Impact of Marketing Messages and Time Payments on Uptake of Clean Cookstoves

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Introduction

If we know what is harmful to us, and we know how to avert that harm, what is preventing us from making that decisive switch for the healthy alternative? This paper aims to address that question in the realm of cooking alternatives to the three-stone fire in Uganda.

There is substantial scholarship on the harm cooking over a three-stone fire has on an individual's health and the environment (Parikh et. al. 2003; Grieshop et. al. 2011). There is also substantial evidence showing that efficient cookstoves offer an alternative that minimizes the harmful impacts of cooking with biomass (Grieshop et. al. 2011; Hankey et. al. 2015). What this study aims to achieve is to decipher what methods of advertising and what demographic is more open to purchasing an alternative to the three-stone fire.

Via a randomized-controlled trial with over 2000 participants in 36 parishes in the outskirts of Mbarara, Uganda, we have concluded that a message promoting the health benefits of the cookstove alternative has the largest impact on demand for purchasing the cookstove in a traditional payment scheme. We also found that wealth is a main determinant for demand for purchasing a cookstove, while we determined that age and gender do not conclusively affect demand.

This study adds to the wealth of knowledge in regards to cookstove adoption because it focuses on what type of message can be delivered to garner demand for changing from a three-stone to an efficient cookstove. A study by MIT gives recommendations for scaling independent improved cookstove companies, though their focus was more on structuring businesses and handling the financial aspects of a company and not on what message should be delivered (Verploegen and Kenney 2017).

Literature Review

Globally, 2.8 billion people rely on household solid fuels in cooking (Rehfuess et al., 2014). Most traditional cooking practices that use biomass fuel, such as three-stone fires, produce hazardous emissions, damaging the health of the users (primarily women and girls) and contributing to global air pollution. Improved cookstoves (ICSs) or clean cookstoves are one mechanism of alleviating these effects. ICSs are a broad category of cooking devices that improve

fuel efficiency and reduce hazardous emissions in comparison to traditional cooking methods (Kenney and Verploegen, 2017).

The Global Alliance for Clean Cookstoves (GACC) (2017) estimates that of cooking fuels in Uganda, unprocessed biomass is used by more than 85 percent of the population, while charcoal is used by the remaining 13 percent. Switching to "clean" alternatives either means using ICSs or switching to "clean" fuels such as liquefied petroleum gas (LPG), biogas and ethanol. However, access by poorer and rural communities to modern, clean fuel is currently limited by relatively high prices, low demand and unreliable supply - especially in Uganda where main supplies of LPG are imported (Price, 2017).

Switching to clean alternatives can have potential impacts on three aspects: 1. Time and money; 2. Health; 3. Environment. First, clean alternatives use less fuel so it can reduce time and money used in buying and/or gathering fuel (Bensch and Peters, 2013). Second, clean alternatives also produce less household air pollution through its technology that ensures complete combustion (Grieshop et al., 2011) - thereby reducing incidence of respiratory health concerns. Finally, clean alternatives limit the rate of deforestation and reduce household contribution to global air pollution (Bensch and Peters, 2013). In fact, one study found statistically significant reductions in kitchen concentrations of fine particles (PM2.5) in rural Ugandan households that used a clean cookstove for a one-month acclimation period (Hankey et al., 2014). Moreover, in a randomized-controlled trial (RCT), Burwen and Levine (2012) also found that women who received improved cookstoves self-reported far fewer symptoms related to cooking and respiratory symptoms than the women who did not receive cookstoves.

It is particularly interesting how, despite these benefits, the uptake on clean cookstoves has encountered significant challenges. The low incidence of clean cookstove usage has attracted the development sector's attention in recent years. A study conducted by Rehfuess et al. (2014) found seven domains influencing clean cookstove uptake - 1. fuel and technology characteristics; 2. household and setting characteristics; 3. knowledge and perceptions; 4. finance, tax, and subsidy aspects; 5. market development; 6. regulation, legislation, and standards; 7. programmatic and policy mechanisms. We have summarized the findings here as they are a relevant context to the research findings and recommendations.

Domain 1: Fuel and technology characteristics. The fundamental requirement that clean cookstoves are designed to meet user needs and available fuels (general design requirements). The importance of incorporating user requirements in research and

development and of offering a choice of high-quality designs. Even if the stove is well-designed to meet local needs, its use will decline if durability is poor.

Domain 2: Household and setting characteristics. The socioeconomic, demographic, structural, and geographical contexts of households - Higher socioeconomic status, related to income, household assets, or expenditure, is widely found to enable adoption. Similarly, greater education (years of schooling or educational attainment) among women and men, increases uptake. Somewhat less consistent results emerge for demographic characteristics, notably with respect to sex and age of the head of household (demographics). Larger family size appears to act as a barrier to adoption, possibly due to the low value assigned to time and labor used to collect firewood and/or the need to cook for more people.

Domain 3: Perceptions and Expectations. Addresses the perceptions and expectations of users, mostly women, regarding the impact of clean cookstoves on their daily lives. A prerequisite for adoption and sustained use is that users should be able to prepare their local dishes to the same taste, using established cooking utensils, especially in view of resistance to changing traditional practices (tradition and culture). The ability to cook for larger gatherings is also important in many settings. Fewer adverse health effects, especially those directly perceived to be smoke-related, and a reduction in risk of burn injuries and house fires emerge as enablers for adoption and sustained use (smoke, health and safety).

Domain 4: Financial, tax, and subsidy aspects. Derived from government-led, NGO-led, and market-based dissemination approaches. Whatever the approach, the cost is an important barrier to adoption and/or repurchase, which may be overcome through government - or market-led economies of scale or stove subsidies (stove costs and subsidies). Subsidies toward the stove or its component parts enable initial adoption. Large subsidies can devalue, limiting maintenance efforts and longer-term use and repurchase by households and, through subsidy expectations into the future, program sustainability.

Domain 5: Market development. Creating demand through appropriate and, potentially, setting-specific strategies is important for stove uptake (demand creation). Modes of demand creation comprise general awareness raising activities about the benefits of clean cookstoves (e.g. through media campaigns) and personal contact through women's organizations or company representatives. Product demonstrations and "word-of-mouth" advertising appear

to be the most important general drivers of adoption. A demand-driven approach facilitates long-term adoption and use.

Domain 6: Regulation, legislation, and standards. The clear message is that standards and their enforcement are critical for large-scale promotion of high quality clean cookstoves. Certification of stove or stove component manufacturers by a standards agency or a network of producers is a means of ensuring adherence to design specifications for fuel efficiency and emissions (regulation, certification, and standardization).

Domain 7: Programmatic and policy mechanisms. This domain addresses interactions between different stakeholders and specific aspects of program planning and implementation, monitoring, and quality control. Coordination and regular interaction between stakeholders—be they government agencies, NGOs, private sector entities, or targeted households and communities—and careful program management with good feedback systems are enablers of uptake (institutional arrangements).

Achieving adoption and sustained use of clean cookstoves at a large scale requires that all factors be assessed and also be supported by policy (Rehfuess et al., 2014).

Methodology

Key Research Question

The research was conducted to gain insights on demand drivers for clean cookstoves by studying the impact of different marketing messages and of different time payment arrangements.

Design and Data Collection

The research was conducted in partnership with the Center for Integrated Research and Community Development (CIRCODU), a local implementing partner. The data was collected from 36 parishes in Mbarara, Uganda from January 31, 2012 to March 1, 2012.

Mbarara is a rural area located in the Southwestern part of Uganda. It was chosen because in this area, majority of families used three-stone fires for cooking and spent a considerable amount of time gathering wood. At the time of the experiment, there were no active clean cookstove interventions in place in the market yet.

Respondents were randomly split into four groups with each group receiving a different informational marketing message. The four messages were: (1) cookstoves save time and money, (2) cookstoves are good for your health, (3) both messages, and (4) no marketing message. CIRCODU then conducted two kinds of auctions for a clean cookstove in each parish: (1) traditional - pay within a week; and (2) novel - pay over four weeks. The Vickrey second price auction method was used where the second highest bidder wins the product. Studies show that the second-price auction mechanism is a more accurate valuation of what a customer is willing to pay for a product in real-life (Vickrey, 1961). A second-price mechanism encourages everyone to bid truthfully, and the item ships to the person who really values it at the highest price. The clean cookstove brand used in the research is the Envirofit G3300 stove, which is manufactured by Envirofit International, a social enterprise that innovates smart energy products and services.

The effect of the marketing message on bids for cookstoves would be estimated by the following model:

$$Bid_i = Marketing_i x_{i1} + D_i x_{i2} + W_i x_{i3} + S_i x_{i4} + \varepsilon_i \tag{1}$$

where Bid_i is the amount of bid of the individual; $Marketing_i$ is the categorical variable for the marketing message with "no message" as the control; D_i is the vector for demographic variables, which are age, gender, marital status, wife as primary cook, household decision maker is husband, and household decision maker is both husband and wife; W_i is the vector for wealth variables, which are amount of total assets owned and time employed; and S_i is the vector for stone use for household variables, which are use of three stone fire as primary stove, use of firewood as fuel source, purchased wood within last month, and gathered wood last month. The vectors x_{i1}, x_{i2}, x_{i3}, and x_{i4} are parameters associated with each control variable, and ε_i is the error term.

Aside from this full model, the effect of the marketing message on bids for cookstoves would also be estimated with only the demographic, wealth, and stone use controls.

The same model would also be employed to explore the impact of marketing message on the novel time payment scheme. A t-test between the bids for traditional and novel payment scheme would also be done to analyze if there are statistically significant differences in the bids for the different payment schemes.

Data
Sample Size and Sample Description

Table 1. Summary Statistics

Variable	Mean (SD)
Maximum Bid (in USD)	3.30 (3.16)
Maximum Bid for Novel Payment (in USD)	4.64 (4.34)
Age (years)	39.4 (13.60)
Gender (% male)	0.29 (0.45)
Marital Status (% married – monogamous and polygamous)	0.80 (0.40)
Wife is primary cook (% share)	0.87 (0.34)
Decisions are made jointly by husband and wife (% share)	0.44 (0.50)
Decisions are made by the husband (% share)	0.25 (0.45)
Assets owned (in USD)	565.00 (1066.00)
Have year-round employment (% share)	0.55 (0.50)
Three fire stone as primary stove (% share)	0.73 (0.45)
Gathered wood within the last month (% share)	0.88 (0.32)
Purchased wood within last month (% share)	0.30 (0.46)
Wood as primary fuel source (% share)	0.97 (0.17)
# of observations	2234

The mean is presented with the standard deviation in parenthesis.

Maximum bid for traditional and novel payments, the dependent variables concerning the bid amounts of participants for the regular and novel offers respectively, were converted to US Dollars. To measure wealth, the assets measured were provided a realistic value, and each participant was assigned a wealth sum variable based on the total value of all the assets a participant indicated they owned. The wealth sum was kept in US dollars for all regressions.

Table 2. Check for Randomization

	Control (No Marketing)	Health Group	Time and Money Group	Time, Money, and Health Group	Difference of Health Group from Control	Difference of Time and Money Group from Control	Difference of Time, Money, and Health Group from Control
Age	38.8 (13.60)	40.40 (13.90)	39.46 (13.32)	39.10 (13.42)	1.62 (0.82)	0.86 (0.80)	-0.33 (0.80)
Gender (%male)	0.31 (0.46)	0.30 (0.46)	0.27 (0.44)	0.28 (0.45)	-0.01 (0.03)	-0.03 (0.03)	-0.03 (0.03)
Marital Status (%married)	0.78 (0.42)	0.81 (0.40)	0.78 (0.41)	0.81 (0.39)	0.03 (0.02)	0.01 (0.02)	0.04 (0.3)
Wife is Primary Cook (%share)	0.86 (0.35)	0.92 (0.27)	0.86 (0.34)	0.84 (0.36)	0.06*** (0.02)	0.01 (0.02)	-0.02 (0.02)
Decisions are Made Together (%share)	0.43 (0.50)	0.34 (0.47)	-0.45(0.50)	0.55 (0.50)	-0.09*** (0.03)	0.02 (0.03)	0.12*** (0.03)
Decisions are Made by Husband (%share)	0.23 (0.42)	0.46 (0.48)	0.21 (0.41)	0.21 (0.41)	0.12*** (0.03)	-0.02 (0.02)	-0.02 (0.02)
Wealth (in USD)	602.67 (1086.33)	573.58 (1048.35)	453.00 (866.00)	628.01 (1222.66)	-29.09 (63.59)	-149.67** (58.56)	25.34 (68.86)
Employed Annually (%share)	0.51 (0.50)	0.52 (0.5)	0.45 (0.50)	0.71 (0.45)	0.01 (0.03)	-0.06 (0.03)	0.20*** (0.03)
Three Fire Stone as Primary Stove (%share)	0.69 (0.46)	0.78 (0.42)	0.76 (0.43)	0.69 (0.47)	0.08*** (0.03)	0.07** (0.03)	-0.01** (0.03)
Gathered Wood Last Month (%share)	0.87(0.34)	0.88 (0.32)	0.90 (0.30)	0.89 (0.32)	0.01 (0.02)	0.03 (0.02)	0.02 (0.02)
Purchased Wood Last Month (%share)	0.30 (0.46)	0.25 (0.43)	0.33 (0.47)	0.32 (0.47)	-0.05 (0.03)	0.03 (0.03)	0.02 (0.03)
Wood as Primary Fuel Source (%source)							
Joint Significance (p-value)	0.0118**	<0.0001***	<0.0001***	<0.0001***			
# of observations	572	555	549	558			

*significant at p<0.10, **significant at p<0.05, ***significant at p<0.01

Before any regression, it is important that we establish that the randomization of the people into four groups was successful. In order to do this, the key demographic, wealth, and stone use profiles between for each group were summarized. Table 2 shows the profile for each group.

It must be noted that there are statistical differences between the control group and each of the marketing groups. Taken as a whole, the joint significance indicates that the variables are statistically significant in determining which marketing group they would belong to - this would mean that we are not successful in randomizing between the treatment groups. If all the marketing messages are grouped as one, however, the difference between the treatment groups and control group is only statistically significant for p < 0.05.

Results

Table 3. Effect of Marketing Message on Bid for Clean Cookstove in Traditional Payment Scheme

	Bid Amount in Traditional Payment Scheme				
	Marketing (1)	Demographics (2)	Wealth (3)	Stone Use (4)	Full (5)
Improves Health	0.628*** (0.192)	0.667*** (0.194)	0.636*** (0.191)	0.682*** (0.193)	0.707*** (0.192)
Saves Time and Money	-0.071 (0.194)	-0.055 (0.193)	0.001 (0.192)	-0.029 (0.194)	0.039 (0.193)
Time, Money, and Health	0.203 (0.191)	0.184 (0.192)	0.118 (0.191)	0.198 (0.191)	0.142 (0.192)
Age		-0.007 (0.005)			-0.009* (0.005)
Gender		0.660*** (0.165)			0.624*** (0.165)
Marital Status		0.066 (0.232)			0.024 (0.231)
Wife is Primary Cook		-0.205 (0.227)			-0.112 (0.226)
Decisions are Made Together		0.253 (0.213)			0.136 (0.212)
Decisions are Made by Husband		0.055 (0.229)			0.048 (0.227)
Wealth			0.0003*** (0.00001)		0.0003*** (0.0001)
Employed Annually			0.401*** (0.140)		0.253* (0.144)
Three Fire Stone as Primary Stove				-0.670*** (0.157)	-0.514*** (0.159)
Gathered Wood Last Month				0.146 (0.239)	0.213 (0.238)
Purchased Wood Last Month				0.159 (0.163)	0.174 (0.162)
Wood as Primary Fuel Source				0.466 (0.451)	0.562 (0.448)
Constant	3.109*** (0.135)	3.171*** (0.327)	2.707*** (0.154)	2.943*** (0.464)	2.525*** (0.537)
Adjusted R-squared	0.006	0.016	0.023	0.013	0.034
F Statistic	5.221***	4.930***	10.879***	5.078***	5.961***
Observations	2125	2119	2125	2119	2119

*significant at $p<0.10$, **significant at $p<0.05$, ***significant at $p<0.01$

The health marketing message increased the willingness to pay for cookstoves. This is true for the full model and with any controls at any reasonable level of significance. Interestingly, when the health message is mixed with time and money message, it has no effect on the willingness to pay for cookstoves.

When the bidder is male, the willingness to pay increases by 0.66 USD when demographic variables are controlled, and by 0.624 USD when all variables are controlled, at any reasonable level of significance.

Wealth is also correlated to increase in willingness to pay at any reasonable level of signficance. Being employed on a year-round basis also increases the willingness to pay by 0.401 USD (at $p < 0.01$) when wealth is controlled, and by 0.25 (at $p < 0.1$) when all variables are controlled.

Using a three-fire stone as primary stove is correlated to a decrease in the willingness to pay for clean cookstoves at any reasonable level of significance.

In summary, having a health message as marketing increases the willingness to pay for cookstoves in a traditional payment scheme. Wealth variables are also a correlated to an increased willingness to pay, while having a three-fire stone as primary stove is correlated to a a decreased willingness to pay.

Table 4. Effect of Marketing Message on Bid for Clean Cookstove in Time Payment Scheme

	Bid Amount with Time Payment Scheme				
	Marketing (1)	Demographics (2)	Wealth (3)	Stone Use (4)	Full (5)
Improves Health	0.056 (0.267)	0.098 (0.268)	0.056 (0.265)	0.121 (0.267)	0.137 (0.267)
Saves Time and Money	0.298 (0.264)	0.319 (0.264)	0.387 (0.263)	0.351 (0.265)	0.443* (0.263)
Time, Money, and Health	-0.084 (0.263)	-0.100 (0.264)	-0.208 (0.264)	-0.086 (0.263)	-.0163 (0.265)
Age		-0.008 (0.007)			-0.010 (0.007)
Gender		0.925*** (0.227)			0.873*** (0.228)
Marital Status		0.146 (0.319)			0.097 (0.317)
Wife is Primary Cook		-0.112 (0.309)			-0.014 (0.309)
Decisions are Made Together		0.314 (0.294)			0.161 (0.293)
Decisions are Made by Husband		0.051 (0.315)			0.041 (0.313)
Wealth			0.0004*** (0.0001)		0.0003*** (0.0001)
Employed Annually			0.568*** (0.192)		0.352* (0.198)
Three Fire Stone as Primary Stove				-0.847*** (0.216)	-0.666*** (0.219)
Gathered Wood Last Month				0.129 (0.330)	0.214 (0.328)
Purchased Wood Last Month				0.365 (0.223)	0.368* (0.223)
Wood as Primary Fuel Source				0.934 (0.616)	1.055* (0.614)
Constant	4.572*** (0.186)	4.449*** (0.452)	4.062*** (0.212)	4.025*** (0.633)	3.322*** (0.736)
Adjusted R-squared	-0.0003	0.010	0.013	0.007	0.024
F Statistic	0.770	3.314***	6.454***	3.213***	4.541***
Observations	2135	2129	2135	2129	2129

*significant at $p<0.10$, **significant at $p<0.05$, ***significant at $p<0.01$

Once the liquidity constraint has been lifted, marketing messages would not have an effect on the willingness to pay for a clean cookstove. With a novel payment scheme, where bidders can pay for the cookstove over a period of four weeks, no marketing message has a significant impact on the bid amount. The group that received the "save time and money" message only had a significant impact when all variables are controlled and only at a 90% significance level.

Being male remains to have a significant effect on the willingness to pay for a cookstove. When the bidder is male, the willingness to pay increases by 0.925 USD when demographic variables are controlled, and by 0.873 USD when all variables are controlled, at any reasonable level of significance.

Variables related to wealth also remain to be significant at any reasonable level of significance. Being employed on a year-round basis increases the bid amount for cookstoves by 0.568 USD (at $p < 0.001$) when wealth variables are controlled, and by 0.352 USD (at $p < 0.1$) when all variables are controlled.

Using a three-fire stone as primary stove still decreases the willingness to pay for clean cookstoves at any reasonable level of significance.

Therefore, under a time payment scheme, marketing messages do not have a significant effect while wealth variables continue to be correlated to a significant increase in willingness to pay.

Table 5. Difference is Bids between Traditional Payments and Time Payments

	Traditional Payment	Time Payment	Difference	T-statistic
Bid Amount (in USD)	3.299	4.639	1.340	-11.532***
	(3.158)	(4.336)	(2.531)	(df=3901.3)

***significant at $p<0.01$

The removal of the liquidity constraint through time payments increased the willingness to pay for the cookstoves. The bids for the time payments were higher at a mean of 4.639 USD than the bids for traditional payments at a mean of 3.299 USD, with a t-statistic of $t(3901.3) = -11.532$, $p < 0.01$. This means that the increase in the willingness to pay in a time payment scheme is statistically significant at any reasonable level of significance.

Conclusion

Based upon the results of our study, the message that communicates the health benefits of a cookstove was the most effective for generating demand. We also saw that if we offered an alternative form of paying for the cookstove, instead of paying for one in cash right away, we could generate more demand. We also found that once the liquidity constraint has been removed through a time payment scheme, marketing messages no longer have a significant effect on demand. Alternative ways of paying would be offering a trial period and being able to pay later, or paying in instalments, or perhaps offering means of credit to pay for the cookstove.

We did notice in our study that there was a particular demographic that tended to generate more demand for the cookstove. We noticed that the most likely person to bid a higher amount for a cookstove was male with a higher wealth score. This demographic should be kept in mind for any future push for developing a market for these life-saving devices.

Recommendations / Opportunities for Further Research

The research can gain considerable insight if it were expanded to a continuous tracking study, where follow-up data collection is done at different points during the product lifespan. The current research scope focuses on studying domains 2 - household characteristics and 5 - market development, as described in the review of related literature. There is an opportunity to expand the study coverage to assess domain 1 - product ability to meet user needs and domain 3 - perceptions and expectations. However, these can only be done after the clean cookstoves are introduced into the market and have been used by consumers for at least six months.

A related study done by Harrell et al. (2013) suggests that the Envirofit 3300 stove has other major issues that affect long-term use and impedes replacement of traditional stoves. Some reasons stated are that the stove is too small for many households; does not allow for cooking two pots concurrently; requires chopping small pieces of wood and frequent attention; not sturdy enough for heavy stirring; and does not retain heat for a long period.

A study done in rural Rwanda by Rosa et al. (2014) found similar results. Assessing this product design aspect and how it relates to consumers' usage habits, attitudes, and product perception is also a crucial factor in increasing the adoption of clean cookstoves. Furthermore, recent studies have found that apart from measuring purchase rates, it is also important to measure reduction in use of traditional stoves since many owners of new stoves continue to use old stoves and fuels. (Ruiz-Mercado et al., 2011). However, it is only with complete transition to clean cooking methods that households gain significant benefits from this technology (Johnson and Chiang, 2015).

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