When financial incentives backfire: evidence from a community health worker experiment in Uganda*

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Abstract

There is growing support for an entrepreneurial community health worker (CHW) model, where CHWs charge for health products and retain the profits. Such a model is thought to improve CHW effort, which is often limited. We exploit experimental variation in whether CHWs in Uganda were instructed to sell ORS+zinc, highly effective but underused treatments for child diarrhea, or distribute ORS+zinc for free. This allows us to examine the impact of an entrepreneurial design on CHW performance. We find that, despite stronger financial incentives, the entrepreneurial model led to substantially less effort (fewer household visits). Qualitative evidence suggests that differential effort was driven by differences in social incentives; selling had a social penalty whereas free distribution was socially rewarding. The supply-side benefits of free distribution (increased CHW effort) are equaly as important as the demand-side benefits of free distribution in terms of increasing ORS+zinc coverage. Our results call into question the notion that an entrepreneurial model of health product distribution increases CHW motivation and provides further support for eliminating user fees for some products.

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1 Introduction

Hundreds of thousands of community health workers (CHWs) provide access to basic health services in poor countries. However, many CHWs do not perform all of their assigned activities (Strachan et al., 2012; Chen et al., 2004). Unfortunately, little evidence exits on how best to increase CHWs' effort. Given the expanded role CHWs are expected to play in achieving the sustainable development goals (WHO et al., 2016), ensuring that such programs function effectively is of great concern for the global health community.

In light of this, there is growing support for an entrepreneurial model, where CHWs sell health products door-to-door and retain the profits (Skoll, 2018; Kopf, 2016; Economist, 2012; Bjorkman Nyqvist et al., 2018). Such a model is thought to increase and sustain CHW effort. However, there is little evidence on when this entrepreneurial model increases effort compared to more traditional CHW models (e.g., free health product distribution). In this paper, we use a field experiment to examine whether an entrepreneurial model increases CHW effort relative to free health product distribution.

Textbook economic theory suggests the entrepreneurial model should improve CHW effort relative to free distribution, because CHWs earn more if they distribute more products. At the same time, theories of intrinsic motivation and social recognition suggest CHWs could put in less effort under an entrepreneurial model than when distributing products for free, if the utility they get from helping their community with free distribution outweighs the utility from higher pay (Deci, 1975). These social motivations are likely to be higher for CHWs than for workers other settings, as CHWs serve families they know. Moreover, CHWs might be particularly socially motivated Deserranno (2019).

The evidence on how financial incentives affect performance in poor country health sectors is mixed. Basinga et al. (2011) find that financial incentives improved the performance of public sector health workers in Rwanda. Miller et al. (2012) document an improvement in anemia prevalence as a result of financial incentives to public sector workers in China. In contrast, Ashraf et al. (2014) find no effect of financial incentives on female condom distribution in Zambia.

The evidence on how pro-social incentives impact health worker motivation is scarce. Ashraf et al. (2014) find that non-financial social incentives increased health worker performance in Zambia and outperform financial incentives. Studying the same CHW program used for the current study, (Deserranno, 2019) documents that pro-social CHWs perform better than more financially motivated CHWs.

To explore how an entrepreneurial model compares to free distribution in terms of CHW effort, we randomly assigned CHWs in Uganda to either sell oral rehydration salts and zinc (ORS+zinc)—highly cost-effective but underused treatments for child diarrhea—or distribute ORS+zinc for free. We gave CHWs in both study arms free ORS+zinc to distribute and asked them to visit all households in their catchment area to carry out their assigned interventions. CHWs in the home sales arm we allowed to keep the sales revenue and therefore had a stronger financial incentive to put in more effort.

Our main result is that the entrepreneurial model led to substantially *less* CHW effort than free distribution. Only 35% of households with a CHW assigned to sell ORS+zinc (and retain the profits) received a home visit, whereas 61% of households with a CHW assigned to free distribution received a home visit. Home visits (our primary measure of CHW effort) are the main job task as nearly all job activities occur during these visits. In a rare example of a backward-bending labor supply curve, free distribution led to 74% increase in CHW effort relative to home sales. The low effort among CHWs assigned to the entrepreneurial model left a non-trivial amount of money on the table (11% to 57% of the average monthly income).

Qualitative interviews validated the importance of social motivations. CHWs assigned to the entrepreneurial model reported that it was unpleasant to ask their poor neighbors to purchase something. They said they would have visited more households had they been distributing products for free. Moreover, CHWs assigned to free distribution reported feeling good about giving products away for free. They explained free distribution meant they were helping their community and it made them look good to their peers.

In prior work, Wagner et al. (2019) document that free distribution increases ORS coverage by 18% compared to an entrepreneurial model. However, these intention-to-treat (ITT) effects include both supply-side effects (CHW effort) and demand-side effects (the price elasticity of demand). In this study we disentangle supply- and demand-side effects. We show that roughly half of the increase in ORS use that resulted from free distribution was attributable to extra CHW effort.

There is a large body of evidence documenting that household demand is sensitive to the price of health products (see Kremer et al. (2011a) or Dupas and Miguel (2017) for reviews). This work is the first to document the supply-side benefits of free distribution; that is, increased CHW effort. These results call into question the notion that an entrepreneurial model necessarily increases CHW effort, and provides further support for eliminating user fees for some products. Moreover, this work identifies free delivery of health products as a useful tool for motivating CHWs to make household visits.

However, charging for health products could have other benefits over free distribution aside from CHW effort. First, user fees could improve *targeting to high-risk cases*—high-risk cases could be more willing to purchase than low-risk cases, but equally likely to obtain for free. Several studies have failed to demonstrate that user fees better target high-risk groups. Kremer and Miguel (2007) find that parents of children with higher levels of parasitic worms are no more likely to purchase deworming treatment. Cohen and Dupas (2010) find that pregnant women who are anemic (a sign of a prior malaria case) are no more likely to purchase a mosquito net than non-anemic women. Ashraf et al. (2010) and Kremer et al. (2011b) find that households with young children (who are more vulnerable to death from diarrhea) are not willing to pay more for point-of-use water treatment.

Our study contributes to this literature in several ways. First, our experiment examines the targeting benefits of user-fees at the program level (i.e., similar to how it would look at scale-up), whereas most prior studies varied prices outside of the context of an existing program. Second, our experiment intervened at the CHW level, and therefore any targeting effects include supply-side effects (CHW selection of households to visit) and demand side effects (price as a screening mechanism). Third, this is the first study to assess the role of user-fees in terms of targeting subsidized diarrhea treatment to the most vulnerable.

We find mixed evidence on whether imposing user fees for ORS+zinc better targets higher-risk cases of diarrhea. The entrepreneurial model did not do a better job of targeting younger children, who have a higher mortality risk from diarrhea. However, there is some (imprecisely estimated) evidence that user fees bettered target children with 'severe' cases of diarrhea (defined as either blood in the stool or concurrent fever).

Another way charging could provide benefit is through a screening effect. Prices could *screen out* beneficiaries with a low propensity for product adherence. Those who are unlikely to use ORS+zinc if they have it on hand might also be less likely to buy it. These people, therefore, are screen out by prices. There is mixed evidence in the existing literature on whether charging for health products screens out those with low propensity for adherence (Ashraf et al., 2010; Cohen and Dupas, 2010; Dupas et al., 2016). In our experiment, the entrepreneurial model does a modestly better job of screening out non-adherers. Of the caretakers who acquired ORS from the CHW, 89% used ORS to treat a case of diarrhea if distributed for free, compared to 94% if purchased (p=0.06).[1] However, this improved screening comes at the cost of substantially dampening demand and coverage. 76% of cases used ORS under free distribution compared to 64% in the entrepreneurial model. As such, our results are consistent with prior research, which finds that moving from free to positive prices strongly reduces usage of health products (Kremer et al., 2011a; Dupas and Miguel, 2017).

In a recent study, Dupas et al. (2016) find that imposing small hassle costs for free point-of-use water treatment is a more efficient screening mechanism than prices, because it screens out non-adherers (reduces over-inclusion), while not dampening demand among adherers (no effect on over-exclusion). We estimate the targeting and screening benefits of hassle costs by randomly assigning half of the CHWs assigned to free distribution to deliver ORS+zinc to the door and the other half to deliver vouchers that could be redeemed for free ORS+zinc at the CHW's home. We find no evidence that imposing the extra hassle cost performed better at targeting high-risk cases. Also, in contrast to Dupas et al. (2016), the vouchers did not do a statistically distinguishable better job than free distribution of screening for caretakers who used ORS when a child got diarrhea. However, hassle costs led to lower acquisition of ORS among households without a diarrhea episode, which could slightly reduce the implementer's costs.

Taken together, this study suggest that, compared to free distribution, an entrepreneurial model dampens household demand for ORS+zinc and reduces CHW effort, while (at best) modestly

[1] We are unable to separate the *screening effect* and *sunk cost effect*, however prior work in this context finds no evidence of the sunk cost effect (Ashraf et al., 2010; Cohen and Dupas, 2010)

improving targeting and screening. The rest of the paper proceeds as follows. Section 2 provides a background on CHW programs, sections 3 and 4 provide an overview of the study design and sample characteristics, section 5 presents results on CHW effort, sections 6 and 7 present the targeting and screening effects of user fees, and section 8 concludes.

2 Background: Community Health Workers

2.1 Effectiveness, Incentives, and Motivation

Community health workers are an important part of the health care system in many developing countries. Nearly all countries in sub-Saharan Africa and South Asia have a CHW program. CHWs are generally members of the community who live near the households they serve. CHWs provide very basic health care, provide some health-related products, and refer severe cases to the formal health-care system.

In most nations the Ministry of Health funds the CHW program. For example, in Uganda, government sponsored CHWs are present in over 30,000 villages. Although there is evidence demonstrating that some CHW programs can reduced mortality and morbidity (see Christopher et al. (2011) for a review), several recent evaluations have found little to no benefit of some national CHW programs (Amouzou et al., 2016a,b; Munos et al., 2016).

The ineffectiveness of some CHW programs could be driven by weak incentives (Strachan et al., 2012; Chen et al., 2004). For example, most government CHWs are volunteers and receive no payment. High CHW attrition rates are often attributed to low motivation and lack of incentives (Bhattacharyya et al., 2001).

These problems have led to growing support for an entrepreneurial model, where CHWs purchase health products at a highly subsidized price and sell the products in their community for a profit (Skoll, 2018; Kopf, 2016; Economist, 2012). In addition to being more financially sustainable, the stronger financial incentives could help motivate health workers to carry out their duties.

A recent randomized trial found that introduction of such an entrepreneurial CHW program in Uganda (run by BRAC and Living Goods) reduced child mortality by 27% relative to a control group with no CHWs present (Bjorkman Nyqvist et al., 2018). However, it is unclear if the entrepreneurial features of the program were driving the effect, or if having CHWs provide some free products and services would have worked at least as well.

2.2 Overview of BRAC's CHW Program

We worked with BRAC Uganda's CHW program to carry this study. BRAC has CHW programs in 12 countries and manages over 3,000 CHWs across 70 districts in Uganda. BRAC

CHWs are community members who are hired by BRAC to sell essential health products to others in the village. CHWs sell an array of products such as ORS, zinc, water treatment, bed nets, malaria treatment, and other basic household items (e.g. soap). CHWs purchase products from BRAC at a subsidized price and sell them back to community members for a profit (usually at the market price). BRAC also trains CHWs to provide very basic primary care (e.g., helping to administer simple treatments) and health education (e.g., case management of common illnesses and hand washing) but they do not have any formal training. Each month CHWs attend a refresher training at the BRAC office, at which point they refill their supply of health products.

CHWs are responsible for around 100 households. BRAC instructs CHWs to visit each household at least once per month, offer their services, and provide basic health education. A key aim of the CHW program is to promote ORS and zinc to treat child diarrhea. Qualitative evidence and household surveys suggest that CHWs often do not carry out their tasks as designed. The baseline survey for this study revealed that fewer than 25% of households received a home visit from a CHW in the prior month. Contrary to BRAC's ideal model, CHWs in our sample make most sales from their own homes instead of customer's homes.

3 Study Design

3.1 Study Overview

This study was a cluster randomized controlled trial with random assignment occuring at the village level (118 villages). We worked with BRAC to select 6 branches in central Uganda to enroll in the study. Branches are local offices used to coordinate all of BRAC's operations in the surrounding villages. We then enrolled all villages affiliated with the selected branches where a CHW was active (about 20 per branch) resulting in 118 villages. All branches were within a 3-hour drive from Kampala, Uganda's capital city, and most villages were peri-urban (see Figure 1). The interventions took place at the village level, because one CHW serves an entire village. Although some villages were in close proximity of each other, CHW catchment areas did not overlap.

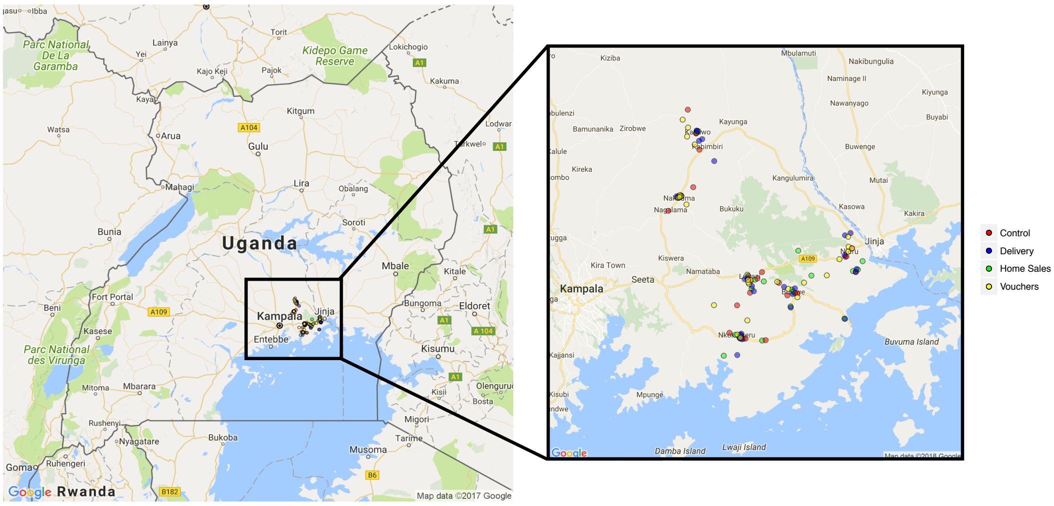
We focused the interventions on ORS+zinc distribution for two main reasons. First, diarrheal diseases remain the second leading cause of death for children around the globe. This problem remains even though ORS could prevent nearly all of these deaths (Liu et al., 2015; Munos et al., 2010). In Uganda, only 46% of cases are treated with ORS (UDHS, 2016). Zinc is recommended in combination with ORS and further reduces morbidity and mortality (Bhutta et al., 2000). Unfortuneately, only 40% of diarrhea cases in Uganda are treated with zinc (UDHS, 2016). Finding cost-effective ways of increasing ORS+zinc use is a key challenge for the global health community, and using CHWs for this task is a promising strategy.

Second, ORS+zinc promotion is incorporated in many CHW programs around the world. Distributing ORS is a key responsibility of BRAC's CHWs in Uganda. Therefore, it is particularly important to understanding how different CHW models affect effort put towards ORS+zinc promotion.

We supplied free ORS+zinc to all CHWs enrolled in the study. We instructed CHWs to visit all households in their catchment area with a child under-5 at the beginning of the study.

We randomly assigned each CHW to one of three treatment arms.[2]. What CHWs were instructed to do when they arrived at the household differed by treatment assignment.

Figure 1: Map of study area



1. Home Sales (monetary costs): We instructed CHWs to offer to sell ORS+zinc to caretakers at the market price ($0.15 USD per ORS packet and $0.30 for a 10 tablet strip of zinc) during the home visit and to retained the money from any sales.

2. Vouchers (free + hassle costs): We instructed CHWs to provide caretakers with one voucher per child under-5. Caretakers (or others) could redeem these vouchers at the CHW's home for two packets of ORS and 10 tablets of zinc (a recommended dose for children over 2-years of age). On average it takes about 10 minutes to walk to the CHW's home.

3. Delivery (free): We instructed CHWs to give caretakers two packets of ORS and ten tablets of zinc per child under-5 (free of charge) to store in their homes for future use.

In all treatment arms, we instructed CHWs to provide BRAC's standard information on the benefits of ORS+zinc, and directions on proper use (see Appendix Figure 1). CHWs received $12 (USD) to carry out the households visits ($6 during training for the intervention and $6 after the interventions were carried out). Although there was no formal method for monitoring or enforcing CHW activities, we wanted them to know that the research team would follow-up to ensure the intervention was carried out. We did not have the means to make the payments conditional on activities being carried out appropriately and we ultimately provided the payments to all CHWs that we trained. We stratified random assignment by BRAC

[2]We also had a pure control group, but this group does not contribute to the current study

branch (5 villages in each arm per branch) and baseline ORS use. We split baseline ORS use into quintiles within each branch to ensure that 1 village from each quintile-branch was in each of the 3 treatment arms. Figure 2 displays the CONSORT flow diagram for the study.

Figure 2: Randomization Flow Diagram

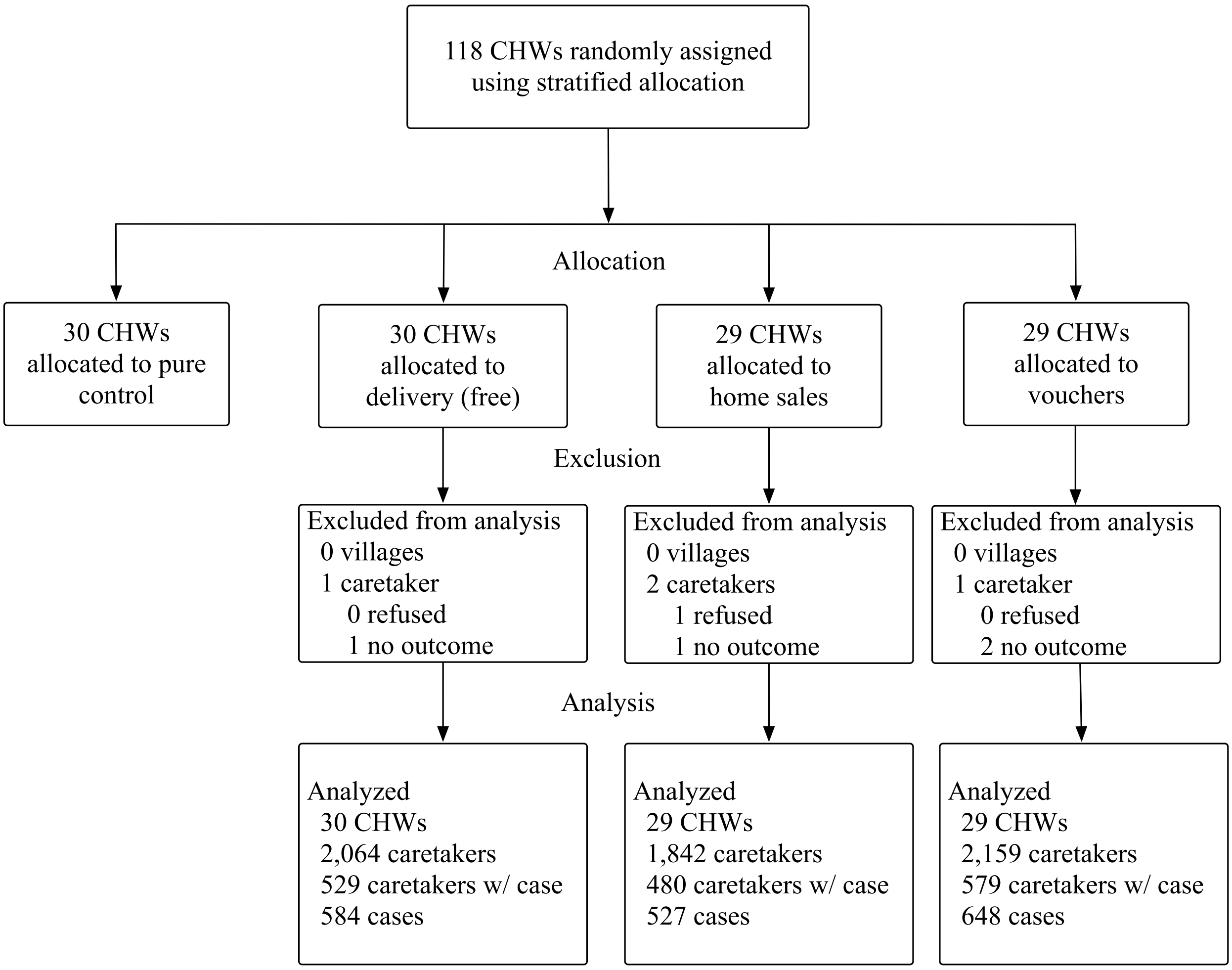


Table 1 presents the different mechanisms of the interventions. Comparing delivery to home sales allows us to assess the potential benefits of an entrepreneurial model of ORS+zinc distribution relative to a model without user fees, because the only difference between these arms is the entrepreneurial mechanism. If the financial incentives of the profits from selling ORS+zinc were effective at motivating CHWs then we would expect CHWs in the home sales arm to increase effort relative to the free distribution arms. CHWs in the home sales arm earned roughly \$0.15 for each ORS packet sale and \$0.30 for each zinc strip sale (discussed more in section 5.3). Comparing delivery to vouchers allows us to assess the potential benefits of requiring small hassle costs to obtain free ORS+zinc.

Table 1: Mechanisms At Work

	Free Distribution?	Hassle Cost?	Information?	ORS+Zinc Stock?
Home Sales	no	no	yes	yes
Vouchers	yes	yes	yes	yes
Delivery	yes	no	yes	yes

3.2 The Intervention

We asked CHWs assigned to one of the treatment arms to attend a short training session at the local BRAC office. During the training, we provided CHWs with instructions on how to carry out their treatment arm's intervention. We also provided a refresher training on the best practices for treating diarrhea, although all CHWs had already received this training from BRAC. The trainings for the three different interventions were conducted separately, and we asked CHWs not to discuss the training with other CHWs. Trainings were identical across treatment arms aside from instructions on ORS+zinc distribution. Below is a summary of the instructions provided to CHWs during the trainings:

1. Visit all households with child under-5
2. Ask for main caretaker
3. Intervention-specific element:
   (a) provide free ORS+zinc,
   (b) offer to sell ORS+zinc, or
   (c) provide voucher
4. Provide standard information on using ORS+zinc (Appendix Figure 1)
5. Re-visit a household if primary caretaker is not home
6. Visit closest households first
7. We will check to make sure these tasks are followed appropriately
8. We will pay you 12 USD to make these household visits (half now, half in one month after verification of intervention)
9. Start immediately
10. Do not discuss this with other CHWs

We kept the order of the instructions the same across all interventions and item (3) was the only area where the instructions differed. We instructed CHWs in the home sales arm to sell each packet of ORS for $0.15 and each packet of zinc for $0.30 (the market price for each). Sales of 10 ORS packets or 5 zinc tablets would generate profit equivalent to the daily wage for women in Uganda (about $1.46).

At the end of training we provided all participants with a box filled with two ORS packets and ten zinc tablets per child under-5 in their catchment area. To estimate the number of children in the catchment area, we used the number of total households reported by the CHW and assumed that 60% had a child under-5. Conditional on having at least one child under-5, we assumed households had 1.8 children under-5 ($HH * .6 * 1.8$) (UDHS, 2016). We estimated that CHWs were responsible for an average of 88 households with a child under-5 and we provided an average of 290 packets of ORS and 145 strips of zinc (10 tablets per strip) per CHW. We gave the same quantity of ORS and zinc regardless of intervention assignment.

Of the 88 CHWs requested to attend a training session, 86 CHWs were actually trained. In two villages, the CHW had quit and a new CHW had not yet been hired, both in the delivery arm. Our main analysis includes all 88 CHWs, which preserves the benefits of random assignment, but provides a lower bound of the benefits of free delivery (this was pre-specified).

3.3 Sampling and Data Collection

After enrollment but prior to random assignment, we had CHWs create a list of all households in their catchment area with a child under-5, which was used as the household sampling frame. After the village listing, we conducted a baseline survey, where we visited the 40 closest households on the list to the CHW's home. One month after the intervention occurred, we conducted an endline survey, where we visited the 80 closest households on the list with a child under-5. If a village had less than 80 households, we conducted a full census at endline. The baseline survey was used primarily to assess pre-intervention balance and to construct village level covariates to adjust endline results and improve power. We chose to visit only 40 households at baseline to preserve our budget. Although our sample might not be representative of the entire population in larger villages, it will be representative of the households most likely to benefit from CHW interventions (i.e. those that live closest to the CHW's home).

At both baseline and endline, the interviewers asked the main caretaker whether a child had a diarrhea episode in the last 4-weeks. For the roughly 1/3 of households for which a child did have a diarrhea episode, the caretaker was asked a series of question about how this case was managed as well as about prior diarrhea treatment behavior, knowledge about case management, and other relevant characteristics about the household, caretaker, and child. Caretakers that did not care for a recent diarrhea episode completed only a short survey asking about take-up of ORS+zinc and contact with the CHW. Only children with a recent episode were included in our analysis of diarrhea treatment outcomes. Since a different set of children had an episode of diarrhea at baseline than at endline, we do not have a panel of (most) households, but rather a repeated cross-section.

We surveyed 4,742 caretakers at baseline, of which 1,537 cared for a child with a case of diarrhea in the last 4 weeks (32%). Since some caretakers cared for multiple cases of diarrhea, this provided data on 1,770 cases at baseline (some analyses are at the diarrhea case level). The team surveyed 7,949 caretakers at endline, of which 2,122 cared for a child with a case of diarrhea (27%). This resulted in data on 2,363 cases at endline.

4 Summary Statistics

Table 2 presents the characteristics of the sample, and how these characteristics compare between arms. The sample size was fairly well distributed across treatment arms and randomization appears to have been successful at ensuring balance between arms. Caretakers in the home sales arm were slightly younger, but slightly more educated. CHWs assigned to home sales had fewer households in their catchment areas, although this should not affect our estimates, because our survey team only visited the closest 80 households per village. A joint test for orthogonality using a multinomial logit model with treatment assignment as the categorical outcome (conducted separately for caretaker, child, and CHW level characteristics) produced a χ^2-test statistic that corresponds to a p-value of less than 0.01 for caretaker and child level variables. This suggests that these covariates are jointly predictive of arm assignment, which is indicative of imbalance and provides some motivation for including these covariates as controls in our analyses.

5 CHW Effort

Our experimental design allows us to estimate the impact of an entrepreneurial model of ORS+zinc distribution on CHW effort relative to a model free distribution (either through home delivery or vouchers). We use the following equation to estimate the unadjusted differences in CHW effort between treatment arms.

$$y_{iv} = \beta_0 + \beta_1 Delivery_{iv} + \beta_2 Vouchers_{iv} + u_{iv} \tag{1}$$

Where y_{iv} is an outcome related to CHW effort (mainly whether the household was visited) for household i in village v at endline. The terms $Delivery$ and $Vouchers$ are indicators for whether we assigned the household to the delivery arm or the voucher arm. The terms β_1 and β_2 estimate the difference in CHW effort for the two free distribution models relative to the entrepreneurial model. Figure 3 presents the results form equation 1 with home visits as the measure for CHW effort. We argue that home visits are the best measure of CHW effort because these visits are necessary for many the tasks assigned to CHWs. Contrary to expectations, CHWs in the free distribution arms visited more homes than CHWs in the entrepreneurial arm. Only 36% of households in the home sales arm received a visit from the CHW, whereas 61% and 56% of households in the delivery and voucher arms received a home visit, respectively (72% and 56% increases).[3] These results suggests that instructing CHWs to sell ORS+zinc

[3]This is almost certainly an under estimate of the motivational benefits from free distribution, because we included all villages in this analysis. However, there were two villages in the free delivery arm where the CHW had quit and there was no CHW available to make the household visits. This did not happen in either of the

Table 2: Sample Characteristics and Balance Between Arms

	(1) Delivery	(2) Home Sales	(3) Vouchers
Number of CHWs	30	29	29
Number of Caretakers	2,064	1,842	2,159
Caretakers w/ Diarrhea Case	529	480	579
% of Caretakers w/ Diarrhea Case	0.27	0.26	0.27
Total Diarrhea Cases	585	529	649
Caretaker Characteristics[1]			
Caretaker Age	29.8	27.9**	29.7
Number of Children	3.00	2.91	3.06
Education			
None	0.12	0.05***	0.09
Primary	0.45	0.45	0.48
Secondary+	0.44	0.50	0.43
Child Characteristics[2]			
Child Age (Months)	23.9	22.2	24.3
Male	0.54	0.53	0.53
Diarrhea Case Characteristics[2]			
Blood in Stool	0.06	0.11**	0.06
Concurrent Fever	0.51	0.56	0.57
Main Outcomes at Baseline[3]			
Visited by CHW Last 4 Weeks	0.42	0.32	0.36
Used ORS for Recent Case	0.62	0.57	0.59
Used ORS+Zinc for Recent Case	0.34	0.29	0.35
CHW Characteristics[3#]			
Number of Households in Catchment Area	163.9	100.0***	212.1
Years as CHW	4.48	3.86	4.44

Includes endline data for households with a case of diarrhea

$***p < .01, **p < .05, *p < .1$ relative to delivery mean

SEs of differences corrected for clustering at the village level

Marginal effects assessed with OLS

[1]Unit of observation=household

[2]Unit of observation=child

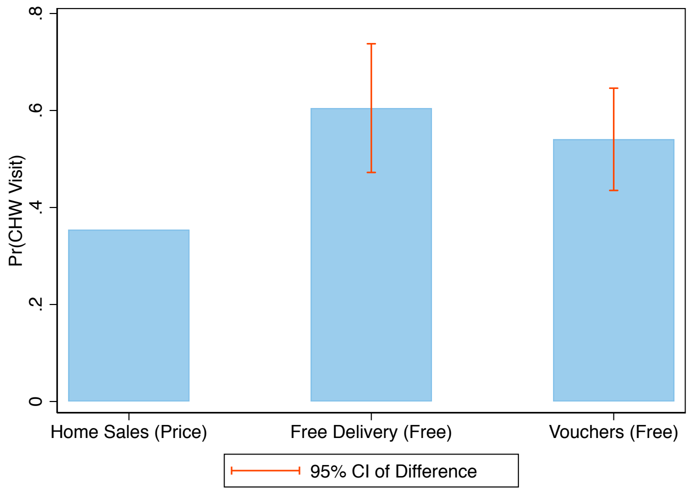
[3]Unit of observation=CHW

[#]CHW characteristics only available for 81 CHWs

led to substantially less effort than instructing CHWs to give ORS+zinc away for free, even though the financial incentive was stronger in the home sales arm.

other treatment arms.

Figure 3: Share of Households Visited by CHW



We also estimated equation 1 with a set of pre-specified control variables, which include caretaker characteristics (age, education, number of children) child characteristics (age, frequency of diarrhea, blood in the stool, concurrent fever), household characteristics (water source, income type, latrine type), baseline village level characteristics (% of households with CHW visit in prior month, % of case treated with ors, % of households with ORS stored in home), and branch fixed effects. Arm assignment was random, which means these controls should not affect on our estimates in expectation, but should improve precision. As expected, the inclusion of controls does not change our estimates (Table 3).

Table 3: CHW Effort

	Pr(Home Visit)	
	(1)	(2)
	Unadjusted	Adjusted
Delivery	0.251***	0.239***
	(0.068)	(0.053)
Voucher	0.186***	0.161***
	(0.054)	(0.052)
Controls	No	Yes
Control Mean	0.354	0.354
Obs	1,588	1,588
R^2	0.031	0.082

$***p < .01, **p < .05, *p < .1$

Estimates are marginal effects from a logit regression

Village Clustered SEs in parentheses

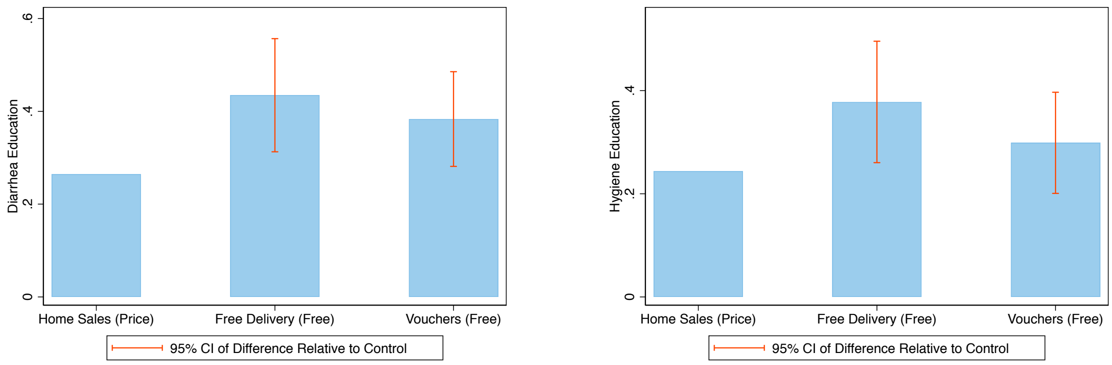
Unit of observation=household

Controls include caretaker characteristics (age, education, number of children) child characteristics (frequency of diarrhea, blood in the stool, concurrent fever), household characteristics (waterer source, income type, latrine type), baseline village level characteristics (% households with CHW visit in prior month, % case treated with ors, % of households with ORS stored in home), and branch fixed effects

Because many of the tasks assigned to CHWs require home visits, the additional visits generated by free distribution could lead to improved CHW performance on other tasks and improved child outcomes. Figure 4 presents estimates from equation 1 with health education as the outcome. Not only did free distribution lead to more home visits, but this increased contact with the CHW also increased the probability of a household receiving diarrhea education and hygiene education. These health education benefits were driven almost entirely by additional CHW visits, and there was no difference in health education when conditioning on CHW visit (available upon request).

Figure 4: Share of Households That Received Health Education

(a) Diarrhea Education (b) Hygiene Education



This increase in health education appears to have led to improved knowledge of the best practices for treating diarrhea. Table 4 shows the share of caretakers with appropriate responses to questions about how diarrhea should be treated. We pooled delivery and vouchers for this analysis because they appeared to induce a similar amount of CHW effort. Caretakers in the free distribution villages were more likely to indicate ORS, zinc, and ORS+zinc as the best treatment for diarrhea. However, there was little difference in knowledge proper use (dosing, initiation, and duration). It is important to note that this analysis should be considered with caution, because it is not clear if the additional CHW effort was responsible the differences in knowledge, or if simply giving away ORS for free would have had the same effect. Regardless, free distribution appears to improve knowledge of the best treatment for diarrhea one way or another.

Table 4: Impact on ORS and Zinc Knowledge

	(1) Home Sales	(2) Free Distribution
ORS Best Treatment	0.77	0.85***
Zinc Best Treatment	0.52	0.63**
ORS+Zinc Best Treatment	0.46	0.60***
Start ORS 1st loose stool	0.47	0.51
Give ORS after each loose stool	0.29	0.28
Start Zinc 1st loose stool	0.41	0.49**
Give Zinc once per day	0.71	0.72
Give Zinc for 10 days	0.15	0.13

Includes endline data for households with a case of diarrhea
Unit of observation=Caretaker
$***p < .01, **p < .05, *p < .1$ relative to home sales
P-values adjust for clustering at the village level
Analysis not pre-specified

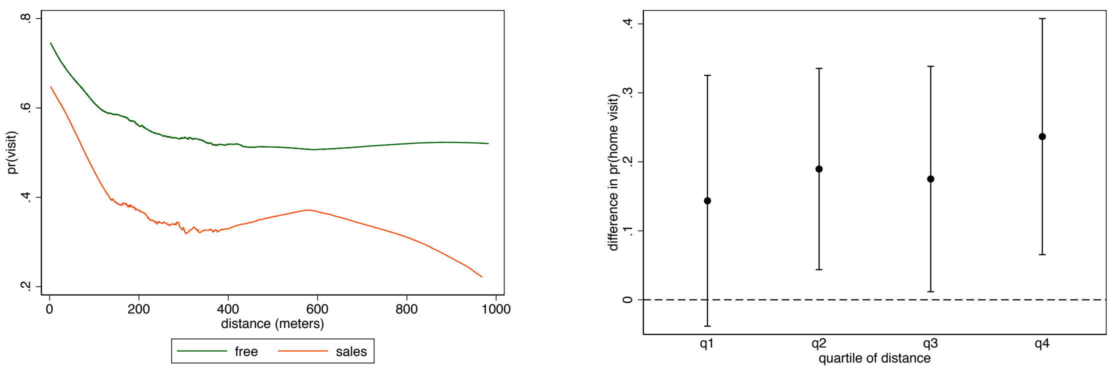
5.1 Reasons for Differential Effort

Qualitative interviews revealed that social motivators were a key driver of effort. Several CHWs in the home sales arm reported that it was unpleasant to ask their poor neighbors to purchase something and that they would have visited more households had they been distributing free ORS. About 10% of households in the home sales arm reported receiving ORS for free from the CHW. Moreover, CHWs assigned to free distribution reported feeling good about giving products away for free, because it made them look good to their peers and they felt like they were helping their community. This suggests that CHW effort is partly driven by how a given task makes them look to their community. This is consistent with Ashraf et al. (2014) who find that health workers in Zambia are more responsive to social incentives that make them look good than to fina ncial incentives.

Qualitative interviews also revealed that CHWs lost interest in completing sales visits after a poor initial experience with the first few households or if the first few households were not interested in making a purchase. Figure 5 supports this, demonstrating that the difference in home visit probability between free distribution (delivery and vouchers are pooled) and home sales increased with distance to the CHW's home. The inverse relationship between distance and visit probability persists across the full range of distance for home sales; in contrast, CHWs in the free distribution arms are equally likely to visit homes at 300 meters or 1 km away (panel A). The result is a larger difference between the free distribution and home sales arms at farther distances from the CHW's home (14 percentage point difference in the first quartile of distance compared to 24 percentage point difference in the fourth quartile; panel B), although this heterogeneity is not statistically significant. We instructed CHWs to visit closer households first, and this is consistent with reports that the sales arm did not complete all of their home visits because the first few visits were unpleasant.

Figure 5: Home visits by distance from CHW's house

(a) Home Visits (b) Difference (*Free* − *Sales*)



One would expect that CHWs assigned to home sales would select to visit households that are more likely to purchase ORS+zinc. Indeed, this is what CHWs reported during qualitative interviews. However, CHWs in the free arm and the home sales arm visited homes with very similar observable household and child characteristics. Free distribution CHWs were no more likely to visit poorer households, households with more children, less educated caretakers, or younger children (Table A1).

5.2 Contribution of Additional CHW Effort to Improved ORS Use

Wager et al. (2018), analyzing the same experiment, demonstrate that free distribution substantially increases ORS use relative to a home sales model (12 percentage point difference). This study focused on the public health benefits of free distribution of ORS relative to charging and used an ITT analysis. However, this produces treatment effects in terms of ORS use that include both supply-side effects (increased CHW effort) and demand-side effects (price-elasticity of demand). It is important to understand what share of the improvement in diarrhea treatment outcomes is driven by the supply-side effects (documented in previous section) and the demand-side effects. Because the interventions simultaneously varied CHW effort and the price faced by the household, teasing out the relative contribution of each is challenging.

Table 5 presents estimates from several analysis examining what share of the increase in ORS+zinc use was the result of increased CHW effort and what share was the result of free access. The top panel shows estimates for ORS use (the pre-specified primary outcome from Wagner et al. (2018)) and the bottom panel shows estimates for ORS and zinc use combined. This analysis excludes the voucher arm in order ensure the effect of the hassle cost is omitted. Columns 1 and 3 present the ITT estimates reported in Wagner et al. (2018), with and without controls, respectively. Columns 2 and 4 control for whether or not the household had a CHW visit during the study period. Comparing column 1 to 2 and column 3 to 4 provides insight into how important the additional effort put forth by CHWs was for increasing ORS and ORS+zinc use.

The first thing to note is that receiving a CHW visit is an important predictor of ORS use (25 percentage point increase, p<0.01) and ORS+zinc use (35 percentage point increase, p<0.01). After controlling for CHW effort, the estimated difference in ORS use between free distribution and home sales reduces by roughly 50% relative. This result suggests that increased CHW effort was responsible for about half of the increase in ORS use. We find similar results for ORS+zinc use as the outcome; roughly half of the improvement in ORS+zinc was attributable to increased CHW effort.

Table 5: Impact On ORS Use (Contribution of Additional CHW Effort)

	Marginal Effects from Logit Regressions			
	Panel A: Outcome = ORS use			
	(1)	(2)	(3)	(4)
Delivery vs. Home Sales	0.123***	.063**	0.110***	0.055**
	(.035)	(.032)	(.03)	(.027)
CHW Visit		0.247***		0.234***
		(.024)		(.025)
Controls	No	No	Yes	Yes
Obs	2,356	2,356	2,356	2,356
	Panel B: Outcome = ORS+zinc Use			
	(1)	(2)	(3)	(4)
Delivery vs. Home Sales	0.183***	0.093**	0.159***	0.084**
	(0.050)	(0.040)	(0.044)	(0.037)
CHW Visit		0.350***		0.328***
		(0.027)		(0.029)
Controls	No	No	Yes	Yes
Obs	2,356	2,356	2,356	2,356

$***p < .01, **p < .05, *p < .1$
Village Clustered SEs in parentheses
Estimates are marginal effects from a logit regression
Covariates for adjusted model described in section 5
Unit of observation=diarrhea case
Analysis not pre-specified

Controlling for a post-treatment indicator for CHW visit is an imperfect way of holding CHW effort constant, because it assumes the probability of a visit is orthogonal to ORS+zinc use (Acharya et al., 2016). In reality, CHWs selected which households to visit. Qualitative interviews with CHWs in the home sales arm revealed that they avoided poorer households, households that were historically less receptive to BRAC programs, and those whom they expected held lower regard for ORS and zinc. However, our data does not support the notion that there was differential CHW selection between arms. Table A1 presents caretaker, child, and household characteristics by whether the household received a CHW visit (delivery and home sales arms only). There is not clear evidence that CHWs differentially selected certain types of households. However, a joint test for orthogonality produces a χ^2-test with $p < .01$, suggesting that CHW visits are non-random.[4] Therefore, the analysis in Table 5 should be interpreted with caution.

5.3 Unpacking the Financial Incentives of Home Sales

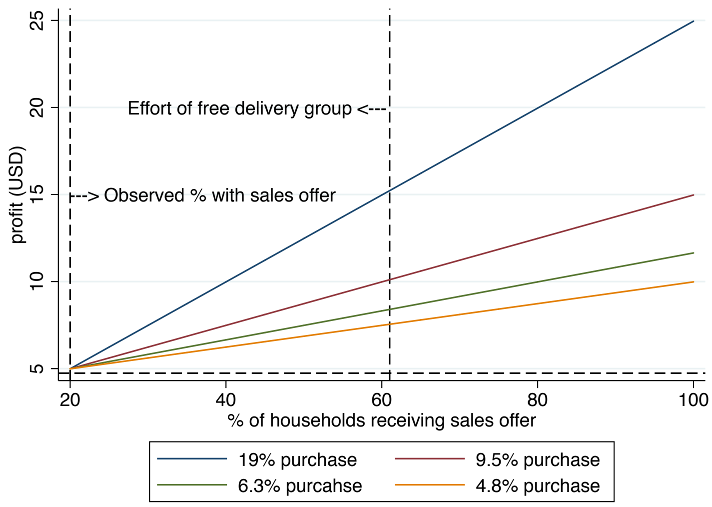
The financial incentives associated with the home sales intervention may not have been strong enough to engender effort. About 19% of households with a CHW assigned to home sales received a sales offer, and of these, 19% made a purchase. We estimate that these CHWs earned an average of $ 16,120 UGX (about $4.74 USD) from these sales over the one month study period. Assuming the probability of purchase was the same for the marginal household visited, this implies that if they made a sales offer to every household, then they would have made over 5 times as much income ($4.74/.19=$24.95). The average monthly wage for paid female workers in Uganda is about $44 (USD) (Uganda Bureau of Statistics, 2012). In other words, there may have been a substantial amount of money left on the table by not offering to sell ORS+zinc to more households. If CHW assigned to home sales carried out their assigned task at the same level as the free delivery CHWs (61% of households received a free delivery), they would have made more than three times as much income ($15.20).

Household visits took an average of 15 minutes to complete and offering to sell to 100% of households (81 additional households on average) would result an additional 20.25 hours of work. With an hourly wage of about $0.28/hour, this cost of time is equivalent to $5.60 in lost wages, far less than the $24.95 they could have earned.

However, as mentioned above, CHWs may have selected to visit households that were likely to purchase ORS+zinc, and therefor the additional households visited might have a lower probability of purchase. Figure 6 presents estimated profits from home sales with different shares of households visited and under different assumptions about the probability of purchase for the additional households visited.

[4]This test was done separately within delivery and home sales households. We used a logit model with CHW visit as the outcome and the characteristics from Table A1 as explanatory variables

Figure 6: Profit from home sales under higher levels of effort



This figure demonstrates that if CHWs visited all households and only 4.8% of the additional households visited made a purchase (25% of the observed purchase rate), the income from sales still would have doubled and been roughly equivalent to what they would have earned with wage work. This additional $5 represents an 11% increase over the average female monthly income in Uganda. This exercise demonstrates that although ORS+zinc are cheap, sale of these products can result in a substantial increase in income for CHWs and the incentive size from the sales intervention was non-trivial. The low levels of effort put forth by CHWs assigned to sell likely left a relatively important amount of money on the table.

6 Costs as Mechanisms to Improve Targeting to High Risk Cases

Another potential benefit of an entrepreneurial CHW model, or a model that imposes hassle costs, is better targeting to high-risk cases. Presumably, caretakers of children at higher risk of mortality from a case of diarrhea would be willing to pay a larger cost to acquire the life-saving treatments than caretakers of low-risk cases. If so, then we would expect prices and hassle costs to help screen out low-risk cases, and the extra cases treated with ORS under free delivery to be lower-risk. To address this, we test for heterogeneity in intervention impacts by two different measures of diarrhea mortality risk.

1. **Infants:** The majority of deaths from diarrhea happen among infants (i.e., within the first year of life). We used a dummy variable indicating that the child is less than 12 months old.

2. **Severity of Episode:** We used two criteria to identify severe episodes: concurrent fever and blood in the stool. We coded a case as "severe" if either of these criteria were satisfied.

We tested for how ORS and ORS+zinc use is affected differently based on these characteristics using equation 2

$$y_{iv} = \beta_0 + \beta_1 HomeSale_{iv} + \beta_2 Voucher_{iv} + \beta_3 Risk_{iv} + \beta_4 RiskXHomeSale_{iv} + \beta_5 RiskXVoucher_{iv} + \epsilon_{iv} \quad (2)$$

Where y is a treatment outcome (ORS use), *Risk* is either age or severity of episode. In this equation, β_4 and β_5 represent the benefits of imposing monetary or hassle costs, respectively, in terms of targeting high-risk cases. These estimates are presented in Table 6. Columns 1 and 3 of Table 6, which include the full sample, include supply-side effects (costs influencing CHW selection of household to visit) and demand-side effects (costs as a screening mechanisms for caretakers). Columns 2 and 4 control for the supply-side effects by including CHW visit as a covariate. Using age as a risk proxy (column 1), the coefficients on the interaction terms are both close to zero and insignificant, suggesting that neither monetary nor hassle costs do a better job of targeting younger children. Holding constant supply-side effects has little effect (column 2).

Table 6: Targeting high-risk cases

	Outcome = ORS use			
	(1)	(2)	(3)	(4)
	risk=age	risk=age	risk=severity	risk=severity
home sales	-0.119***	-0.048	-0.163***	-0.095*
	(0.043)	(0.036)	(0.058)	(0.053)
vouchers	-0.033	-0.018	-0.040	-0.018
	(0.037)	(0.033)	(0.055)	(0.051)
risk	-0.032	-0.019	0.053	0.054
	(0.047)	(0.049)	(0.047)	(0.046)
home sales X risk	-0.012	-0.024	0.060	0.061
	(0.073)	(0.075)	(0.072)	(0.067)
vouchers X risk	0.013	0.013	0.011	-0.001
	(0.059)	(0.062)	(0.065)	(0.064)
CHW Visit?	No	Yes	No	Yes
Obs	1759	1759	1759	1759

$***p < .01, **p < .05, *p < .1$

Village Clustered SEs in parentheses

Estimates are from OLS regressions in the form of equation 2

Unit of observation=diarrhea case

For severity of episode, we see similar results (columns 3 and 4). Although the coefficient on the interaction between home sales and severity is of an important magnitude (6 percentage points), it is not statistically significant (p=0.41). We find similar results to the above when we use ORS+zinc as the treatment outcome of interest (not shown).

It is important to note that the estimates on the interaction terms in this table are imprecise, and confidence intervals include important magnitudes. Therefore, although we find no evidence that prices or hassle costs do a better job of targeting high-risk cases, we cannot rule out large effects.

7 Costs as Screening Mechanisms to Avoid Wastage

Ideally, a policy maker would like to use subsidies to maximize coverage of health products while minimizing wastage of these subsidized products. This goal requires giving products to people with a high propensity for use (adherers). An entrepreneurial model could improve targeting to adherers relative to free distribution through a *screening* effect—those with low propensity for use could be less likely to purchase. If such effects are present, charging for health products could help avoid product wastage. However, public health proponents often argue that charging for health products will reduce coverage by dampening demand, particularly among the poor and vulnerable. Although there is mixed evidence on price a screening mechanism (Ashraf et al., 2010; Cohen and Dupas, 2010), there is an abundance of evidence demonstrating that poor households in developing countries are sensitive to price (see Kremer et al. (2011a) or Dupas and Miguel (2017) for a review). In a recent study, Dupas et al. (2016) find that small hassle costs to retrieve point-of-use water treatment are effective at screening out non-adherers without dampening demand among adherers. This suggests that imposing hassle costs could be a more efficient way of targeting products than either free delivery or charging, since it produces less wastage than free delivery without sacrificing coverage.

The experimental design of this study allows us to assess the trade-offs in ORS+zinc coverage and targeting ORS+zinc to adherers, and how those trade-offs differ when user fees or hassle costs are imposed. The following outlines the framework we use to analyzing this trade-off.

7.1 Framework to Compare Wastage/Coverage Trade-off

Let α_i be the share of respondents with a diarrhea episode in intervention i that acquired subsidized ORS from the CHW during the study period (take-up) and μ_i be the share of respondents that used ORS to treat a case of diarrhea during our study period (coverage). Let λ_i, be the share of those that obtained ORS that used it to treat a case of diarrhea (roughly $\frac{\mu_i}{\alpha_i}$)[5] (adherence). There are three important inequalities of interest between the $\lambda's$ and $\mu's$:

[5]Due to measurement errors, this ratio is not exact

1. $\lambda_i > \lambda_j$ and $\mu_i < \mu_j$: this implies that intervention i does a better job of targeting to adherers than intervention j, but intervention j does a better job of getting ORS to all that need it.

2. $\lambda_i > \lambda_j$ and $\mu_i \geq \mu_j$: this implies that intervention i does a better job of targeting to adherers than intervention j, and also does at least as good of a job at getting ORS to all that need it.

3. $\lambda_i \geq \lambda_j$ and $\mu_i > \mu_j$: this implies that intervention i does at least as good as good of a job of targeting to adherers as intervention j, but does a better job at getting ORS to all that need it.

Prior evidence discussed above suggests that hassle costs do a better job of targeting to adherers and at least as good of a job of getting ORS to all that need it relative to free distribution (scenario 2). Prior work also suggests that charging sacrifices coverage but improves targeting to adherers (scenario 1).

7.2 Results

To assess trade-offs in coverage and targeting to adherers, we use estimates of coverage (share of cases treated with ORS), take-up of ORS, and the probability of use conditional on take up (adherence). We define take-up as acquiring ORS in the last 4 weeks (overall and directly from the CHW). For adherence, we estimate the share of caretakers that obtained ORS in the last 4 weeks that used ORS to treat a case of diarrhea. We restrict this analysis to the sample of households that reported a case of diarrhea, because the wastage implications among households that take-up ORS but have no diarrhea episode are unclear (they had no opportunity to use ORS).

Table 7 presents means of the coverage, take-up, and adherence metrics by arm assignment and reports statistical differences relative to the delivery arm. As documented previously by Wagner et al. (2018), coverage was highest in the delivery arm (77% of diarrhea cases received ORS). The voucher arm produced slightly lower coverage estimates (74%), but this difference was statistical insignificant (p=0.39). Home sales produced significantly lower coverage than the free distribution arms (64%, p<0.01).

Overall take-up was highest in the delivery arm (82% of caregivers obtained ORS during the study period), most of which came from the CHW (65% obtain ORS from the CHW). The voucher arm produced slightly lower take-up (77% overall and 55% from the CHW), but again was statistically indistinguishable from the delivery arm (p=0.12 for overall take-up and p=0.149 for take-up from CHW). The home sales arm had significantly lower take-up than both the free distribution arms. Only 65% of households in the home sales arm obtained ORS and only 25% from the the CHW (p<0.01 for both). Adherence was high in all arms ($\sim$ 90%), suggesting that wastage of ORS is not a big concern (if a child has a case of diarrhea). Adherence was slightly higher in the voucher arm than the delivery arm (3 percentage points) but this was not statistically significantly (p=.39). Adherence in the home sales arm was also higher than the delivery arm (6 percentage points) and this difference was significant at the 10% level (p=.06), suggesting that monetary costs might help target ORS to those more likely to adhere.

Table 7: Take-up, Coverage, and Adherence

	Delivery (free)	Home Sales (monetary cost)	Vouchers (hassle cost)
Coverage	0.767	0.644***	0.737
Take-Up (overall)	0.826	0.645***	0.772
Adherence (overall)	0.894	0.938*	0.922
Take-Up (CHW)	0.648	0.250***	0.553
Adherence (CHW)	0.892	0.955*	0.919

Unit of observation=diarrhea case

$***p < .01, **p < .05, *p < .1$ relative to delivery

P-values adjust for clustering at the village level

Coverage = share of cases treated with ORS

Take-Up = share obtained ORS in last 4 weeks

Take-Up (CHW) = share obtained ORS from CHW in last 4 weeks

Adherence = Pr(Use|Take-Up)

Adherence (CHW) = Pr(Use|Take-Up (CHW))

Overall, these results imply that adherence to ORS is not a big concern if a child has a case of diarrhea, because more than 90% of caretakers used ORS to treat a case of diarrhea. However, charging for ORS may increase distribution to caretakers with a slightly higher propensity for adherence. Hassle costs do not appear to improve targeting to adherers in this context.

It is important to note that we are underpowered to assess equality (i.e. precise zeros) of coverage, take-up, or adherence between any two study arms, which is a criterion for scenarios 2 and 3 of the conceptual framework. For example, the confidence interval of the coverage difference between delivery and vouchers includes important differences on the upper end (9 percentage points), which means we cannot rule out that delivery actually does a better job of increasing coverage than vouchers. Similarly, although we are unable to detect a statistical difference in take-up between vouchers and free delivery, the differences are of an important magnitude, and our results show a pattern consistent with Dupas et al. (2016) (i.e., vouchers lead to lower take-up without sacrificing coverage).

8 Discussion

Understanding how to motivate CHWs is of growing importance. This study provides a head-to-head comparison of competing models of CHW health product distribution in terms of motivating CHWs to carry out their work. Contrary to conjecture about the motivational benefits of an entrepreneurial model, distributing ORS+zinc for free induced more effort and better performance. The social incentives associated with providing a household with free treatment for child diarrhea appear to be more powerful than the financial incentives of earning profit from sales. The extra effort put forth by CHWs assigned to free distribution led to more health education, better caretaker knowledge, and increased ORS+zinc use. CHWs reported a preference for free distribution over home sales, due to improved social status, a desire to help their community, and a dispreference for sales visits. This is consistent with prior work demonstrating that pro-social CHWs perform better than more financially motivated CHWs (Deserranno, 2019) and evidence that social incentives for health workers can be more powerful than financial incentives (Ashraf et al., 2014).

Our study adds to a substantial body of literature documenting that user fees are detrimental to public health objectives (Kremer et al., 2011a; Dupas and Miguel, 2017). Not only does charging for health products dampen household demand as has been previously documented, but it results in detrimental supply-side effects. We estimate that these supply-side effects account for about half of the difference in ORS+zinc use between free distribution and home sales.

The results of this study might appear to be in conflict with Bjorkman Nyqvist et al. (2018), who use an RCT to estimate a 27% reduction in child mortality after introduction of BRAC's entrepreneurial CHW program. However, that study did not isolate for the effect of the entrepreneurial features of the model, but rather compared the villages where entrepreneurial CHWs were introduced to villages with no CHW program.[6] Therefore, although the results are promising, it is possible the treatment effects would have been even larger if the CHWs were giving products away for free. Future research should aim to compare entrepreneurial model features at scale and over a longer period of time.

We document that the extra effort under free distribution led to more health education and better knowledge for caregivers, but this increased contact could generate benefits beyond those measured in this study. CHWs provide many other important health products and services. The extra contact with households that results from having CHWs distribution products for free could lead to increased vaccination rates, more and quicker referrals to health clinics for sick children, better monitoring of illness and malnutrition, and increased bed net or chlorine use. Future research should explore using free home delivery as a tool for increasing households' contact with the CHW and the potential spillover benefits from this extra contact.

Part of the allure of entrepreneurial CHW models is that they are thought to be more sustain-

[6]This study used both BRAC CHWs and Living Goods CHWs, both of which use the same entrepreneurial model

able and this work does not address issues of sustainability. Contrary to government CHWs in Uganda, BRAC's CHWs earn income from their work, which is likely to improve retention. Moreover, the community members provide payment to CHWs so that BRAC does not have to. Asking CHWs to switch to free distribution could lead to poor retention and would require BRAC to fully subsidize health products (the status is for them to provide a large but partial subsidy). An ideal free distribution model would thus entail a full subsidy of health products and a monthly salary for CHWs. This would certainly increase costs for the implementor, but the benefits associated with free distribution, both in terms of improved CHW effort and increased coverage, are likely worth the extra cost.

We use qualitative evidence to demonstrate that social incentives appear to be a key driver of CHW effort, and differences in social incentives between treatment arms partly explain the differential effort put forth. CHWs work in a unique setting where, by design, their clients are also neighbors, family members, and friends. In this setting, it is not surprising that sales visits appear to include a social penalty, whereas free distribution is socially rewarding. Social incentives could be less influential and financial incentives more influential in a setting where health workers deal with strangers.

The mechanisms we put forth to explain the difference in effort is far from conclusive. Although, increased effort could be the result of pro-social motivation outweighing financial motivation as we suggest, it could also be the case that CHWs see free distribution as a marketing tool that will help increase future sales. Therefore we cannot rule out financial motivation as a partial driver of higher effort in the free delivery arm. Future work should attempt to carefully tease out these different mechanisms.

It is also unclear if the differences in effort would be sustained over time. It is possible that CHWs put in more effort under free distribution because it was different than the status quo (sales), a novelty effect that could ware off over time. Future work should exam the long term differences in effort between free distribution and sales.

Consistent with prior work, we find no evidence that charging for ORS led to better targeting of high-risk cases relative to free distribution (Kremer and Miguel, 2007; Kremer et al., 2011b; Cohen and Dupas, 2010; Ashraf et al., 2010). This is the first study to examine the role of hassle costs in targeting high-risk beneficiaries, and we find that imposing such costs does no better at targeting than free home delivery. Caregivers had to walk an median of only 5 minutes to the CHW's home to redeem their vouchers and it is possible that larger hassle costs might provided more targeting benefits.

Contrary to Dupas et al. (2016), we cannot conclude that hassle costs were more effective at screening out non-adherers than free delivery. There are several potential reasons for this discrepancy. First, adherence to ORS is much higher than adherence to chlorine based water treatment. About 90% of caretakers who had a child with a case of diarrhea used ORS across all arms, leaving little room for improvement, whereas adherence to proper chlorine use in Dupas et al. (2016) was only 34%. Second, our study examined screening effects after one month, whereas Dupas et al. (2016) examine effects over 12 months. It is possible that voucher redemption decreases over time among non-adherers, which would increase the screening effect over time. Third, we were underpowered to detect small differences in take-up and use between treatment arms. In fact, we document a similar pattern of take-up and use as Dupas et al. (2016)—vouchers led to less take-up but similar coverage—but we could not detect this pattern statistically. Finally, we do find that hassle costs screened out households without a diarrhea episode (Appendix Table A2), which could lead to less wastage if no case ever occurs in some households or if the packages are lost or damaged before a case occurs.

When interpreting this study, several additional limitations should be taken into account. First, we rely on caretaker reports for most of our outcomes. Caretaker reports are used to monitor ORS use globally and are the key metric used to influence decision making around treatment of child diarrhea. However, it is unclear if such reports are accurate. In prior work, we demonstrated that comparing counts of full packets observed to reports of total packets acquired produces similar ORS coverage estimates as caretaker reports (Wagner et al. 2018). However, we have no objective way of validating CHW visit reports, an important outcome of this study. Although there is no clear reason to expect differential reporting of CHW visits between arms, we cannot rule this out. Second, although this study suggests that free distribution of ORS+zinc leads to better CHW performance than charging, it is not clear how well these results translate to a model where all product are sold or given away for free. ORS+zinc are relatively cheap, extremely effective, and adherence appears to be fairly high. CHWs could respond differently if they were instructed to give *all* of their products away for free. Finally, as for all localized RCTs, this study has limited external validity. CHWs in other settings could respond differently to financial incentives, social incentives, or both.

9 Conclusion

Entrepreneurial CHW models are growing in popularity. This is at odds with a large body of economics literature that documents that households are very sensitive to the price of health products (Kremer et al., 2011a; Dupas and Miguel, 2017). Our study suggest that the entrepreneurial features of these models not only dampen demand but also lead to less CHW effort than a model of free distribution. Implementors of CHW programs should reconsider the merits of an entrepreneurial design.

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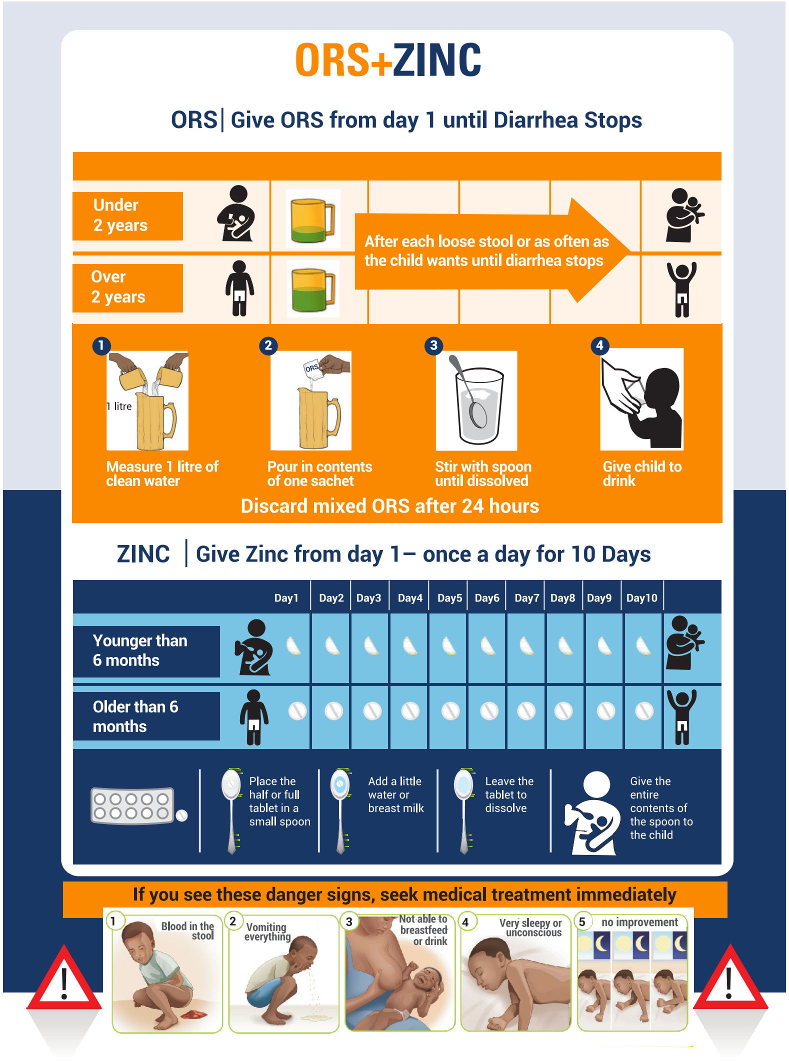
10 Appendix

10.1 Appendix Figures

Figure A1: Flyer used to provide ORS and zinc knowledge to caretakers



10.2 Appendix Tables

Table A1: Endline Characteristics by CHW Visit

	Delivery		Home Sales	
	CHW Visit=1	CHW Visit=0	CHW Visit=1	CHW Visit=0
Number of Diarrhea Cases	357	228	188	341
Caretaker Characteristics				
Caretaker Age	31.4	28.1***	29.5	27.6
Number of Children	3.3	2.8***	3.4	2.8***
Wage Work Last 7 Days	.482	.548	.606	.625
Education				
None	.129	.101	.064	.05
Primary	.473	.43	.495	.449
Secondary+	.398	.469	.441	.501
Child Characteristics				
Child Age (Months)	25.0	22.2***	22.6	22.0
Male	.524	.575	.5	.545
Diarrhea Monthly	.216	.281	.266	.273
Blood in Stool	.067	.044	.09	.114
Concurrent Fever	.51	.518	.574	.557
Household Characteristics				
Water Source				
Piped	.14	.254***	.191	.264
Protected Well	.728	.614	.628	.551
Unprotected Source	.106	.079	.138	.123
Main Income Source				
Agriculture	.238	.167	.176	.123
Public Sector	.014	.013	.021	.029
Private Sector	.104	.14	.154	.217
Self Employed/Informal	.501	.583	.559	.548

Includes endline data for households with a case of diarrhea

Unit of observation=diarrhea case

$***p < .01, **p < .05, *p < .1$ relative to CHW visit=1

Marginal effects assessed with OLS for continuous and Logit for binary outcomes

Test for joint significance produces χ^2 with $p < .001$ for both Free+Delivery and Home Sales

Table A2: Take-up, Coverage, and Adherence (including households with no diarrhea episode)

	Delivery (free)	Home Sales (monetary cost)	Vouchers (hassle cost)
Used ORS for Diarrhea	0.211	0.18	0.214
Take-Up	0.701	0.372^{***}	0.543^{***}
Take-Up (CHP)	0.634	0.211^{***}	0.457^{***}
pr(Use|Take-Up)	0.29	0.455^{***}	0.381^{***}
pr(Use|Take-Up (CHW))	0.251	0.316	0.324^{**}

Unit of observation=diarrhea case

$***p < .01, **p < .05, *p < .1$ relative to delivery

P-values adjust for clustering at the village level

Take-Up = share obtained ORS in last 4 weeks

Take-Up (CHW) = share obtained ORS from CHW in last 4 weeks