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**Abstract:**

Many people do not purchase products that would appear to benefit them. For example, the price of an efficient cookstove can be less than a few months' savings on fuel. If liquidity constraints, present bias, and poor information on fuel savings and stove durability are barriers, then combining a free trial, time payments, and the right to return the stove at any time should increase sales. In a randomized trial, this offer increases uptake of an efficient charcoal-burning stove in Kampala, Uganda, from 4% to 46%. We provide additional evidence that both liquidity constraints and imperfect information were important barriers.



# What Impedes Efficient Adoption of Products? Evidence from Randomized Variation in Sales Offers for Improved Cookstoves in Uganda

By DAVID I. LEVINE AND CAROLYN COTTERMAN \*

*Many people do not purchase products that would appear to benefit them. For example, the price of an efficient cookstove can be less than a few months' savings on fuel. If liquidity constraints, present bias, and poor information on fuel savings and stove durability are barriers, then combining a free trial, time payments, and the right to return the stove at any time should increase sales. In a randomized trial, this offer increases uptake of an efficient charcoal-burning stove in Kampala, Uganda, from 4% to 46%. We provide additional evidence that both liquidity constraints and imperfect information were important barriers.*

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Half the world cooks on inefficient stoves that burn biomass such as wood and charcoal. Smoke from these stoves kills over a million children a year and their inefficient use of fuel contributes to deforestation and global climate change.

The high cost of buying or gathering fuel means that inefficient stoves also deepen poverty. Poor people can spend up to a third of their income on cooking fuel, which is puzzling because improved cookstoves can reduce fuel costs sufficiently to repay the cost of the stove (Global Alliance for Clean Cookstoves, 2011: 13). If markets worked well, even a poor person would pay for an improved cookstove if the savings on fuel quickly covered the stove cost. But in most nations, relatively few households adopt improved cookstoves (Global Alliance for Clean Cookstoves, 2011: 13).

We hypothesize that demand for improved cookstoves is reduced by liquidity constraints (and possibly present bias), lack of information on the benefits of the stoves, and lack of confidence that they are durable.

If the new cookstove, in fact, saves fuel without too many downsides, a novel cookstove sales offer can address these barriers by combining a free trial period, time payments, and the right to return the stove and stop future payments at any time. In the United States, such an arrangement would be called “rent-to-own” with a free trial period.

This sales offer is well suited to selling improved stoves, especially for customers who purchase their own fuel. The initial time payment can be set so that customers pay it largely or entirely from fuel savings they have already accrued during the free trial. If those savings don’t turn out to be enough to begin making payments, the consumer can just return the stove. This process repeats, so subsequent time payments are also largely paid for by recent fuel savings and, if the stove breaks down, the consumer returns it and owes nothing more. With this combination of a free trial and “rent-to-own,” the customer bears almost no risk if

the product does not work as advertised (other than the risk of perhaps burning one dinner).

## **Theory and Literature Review**

### *Theory of Barriers*

The slow adoption of stoves that could substantially reduce fuel expenditures is somewhat mysterious. While poor people have less of most things, in well-functioning markets they should *not* have less of items that could make them less poor. Improved stoves are also capable of reducing indoor air pollution, a top killer of children in less developed countries. While we do not emphasize health effects in this study, the slow adoption of improved cookstoves is even more puzzling when health effects are considered.

We hypothesize that many consumers may not purchase an improved cookstove because of three sets of barriers—liquidity constraints and present bias, savings concerns, and durability concerns—described below:

*Liquidity constraints and present bias.* There is evidence many consumers in poor nations face liquidity constraints and present bias; that is, they find it difficult to come up with the entire purchase price in one lump sum (Banerjee, 2003; Mullainathan and Shafir, 2009). For such consumers, time payments can be a solution. We therefore hypothesize that a sales offer with time payments will increase sales, especially for consumers with liquidity constraints or present bias.

A free trial permits consumers to enjoy a benefit today, but not pay until the trial is over. We therefore also hypothesize that, when a free trial is added to the sales offer, adoption of the stove will increase more amongst consumers who show present bias than amongst consumers who do not.

*Concerns about fuel savings.* Consumers are subject to many marketing messages and quickly learn that not all salespeople can be trusted; some consumers will therefore not believe the claimed fuel savings from an improved cookstove. For such consumers, a free trial can be a credible signal that the stove will, in fact, save fuel (Moorthy and Srinivasan, 1995; Shieh, 1996). Davis et al. (1995) emphasize that money-back guarantees increase consumers' willingness to try unfamiliar products when they are unsure of the benefits.<sup>1</sup> In our setting, the free trial period gives consumers a chance to experience the fuel savings and to determine if the improved cookstove fits their cooking style and other needs; that is, we treat stoves as "experience goods." Taking a behavioral view, the trial period may also activate norms of reciprocity, which can increase uptake (Cialdini 2006).<sup>2</sup> All of these forces lead us to hypothesize that a free trial increases sales, especially among consumers who don't trust salespeople.

Because fuel savings are roughly proportional to baseline fuel use, we also expect higher adoption for those with higher baseline fuel expenditures and those with larger families.

*Concerns about durability.* Even in rich nations, consumers face the problem that many "durables" are not all that durable. Consumers in poor nations face the problem of shoddy merchandise even more frequently. For such consumers, adding the option to return the stove at any time to the time payments offer can be a solution, reducing the risk that the stove is not durable and will not deliver the promised savings (Davis et al., 1995). These forces lead us to hypothesize that adoption will be higher when consumers are offered the right to return. We also

<sup>1</sup> See also Grossman (1981), who shows theoretically that a money-back guarantee can reduce adverse selection and increase trade and efficiency.

<sup>2</sup> We thank Adam Galinsky for identifying reciprocity as a possible motive.

hypothesize that the effect that a right to return will have on adoption will be strongest for consumers with above-average concerns about durability.

### *Potential Weaknesses of the New Offer*

We were concerned that the stove might break, that it might not cook the way people like, that it might not actually save fuel, or that consumers might not be able to detect the true fuel savings. Any of these forces would lead to high return rates.

Our offer will also perform poorly if consumers keep the stove but do not pay for it, perhaps because they have moved away or are hard to find at home. In addition, consumers are not required to pay for the stove if it is stolen. Of course, our offer would be particularly attractive to customers who had no intention of paying, leading to potential adverse selection.<sup>3</sup>

### *Related Sales Offers*

In many settings, sellers already offer combinations of a free trial period, time payments, and the right to return.

For example, time payments are at the heart of the microfinance revolution. Energypedia (2011) and MicroEnergy International (2008) discuss linking microfinance with projects that sell improved cookstoves.

Time payments tied to energy savings have been used in the United States by companies that improve heating and air conditioning efficiency in buildings. The logic of these offers is similar to that of our offer: With no upfront payment, the money to pay for the service comes from fuel savings that have already occurred. These offers have the added benefit of rewarding incremental improvements in

<sup>3</sup> We thank Andy Weiss for pointing out this incentive.

efficiency by the provider, but they also have the added cost of requiring the provider to estimate a counterfactual energy bill without the extra services.

Rent-to-own is a familiar method of selling to poor consumers in the United States (see Lacko, McKernan, and Hastak, 2000 and the citations in footnote 2 of Nehf, 1991). Rent-to-own has also made small inroads in poor nations (e.g., Rent-to-Own Africa, 2011).

## **Methods**

### *Experimental Design*

Our study took place in Kampala, the capital and largest city of Uganda. Kampala had a population of roughly 1.4 million in 2008 (Uganda Bureau of Statistics, cited in Citypopulation.de, 2008). Uganda is one of the poorest nations in the world, with an infant mortality rate of 65 per 1000 live births, 67% literacy (but only 58% for women), and GDP per capita of \$1200 (Central Intelligence Agency, 2010; a 2008 estimate, in 2009 US\$ valued at purchasing power parity). The majority of Kampala households cook with a traditional charcoal stove such as the one pictured in FIGURE 1.

Our intervention markets the Ugastove improved charcoal stove (FIGURE 2). The evidence that the Ugastove reduces fuel use when tested in controlled settings (Wang et al., 2009) was strong enough to make it the first improved stove to pass the voluntary carbon market's "Gold Standard," based on kitchen performance tests (Evans 2008). Partly because the price is subsidized by carbon credits, the retail price is between \$6 and \$10, depending on stove size.

We worked with CIRCODU, an NGO based in Kampala that specializes in market research related to household energy. CIRCODU recruited and trained pairs of enumerators, who also served as our salespeople.

We selected neighborhoods in which we expected to find a high use of charcoal stoves, avoiding the very richest neighborhoods where most people cook with gas and the informal settlements where many people cook with wood and waste. We kept offers homogeneous within neighborhoods to reduce the social comparison and potential anger if customers heard we had offered a neighbor a better deal.

In each neighborhood, sales teams consisting of two enumerators marketed the stoves to ten households in which an adult was home. The enumerators selected homes according to a pre-determined set of rules that aimed to improve randomization, and reduce peer effects. They gave presentations to approximately every sixth household so that each consumer approached would be an independent unit who had not seen or heard the enumerators give presentations to their neighbors. To reduce socioeconomic similarity within a cluster, after five households the team returned to the car and drove approximately a kilometer.

At each home, the sales team made a marketing presentation about the stove and presented one of four sales offers: traditional, free trial, time payments, or novel. Both the novel contract and the time payments contract consisted of four equally-sized weekly installments and always included the right to return the stove during the period before all scheduled payments were due.

After gathering some basic information pertaining to the household's cooking and purchasing behavior, enumerators next recorded the homeowners' purchasing decision. (See Online Appendices 2 and 3 for the sales script and corresponding survey.) If a traditional or time-payment offer was accepted, the salespeople collected the first payment. If the consumers asked to defer the decision, the salespeople offered to return in a week.

For some neighborhoods where we were making the traditional offer, we did not make the traditional posted price (also known as a take-it-or-leave-it offer). Instead, we used an incentive compatible Becker-DeGroot



We measured willingness-to-pay using an incentive-compatible Becker-DeGroot-Marschak (BDM) procedure.<sup>23</sup> We told each participant that the price of the stove is set at random, and is hidden within an envelope we showed her. We asked the participant the highest price she would agree to pay, explaining she could purchase the stove at the envelope price if the maximum willingness to pay she stated was above the unknown price hidden inside the envelope. We explained that if she stated a maximum below the envelope price we would not be able to sell her the stove.

Because stated willingness to pay affects whether someone can purchase a product, but *not* how much they pay, this procedure provides incentives for respondents to truthfully report their willingness to pay (at least if participants understand and believe all the instructions). That is, it is not in the best interests of a respondent to name a higher price than what the product is worth to her, because she may end up paying a higher willingness to pay than her actual willingness to pay. Similarly, if a participant understates her true willingness to pay, she might lose the opportunity to buy the stove at a price she was, in fact, willing to pay. We gave participants up to seven days to gather funds if needed and allowed them to ask any questions prior to participating in the auction to ensure their understanding.

Consumers made their purchasing decision, enumerators thanked them for their time and offered a small gift (a bar of soap) in exchange for answering a few more questions, which were about liquidity constraints, trust, and concerns and experience with product durability. (See Online Appendix 4 for that survey.)

Over the following months, the salespeople recorded the experiences their customers had with the stoves, as well as return rates, warranty repair rates, and default rates.

### *Measures of Barriers*

Using our survey responses, we characterized participating consumers according to whether they appeared to face our hypothesized barriers.

*Liquidity constraints.* We classified consumers as liquidity-constrained if they reported that they had wanted to borrow money in the last three months and had either been denied a loan or had not even sought one for fear of being refused.

*Present bias.* To measure present bias we asked two items about simulated intertemporal choices:

- “If a trusted relative wanted to give you a gift, would you choose 6,000 Ugandan shillings (Ushs) [about \$3] now or 36,000 Ushs [\$18] in 1 month?”
- “If a trusted relative wanted to give you a gift, would you choose 6,000 Ushs [\$3] in 3 months or 36,000 Ushs [\$18] in 4 months?”

If respondents have time-consistent preferences, they will give the equivalent response to both questions. Other researchers have found frequent preference reversals, with respondents choosing the option of immediate payout, but otherwise being willing to postpone payments if both options are delayed (see Benhabib et al., 2010 and citations therein). If a consumer chose 36,000 UGX in four months over 6,000 UGX in three months but preferred a 6,000 immediate payout over 36,000 in one month, we coded him or her as present-biased.

*Concern about fuel savings.* Our survey included one item that inquired directly about the consumer’s trust in Ugastove’s fuel savings: “Do you believe that this stove will save you half of your current charcoal expenditures?” (Coded 1 = “Definitely yes” to 5 = “Definitely no”).

Related to a consumer's trust in the Ugastove's fuel savings is her general trust in salespeople: we classified consumers as having "concerns about salesperson honesty" if any of the following were true:

- The consumer replied with "Never trust" to the question, "How much did you trust that salesperson/those salespeople?" (conditional on having been visited by door-to-door salesperson in past).
- The consumer replied with "three" or fewer to the question, "Out of 10 salespersons, how many would you say that you would trust?" (conditional on having been visited by door-to-door salesperson in past).
- The consumer replied with "Yes, all" or "Yes, most" to the question, "In your experience, do most salespersons promise more than their products deliver?"

*Concerns about product durability.* We classified consumers as having "concerns about product durability" if they reported that most or all of the products that they purchase break soon after.

## **Results**

### *Descriptive Statistics and Checks on Randomization*

Baseline median weekly consumption of charcoal was \$2.20, with an interquartile range of \$1.60 to \$3.20. Households (defined as the number the respondent regularly cooks for) have a median size of five with an interquartile range of three to six.

The several experimental arms are balanced on baseline measures including household size, charcoal expenditures, and prior experience with an improved cookstove (see Table 1). In a multinomial logit, these variables are jointly not statistically significant in predicting the experimental arm.

### *Survey Measures of Barriers*

Subjects self-report low rates of liquidity constraint. Only 4% report that they wanted to borrow money in the last three months and were either denied a loan or did not even ask for one for fear of being refused.

In contrast, they self-report very high rates of discounting or present bias, with 63% preferring an immediate payout of \$2.70 over a payout of \$16 in six months (that is, preferring 6,000 Ugandan shillings immediately to 36,000 shillings later). Almost half these respondents (29% of the entire sample) showed present bias, as they also preferred \$16 in four months to \$2.70 in three months.

Consumers also showed high concerns about salesperson honesty, with 85% meeting one or more of our criteria: “never trusting” door-to-door salespeople, saying that three or fewer out of 10 salespeople are trustworthy, and/or saying that all or most salespeople promise more than their products deliver.

A smaller but still significant group of respondents had strong concerns about the durability of products they purchase, with 21% reporting that most or all of the products they purchase break soon after they have bought them.

### *Effects of Sales Offers on Uptake*

The main results are in Table 2, which shows rates of adoption and payment for each sales offer.

*Traditional Offer.* Even given the choice of buying the stove that day or in a week, only 4% of the households offered the traditional sales offer (N = 570 offers) wanted to purchase the stove at the regular price (pooling the posted price and the BDM price elicitation variations of the traditional offer). For those given the traditional offer followed by a BDM price elicitation, the entire demand curve is shown in Figure 3.

Of the subsample offered a posted price (equal to the retail price), six percent accepted. The share in the auction who stated they were willing to pay at least the retail price was 3 percentage points lower, though the difference is not statistically significant (chi-squared = 2.0, P = 0.15). The difference between the share of stated willingness to pay of at least the retail price and the somewhat—but not statistically significantly—higher share that accepted the posted price is consistent with the notion that consumers shaved their stated willingness to pay relative to their actual willingness to pay (Berry, Fisher, and Guiteras, 2011). Even if we assume stated willingness to pay averaged 10% below true willingness to pay, the uptake rate at the retail price would be unchanged.

*Novel offer.* We were concerned that people might not understand or trust the novel sales offer. In fact, 48% percent of households to whom the offer was made (166 out of 355) accepted it.

We were concerned that consumers might return the stove because they did not like it, it did not save much fuel, or they could not detect the fuel savings. In fact, only 6% of those who accepted a free trial (9 out of 166) returned the stove. In a few cases, this was because the consumer could not afford a payment, not because she did not like the stove. (We allowed one grace period to consumers who missed a payment.)

Thus, after returns, the novel offer led to sales at 46% of homes (157 sales from 355 offers). To achieve the same uptake with the traditional offer, we would have had to drop prices by roughly 62%; that is, to a price barely more than that of a traditional stove.

The novel offer removes risk for consumers, but opens the seller up to risks of consumer moral hazard; that is, people might steal the stove or merely move away. In fact, we received 97.1% of the expected revenue. Our revenue loss was distributed among 7% of those accepting the novel offer who failed to make all

the payments, most often because no one was home during the regular collection visit and one or more follow-ups. We do not know what share of these households moved away. In a few cases, the consumer was home but did not intend to pay. These defaults always occurred after some payments had been made; 82% of those who failed to pay the full price nevertheless paid at least half.

In the United States, rent-to-own consumers frequently make late payments (Lacko, McKernan, and Hastak, 2000). We were worried that, because we charged no late fee, late payments might be common and it would take many more visits to collect payments. As expected, some customers who took our novel offer required more than four collection visits to make all payments, either because they were not home or still had no money at the final scheduled collection visit (11% of those who eventually paid in full did not finish their payments on time). To our surprise, a much larger share of customers completed their payments early: fully 35% of those who completed payments.

*Offering only some features of the novel offer.* We were interested in finding out which of the possible barriers our novel offer addressed. If the main problems are difficulty in coming up with the entire purchase price at once and fears about durability, then time payments plus the right to return the stove should raise demand almost as much as the three-featured novel offer; that is, we could leave out the free trial and get nearly the same effect. Conversely, if the main problem is that customers doubt the new stove will both cook well and save money, then a free trial should suffice without time payments.

To test the relative importance of these barriers, we randomly selected some neighborhoods to receive a sales offer with either the time payments *or* the free trial, but not both.

Each of these offers raised uptake about half as much as the novel offer did. Specifically, a fourth (26%) of the households offered time payments (but without

a free trial) and 33% of those offered a free trial (but without time payments) accepted the offer (N = 389 and 539, respectively). Return rates were 14% after the free trial offer (statistically significantly higher at the 1% level than the 5.5% return rates with the novel offer), so only 29% of households offered the free trial ended up accepting the new stove.

Thus, either time payments or the free trial contracts raised uptake more than 20 percentage points above the 4% uptake with the traditional offer. Moving from either intermediate offer to the novel offer increased uptake by roughly another 20 percentage points to 46 percent.

The default rates for the free trials (12%) and the time payments (7%) were not statistically significantly different from the rate for novel offers (7%). As with the novel offer, those who defaulted on time payments almost always made at least partial payments. As the free trial had only a single scheduled payment, most of those who defaulted made no payments.

Among those who eventually paid in full, 8% of households taking the time-payments offer required extra collection visits, which was similar to the 11% share for those taking the novel offer. Over a third (38%) of those taking the time-payments offer completed their payments early; again, this was not statistically distinguishable from the share for those taking the novel offer (35%).

Overall, the payment rates on stoves not returned were 97% for the novel offer, 90% for the free trial only, and 96% for time payments only.

#### *Household Characteristics of Those Who Adopt the New Stove*

We expected the new stoves to be most valuable for households with higher charcoal expenditures and larger household size. Results are weakly in line with those expectations (see Figures 4A and 4B). For this analysis, we compress a

handful of outliers reporting spending over \$30 a week for charcoal or reporting more than 40 household members.

On average, adopters used about 20% more charcoal per week than decliners and tended to have about 20% larger households (closer to six people than five). In results not shown, both household size and charcoal expenditure significantly predict uptake of the traditional or time-payment offers, but neither is statistically significant in predicting uptake of the free trial or novel offers. When both factors are entered in a regression jointly, household size has a larger effect than charcoal expenditure.

We anticipated that, holding the sales offer constant, consumers with present bias, low trust in salespeople, and the experience of most or all of the products they purchase breaking soon after they have bought them will be less likely to adopt the new cookstove when offered the traditional offer. In fact, adopters and decliners of the traditional offer reported almost identical rates of each of those constraints (see Appendix Table A1).

### *Are Sales Offers Signals of Quality?*

Signaling theories suggest that offering a free trial signals the producer's confidence that the product meets consumer needs and that offering a guarantee signals durability (Moorthy and Srinivasan, 1995; Shieh, 1996). We therefore expected to find higher confidence in fuel savings amongst those given the offer with a free trial than amongst those given the traditional offer and higher confidence in fuel savings amongst those given the novel offer, which includes a free trial, than amongst those given the offer with time payments alone. Similarly, we expected higher confidence in stove durability amongst those given the offer with time payments plus the right to return than amongst those given the traditional offer and higher confidence in stove durability amongst those given the



novel offer (including the right to return the stove) than amongst those given the free trial alone. The prediction about the sales offer signaling durability is muted in this setting because the Ugastove company always promises to repair manufacturing flaws (although not acquired flaws due to consumer misuse).

We find no evidence that the type of sales offer affects consumers' confidence in the product. Almost half (46%) of respondents answered "Definitely" to "Do you believe that this stove will save you half of your current charcoal expenditures?" This fraction was almost identical for all sales offers (see Table 5). Similarly, 21% of respondents answered "Strongly agree" to "This stove will probably last three years or more." Again, rates of agreement were similar across sales offers (see Table 5), with no consistent pattern of greater agreement if the sales offer included time payments with the right to return.

In results not shown, we found the same lack of the predicted relationships when we ran an ordered logit, conditioning on respondents' confidence in salespeople and in product durability more generally. These results do not support the hypotheses that a free trial can signal fuel savings and that the right to return can signal durability.

#### *Importance of Sales Offer Terms to Subgroups Reporting Related Concerns*

We hypothesized that a sales offer with terms that addressed a specific constraint would increase uptake more among households who reported that constraint than among other households. For example, the time payments offer should increase sales more (relative to the traditional offer) for customers who report liquidity constraints than for other customers. Because the novel offer differs from the free trial by the addition of time payments, it should similarly increase sales relative to the free trial disproportionately among those reporting liquidity constraints.

In addition, consumers with low trust in salespeople should value the free trial more than their trusting counterparts value the free trial. We would therefore expect the free trial offer to increase uptake more (relative to the traditional offer) for consumers with low trust in salespeople than for other consumers. By the same principle, we would expect the novel contract to increase uptake more (relative to the time payments contract) among consumers with low trust in salespeople.

Finally, the right to return (which was included with time payments) should matter most for those reporting concerns about product durability. So, the difference in uptake between the time payments offer and traditional offer, and between the novel offer and free trial offer, should be greater for those with durability concerns than for others.

Of these six tests, only two produce results of the right sign and none of the results are statistically significant (see Online Appendix Table A2). Overall these hypotheses do not receive support.

## **Conclusion**

### *Summary*

Our main result is that a sales offer with either time payments or with a free trial increases the uptake of improved cookstoves from 5% to 25%. Combining these offers into the novel sales offer (which also includes the right to return the stove and stop payments) increases uptake further to 45%. Return rates and default rates were both quite low in this sample.

The novel sales offer was designed to address liquidity constraints, present bias, concerns about savings, and concerns about durability. Its success—and our sample's self-reporting of high or very high rates of those four barriers—suggests that they are indeed collectively important.

At the same time, those reporting these constraints did not purchase improved stoves less often than those who did not. In addition, there is no evidence that a sales offer designed to address a particular barrier (such as a free trial for those with concerns about the honesty of salespeople) increased adoption more for those reporting that barrier than it did for those who did not.

It is likely that some respondents under-report near-pervasive constraints; it may be, for example, that almost none of our respondents trust salespeople's promises and that almost all of them fear that a new stove will not last long. If such under-reporting is substantial, we would not expect to see an interaction. The modest number of those who accepted the traditional offer also limits the precision of some of our tests.

There is also no support for the hypotheses, suggested by signaling theory, that a free trial signals fuel savings or that the right to return signals durability. But these negative results could also be due to weaknesses in our self-reported measures of belief in the stove's fuel savings and durability.

### *Discussion*

The barriers we identified—liquidity constraints, present bias, concerns about savings, and concerns about durability—appear to be important for many consumers and the improved sales offer we tested appears to address these barriers. At the same time, we were not able to identify how the different components of the novel sales offer overcame specific barriers.

We also identified important anomalies belying a simple understanding of the barriers. For example, although our sample showed very high self-reported discount rates, there were also high rates of prepayment. Apart from the survey results, we have some qualitative evidence that is consistent with the view that, for many Ugandans, debt is undesirable. Several respondents, for example, said

they were prepaying so the stove salesperson would not come by for collections; they apparently feared the stigma of owing time payments. Prepayment may also have been motivated by the irregular nature of many customers' incomes coupled with the challenges of saving; by prepaying when they had cash on hand, they reduced the risk of losing the stove if they had no cash when the next payment was due.

### *Limitations and Implications*

*For researchers.* Widespread failure to purchase an available cost-effective cookstove provides a natural laboratory for studying human decision-making. Our overall results suggest that the combination of barriers we identify is important, but our research methods were not able to distinguish their individual relative importance.

Some of the problem was our measures. We used short scales, which limits reliability. We relied on self-reports, although behavioral measures typically have higher validity. Data was collected by the salespeople, which can increase politeness bias on the part of respondents (particularly when reporting if salespeople are trustworthy). Future research (with a larger budget) can address each of these limitations; for example, by using real money games to measure discounting and liquidity constraints.

More generally, future research can offer a wider variety of sales offers. By measuring willingness to pay when offered different timings and numbers of payments, it should be feasible to disentangle the effects of liquidity constraints, present bias, and high subjective discount rates.

*For practitioners.* The novel sales offer has been highly effective at increasing uptake of an improved Ugastove. We hope to test whether a business model can implement the novel offer at much lower transaction costs, using mobile banking

or selling to organized groups of consumers (e.g., members of a microfinance or church group) rather than to individuals in a door-to-door format.

Local salespeople usually have too little liquidity to lend stoves to customers and limited ability to bear the risk of customer returns and defaults. We are interested in testing novel distribution contracts that can induce salespeople to make the novel sales offer while still giving them incentives to select reliable customers, work hard to collect payments, and report payments truthfully.

It is important to understand what products work well with the novel offer. For example, we are currently (as of 2012) testing it with wood-burning stoves. Wood and other biomass fuels are typically gathered, whereas charcoal—the fuel used in our trials so far—is purchased. We would like to explore the circumstances under which the financial decision-makers (typically men) will pay to save the time of those who gather the fuel (typically women and children).

It is also important to test if a sales offer combining a free trial plus a “subscription” for fuel can work with stoves that use distinctive fuels such as liquefied petroleum gas (LPG) or briquettes. More generally, it would be valuable to test how well the novel sales offer increases adoption of goods that avert costs, such as a water filter that reduces the need to purchase fuel for boiling water. Eventually, we hope to test the novel sales offer for goods that raise a small business’s revenue, such as solar-powered lights for merchants at night markets.

The goal of most programs for improved cookstoves is to reduce fuel use (to reduce deforestation and global climate change) and to reduce dangerous household air pollution. Thus, it is important both to increase the use of efficient and low-emissions stoves and also to reduce use of old stoves, a goal more ambitious than our sales offer can achieve. It is important to study how to combine sales of new stoves with programs that use information, incentives, shifts in norms, and so on to change people’s behavior.

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FIGURE 1: TRADITIONAL CHARCOAL STOVE



FIGURE 2: UGASTOVE IMPROVED STOVE

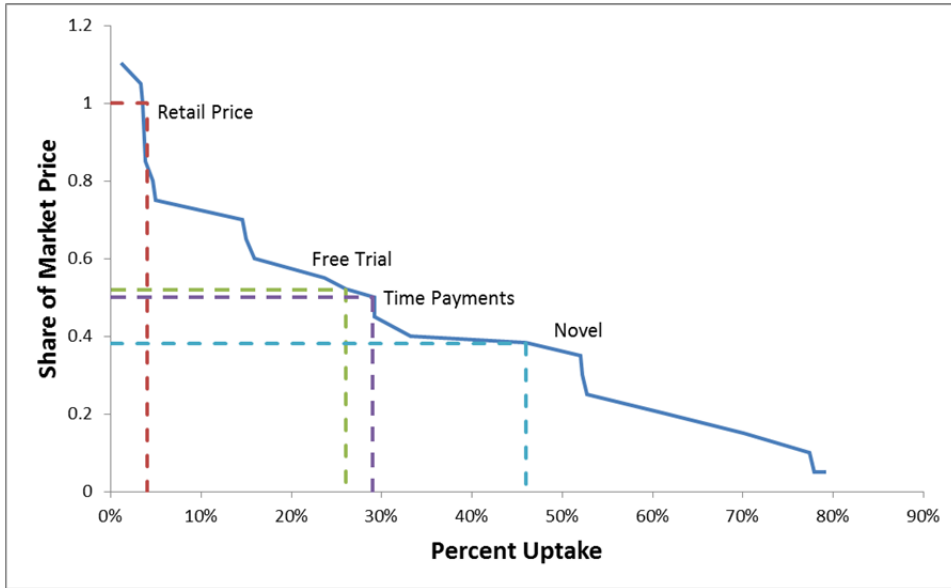


FIGURE 3: DEMAND CURVE FROM INCENTIVE-COMPATIBLE AUCTION WITH TRADITIONAL OFFER

*Notes:* The vertical lines indicate uptake for the four sales offers: 3% for traditional offer (using the BDM elicitation), 26% for the free trial, 29% for time payments, and 46% for the novel sales offer. For the free trial, time payments, and novel offer, the uptake calculations are not from the auction, but from separate sales that were not followed by returns. The horizontal lines indicate the price (relative to the market price) required for the traditional offer to achieve the uptake of the other sales offers. Specifically, price would have to fall by roughly half to have as many participants state a willingness to pay with the traditional offer as accepted the free trial or time payments and it took a reduction of 62% off regular price to have the same uptake as the novel offer.

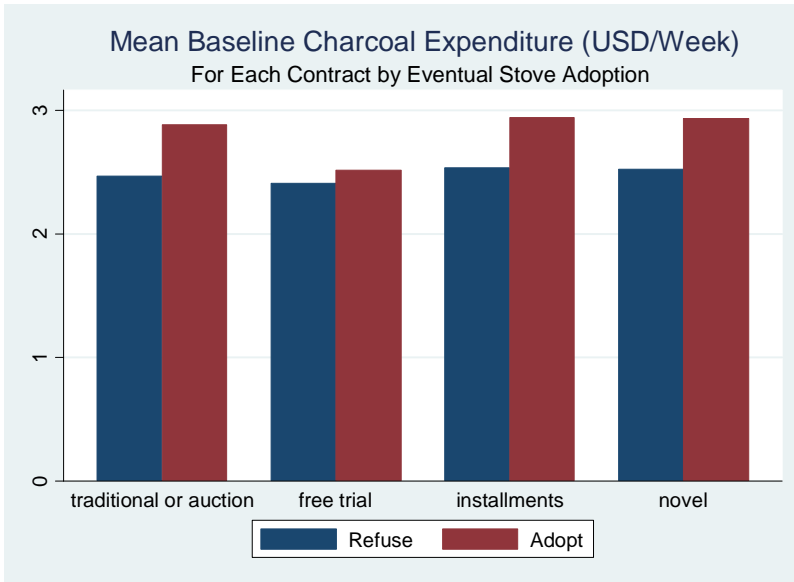


FIGURE 4A: MEAN BASELINE CHARCOAL EXPENDITURE

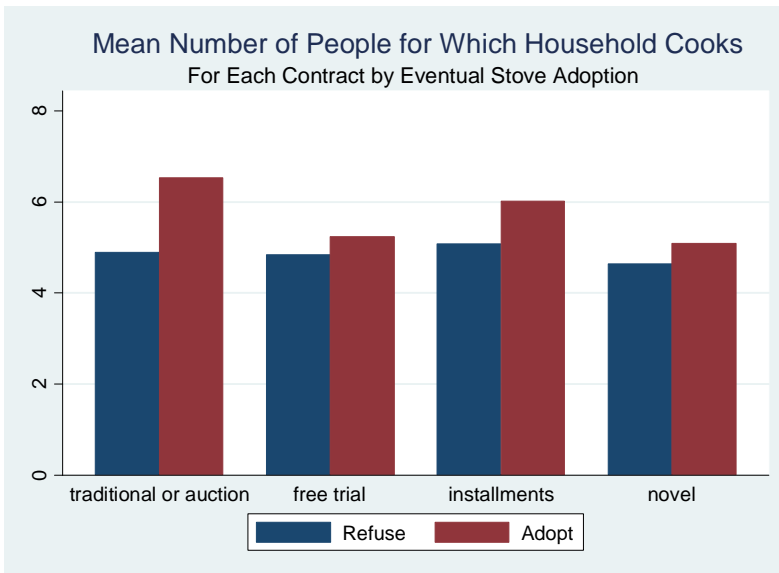


FIGURE 4B: MEAN NUMBER OF PEOPLE IN HOUSEHOLD

TABLE 1—BASELINE HOUSEHOLD CHARACTERISTICS AND RANDOMIZATION CHECKS

	By Contract				Overall	Test of Row Equality (chi2)
	Traditional and Auction	Free Trial	Time Payments	Novel		
<b>Baseline Charcoal Expenditure (USD per week)</b>						
Mean	2.5	2.5	2.7	2.7	2.6	0.23
Standard deviation	1.5	1.6	1.7	1.5	1.6	
10th percentile	1.1	1.1	1.1	1.6	1.1	
50th percentile	2.1	1.6	2.8	2.7	2.1	
90th percentile	3.7	3.7	4.5	3.8	3.7	
<b>Household Size</b>						
mean	4.9	4.9	5.4	4.8	5.0	0.17
Standard deviation	2.6	2.5	2.8	2.7	2.7	
10th percentile	2	2	2	2	2	
50th percentile	4	5	5	4	4	
90th percentile	8	8	9	8	8	
<b>Prior Experience with Stoves</b>						
% who use more than one stove on weekly basis	70.9	64.5	68.3	71.1	68.5	0.33
% who use non-improved charcoal-burning clay stove weekly	88.8	84.6	85.9	82.5	85.8	0.13
% who use non-improved charcoal-burning metal stove weekly	33.4	34.5	34.8	36.6	34.6	0.88
% who already own improved charcoal stove (ICS)	6.7	9.0	9.5	7.7	8.2	0.36
% of non-owners who have seen an ICS before	51.3	57.0	50.7	49.7	52.5	0.50
% aware that ICSs save fuel, of those who have seen an ICS before	54.8	48.3	55.8	54.8	53.0	0.55
Number of observations	534	483	357	316	1690	

*Notes:* We dropped 13 households reporting \$45 or more per week in charcoal expenditures; all other responses were below \$20/week. We dropped two households reporting 500 members; all other respondents reported 20 or fewer members. The exact number of responses for a given question may be slightly lower due to missing values.

TABLE 2: ADOPTION AND PAYMENTS SUMMARY BY SALES OFFER

	Traditional/ Auction	Free Trial	Time Payments	Novel	Test of Row Equality (chi2)
# of offers to randomized homes	Fixed price: 114 Auction: 456	539	389	355	
Share of offers accepted	Fixed price: 6% Auction: 3% <sup>a</sup>	33%	26%	48%	.00
Among accepted offers					
% returned		14%	1%	6%	.10
% paid in full		73%	92%	87%	
% finished paying early, of those who fully paid		9%	38%	35%	
% finished paying late, of those who fully paid		8%	12%	11%	
% of stoves in default		12%	7%	7%	.24
% of stoves in default that paid > 0		42%	83%	100%	
% of stoves in default that paid ≥ half of price		33%	50%	82%	
Eventual uptake (after returns) as share of offers	4% (combined)	29%	26%	46%	.00
Share of money received (relative to retail price of stoves that were not returned)	100%	89.9%	96.1%	97.1%	

*Note:* The Test of Row Equality column reports the p-value of the chi-squared statistic of a multinomial logistic regression predicting sales.

<sup>a</sup> This is the percent of households that stated a willingness to pay of at least the stove's retail price or higher. The fact that the percent of households agreeing to the retail price is lower than the percent that accepted the fixed-price traditional offer of the retail price is consistent with some consumers shaving their bids slightly below their actual willingness to pay, although the difference in shares is not statistically significant. Adding 10% to all stated willingness to pay does not increase uptake in the BDM procedure.

TABLE 3: ARE SALES OFFERS GOOD SIGNALS OF QUALITY?

	Sales Offer				Overall
	Traditional & Auction	Free Trial	Time Payments	Novel	
Reply “Definitely yes” to “Do you believe that this stove will save you half of your current charcoal expenditures?”	48%	<b>44%</b>	40%	<b>51%<sup>a</sup></b>	46%
Reply “Strongly agree” to “This stove will probably last 3 years or more?”	22%	21%	<b>20%</b>	<b>22%</b>	21%
N	513	433	299	214	1,459

*Note:* Signaling theory suggests the shaded cells will be larger than the cells immediately to their left on the top row and two columns to their left on the bottom row.

<sup>a</sup>  $P < 0.05$  for this comparison one column at a time. Neither joint test of both comparisons in a row is statistically significant at the 10% level.