solar lamp penetration rate in the village and the order of lamp presentation. Overall, the sample sizes are slightly smaller than in Table 4 because some respondents refused to answer the perceived-quality question.

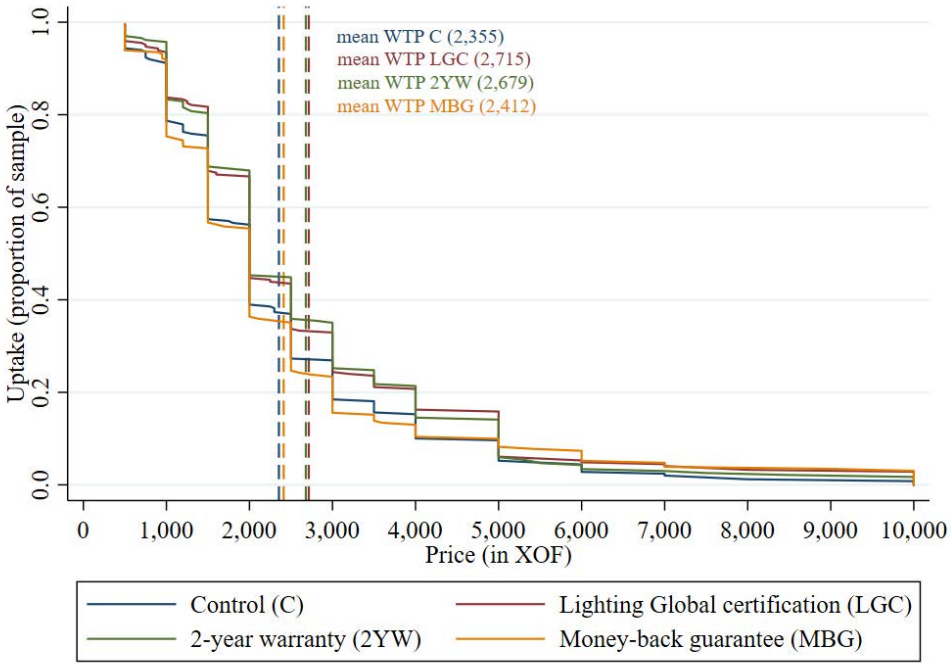
Figures

Figure 1: Study design



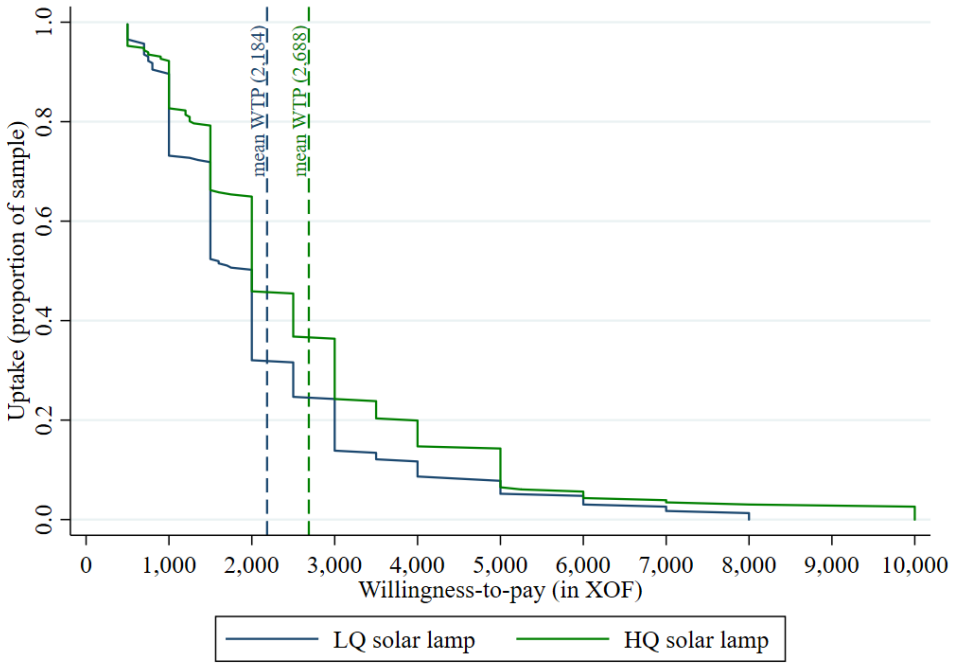
Note: Original sample of 1,200 participants across fifty villages. We exclude 200 participants for whom cross-randomization on lamp order was not implemented and 40 participants on whom we have incomplete information. LQ = low quality, HQ = high quality, LGC = Lighting Global certification, 2YW = two-year warranty, MBG = money-back guarantee, BDM method = Becker-DeGroot-Marschak method.

Figure 2: Treatment effect on WTP for high-quality solar lamp



Note: WTP is winsorized at the two lower and upper percentiles. XOF 1,000 ≈ USD 1.60. Two-sample Kolmogorov-Smirnov test for equality of distribution functions provides (a) a p-value = 0.067 that control-group values are significantly smaller than LGC-treatment values; (b) a p-value = 0.036 that control-group values are significantly smaller than 2YG-treatment values; and (c) a p-value = 0.805 that control-group values are significantly smaller than MBG-treatment values.

Figure 3: Demand curves for low-quality and high-quality solar lamps



Note: WTP is winsorized at the two lower and upper percentiles. XOF 1,000 ≈ USD 1.60. Data are from the treatment group (LGC and 2YW) and experienced consumers.

Online Appendix

A. Solar lamps and quality signals

Figure A1: Pictures of lamps used for the experiment

Type # 1 Lampe S20 by d.light	Type # 2 Différents marques et producteurs
	

Figure A2: Third-party quality certificate



LIGHTING GLOBAL
Catalyzing markets for modern off-grid energy

GROUPE DE LA BANQUE MONDIALE

Ce document certifie que la lampe solaire S20 était jugée conforme aux normes de qualité « Lighting Global » suite aux tests de qualité établis par la Commission électrotechnique internationale et conduits en Juin 2016*

Détails des tests :

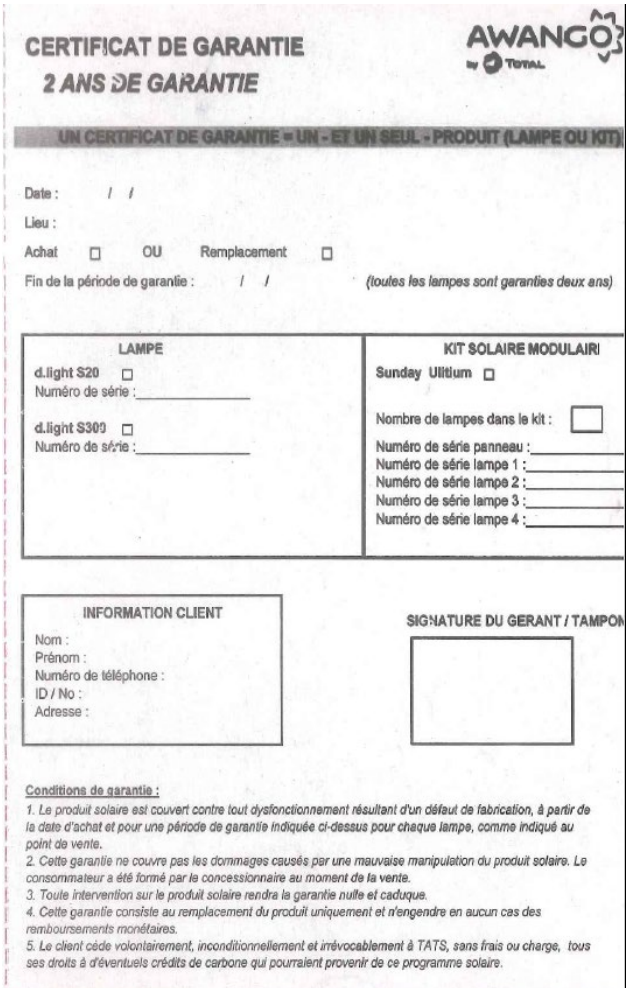
Nom appareil : Lampe solaire S20
Nom modèle : S20
Société commerciale productrice : d.light design Inc.
Pays de fabrication : Chine
Contact auprès de la société productrice : David Xu, testing@dlight.com
Echantillon du test : 6 exemplaires
Test de renouvellement conduit : oui
Méthodologie de sélection des appareils : choix aléatoire du stock
Laboratoire : Schatz Energy Research Center, Arcata, Californie, Etats-Unis

* A partir du 1er juillet 2018, **la lampe solaire S20 n'est désormais plus sous l'égide de Lighting Global**, ayant été remplacée par sa plus récente version (lampe S30), qui sera prochainement distribuée par Total au Sénégal. Les résultats des tests du laboratoire indépendant sont cependant toujours valables.

Russell Sturm
Global Head, Energy Access
Lighting Global Project Manager
International Finance Corporation

Produit conçu aux Etats-Unis

Figure A3: Warranty certificate



CERTIFICAT DE GARANTIE

2 ANS DE GARANTIE

AWANGO by TOTAL

UN CERTIFICAT DE GARANTIE = UN - ET UN SEUL - PRODUIT (LAMPE OU KIT)

Date : / /

Lieu :

Achat ☐ OU Remplacement ☐

Fin de la période de garantie : / / *(toutes les lampes sont garanties deux ans)*

LAMPE	KIT SOLAIRE MODULAIRI
d.light S20 ☐ Numéro de série :_____	Sunday Ulitium ☐
d.light S300 ☐ Numéro de série :_____	Nombre de lampes dans le kit : ☐ Numéro de série panneau :_____ Numéro de série lampe 1 :_____ Numéro de série lampe 2 :_____ Numéro de série lampe 3 :_____ Numéro de série lampe 4 :_____

INFORMATION CLIENT

Nom :
Prénom :
Numéro de téléphone :
ID / No :
Adresse :

SIGNATURE DU GERANT / TAMPON

Conditions de garantie :

1. Le produit solaire est couvert contre tout dysfonctionnement résultant d'un défaut de fabrication, à partir de la date d'achat et pour une période de garantie indiquée ci-dessus pour chaque lampe, comme indiqué au point de vente.
2. Cette garantie ne couvre pas les dommages causés par une mauvaise manipulation du produit solaire. Le consommateur a été formé par le concessionnaire au moment de la vente.
3. Toute intervention sur le produit solaire rendra la garantie nulle et caduque.
4. Cette garantie consiste au remplacement du produit uniquement et n'engendre en aucun cas des remboursements monétaires.
5. Le client cède volontairement, inconditionnellement et irrévocablement à TATS, sans frais ou charge, tous ses droits à d'éventuels crédits de carbone qui pourraient provenir de ce programme solaire.

Figure A4: Money-back guarantee coupon



COUPON POUR REMBOURSEMENT

Montant à récupérer :

_ _ _ _ _ _ _ _ _ _ CFA

Valable jusqu'au : _ _ / _ _ / 2018

Nom du bénéficiaire : _

Nom de l'agent de terrain : _

Téléphone de l'agent de terrain : _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Signature de l'agent de terrain et cachet :

Ce coupon permet de récupérer, dans toute boutique Total, le montant indiqué en haut contre présentation de ce coupon, d'une pièce d'identité et de la lampe solaire « d.Light S20 » portant numéro de série :

_ _

BANQUE MONDIALE TOTAL

B. Detailed balance tests

Table B1: Detailed balance tests between control and treatment groups

	(1) C vs. T	(2) C vs. LGC	(3) C vs. 2YW	(4) C vs. MBG	(5) LGC vs. 2YW	(6) LGC vs. MBG	(7) 2YW vs. MBG
Age (years)	0.00	-0.00	0.01	0.00	0.01	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Female	0.02	-0.03	0.08	0.06	0.10	0.07	-0.02
	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
No education	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Primary school	0.05	0.02	0.11	0.07	0.07	0.05	-0.02
	(0.04)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Secondary school	-0.00	-0.13	0.07	0.05	0.17	0.16	0.01
	(0.05)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Higher education	0.11	0.14	0.18	0.11	0.03	-0.08	0.03
	(0.11)	(0.17)	(0.21)	(0.20)	(0.17)	(0.16)	(0.19)
Other: Koranic school/Daara	0.04	-0.05	0.09	0.12	0.11	0.15	0.02
	(0.06)	(0.10)	(0.10)	(0.09)	(0.10)	(0.10)	(0.09)
Finished roof	0.04	0.01	0.05	0.09	0.03	0.05	0.03
	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
HH size (members)	0.00	-0.00	0.00	-0.00	0.00	-0.00	-0.01
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Monthly available income (XOF)	0.00	0.00	0.00	0.00	-0.00	-0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Willingness to take risks (0–10)	-0.01	-0.02	-0.01	-0.01	0.01	0.01	-0.00
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Trust in World Bank	-0.02	-0.01	-0.02	-0.01	0.02	0.05	0.05
	(0.05)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.07)

Trust in Total Senegal	0.01	-0.01	-0.03	0.05	-0.04	0.03	0.08
	(0.04)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)
Trust in NGOs	0.04	0.08	0.06	0.01	-0.01	-0.08	-0.06
	(0.04)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Solar lamp experience	0.01	0.04	-0.04	0.05	-0.08	0.01	0.08
	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Village-level solar lamp penetration rate	-0.10	-0.01	-0.19	-0.26	-0.17	-0.30	-0.04
	(0.09)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)
Constant	0.68	0.53	0.23	0.46	0.21	0.50	0.70
	(0.08)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Observations	958	493	483	480	478	475	465
R-squared	0.02	0.03	0.04	0.03	0.06	0.03	0.05
F-test	0.991	1.111	1.357	1.073	1.808	1.056	1.460
Prob > F	0.462	0.343	0.165	0.379	0.031	0.396	0.116

Note: The table presents baseline balance comparison using data collected during the household survey prior to making the solar lamp offer. Linear probability regression. Robust standard errors are in parentheses. C = control group, T = treatment group, LGC = Lighting Global certification, 2YW = two-year warranty, MBG = money-back guarantee.

Table B2: Balance test between respondents without and with solar lamp experience

	(1) Solar lamp experience
Quality-signaling treatment	0.02
	(0.03)
Age (years)	0.00
	(0.00)
Female	-0.02
	(0.03)
No education	Ref.
Primary school	0.02
	(0.04)
Secondary school	-0.01
	(0.05)
Higher education	0.20
	(0.11)
Other: Koranic school/Daara	0.11
	(0.06)
Finished roof	0.21
	(0.03)
Household size (members)	0.00
	(0.00)
Monthly available income (XOF)	0.00
	(0.00)
Willingness to take risks (scale 0–10)	0.00
	(0.00)
Trust in World Bank	0.01
	(0.05)
Trust in Total Senegal	0.05
	(0.05)
Trust in NGOs	0.04
	(0.04)
Village-level solar lamp penetration rate	0.94
	(0.08)
Constant	-0.29
	(0.09)
Observations	958
R-squared	0.20
F-test	15.27
Prob > F	0.000

Note: Linear probability regression. Robust standard errors are in parentheses.

C. Robustness of results in section 4 and 5

WTP in levels

Table C1: Table 2 with WTP in levels

	(1)	(2)	(3)	(4)
	WTP for high-quality solar lamp (XOF)			
LG certification	360.03	366.68		
	(162.08)	(162.26)		
2-year warranty	324.07	274.88		
	(156.60)	(158.28)		
Money-back guarantee	56.70	-19.39		
	(166.77)	(165.17)		
Durability signaling (LGC, 2YW)			342.49	311.17
			(134.56)	(135.02)
Constant	2,355.42	1,991.30	2,355.42	2,200.64
	(103.98)	(354.75)	(103.91)	(365.59)
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.01	0.05	0.01	0.06

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C2: Table 3 with WTP in levels

	(1)	(2)	(3)	(4)
	WTP for low-quality solar lamp (XOF)			
LG certification	229.96	265.20		
	(139.26)	(141.83)		
2-year warranty	201.72	156.07		
	(130.82)	(133.02)		
Money-back guarantee	30.62	-19.63		
	(139.24)	(137.13)		
Durability signaling (LGC, 2YW)			216.19	208.01
			(114.42)	(116.47)
Constant	2,090.16	2,053.73	2,090.16	2,205.77
	(88.90)	(297.24)	(88.83)	(324.24)
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.00	0.05	0.00	0.04

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C3: Table 4 with WTP in levels

	Full sample		No experience		Solar lamp experience	
	(1)	(2)	(3)	(4)	(5)	(6)
(A) WTP for high-quality solar lamp (XOF)						
Durability signaling (LGC, 2YW)	419.81	418.30	419.81	421.07	254.47	226.58
	(175.56)	(178.15)	(175.54)	(181.46)	(207.34)	(218.69)
Solar lamp experience	146.40	161.88				
	(210.58)	(223.71)				
Treatment × experience	-165.34	-226.49				
	(271.66)	(280.84)				
Constant	2,287.22	2,131.27	2,287.22	1,968.16	2,433.62	2,488.39
	(131.52)	(366.61)	(131.51)	(482.86)	(164.48)	(677.97)
Observations	729	727	382	381	347	346
R-squared	0.01	0.06	0.01	0.07	0.00	0.07
(B) WTP for low-quality solar lamp (XOF)						
Durability signaling (LGC, 2YW)	498.10	509.35	498.10	512.36	-99.21	-111.42
	(144.92)	(148.88)	(144.90)	(151.75)	(179.70)	(187.53)
Solar lamp experience	360.58	450.19				
	(180.66)	(188.15)				
Treatment × experience	-597.31	-637.13				
	(230.83)	(236.83)				
Constant	1,922.18	2,010.62	1,922.18	1,964.51	2,282.76	2,495.67
	(101.18)	(327.47)	(101.17)	(470.23)	(149.69)	(516.45)
Observations	729	727	382	381	347	346
R-squared	0.01	0.05	0.02	0.08	0.00	0.07
(C) Difference in WTP (XOF): high-quality minus low-quality solar lamp						
Durability signaling (LGC, 2YW)	-78.29	-91.06	-78.29	-91.29	353.68	338.00
	(123.41)	(126.83)	(123.40)	(130.17)	(148.81)	(157.67)
Solar lamp experience	-214.18	-288.31				
	(154.46)	(160.36)				

Treatment × experience	431.97	410.64				
	(193.31)	(200.44)				
Constant	365.04	120.65	365.04	3.65	150.86	-7.28
	(95.11)	(258.45)	(95.10)	(366.53)	(121.72)	(426.16)
Observations	729	727	382	381	347	346
R-squared	0.01	0.04	0.00	0.03	0.02	0.05
Controls	NO	YES	NO	YES	NO	YES

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. The sample consists of only the participants receiving the LGC and 2YW treatments (= "Durability signaling") and those in the control group. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar lamp penetration rate in the village and the order of lamp presentation.

Different levels of winsorization

Table C4: Table 2 without winsorization and winsorized at the five lower and upper percentiles

	No winsorization				Winsorized at the five lower and upper percentiles			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log WTP for high-quality solar lamp							
LG certification	0.16	0.16			0.12	0.12		
	(0.06)	(0.06)			(0.05)	(0.05)		
2-year warranty	0.16	0.14			0.13	0.11		
	(0.06)	(0.06)			(0.05)	(0.05)		
Money-back guarantee	0.01	-0.02			-0.02	-0.05		
	(0.06)	(0.06)			(0.05)	(0.05)		
Durability signaling (LGC, 2YW)			0.16	0.14			0.12	0.11
			(0.05)	(0.05)			(0.04)	(0.04)
Constant	7.55	7.43	7.55	7.44	7.58	7.50	7.58	7.49
	(0.04)	(0.14)	(0.04)	(0.15)	(0.04)	(0.11)	(0.04)	(0.12)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Observations	960	958	729	727	960	958	729	727
R-squared	0.01	0.06	0.01	0.07	0.01	0.06	0.01	0.07

Note: WTP is not winsorized in Columns (1) to (4) and winsorized at the five lower and upper percentiles in Columns (5) to (8). Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3), (4), (7) and (8) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C5: Table 3 without winsorization and winsorized at the five lower and upper percentiles

	No winsorization				Winsorized at the five lower and upper percentiles			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Log WTP for low-quality solar lamp							
LG certification	0.14	0.16			0.08	0.09		
	(0.07)	(0.07)			(0.05)	(0.05)		
2-year warranty	0.17	0.15			0.11	0.10		
	(0.07)	(0.07)			(0.05)	(0.06)		
Money-back guarantee	0.04	0.01			-0.02	-0.04		
	(0.07)	(0.07)			(0.06)	(0.06)		
Durability signaling (LGC, 2YW)			0.15	0.15			0.09	0.09
			(0.06)	(0.06)			(0.05)	(0.05)
Constant	7.41	7.45	7.41	7.52	7.44	7.48	7.44	7.51
	(0.05)	(0.14)	(0.05)	(0.15)	(0.04)	(0.12)	(0.04)	(0.13)
Controls	NO	YES	NO	YES	NO	YES	NO	YES
Observations	960	958	729	727	960	958	729	727
R-squared	0.01	0.05	0.01	0.05	0.01	0.05	0.01	0.05

Note: WTP is not winsorized in Columns (1) to (4) and winsorized at the five lower and upper percentiles in Columns (5) to (8). Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3), (4), (7) and (8) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C6: Table 4 without winsorization and winsorized at the five lower and upper percentiles

	No winsorization						Winsorized at the five lower and upper percentiles					
	Full sample		No experience		Solar lamp experience		Full sample		No experience		Solar lamp experience	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(A) Log WTP for high-quality solar lamp												
Durability signaling (LGC, 2YW)	0.19	0.17	0.19	0.19	0.13	0.12	0.14	0.13	0.14	0.14	0.10	0.09
	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.08)	(0.06)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)
Solar lamp experience	0.04	0.05					0.02	0.03				
	(0.09)	(0.09)					(0.07)	(0.08)				
Treatment × experience	-0.06	-0.07					-0.05	-0.06				
	(0.11)	(0.11)					(0.09)	(0.09)				
Constant	7.53	7.42	7.53	7.32	7.57	7.55	7.57	7.47	7.57	7.40	7.59	7.57
	(0.06)	(0.15)	(0.06)	(0.20)	(0.07)	(0.26)	(0.05)	(0.13)	(0.05)	(0.17)	(0.06)	(0.21)
Observations	729	727	382	381	347	346	729	727	382	381	347	346
R-squared	0.01	0.07	0.02	0.08	0.01	0.09	0.01	0.07	0.02	0.08	0.01	0.09
(B) Log WTP for low-quality solar lamp												
Durability signaling (LGC, 2YW)	0.24	0.24	0.24	0.25	0.06	0.05	0.19	0.19	0.19	0.20	-0.01	-0.02
	(0.07)	(0.07)	(0.07)	(0.07)	(0.10)	(0.10)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)
Solar lamp experience	0.09	0.13					0.11	0.16				
	(0.11)	(0.11)					(0.08)	(0.08)				
Treatment × experience	-0.18	-0.20					-0.20	-0.21				
	(0.12)	(0.12)					(0.10)	(0.10)				
Constant	7.36	7.46	7.36	7.31	7.45	7.71	7.39	7.44	7.39	7.33	7.49	7.71
	(0.06)	(0.15)	(0.06)	(0.21)	(0.09)	(0.23)	(0.05)	(0.14)	(0.05)	(0.19)	(0.06)	(0.21)
Observations	729	727	382	381	347	346	729	727	382	381	347	346
R-squared	0.01	0.05	0.03	0.07	0.00	0.07	0.01	0.05	0.02	0.06	0.00	0.09
(C) Difference in log WTP: high-quality minus low-quality solar lamp												
Durability signaling	-0.05	-0.07	-0.05	-0.06	0.07	0.06	-0.05	-0.06	-0.05	-0.05	0.11	0.11

(LGC, 2YW)												
	(0.05)	(0.05)	(0.05)	(0.05)	(0.09)	(0.09)	(0.04)	(0.04)	(0.04)	(0.05)	(0.05)	(0.05)
Solar lamp experience	-0.05	-0.08					-0.09	-0.12				
	(0.10)	(0.10)					(0.06)	(0.06)				
Treatment × experience	0.12	0.12					0.16	0.16				
	(0.10)	(0.10)					(0.07)	(0.07)				
Constant	0.16	-0.04	0.16	0.01	0.12	-0.15	0.18	0.03	0.18	0.07	0.09	-0.13
	(0.04)	(0.11)	(0.04)	(0.14)	(0.09)	(0.19)	(0.03)	(0.10)	(0.03)	(0.13)	(0.04)	(0.15)
Observations	729	727	382	381	347	346	729	727	382	381	347	346
R-squared	0.00	0.03	0.00	0.04	0.00	0.04	0.01	0.05	0.00	0.05	0.01	0.07
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Note: WTP is not winsorized in Columns (1) to (6) and winsorized at the five lower and upper percentiles in Columns (7) to (12). Robust standard errors are in parentheses. The sample consists of only the participants receiving the LGC and 2YW treatments (= "Durability signaling") and those in the control group. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar lamp penetration rate in the village and the order of lamp presentation.

Multiple hypothesis testing

Against the background that we have multiple treatments of interest and that we look at heterogeneous effects by level of experience, we are testing multiple null hypotheses simultaneously. To test the robustness of our results with regard to multiple hypotheses testing, we apply the bootstrap-based procedure by List, Shaikh and Xu (2019) and report their adjusted p-values (without covariate adjustment). For Tables 2 and 3, we test the families of null hypotheses that emerge due to multiple treatments and for Tables 4 and 5 we test the families of null hypotheses that emerge due to multiple subgroups. In each case, we list the respective coefficient in Column (1) with the unadjusted p-value in Column (2), which List et al. (2019) refer to in 'Remark 3.1.' Moreover, we consider inference based on their Theorem 3.1 using the studentized test statistics described in Remark 3.4. When exploring multiple treatments, we will also display in Column (4) an adjusted p-value described in Remark 3.7 obtained by exploiting the logical restrictions among null hypotheses when there are multiple treatments. Last, in the last two columns we provide p-values obtained by using the classical Bonferroni and Holm multiple testing procedures.

Table C7: Coefficients (without controls) of Table 2 with unadjusted and multiplicity adjusted p-values

Comparison groups		p-values				
		Unadjusted	Multiplicity adjusted			
	(1)	(2)	(3)	(4)	(5)	(6)
	Coeff.	Remark 3.1	Theorem 3.1	Remark 3.7	Bonferroni	Holm
Control vs. LGC	0.13	0.023	0.062	0.023	0.140	0.070
Control vs. 2YW	0.14	0.012	0.057	0.057	0.070	0.070
Control vs. MBG	-0.01	0.839	0.975	0.839	1.000	1.000
LGC vs. 2YW	0.01	0.897	0.897	0.897	1.000	0.897
LGC vs. MBG	-0.15	0.012	0.042	0.032	0.072	0.048
2YW vs. MBG	-0.15	0.012	0.051	0.033	0.072	0.060

Table C8: Coefficients (without controls) of Table 3 with unadjusted and multiplicity adjusted p-values

Comparison groups		p-values				
		Unadjusted	Multiplicity adjusted			
	(1)	(2)	(3)	(4)	(5)	(6)
	Coeff.	Remark 3.1	Theorem 3.1	Remark 3.7	Bonferroni	Holm
Control vs. LGC	0.09	0.101	0.252	0.101	0.608	0.304
Control vs. 2YW	0.12	0.031	0.123	0.081	0.188	0.157
Control vs. MBG	-0.01	0.825	0.825	0.825	1.000	0.825
LGC vs. 2YW	0.02	0.669	0.887	0.669	1.000	1.000
LGC vs. MBG	-0.11	0.069	0.207	0.162	0.416	0.277
2YW vs. MBG	-0.13	0.024	0.111	0.111	0.146	0.146

Table C9: Coefficients (without controls) of Table 4 with unadjusted and multiplicity adjusted p-values

Comparison groups		p-values				
		Unadjusted	Multiplicity adjusted			
	(1)	(2)	(3)	(4)	(5)	(6)
	Coeff.	Remark 3.1	Theorem 3.1	Remark 3.7	Bonferroni	Holm
(A) Log WTP for high-quality solar lamp						
No experience	0.17	0.012	0.024	-	0.048	0.024
Solar lamp experience	0.10	0.183	0.183	-	0.733	0.183
(B) Log WTP for low-quality solar lamp						
No experience	0.21	0.001	0.002	-	0.005	0.003
Solar lamp experience	-0.01	0.890	0.890	-	1.000	0.890
(C) Difference in log WTP: high-quality minus low-quality solar lamp						
No experience	-0.04	0.380	0.380	-	0.753	0.380
Solar lamp experience	0.11	0.051	0.097	-	0.203	0.101

Randomization inference

Due to randomization into four treatment groups and additional subgroup analyses, we additionally implement randomization inference following the approach and Stata code developed by Heß (2017). Besides conventional p-values (in round parentheses), we document significance according to randomization inference p-values (in square parentheses).

Table C10: Table 2 with randomization inference p-values

	(1)	(2)	(3)	(4)
	Log WTP for high-quality solar lamp			
LG certification	0.13	0.14		
	(0.021)	(0.016)		
	[0.016]	[0.017]		
2-year warranty	0.14	0.12		
	(0.014)	(0.032)		
	[0.018]	[0.040]		
Money-back guarantee	-0.01	-0.04		
	(0.831)	(0.501)		
	[0.836]	[0.494]		
Durability signaling (LGC, 2YW)			0.14	0.12
			(0.006)	(0.014)
			[0.005]	[0.013]
Constant	7.56	7.48	7.56	7.48
	(0.000)	(0.000)	(0.000)	(0.000)
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.01	0.06	0.01	0.07

Note: WTP is winsorized at the two lower and upper percentiles. P-values are in round parentheses. Randomization inference p-values are in square parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C11: Table 3 with randomization inference p-values

	(1)	(2)	(3)	(4)
	Log WTP for low-quality solar lamp			
LG certification	0.09	0.11		
	(0.104)	(0.055)		
	[0.105]	[0.052]		
2-year warranty	0.12	0.10		
	(0.037)	(0.081)		
	[0.047]	[0.088]		
Money-back guarantee	-0.01	-0.03		
	(0.821)	(0.582)		
	[0.827]	[0.589]		
Durability signaling (LGC, 2YW)			0.10	0.10
			(0.034)	(0.043)
			[0.027]	[0.032]
Constant	7.44	7.49	7.44	7.52
	(0.000)	(0.000)	(0.000)	(0.000)
Controls	NO	YES	NO	YES
Observations	960	958	729	727
R-squared	0.01	0.05	0.01	0.05

Note: WTP is winsorized at the two lower and upper percentiles. P-values are in round parentheses. Randomization inference p-values are in square parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience, solar lamp penetration rate in the village and the order of lamp presentation. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.

Table C12: Table 4 with randomization inference p-values (only for split sample)

	No experience		Solar lamp experience	
	(1)	(2)	(3)	(4)
(A) Log WTP for high-quality solar lamp				
Durability signaling (LGC, 2YW)	0.17** #	0.17** #	0.10	0.09
	(0.011)	(0.011)	(0.176)	(0.227)
	[0.014]	[0.012]	[0.175]	[0.211]
Constant	7.55***	7.37***	7.58***	7.58***
	(0.05)	(0.18)	(0.06)	(0.24)
Observations	382	381	347	346
R-squared	0.02	0.08	0.01	0.09
(B) Log WTP for low-quality solar lamp				
Durability signaling (LGC, 2YW)	0.21*** ##	0.22*** ##	-0.01	-0.02
	(0.001)	(0.001)	(0.889)	(0.843)
	[0.000]	[0.002]	[0.883]	[0.831]
Constant	7.39***	7.35***	7.51***	7.71***
	(0.05)	(0.20)	(0.06)	(0.22)
Observations	382	381	347	346
R-squared	0.03	0.07	0.00	0.08
(C) Difference in log WTP: high-quality minus low-quality solar lamp				
Durability signaling (LGC, 2YW)	-0.04	-0.05	0.11** #	0.11* #
	(0.385)	(0.304)	(0.046)	(0.060)
	[0.406]	[0.308]	[0.039]	[0.051]
Constant	0.16***	0.03	0.07	-0.13
	(0.04)	(0.13)	(0.05)	(0.17)
Observations	382	381	347	346
R-squared	0.00	0.05	0.01	0.06
Controls	NO	YES	NO	YES

Note: WTP is winsorized at the two lower and upper percentiles. P-values are in round parentheses. Randomization inference p-values are in square parentheses. The sample consists of only the participants receiving the LGC and 2YW treatments (= "Durability signaling") and those in the control group. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar lamp penetration rate in the village and the order of lamp presentation.

D. Lamp order effects

Table D1: Effects of treatments for high-quality lamp on WTP for low-quality solar lamp, by lamp-presentation order

	Full sample		Low-quality lamp first		High-quality lamp first		Full sample		Low-quality lamp first		High-quality lamp first	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Log WTP for low-quality solar lamp											
LG certification	0.26	0.28	-0.09	-0.06	0.26	0.28						
	(0.08)	(0.08)	(0.08)	(0.09)	(0.08)	(0.08)						
2-year warranty	0.25	0.23	-0.02	-0.03	0.25	0.21						
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)						
Money-back guarantee	0.01	-0.03	-0.05	-0.05	0.01	-0.04						
	(0.08)	(0.08)	(0.09)	(0.09)	(0.08)	(0.08)						
Low-quality lamp first	0.20	0.19										
	(0.08)	(0.08)										
LGC × LQ lamp first	-0.35	-0.34										
	(0.11)	(0.11)										
2YW × LQ lamp first	-0.27	-0.26										
	(0.11)	(0.11)										
MBG × LQ lamp first	-0.06	-0.02										
	(0.12)	(0.12)										
Durability signaling (LGC, 2YW)							0.25	0.25	-0.05	-0.04	0.25	0.24
							(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Treatment × LQ lamp first							-0.31	-0.30				
							(0.10)	(0.10)				
Constant	7.35	7.39	7.55	7.71	7.35	7.22	7.35	7.41	7.55	7.84	7.35	7.11
	(0.05)	(0.13)	(0.06)	(0.17)	(0.05)	(0.19)	(0.05)	(0.14)	(0.06)	(0.18)	(0.05)	(0.21)
Controls	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES
Observations	960	958	479	478	481	480	729	727	360	359	369	368
R-squared	0.02	0.06	0.00	0.05	0.04	0.11	0.02	0.06	0.00	0.06	0.04	0.12

Note: WTP is winsorized at the two lower and upper percentiles. Robust standard errors are in parentheses. Individual and household controls are age, gender, education, finished roof, household size. Risk and trust controls are willingness to take risks, trust in World Bank, trust in Total Senegal, trust in NGOs. We furthermore control for solar kit experience and solar lamp penetration rate in the village. The sample in Columns (3) and (4) consists of only the participants receiving the LGC and 2YW treatment and those in the control group.