Catalyzing Energy Access among the Ultra-Poor in Malawi

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Introduction

Energy poverty, defined as lack of access to electricity and clean cooking, affects four billion people globally, many of whom reside in rural developing regions of the world (International Energy Agency, 2017a). Households in sub-Saharan Africa have lower rates of energy access than any other region in the world (International Energy Agency, 2017b). Specifically, an estimated 800 million people or 84% of the population in Africa rely on biomass fuels (wood, charcoal, crop residues, dung) burned in three stone fires or poorly ventilated stoves (International Energy Agency, 2017a). The inefficient combustion of biomass fuel is associated with adverse health impacts (Dherani et al., 2008; Forouzanfar, 2015; Fullerton, Bruce, & Gordon, 2008; Gordon et al., 2014; Smith, Mehta, & Maeusezahl-Feuz, 2004) and limits social and economic development of women (Global Alliance for Clean for Cookstoves, 2016). While recent gains in energy access have been made, including scaling up on cookstove interventions, their impact on the ultra-poor or those living in extreme poverty is less well known.

Energy poverty among the ultra-poor presents a particularly vexing problem for program implementers, policy makers and the private sector due to lack of capital for investments in household energy. In Malawi, the Ministry of Gender, Children, Disability and Social Welfare is collaborating with an international non-governmental organization, United Purpose (UP), to couple distribution of a locally produced fuel-efficient stove (FES) with the national Social Cash Transfer Program (SCTP). The SCTP targets ultra-poor and labour-constrained households. The UP plans to distribute 82,000 households with fully subsidized FES to SCTP eligible households in eight Districts in Southern Malawi between 2015 and 2019 (United Purpose, 2018).

Our objectives are two-fold. First, we quantified the extent of energy poverty among the ultra-poor. Secondly, we evaluate the impact of a cookstove intervention among the ultra-poor. Our research questions are: 1) what is the extent of energy access/poverty among the ultra-poor compared to better-off households; and 2) does use of FES reduce fuelwood consumption and time spent collecting fuelwood and cooking?

Malawi presents an opportunity to study the influence of policy action on these trends via an emerging, regionally scalable household energy intervention aiming to lower household-level fuel consumption by at least 30%. If successful, it presents a novel and highly effective way to improve energy access for the ultra-poor, who are most likely to be excluded from energy transitions.

Study Design and Methods

The study is a longitudinal non-experimental equivalent of comparison group design. This paper presents baseline and midline data from impact evaluation of a biomass cookstove intervention in southern Malawi. The study site is chosen from among the eight southern districts where the SCTP/Cookstove roll-out is taking place. District selection is based upon the roll-out schedule of SCTP/Cookstove Program. Three districts were chosen as study sites; Mulanje and Thyolo Districts served as treatment (T) districts, and Chiradzulu District as control (C). There are currently no immediate plans to roll-out the SCTP/Cookstove program in Chiradzulu District. Chiradzulu has similar overall agroecological conditions, population density, and market access to treatment Districts, Mulanje and Thyolo.

Primary data collection instrument was an in-depth household survey, which collected detail information on household demographics, socio-economic indicators, time use, health symptoms, and fuels and technologies used for household energy (cooking, lighting, and space heating), and income and expenditures. Baseline data was collected from 900 SCTP-eligible/ultra-poor households (600T; 300 C) from July-November 2017. In addition, rapid surveys were administered in approximately 1,600 households in non-SCTP (better-off households) in the same villages where SCTP households were surveyed. The main purpose of the rapid survey was to assess the adoption spill-over effect in non-targeted households.

The midline follow-up household survey was conducted from July to August 2018 in half of the baseline sample population (N=450). Rapid surveys were repeated in non-SCTP households though not necessarily in the same households. An endline data collection is planned for July to August 2019 where household surveys in the same households as baseline (N=900) and rapid surveys (N=1,600) will be administered.

Statistical analysis

Descriptive statistics were calculated to: 1) compare energy access between ultra-poor and better off households; and 2) check household characteristics between treatment and control households. We used logit regressions models to assess determinants of energy poverty as determined by access to grid electricity, ownership of FES, and solar lighting panels. Ordinary least square regression was used to assess relationship between outcome variables (fuelwood use, time to collect fuelwood and cook) with predictor variables (household size, female head of household, engaging in biomass, deforestation rate, forest cover, etc.).

To assess impacts of cookstove intervention, we conducted a multivariate regression of difference-in-difference (DD) model in the generalized linear model (GLM) framework. The DD estimation allows for comparing changes in outcomes between baseline and follow-up for the treatment group with changes over the same time in the control group. The outcomes of interest were household fuelwood consumption, time spent collecting fuelwood and cooking. The outcomes were regressed against a dummy variable indicating whether the household was an SCTP household in the treatment district, a year indicator, household fixed effect, and socio-economic variables (asset ownership), land cover land use indicators (forest cover and deforestation rates); household head characteristics, such as gender and years lived in village. We calculated robust standard errors, clustered at the village cluster group to correct for correlation of the error terms across village clusters. All analyses were conducted using STATA 15.

Result

Energy access among the ultra-poor

We compare indicators of energy poverty between ultra-poor (social cash transfer program (SCTP) beneficiaries identified by the Government of Malawi and village leaders to be among the poorest 10% of a population within a village) and better off households (non-SCTP recipients). At baseline, we observe statistically significant differences in grid electricity access (4% and 11%) and FES ownership (16% vs. 29%) for ultra-poor and better-off households respectively (Table 1).

Table 1. Comparison of socio-demographics and energy access between SCTP (ultra-poor) and non-SCTP (better off) households at baseline

	Unit	Ultra-poor (N=900)	Better off (N=2,671)	p-value
Household size	People	4.7(2.18)	4.5 (1.9)	
Age of household head	Years	54 (20)	40 (16)	<0.001
Female household head	%	65	49	<0.001
Solar panel	%	2	6	
Concrete floor	%	5	16	
Iron sheet roof	%	36	63	
Electricity	%	4	11	<0.001
FES ownership	%	16	29	<0.001
Time collect fuelwood	Hours/week	7.6 (9.3)	7.0 (5.8)	

Data are mean ± SD or number (%). p-Values are two-tailed t tests for continuous normally distributed variables, and Wilcox-test for non-normal distributed data; chi-square tests for categorical variables. FES=fuel efficient stoves.

Logistic regression results showed improved cookstove ownership and electricity access, both indictors of overall energy access, are strongly positively associated with land ownership, education, and asset ownership. High deforestation during the period 2000 to 2013 in 5 km buffers surrounding village centroids is associated with improved cookstove ownership. The ultra-poor spend less time collective fuelwood than better off households (7 hours vs 7.6 hours/week) (Table 1). Household size, female head, and engaging in a biomass burning business are positively associated with time spend collecting fuelwood.

FES take up

Of the 300 SCTP households in the treatment districts sampled during midline, 93% of households in Mulanje District and 79% of households in Thyolo District decided to accept the freely provided FES from United Purpose (Table 2). Among household that have adopted, at the time of our midline survey, the majority of the households (89%) were using the FES. In 11% of households (N=27) where the FES was accepted but not in use, the major reasons were that it broke (82%) or had been given away for free (7%). The length of time the households owned the FES distributed by United Purpose ranged from 2 weeks to 12 months. Users were asked what they liked about FES. The most frequent response was that it uses less fuelwood (90%). Other stove characteristics mentioned were faster cooking, reduction in smoke, better regulation of cooking fire, and ability to keep food warm after cooking. Respondents cited poor quality (16%), stove is too hot/causes burns (3%), and smoke (2%) as reasons for not liking the FES. The field team independently assessed the stoves' condition and found that one third of the stoves distributed were in good condition with no cracks, 40% had small cracks and 18% had large cracks.

Table 2: Descriptive Statistics by Wave and Treatment Status (N=450)

	Baseline			**Midline**		
	Control	Treatment		Control	Treatment	
	Mean (SD) or %	Mean (SD) or %	p-value	Mean (SD) or %	Mean (SD) or %	p-value
Outcomes of interest						
Time collect fuelwood	4.2 (6.6)	9.3 (10.3)	<0.000	3.9 (6.7)	8.0 (9.6)	<0.000
Time cook	16.4 (9.1)	18.3 (11.5)	0.07	15.7 (8.3)	15.9 (7.7)	0.80
Fuelwood use	7.5 (5.1)	6.8 (3.7)	0.16	5.4 (2.7)	5.7 (3.4)	0.40
Household characteristics						
Household size	4.3 (2.0)	5.1 (2.2)	<0.000	-	-	-
Concrete floor	8.7	4.3	0.06	-	-	-
Iron sheet roof	35.6	43.3	0.12	-	-	-
Bike	10.7	9.0	0.56	-	-	-
Mobile phone	24.2	17.0	0.07	-	-	-
Electricity	0.0	4.0	0.01	-	-	-
FES ownership	25.5	13.0	0.001	-	-	-
Household head						
Age	53 (21)	56 (19)	0.21	-	-	-
Female	52	72	<0.000	-	-	-
Born in village	65.8	80.0	0.001	-	-	-

Data are mean ± SD or number (%). p-Values are two-tailed t tests for continuous normally distributed variables, and Wilcox-test for non-normal distributed data; chi-square tests for categorical variables.

Table 3: Intervention impact on time spent collecting fuelwood and cooking and fuelwood use

	Treat	Time	DD
Collective time spent collecting fuelwood	0.67 *	-0.07	-0.05
	(0.33)	(0.30)	(0.31)
Collective time spent cooking	0.08	-0.04	-0.09
	(0.07)	(0.10)	(0.13)
24-hour fuelwood use	-0.15 +	-0.32	0.16
	(0.09)	(0.08)	(0.10)

*Survey-weighted marginal effects are estimated using difference-in-difference modeling in the GLM framework among panel households (N=450). Models control for baseline socio-economic and demographic characteristics, percentage of forest cover and deforestation. Robust standard errors (in parentheses) corrected for clustering at the village cluster level. + p<0.10 * p<0.05 ** p<0.01*

FES Impacts

Descriptive statistics for control variables and outcomes of interest by wave and treatment status are presented in Table 2. During baseline period, treatment group spent significantly more time collecting fuelwood ($p < 0.00$) and cooking ($p=0.07$). Fuelwood consumption was similar between both treatment (6.8 kg) and control (7.5 kg) groups in the baseline ($p=0.16$). During the midline period, all three outcomes of interest (time spent collecting fuelwood and cooking and fuelwood consumption) decreased. Comparison of control variables between control and intervention groups suggest statistical significant differences for household size, grid electricity access, FES ownership, and characteristics of household head (female and born in village) (Table 2).

Average time spent collecting fuelwood and cooking reduced in the treatment group, however, the reductions were not significant at 0.05 level (Table 3). Treatment group was associated with non-significant increase (0.16) in 24-hour fuelwood consumption in the midline (Table 3). The next steps for analyses are to conduct propensity score matching to reduce bias from systematic differences between control and treatment groups. An endline data collection in 2019 will provide a third round of panel data to provide information on long-term impacts of the intervention program and the extent of adoption spill over.

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