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Paying for Digital Information: Assessing Farmers' Willingness to Pay for a Digital Agriculture and Nutrition Service in Ghana

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Abstract. With the widespread growth of mobile phone coverage and adoption over the past decade, there has been considerable enthusiasm over the potential for information and communication technologies (ICTs) to provide a low-cost approach for farmers to overcome information constraints in agricultural initiatives. The commercial viability of ICTs relies on effective demand for these services. This paper assesses farmers' willingness to pay (WTP) for a digital platform that provides nutrition-sensitive agricultural information in Ghana. Using the Becker-DeGroot-Marschak method to elicit WTP, we randomly vary the framing of the marketing messages for the service, as well as the gender of the person targeted, to examine the effects of framing and respondent gender on demand. We find that farmers are highly price sensitive, but most are willing to pay a low monthly price for the service. A nutrition-focused marketing message leads to higher WTP than an agriculture only message, and women have substantially lower WTP than men, with the latter difference driven by lower WTP for the service among women who report access to alternative sources of nutrition, health, and agriculture information.

[a] International Food Policy Research Institute, [b] Tufts University, [c] Results for Development. * Corresponding author: m.hidrobo@cgiar.org. We would like to thank all individuals in Upper West and Central Region who agreed to take part in this research. We are particularly grateful to Lucy Billing for managing the project in Ghana, and to the Institute of Statistical, Social and Economic Research (ISSER) team in Ghana, led by Simon Bawakyillenuo and Felix Asante, for leading the data collection effort. We would also like to extend our sincere gratitude to Groupe Spéciale Mobile Association (GSMA), Esoko, Vodafone Ghana, and Global Alliance for Improved Nutrition (GAIN) teams for their ongoing cooperation and support for the evaluation. We are also extremely grateful for the ongoing collaborative partnership with The Institute of Development Studies (IDS) and the GAMOS team. We gratefully acknowledge funding support for this research from the Department for International Development (DFID) of the UK and from the Dutch Government through SNV and the Voice for Change Partnership (V4CP) Programme.

I. Introduction

Despite the central assumption that market actors have the necessary information to engage in optimal decision-making in economics, there is widespread evidence that this assumption rarely holds, especially in remote rural areas of developing countries, where information is costly to acquire. Previous research in developing countries suggests that there are potentially large private and social returns to overcoming problems related to imperfect information in agriculture (Cui et al., 2018; Jensen, 2007) and health (Dupas, 2011).

With the widespread growth of mobile phone coverage and adoption in developing countries, reductions in the cost of providing and utilizing information and communication technology (ICT) services have been substantial. This, coupled with studies showing the impact of ICTs on development outcomes, has generated considerable enthusiasm over the use of ICTs as a means of overcoming imperfect information (Aker, Ghosh, & Burrell, 2016). As a result, the number of public and private sector "ICT for development" (ICT4D) initiatives have increased substantially over the past decade, especially in the agriculture and health sectors. Despite their promise, many ICT initiatives fail to scale up (World Bank, 2016). To be financially sustainable, many initiatives have introduced fee based subscription models, however, take-up of these fee based models is low (Fabregas, Kremer, & Schilbach, 2019). Understanding the demand for digital information services is thus important for creating sustainable ICT4D models. In theory, individuals should invest in obtaining information if the expected benefits from that information outweigh the costs. As a result, the observed low take-up of agricultural and health information services—even at moderate prices—could simply be explained by low expected returns. If beliefs are accurate, this equilibrium (low) level of demand is optimal. Alternatively, demand for information could be sub-optimal if the expected returns to information are high, but individuals underestimate the expected benefits, are credit-constrained, or have time inconsistent preferences. These possible explanations are often used as motivation for offering price subsidies for new products in general, and for digital services more specifically. In contrast with traditional health and agricultural products, digital information services also have quasi-public good properties, as they can be non-rival and non-excludable (Fabregas et al., 2019). For ICT suppliers, this may be especially threatening to sustainability, as information service provision typically requires incurring both upfront costs and maintaining ongoing investment.

An optimal model for financing ICT4D initiatives requires detailed information about potential users' initial price sensitivity, as well as the short and longer-term relationships between willingness-to-pay (WTP) and use of the ICT service. This paper explores the demand for one digital service, the Vodafone Farmers' Club (VFC), a "nutrition-sensitive" agricultural information service in Ghana. Using

the Becker-DeGroot-Marschak method (Berry, Fischer, & Guiteras, 2018) to elicit WTP, we explore how gender and framing affect WTP and implied demand. We randomly select an adult male or female from each household and assign them to receive either an agriculture or an agriculture and nutrition-focused marketing script. Using administrative data on active use of the product, we also investigate whether initial WTP predicts later product use.

Overall, our results suggest that individuals' demand for the program is high at low prices. At the monthly market price of 0.5 Ghanaian cedis (GHC) ($US 0.10), 95 percent of individuals would be willing to register for the VFC. However, this drops markedly as the price increases: at 1.0 GHC, 85 percent would register for the service, at 2.0 GHC 53 percent would register, while at 3.0 GHC only 20 percent would register. Emphasizing the nutritional content of the product leads to a small increase in WTP for the VFC service, and women have significantly lower WTP than men at all prices above 1 GHC, with differences concentrated in the Central region. Using pdf lasso techniques, we find that the negative gender gap in WTP in the Central region is concentrated among women who live closer to markets, trust SMS messages on nutrition, met with a community health worker in the previous month, and have some schooling. These women are more likely to have alternative sources of nutrition, health, and agriculture information. Lastly, we find an initial positive relationship between WTP and subsequent use, but this relationship fades over time.

This paper contributes to four main strands of literature. First, it contributes to literature on the use of digital technology in agriculture and health services in developing countries. Studies on digital agriculture initiatives suggest that such services can increase farmers' knowledge in particular areas, but have mixed impacts on other outcomes such as practices, yields, and incomes (Aker et al., 2016; Fabregas et al., 2019; Nakasone, Torero, & Minten, 2014). In the area of health, digital technology services are associated with improvements in disease self-management and treatment compliance (Barnett, Scott, Batchelor, & Haddad, 2016; Stephani, Opoku, & Quentin, 2016), reductions in risky health behaviors (Barnett et al., 2016), and improved breastfeeding practices (Flax et al., 2014; Jiang et al., 2014; Lee et al., 2016). While focusing on impacts, few of these studies in agriculture or health assess individuals' WTP or estimate the price sensitivity of demand, which is crucial for understanding the commercial viability or sustainability of ICT4D initiatives.

More broadly, the paper speaks to the technology adoption literature, especially for technologies that may generate positive externalities (Bryan, Chowdhury, & Mobarak, 2014; Dupas, 2011; Miguel & Kremer, 2004). Respondents in our sample are overwhelmingly willing to pay the market price for agriculture and nutrition information when first introduced to the VFC program, suggesting that true valuations are higher than the market price despite the possibility of nearly costless information sharing. This indicates that respondents either do not fully adjust their valuations to account for the possibility of

information sharing with friends and neighbors, or that respondents internalize the potential benefits to their friends and neighbors from any future sharing of the VFC information.

We also contribute to a growing literature that relates WTP to the subsequent use of products (Ashraf, Berry, & Shapiro, 2010; Berry et al., 2018; Cohen, Dupas, & Schaner, 2015; Dupas, 2014c, 2014a, 2014b; Kremer & Holla, 2009). Charging higher prices could improve markets by improving the sustainability of existing providers, encouraging new suppliers to enter the market, or targeting goods to those individuals and households most likely to use them. Conversely, higher prices may prevent credit constrained or especially poor individuals from getting access to the product, even if it generates a high expected return. Knowledge of these relationships—key for determining whether to offer subsidies, which users to subsidize, and how much subsidy to provide for products and services—is largely absent from the existing literature on ICTs.

Lastly, this paper provides evidence on the existence of gender gaps in agricultural production. Many studies show that plots controlled by men have higher yields than plots controlled by women and attribute the gender gap in production to differences in access to inputs, resources, and services (Croppenstedt, Goldstein, & Rosas, 2013; Udry, 1996). The differences in access are often explained by differences in social norms, property rights, and financial and human capital. However, few studies examine differences in preferences. An exception is Berber and Lambrecht (2019) who examine individual preferences across farming and non-farming activities in Ghana and find that women invest more in non-farm businesses than men. Our paper adds to this literature by showing that women's demand for a nutrition-sensitive agriculture ICT service is lower than men's at most positive prices, highlighting the importance of explicitly considering gender when exploring the screening effects of charging higher prices for access to information.

The remainder of the paper proceeds as follows: Section II introduces the context, ICT intervention being studied, and experimental design; Section III discusses the data and presents baseline summary statistics; Section IV details the empirical strategy; Section V presents the empirical results and Section VI discusses potential threats to our identification strategy. Finally, Section VII discusses potential reasons for the gender gap in WTP in the Central region and Section VIII concludes.

II. Research Context and Experimental Design

A. Context

The study takes place in the Upper West and Central regions of Ghana. A low-middle income country, GDP per capita has risen from just over 263 USD in 2000 to 1,517 USD in 2016.[1] Agriculture contributes 19% of GDP and accounts for 45% of total national employment (World Bank, 2018), with

[1] In 2018 USD.

yams, cassava, and cocoa beans representing the three most important crops in terms of production value (FAO, 2015). While some indicators of malnutrition have decreased substantially over the past decade, undernutrition remains a problem, with 18.8% of children stunted and 42.4% of women anemic (Ghana Statistical Services, Ghana Health Services, & ICF International, 2015). Across the two study regions there are large socio-economic differences, with the Upper West region being poorer, less literate, and having worse diets, but being more engaged in agriculture compared to the Central region (Barnett et al., 2019). While maize is grown in both regions, cocoa and cassava are grown in the Central region and groundnut in the Upper West region. Cocoa is Ghana's most important export commodity and operates under a controlled marketing system (World Bank, 2017).

Government extension agents are an important traditional source of agricultural information, but the ratio of farmers-to-extension agents is high, estimated at 1 agent for every 2000 to 3000 farmers, and actual reach is low due to poor road conditions, inadequate funding, and low levels of access to transportation (McNamara, Dale, Keane, & Ferguson, 2012). Nutrition has not been a central outcome of traditional agricultural extension in Ghana, which also has limited capacity for reaching remote areas and female farmers. Access to nutrition information via formal health services is also low in Ghana. The latest available figures reveal that the number of community health workers (CHW) per 1000 people was just 0.19 in 2008.[2] In 2015 Ghana launched "The Ghana Community Health Worker Programme" aimed to achieve universal health coverage by scaling up the number of CHW, with a goal of 500 people to 1 CHW (Government of Ghana, 2014).

For mobile phones to be a viable platform to reach farmers, a necessary precondition is access to mobile phones. Mobile penetration in Ghana has risen dramatically in the past ten years; according to the Ghana Living and Standards Survey (GLSS Round 6), mobile phone penetration in 2013 was 80 percent, with 70 percent of rural households and 88 percent of urban households reporting that they owned a phone (GLSS 2014). However, access to mobile phones in Ghana varies dramatically by region, socioeconomic status, and gender. According to our baseline survey, only 46.8 percent of females owned a phone (57 percent in the Central region and 37 percent in the Upper West region) compared to 79.6 percent of males (86 percent in the Central region and 74 percent in the Upper West region) (Billings, Gilligan, Hidrobo, Ledlie, & Palloni, 2017). While males and females are equally likely to think that agricultural and nutrition information via text messages is useful (63.2 and 57.5 percent, respectively), there are large regional differences with the Central region finding it more useful than the Upper West region.

[2] https://data.worldbank.org/indicator/SH.MED.CMHW.P3?locations=GH&view=chart

B. Vodafone Farmers' Club (VFC)

The VFC service was a mobile agricultural extension service offering agricultural and nutrition information via voice and SMS to farmers in Ghana. The objective of Vodafone's VFC service was to create and scale commercially sustainable mobile services that enable smallholder farmers to improve their household's nutritional status and increase their productivity. Vodafone began offering the VFC service in May 2015. Smallholder farmers were the primary target for VFC enrolment. The service initially operated in 71 districts of Ghana, which were selected based on network access and crop cultivation patterns to ensure that farmers could receive messages and that content would be relevant to their location and crop choices.

The service package offered to VFC members consisted of a number of components, including weather information (three SMS messages per week on local weather information), market price information (one SMS message per week for a selected crop and market), agricultural and nutrition tips (1-2 recorded voice messages per week with agricultural and nutrition tips) and free access to a call center staffed by agricultural experts. All of the SMS messages were in English, whereas the recorded voice messages were in English or in a local language selected by the VFC member. Overall, individuals received 4 SMS and 1-2 voice messages per week, for a total of 16 SMS and 6 voice messages per month.[3] The service also allowed free calls and SMS with other VFC members (all of whom are on the Vodafone network), as well as discounted SMS and voice to non-VFC members within the Vodafone network. As a result, the service was a bundled intervention that provided digital agricultural and nutrition information, as well as discounted telecommunication services.

The content for the VFC service was provided by Esoko, a digital agricultural information service that has operated in Ghana for over 10 years. The agricultural content included information on planting, cultivation and harvesting tips for particular crops. The nutrition content included crop-specific information on food preparation, food hygiene, safety and storage, and processing, in addition to nutritional information on animal source foods.

The VFC service offered customized information to farmers based on their self-identified preferences. Each new member was profiled by calling the Farmer Helpline and indicating their preferred location for weather and market price information, their preferred language, and their preferred crop. Until profiling was completed, new members were given default profile options based on their district of residence, receiving agriculture and nutrition tips on the crops most widely grown in that district.[4]

[3] 3 agriculture farming tips and 3 nutrition messages are sent via voice message every month.
[4] In general circumstances without the additional assistance provided to treatment farmers in the study, very few farmers call the Farmer help line for profiling.

The VFC service was available through a dedicated Vodafone SIM. While the initial subscription fee was GHC 2 (US$ 0.45) per month, from October 2016 to May 2017, the monthly fee was eliminated to increase take-up of the service. In June 2017, the monthly service fee was reinstated at GHC 0.5. In December 2018, the VFC service was suspended and plans to replace the service with a new revamped service were underway.

C. Marketing interventions and experimental design

At the start of the study, subscriptions to VFC in our intervention area were uncommon, and many individuals had not heard about the service or the price at which it was offered. To encourage adoption of the VFC service, a marketing intervention was delivered to study households. The marketing intervention consisted of door-to-door promotion of the VFC service, with one of two different marketing scripts being read to a targeted individual in the household. Households were randomly assigned to receive either the standard VFC script, which emphasized the potential benefits of the VFC agriculture information (agriculture script) or the standard script with additional information on the potential benefits of the nutrition information (agriculture+ nutrition script) (Appendix A). The individual targeted for the intervention was also randomly assigned to be either the primary adult male or primary adult female in the household.

Randomization occurred at the household level, stratified first at the region level and then within each region stratified by two-person and female-only households.[5] Households with two adults were randomly assigned to either the default agriculture marketing script or the agriculture + nutrition marketing script, and either the primary male or primary female was randomly selected to receive the marketing script and participate in the WTP exercise. Households with only a primary female were randomly assigned to the agriculture script or the agriculture + nutrition script. The marketing interventions were part of a larger randomized control trial to estimate the impact of the VFC service on agriculture and nutrition outcomes (Billings et al., 2017).

D. Measuring WTP

To assess potential demand for the digital agriculture platform, we designed a WTP experiment based on the Becker-DeGroot-Marschak (BDM) method (Berry et al., 2018). The WTP experiment was conducted in treatment households at the end of the baseline household questionnaire. Targeted individuals were introduced to the VFC service through one of the marketing scripts described above and

[5] Adult male-only households were excluded from the broader study because the primary outcome for the overall evaluation was women's dietary diversity.

informed that they may have the chance to register for the service, but that the monthly price and whether they were offered the service would be determined through a game.[6]

After the scripts were read, we measured WTP and registered users using a two-step process (see Appendix B for details). In the first step, we elicited the respondents' WTP for the initial VFC registration (equal to a month subscription) following the method used in Berry et al. (2018). The targeted individual was asked how much they were willing to pay for the VFC service and told that once the bid was finalized, they would not be able to change the amount. We also explained that the bid amount had to be paid on that day, and that if the drawn price was greater than their bid price, then they would not be able to purchase the subscription. After the respondent's bid was recorded, a random price was drawn by the targeted individual using buttons in a cup that represented different prices between 0.2 and 3 GHC. If the individual's bid was greater than or equal to the price drawn, they were offered the product at the randomly drawn price. If the individual's bid was below the price drawn, they were not offered the product. For expected utility maximisers, the optimal strategy is to bid their true valuation for the good. To ensure that the targeted individual understood the exercise, all respondents first practiced the BDM method on a bar of soap before playing for the VFC service.

In the second stage, regardless of the outcome of the first stage, the targeted individual was offered an additional discount and another opportunity to register for the VFC. The targeted individual was not informed about the second stage until after they had completed the first stage procedure. The second stage price discount was introduced as being relative to the randomly drawn first stage price if they won the BDM game, and relative to their bid if they lost the BDM game. To implement the second stage the individual selected a button from the cup, which now contained buttons labelled with the letters A through D. The enumerator entered the letter from the selected button into a tablet, and the final price was revealed. In practice, the second stage price was drawn from a degenerate distribution where the only possible price was 0. The two stages were necessary to first elicit the targeted individual's WTP and then to offer the product for free to all individuals in the treatment group.

E. Registering and activating the service

Individuals who agreed to participate in the VFC service were registered and profiled by enumerators. Registration required either migrating the existing Vodafone phone number of the respondent to VFC or providing the respondent with a new VFC SIM card. When possible, enumerators competed the registration in the respondent's home. Respondents were instructed to check the registration status of their SIM regularly and activate their SIM after it was registered by checking their balance, sending a text message, or making a call. In addition, enumerators collected all the information necessary

[6] Respondents were informed that the monthly price would be between 0 and 3 GHC.

to profile the respondents: language preference, preferred location, preferred markets, and a priority crop for which they would like to receive agricultural tips. The enumeration team used this information to profile the registered individuals.

To increase the likelihood that treatment households activated their VFC subscription, enumerators were sent back to revisit all surveyed households in treatment enumeration areas (EAs) between July and August 2017. The household member initially targeted for the WTP game was located and asked a series of questions about whether they had activated their VFC membership; if not, why; and how they had interacted with the program (if they had activated their VFC registration). Study participants who had not initially registered or activated their VFC membership were assisted through the registration and activation process.

III. Data

A. Data Sources

We rely on three primary datasets for our analysis: 1) baseline household level data; 2) Vodafone administrative data; and 3) Esoko administrative voice call data.

Household Data

The baseline household-level survey was conducted between March and May 2017 and includes the WTP exercise in addition to modules that collected information on demographic characteristics, agricultural production, farming and nutrition knowledge, food security, women's empowerment, and mobile phone usage. In two-person households, a primary male and a primary female were selected[7], and modules on mobile phone usage, market access, and farming and nutrition knowledge were asked separately to both the primary male and primary female. At the end of the baseline survey the randomly selected primary male or female was asked to participate in the WTP exercise.

The baseline data was collected in 5 districts in the Upper West and 5 districts in the Central region of Ghana. The districts were selected based on (1) availability of Esoko market price information for crops, and (2) low FC subscription rates. In each selected district, 20-21 EAs were randomly selected from a list of EAs within a 10-mile radius of a Vodafone cell phone tower. A total of 207 EAs (104 in the treatment arm and 103 in the control arm) are part of the broader study. In this paper, we use data from the 104 treatment EAs where the WTP exercise was conducted. In each EA, 19 or 20 households were randomly sampled. The inclusion criteria into the sample were that households must (1) be a farming

[7] If the household head was male, he was designated as the primary male. If he was married, his first order wife was the primary female. If unmarried, an adult female member who participated in decision making around farming and household expenditure was identified as the primary female. If the household head was female, she was designated as the primary female. If she was married, her husband was identified as the primary male. If unmarried, an adult male who also participated in decision making around farming and housing expenditure was selected as the primary male.

household, (2) own a mobile phone, (3) not be a current member of VFC, and (4) have at least one female member 15-60 years of age. To identify eligible households, a community listing exercise was conducted in selected EAs prior to the baseline survey (see Billings et al. 2017).

We focus our analysis on two-person households in treatment EAs that had an eligible primary male and female respondent. These households qualified for both the framing and targeting interventions. Of the 1,979 households in the treatment EAs, 1,703 households were two-person households. Of these, 86 households did not consent to receive additional information on VFC and therefore did not participate in the WTP exercise. An additional 9 households participated in the first stage of the WTP exercise but were unwilling to participate in the second stage.[8] The final sample included in the analysis consists of the 1,608 two-person households that completed the two-stage WTP exercise.

Each respondent's bid for access to the service in the first stage of the WTP exercise is our measure of WTP. Bids ranged from 0-100 GHC, with 91% equal to or below 3 GHC. To reduce the impact of large outliers, we winsorize the top 5 percent of the distribution, which yields a WTP outcome that ranges from 0-5 GHC. Results are also robust to winsorizing at the 1 percent level (results available upon request).

Vodafone Administrative Data

The second dataset is Vodafone's administrative data that identifies whether study participants are "activated" or on the VFC service in June 2017, September 2017, and each month from December 2017 through April 2018.[9] We create indicators for each month which are equal to one if a respondent had activated their VFC SIM and was still on the service. In order to be on the VFC service in June of 2017, respondents had to incur the additional time and effort cost to activate their SIMs after SIMs had been registered by agents during the baseline survey by checking their balance, making a phone call, or sending an SMS. As mentioned above, we conducted a follow-up visit during which we assisted study participants that had not activated their SIM card to do so in July and August of 2017. The September 2017 rates thus also reflects the extra assistance received from enumerators to activate the VFC service during the follow-up visit, which led to almost universal SIM activation rates. Changes in being on the VFC service after September of 2017 largely are the result of de-activations from respondents who no longer want to be part of the service. As seen in Figure 1, the "activation rates" or the share of respondents on the service increases to around 90 percent after the follow-up survey in September 2017 and then declines to roughly 40 percent by April 2018.

[8] The first row of Table 1 reveals that approximately 6 percent of two-person households did not finish the WTP exercise but this was not significantly different across treatment arms (either male vs female or agriculture vs agriculture+nutrition).
[9] Informed consent to access information on phone usage from mobile network was obtained during the baseline data collection.

Esoko Administrative Data

The third dataset contains administrative data from Esoko Ghana. These data contain information on the outcome of each attempt to send a recorded voice message to the SIMs of study participants. Each month Esoko attempted to send 4-6 unique messages with either agriculture or nutrition tips. Multiple attempts were made to send the same voice message if the targeted SIM card was not successfully reached on the first attempt. The status of each attempt was recorded by Esoko as a hang-up, answered, no answer, voicemail, or disconnected. We have complete data on voice messages starting December 2017, and thus we generate a variable with the share of *unique* voice calls that were answered by each study participant for each month from December 2017 through April 2018.[10] We view this as a good measure of the true dissemination of the information in the voice messages. The median voice call was 35 seconds long, and some were over a minute in length; listening to a full message and being exposed to the information content of the call thus required incurring a non-trivial time cost. As seen in Figure 1, the share of voice messages listened to is low in December 2017 (at around 12 percent) and remains low throughout the study period.

B. Summary statistics

Table 1 displays baseline summary statistics by treatment status and displays two measures of balance for each of the sub-randomizations: the p-value from a t-test of the null hypothesis that there is no difference in means between the two groups, and the normalized difference.[11] Overall, the randomization was successful in creating comparable groups. For the marketing sub-randomization, the normalized differences are small in magnitude: none are above 0.10 in absolute value which is well below the 0.25 threshold suggested by Rubin (2006) as being indicative of imbalance. We also reject the null of no difference for only 1 of the 20 characteristics tested: on average, households in the agriculture script have a larger household size (5.68) than those in the agriculture + nutrition script (5.45).

Male and female targeted-households are also well balanced with respect to household-level characteristics: none of the 8 household-level variables have a normalized difference above 0.10, and only 2 of the primary male and female characteristics have a normalized difference above 0.10. We also reject the null of no difference for only two primary male and female variables—the nutrition knowledge score of the primary male, and the farming knowledge score of the primary female—yet this is roughly what we

[10] We assume missing SIMs from Esoko data means SIM was not activated and receiving messages. Thus we code missing as zeros.

[11] Normalized differences offer a metric that is sample size and scale free, and we therefore use them as our primary measure of balance along with the rule-of-thumb proposed in Imbens and Rubin (2007) that normalized differences below 0.25 in absolute value are indicative of good balance. The normalized difference for characteristic x is defined as $\Delta_x = \frac{\mu_T - \mu_C}{\sqrt{(\sigma_T^2 + \sigma_C^2)/2}}$

should expect to see by chance when we hold gender constant. Treatment arms are also well balanced across regions, with all normalized differences below 0.25 (see Appendix Table C1 and C2).

Progress out of Poverty Index (PPI) scores, which provide a method for mapping 10 household characteristics to the probability that households fall below different national or international poverty lines indicate that around 19 percent of sample households are below 150 percent of the national poverty line in Ghana and 3 percent are living on less than $2.00 per day in 2005 US dollars. Households cultivate, on average, three crops and have an average dietary diversity score (count of the number of food groups they consumed from in the day preceding the survey) of 5.9 out of a possible 12. Approximately 42 percent of households have a Vodafone SIM at baseline. Enumeration areas are approximately 34 minutes from a market and around 74 percent have strong Vodafone network coverage.

There are some important differences between primary males and females in our study sample. Literacy rates and education levels are lower for females than males: 41.2 percent of males are literate and 57.9 percent have some formal education, as compared to just 19.4 percent of females that are literate and 41.9 percent with some formal education. On average, female respondents answered 61 percent of the nutrition knowledge and 54 percent of the farming knowledge questions included in the baseline survey correctly; male respondents answered 56 percent of the nutrition and 58 percent of the farming questions correctly. Assets and mobile phone ownership and access also differ importantly by gender: share of assets solely owned by the primary male is around 68 percent and around 15 percent for the primary female; 42 percent of females report owning and 84 percent report having access to a mobile phone, as compared to 82 percent ownership and 93 percent with access to mobile phones among males.

IV. Empirical Strategy

We begin by plotting the inverse demand for the VFC service at all prices between 0 and 3 GHC. The inverse demand at price p is calculated as the share of individuals i from household h and region r with $WTP_{ihr} \geq p$, or the share of individuals who would be willing to register for the VFC service at price p. We plot the inverse demand curve for all individuals that participated in the WTP exercise and then disaggregate by treatment status, separately displaying the inverse demand for the different marketing scripts and targeted individual. We also plot the difference in demand across the two sub-treatment arms based on the gender of the targeted individual and the marketing script, along with the 95 percent confidence interval from tests of whether the difference is equal to zero. Given the observable differences between the two study regions in terms of farming practices, diets, and access to mobile phones and to the Vodafone service, we disaggregate impacts by region.

In addition to plotting inverse demand curves, we estimate the following specification to explore the impacts of the marketing scripts and gender targeting on WTP for the VFC service, controlling for household characteristics:

$$\mathbf{(1)} \qquad \boldsymbol{WTP_{ihr} = \alpha + X'_{ihr}\beta + \delta nutrition_{hr} + \gamma female_{hr} + C_r + u_{ihr}}$$

Where WTP_{ihr} is the willingness to pay of individual *i* from household *h* and region *r*, measured as their stated bid in the BDM exercise; X_{ihr} is a vector of baseline household characteristics; $nutrition_{hr}$ is an indicator for whether the respondent received the agriculture+nutrition marketing script; $female_{hr}$ is an indicator for whether the female was targeted within the household; and C_r is a stratification indicator for whether the household was in the Central region. Because of random assignment, we can interpret δ as the causal effect of adding the nutrition description on WTP, and γ captures the differential valuation of the VFC service for females, relative to males. Included in the vector of baseline characteristics in the main analyses are household and EA-level controls, such as household size, number of children less than 5 years, the PPI score, normalized value of the total asset index,[12] log value of agriculture production, the household dietary diversity score, an indicator for whether the household had a Vodafone SIM, an assessment of the strength of Vodafone coverage in the EA, and indicators for whether the EA falls into each of the first three quartiles for distance to the nearest market (with the quartile including the most remote EAs left as the omitted category). In some specifications we also include an interaction between whether the targeted respondent was female and whether the household was randomly assigned to receive the nutrition script; the point estimate on this interaction captures whether female respondents differentially value the additional nutrition information. We estimate equation 1 for the full analysis sample and separately by region, and we correct standard errors for heteroscedasticity.

Lastly, we use the Vodafone and Esoko administrative data to investigate whether there are screening effects. Testing for screening effects allows us to assess whether the individuals that would select into participating in the service at different positive prices, would also be differentially likely to use the service. This involves estimating the following specification:

$$\mathbf{(2)} \qquad \boldsymbol{use_{ihr} = \alpha + X_{ihr}'\beta + \delta nutrition_{hr} + \gamma female_{hr} + C_r + \theta WTP_{ihr} + u_{ihr}}$$

where use_{ihr} is a measure of the degree of VFC use—either an indicator for being an active VFC member or the share of voice calls answered. WTP_{ihr} is the individual's WTP as measured during the

[12] Normalized asset index was created by demeaning each total index score by the mean score in the sample and scaling by the standard deviation.

baseline survey, and the other variables are as described above. As WTP is not randomly assigned, estimates of θ include the impact of any unobserved or imperfectly measured determinants of WTP that also influence subsequent use.

V. Results

A. Inverse Demand for VFC

Figure 2 displays the inverse demand curve at all monthly prices between 0 GHC and 3 GHC. The median monthly price that individuals are willing to pay for the service is 2.0 GHC. This is approximately equal to the initial market price VFC charged for the service, even though only a quarter of individuals had heard of the program prior to the survey. Unsurprisingly, the share of individuals who are willing to pay at least as much as price p for the service decreases with price, with considerable bunching at intervals of 0.5 GHC. At 1.0 GHC, the share of individuals willing to pay for the service is 85 percent, whereas at 3.0 GHC the share is just 20 percent.[13] After 3.0 GHC, demand drops dramatically. At the current monthly price of 0.5 GHC, 95 percent of individuals report that they would be willing to pay for the VFC service. This suggests that a temporary price subsidy may not be necessary, as nearly all individuals in our sample would register for the service initially. In contrast, at the initial price charged by Vodafone (2 GHC), only 50 percent of respondents would be willing to participate.

Figures 3 and 4 explore whether there are differences in WTP by marketing and gender. On average, there are no differences in WTP by marketing script: the inverse demand curves for the two groups closely track one another at all prices (Figure 3a) and we never reject that the difference in demand between the two (Figure 3b). This either suggests that respondents are not willing to pay any additional amount to receive the nutrition information in the VFC program, or that the nutrition information is not a primary driver of demand. On the other hand, there are obvious gaps in WTP by gender. At prices between 0 and 1 GHC, a similar share of male and female respondents would be willing to participate in the VFC service; however, at prices above 1 GHC, the inverse demand curve for males lies above the inverse demand curve for females (Figure 4a), and the gap is statistically significant throughout the 1-3 GHC price range (Figure 4b).

To explore differences in WTP by region, we plot the sex-region-specific inverse demand curves (Figure 5a). Demand for the VFC service for females and males in the Upper West region and males in Central region are nearly indistinguishable. Demand for females in the Central region drops substantially more at 1 GHC than it does for the other three groups, and it remains visibly lower at all prices above 1 GHC. Consistent with Figure 5a, the Central region shows a larger female-male gap in demand than the

[13] The inverse demand curve is plotted until a price of 3 GHC, the highest price that could be drawn by the farmer.

pooled results, with a statistically significant difference in demand at all prices above 1 GHC (Figure 5b). The point estimates in the Central region indicate that implied demand for VFC among male respondents is roughly 10 percentage points higher than among female respondents at prices in the 1-3 GHC range. In contrast, there is no significant female-male difference in demand at any price in the Upper West region, and the point estimates are always small (<0.05) in magnitude (Figure 5c).

We next plot the script-region specific inverse demand curves (Figure 6a) and find differences across region. Demand for the VFC service for the agriculture + nutrition script is very similar across the Upper West and Central regions but there are large differences across regions for the agriculture script, with the Upper West region displaying a higher WTP compared to the Central region. In the Central region, the difference in demand across scripts is large and significant. Between 1-3 GHC, the share of farmers purchasing the VFC service for the agriculture +nutrition script is approximately 7 percentage points higher than the share purchasing for the agriculture script, which is significant at the 95 percent level between 2-3 GHC (Figure 6b). In contrast, there is no significant difference in demand across scripts at any price in the Upper West region (Figure 6c).

B. WTP for VFC

Table 2 presents estimates from equation (1). Column (1) shows the estimates for the framing and targeting interventions, controlling only for region fixed effects, while column (2) adds the household and EA level control variables, and column (3) adds an interaction between the "agriculture + nutrition" marketing script indicator and the "female" targeted indicator to explore whether female respondents differentially value the nutrition information. The results in Column 1 are consistent with the relationships shown in Figures 2 and 3: in the specification with limited controls, framing has no impact on WTP for the VFC service, but females have significantly lower WTP. If a female household member is randomly selected, WTP is 0.17 GHC lower, on average, a difference that is statistically significant at the 1 percent level. Adding control variables (column 2) increases the magnitude of the agriculture + nutrition coefficient, making it marginally statistically significant, suggesting that the nutrition marketing increases WTP by 0.11 GHC. The statistically significant and negative association between the female indicator and WTP remains virtually unchanged. In Column 3, the female indicator decreases in size to -0.14 while the interaction between the female targeted indicator and the "agriculture + nutrition" indicator is small in magnitude and not statistically significant, suggesting that females do not differentially value the VFC nutrition information. Across the last two specifications, the only controls that also significantly predict WTP are being from the Central region and a household's dietary diversity score.

Table 3 presents estimates from equation 1 separately for the Upper West (columns 1-3) and Central regions (columns 4-6). Differences in WTP by gender and script are small and not statistically

significant for the Upper West region and large and significant for the Central region. In the Central region, randomly selecting a female household member leads to a WTP that is 0.29 GHC lower, on average, a difference that is statistically significant at the 1 percent level. Similarly, randomly receiving the agriculture + nutrition script leads to a WTP that is 0.26 higher, on average, a difference that is statistically significant at the 1 percent level. Adding household and EA level control variables leads to little change in the coefficients which remain significant at the 5 percent level.

C. Screening Effects: WTP, VFC Activation, and use

Figures 7 and 8 display the coefficient estimates on the WTP measure from equation (2) for each month of data for the full sample and disaggregated by region.[14] Apart from the September 2017 activation rate, Figure 7 finds little correlation between WTP and the share of farmers on the VFC service for the full sample or across regions. Thus, at most WTP is positively correlated with VFC activation in the short-term, with this association fading over time as those households with higher baseline WTP who were more likely to remain in the program 2-3 months after their initial activation begin dropping out at an increasing rate. Females also have significantly lower activation rates than males, a relationship which is concentrated in the Central region (Appendix Table C3 and C4), but the marketing script does not affect activation rates.

In terms of the share of unique voice calls answered, WTP is positively and significantly correlated with the share of voice calls answered in January and February 2018, but after February, the correlation becomes statistically insignificantly different from zero (Figure 8). Females listen to a statistically significantly smaller share of voice messages than males, but only in the months of December and January (Appendix Table C5 and C6), with the female association varying in size and not statistically distinguishable from zero thereafter.

This pattern of a short-term association between WTP and subsequent use which disappears over time could be consistent with several explanations. Individuals with higher WTP may have been more likely to try the VFC service by listening to voice messages in the first few months after receiving access, but then have learned that they did not value the information the service provided and stopped answering the voice calls. Their voice message answer rates would then converge towards the smaller rates of those with lower initial WTP for the service. Alternatively, the expected return to information could be higher during the January and February months of the growing season if critical decisions—for example, when to harvest cocoa plants or how to store or sell harvested cocoa beans in the Central region—need to be made during that time period. Screening effects might then be more pronounced during those months and

[14] We report 90 percent confidence intervals in Figures 7 and 8, consistent with one-sided tests of the null hypothesis that WTP has no effect on VFC activation or use, against the alternative hypothesis that higher WTP is associated with higher probability of activation or use.

smaller or even not present during time periods where the expected return to information, including for higher WTP individuals, is lower.

VI. Threats to Identification

The main results suggest that adding nutrition information to the VFC marketing script leads to a marginal increase in WTP while females are significantly less likely to be willing to participate in the service at all prices above 1 GHC. There are several potential threats to our interpretation of these findings. First, the WTP results could, in part, be driven by the modified BDM design that we used to elicit individual WTP for the first month of VFC service. This modified BDM design—which added a second stage price discount to ensure all participating individuals would receive access to the service for free—could compromise the incentive compatibility of the BDM mechanism. While the second stage offer occurred after the initial BDM game that generates the WTP measure for all respondents, if individuals surveyed earlier shared information about the second stage price discount with their friends and neighbors who were visited later, it could have affected their incentive to report their true WTP for VFC. Second, as with any data collection activity, it is possible that enumerator characteristics could impact individual WTP. Third, by requiring respondents to show that they could pay their bid amount for the first month of VFC service, the elicited WTP could be affected by liquidity constraints and therefore reflect ability-to-pay as opposed to willingness-to-pay. We address each of these potential threats below.

To explore whether the spread of information regarding the second stage price discount had any impact on our WTP estimates, we use data on the interview order within each EA. Fieldwork in each EA typically took 1-2 days and for all 104 treatment EAs we can identify the time and date of the baseline interview and classify households by whether they were interviewed in the first or second half of the fieldwork in that EA. If relevant, we should expect the spread of information to have a larger impact on stated WTP for those households that were surveyed later, potentially generating a difference in WTP over time. To test this, we calculate the difference in inverse demand between early and late surveyed households at each price between 0 and 3 GHC by regressing the indicator for whether each individual would be willing to participate in the service ($1\{WTP_{ihr} \geq p\}$) on an indicator for whether the household was interviewed during the first half of field work in their EA. Appendix Figure D1 displays these results. At no price between 0 and 3 GHC are the inverse demand curves statistically significantly different for "early" and "late" respondents. Further, the point estimates always have a magnitude smaller than 0.02 in absolute value, suggesting that—at most—there is a 2-percentage point difference in the share of households that would purchase at any price. The evidence therefore does not support the idea that the spread of information about the second stage price randomization influenced respondent's stated WTP for VFC.

To test whether enumerator characteristics could be driving the variation in elicited WTP, we plot two versions of the range of inverse demand curves across enumerators at each price between 0 and 3 GHC. For each enumerator, we calculate the share of individuals that they interviewed in treatment villages that would be willing to register for the VFC service at each price. We then identify the minimum share and the maximum share at each price to generate bounds on the overall share of households that would purchase. Similarly, we identify the enumerator with the 3rd highest share and the 3rd lowest share at each price to generate bounds that can be interpreted as a 90 percent interval for the overall share that would purchase.[15] Because enumerators only completed between 28 and 63 household surveys in treatment villages, both sets of bounds based on enumerator-specific inverse demand curves are noisy. Still, they provide useful information about the likelihood that enumerator characteristics impacted stated WTP. Appendix Figure D2a presents these min-max bounds on the inverse demand curve, together with the inverse demand curve for the full sample while Appendix Figure D2b does the same for the enumerator-specific 90 percent confidence interval.

Though the bounds are quite wide—beginning around a monthly price of 0.5 GHC the difference between the minimum and maximum share exceeds 0.3—the min-max bounds in Figure D2a still clearly illustrate the same pattern as the overall inverse demand curve. A high fraction of households would be willing to register at monthly prices below 0.5 GHC, while few would be willing to register at monthly prices above 2.0 GHC. Unsurprisingly, the 90 percent bounds are substantially narrower and track the overall mean share that would purchase at each price quite closely. For example, at the current monthly price of 0.5 GHC, even the lower bound of the 90 percent interval indicates that over 80 percent of individuals would register for the VFC. The results therefore do not appear to be overly sensitive to the enumerator conducting the fieldwork.

Because we required respondents to be able to pay the amount of their bid during the interview, subjects facing short-term liquidity constraints could have stated a WTP less than their true WTP. This would suggest that our measures are a lower bound on true WTP. That is, if anything, *more* than 95 percent of households would register for the service at the current monthly price, further reinforcing the conclusion that initial price subsidies may not be necessary to get households to experience the VFC service. Further, given respondents' spending patterns on airtime, we do not believe that liquidity constraints are a relevant issue for most of the sample. The maximum random price draw of 3 GHC is just 33 percent of the mean monthly spending on airtime in a typical month for female respondents and less than 14 percent for males. For households where we collected mobile phone usage information from both the primary female and the primary male, 3 GHC represents 9.5 percent of total monthly airtime in a

[15] With 40 total enumerators the 3rd and 37th highest shares contain the central 90% of the enumerator-price specific shares.

typical month. While high monthly expenditures on mobile airtime certainly do not preclude the existence of short-term liquidity constraints, they do emphasize how small the immediate cash requirement was, decreasing the likelihood that the liquidity constraint was binding for participating individuals. In Table 3, we also find no relationship between stated WTP and the household PPI score. Under the assumption that liquidity constraints are more likely for less wealthy households (those with lower PPI scores), we would expect to find an important positive correlation between WTP and PPI score if liquidity constraints were important for the sample.

VII. Exploring the Gender Gap in Demand

There are many potential explanations for why female respondents were willing to pay less for the VFC service than male respondents. While the random selection of a male or female respondent from each two-adult household ensures that household-level characteristics are balanced across the two treatment arms, male and female *individuals* differ from one another in various ways as seen in Table 1. These differences and how they relate to demand for agricultural and nutrition information services are of interest both for policy and broader learning-related purposes.

To identify the characteristics that are predictive of the WTP gender gap, we explore different ways of selecting the control variables included in the X_{ihr} matrix of equation (1). We conduct our analysis in the Central region only, where the gender gap is concentrated. To begin, we add individual-level baseline co-variates that we expect to be correlated with both WTP and respondent gender. Given that the assignment of households to a gender sub-treatment was random, household-level characteristics should be balanced and not correlated with the gender of the respondent; however, individual-level characteristics could still be related to both respondent gender and WTP, and therefore their inclusion could affect the estimated relationship between the female indicator and WTP. Second, we implement the post-double-selection Lasso (pds lasso) estimator of Belloni et al. (2014) to select from the high dimensional set of possible controls. Under a sparsity assumption—that controlling for relatively few, unknown characteristics is sufficient to reduce the size of any bias to the point of ignorability—pds lasso allows for inference about a treatment indicator while considering a high-dimensional set of potential controls whose dimensionality exceeds the sample size. As the name suggests, pds lasso relies on penalized regression methods to select two sets of controls: characteristics that are associated with whether the randomly selected respondent is female and characteristics that are predictive of WTP. The final estimate is then based on OLS using the union of controls identified in these two steps. We

implement pds lasso restricting the set of controls considered to all first and second-order terms excluding interactions with the female indicator and then again after allowing for interactions.[16]

Table 4 presents the results of these exercises. Column 1 presents results from OLS regressions that control for household and individual level variables that we identified as being likely correlates of both WTP and whether the respondent was female. Adding individual controls increases the gender gap to -0.34. Interestingly, the share of assets owned by the respondent and meeting with a community health worker is negatively associated with WTP for the service, while farming knowledge is positively associated with WTP. Column 2 presents the pds lasso results when considering the full set of possible first- and second-order terms for an extended set of household and individual level variables relative to those included in column 1. Of the 390 characteristics included in the potential set of controls for pds lasso, 14 are identified in one of the two selection models and therefore included in the final OLS specification. The gender gap in WTP remains similar in the pds lasso specification, and if anything, increases in magnitude to -0.35.

Columns 3 adds interactions between the controls included in column 2 and the indicator for whether the household was assigned to the female treatment arm. Of the 726 variables included in the potential set of controls with interactions, 42 are selected. The point estimate on being female is now positive (0.61) and not statistically significant. Several of the selected female interactions are significant in the final OLS specification; the squared value of HDDS, indicators for being in the first and second quartiles of distance to the market, whether the respondent has any formal schooling, whether the respondent trusts SMS nutrition information, and whether the respondent met with a health worker in the past three months – each interacted with an indicator for female. The interactions between the female indicator and indicators for distance, having any formal education, trusting SMS information on nutrition, and having met with a health worker are all negative suggesting that these characteristics each decrease a female's WTP. This could plausibly be a result of female demand for new information being more elastic to alternative information sources or simply indicative of these female sub-groups having better access to other sources of information. Though only suggestive, this points towards the gender gap in WTP potentially being driven by heterogeneity across genders in the crowding out of demand for the service from access to alternative nutrition and agriculture information.

[16] Forcing the OLS specification to include all first- and second-order interactions, even without also allowing for interactions between the controls and the female indicator, quickly exhausts the available degrees of freedom (there are 390 potential controls) and yields extremely imprecise estimates for all variables. Additionally allowing for interactions with the female indicator results in 726 potential controls, rendering the estimates even more imprecise and uninformative.

VIII. Conclusion

In this paper we use a variant of the BDM method to elicit a farmers' willingness-to-pay for a nutrition-sensitive agriculture information service—the Vodafone Farmers' Club (VFC)—among farming households in rural Ghana. We find that participating individuals are overwhelmingly willing to pay the monthly price for the service: nearly 95 percent of respondents stated a WTP of at least 0.5 GHC. This suggests that temporary initial price subsidies may not be necessary to ensure that potential beneficiaries experience the service in our context. The share of farmers willing-to-pay for VFC service decreases rapidly as the price increases. At 1.0 GHC, 85 percent would register for the service; at 2.0 GHC 50 percent would register; and at 3.0 GHC, just 20 percent would still be willing to register.

Farmers' demand for the VFC service depends on the marketing script and whether the targeted individual is female. In particular, when nutrition is added to the marketing script, farmers are more willing to pay for the service, but women are less willing to pay for the service than men. The gender gap in WTP and the nutrition premium is concentrated in the Central region. Using pdf lasso techniques, we find that the negative gender gap in WTP in the Central region is concentrated among women who live closer to markets, trust SMS messages on nutrition, met with a community health worker in the previous month, and have some schooling. These women seem more likely to have alternative sources of nutrition, health, and agriculture information.

We link WTP estimates with administrative data on the activation rates of the VFC service and the share of voice calls answered to explore whether individuals who are willing to pay more for the service are subsequently more likely to use the service. The results suggest that respondents with higher WTP are initially more likely to use the VFC service, but this fades quickly over time and even the initial differences in use are small in magnitude. Thus, there may be some initial trade-off for policy makers with respect to making the service available at a lower price and ensuring that the individuals who are sent the content use the information they receive, but this small, short-term screening effect is dominated by the increase in access to the information that would be generated through lower prices.

From the standpoint of identifying a price that enables the operating organization to recover some of their costs while still reaching as many interested farmers as possible, the results suggest that small positive monthly prices (between 0-1 GHC) for the VFC service are not likely to substantially decrease demand. At the price of 0.5 GHC, Vodafone needed around 200,000 subscribers to have an internal rate of return greater than zero (Barnett et al., 2019). While Vodafone was able to initially reach 200,000 subscribers, they were not able to sustain these numbers, and the service was eventually suspended, in December 2018. Thus, beyond ensuring a price that subscribers are initially willing to pay, it is also important to ensure that the content is up-to-date, dynamic, and relevant so that subscribers continue to pay the fee or that the service has the capacity to continuously reach new clients overtime.

There are several limitations to our study that are worth noting. The first is that although we find high demand for the VFC service at the market price of 0.5 GHC, take-up of the program outside our study area is much lower. One possible reason for such high WTP in our sample is that our intervention included door-to-door marketing of the service, which is much more intense marketing than the typical Vodafone promotional campaigns involving community-level events or asking marketing agents to stand on street corners and search for new customers. Moreover, we elicited WTP after spending two hours with farmers asking them questions related to their farming. This could have increased interest and WTP for the service relative to the situation where VFC is offered with little or no prior face-to-face interaction. Second the VFC service was a bundled service that offered discounted calling and SMS rates in addition to agriculture and nutrition information. We are not able to disentangle farmer's WTP for the agriculture and nutrition information from the discounted telecommunication services. However, we are able to disentangle the premium individuals are willing to pay for the nutrition information and can conjecture that the premium for the agriculture information would be at least as large as the nutrition information.

Despite these limitations, our findings hold several lessons for policy makers and the private sector. First, when faced with strong marketing campaigns that include face-to-face interaction, farmers are willing to pay small positive prices for access to an ICT focused on agriculture and nutrition. Second, there are large gender differences in demand for ICT services and subsequent use, with women having lower WTP and being less likely to use the service than men. Thus, services that wish to target women need to take these differences into account and find ways to make the service more attractive to female farmers. Third, while individuals with a higher WTP for the ICT are more likely to use the service initially—providing some evidence of a short-term screening effect—this association fades over time. This suggests that reducing prices may not importantly change the likelihood that individuals who selected into registering for the program actually listen to the information provided, at least in the medium- to long-term. Fourth, although farmers are initially willing to pay low prices for an ICT focused on agriculture and nutrition, they will likely not be willing to continually pay for the service if the information provided is not easily accessible, relevant, dynamic, and up-to-date. Therefore, while mobile based agricultural advisory services can be financially stable under certain circumstances, if farmers are not actively using the service, it may not be effective as a standalone channel for providing information and changing behavior. The challenge for policy makers and the private sector is thus to create a service that farmers are willing to pay for and use on a continuous basis in order to effectively improve agriculture and nutrition outcomes.

References

Aker, J. C., Ghosh, I., & Burrell, J. (2016). The promise (and pitfalls) of ICT for agriculture initiatives. *Agricultural Economics*, *47*(S1), 35–48. https://doi.org/10.1111/agec.12301

Ashraf, N., Berry, J., & Shapiro, J. M. (2010). Can Higher Prices Stimulate Product Use? Evidence from a Field Experiment in Zambia. *American Economic Review*, *100*(5), 2383–2413.

Barnett, I., Batchelor, S., Faith, B., Gilligan, D., Gordon, J., Hidrobo, M., … Scott, N. (2019). *External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and South Asia: Final Ghana mixed methods evaluation report*.

Barnett, Inka, Scott, N., Batchelor, S., & Haddad, L. (2016). *Dial " N " for Nutrition ? A Landscape Analysis of what we know about m-Nutrition, m-Agriculture and m-Development* (IDS Working Paper No. 481).

Belloni, A., Chernozhukov, V., & Hansen, C. (2014). Inference on Treatment Effects after Selection among High-Dimensional Controls. *The Review of Economic Studies*, *81*(2), 608–650.

Berry, J., Fischer, G., & Guiteras, R. (2018). *Eliciting and Utilizing Willingness-to- Pay : Evidence from Field Trials in Northern Ghana*. *Center for Environmental and Resource Economic Policy* (Vol. 18–016).

Billings, L., Gilligan, D., Hidrobo, M., Ledlie, N., & Palloni, G. (2017). *External evaluation of mobile phone technology-based nutrition and agriculture advisory services in Africa and Ghana : Quantitative Baseline Report*. Washington D.C.

Bryan, G., Chowdhury, S., & Mobarak, A. M. (2014). Underinvestment in a Profitable Technology: The Case of Seasonal Migration in Bangladesh. *Econometrica*, *82*(5), 1671–1748.

Cohen, B. J., Dupas, P., & Schaner, S. (2015). Price Subsidies , Diagnostic Tests , and Targeting of Malaria Treatment : Evidence from a Randomized Controlled Trial, *105*(2), 609–645.

Croppenstedt, A., Goldstein, M., & Rosas, N. (2013). Gender and agriculture: Inefficiencies, segregation, and low productivity traps. *World Bank Research Observer*, *28*(1), 79–109. https://doi.org/10.1093/wbro/lks024

Cui, Z., Zhang, H., Chen, X., Zhang, C., Ma, W., Huang, C., … Lu, J. (2018). Pursuing sustainable productivity with millions of smallholder farmers. *Nature*, *555*, 363–366. https://doi.org/10.1038/nature25785

Dupas, P. (2011). Health Behavior in Developing Countries. *Annual Review of Economics*, *3*, 425–449.

Dupas, P. (2014a). Getting essential health products to their end users: Subsidize, but how much? *Science*, *345*(6202), 1279–1282.

Dupas, P. (2014b). *Global Health Systems : Pricing and User Fees*. (A. J. Culyer, Ed.), *Encyclopedia of Health Economics* (Elsevier, Vol. 2). San Diego.

Dupas, P. (2014c). Short-run subsidies and long-run adoption of new health products: evidence from a field experiment b. *Econometrica*, *82*(1), 197–228. https://doi.org/10.3982/ECTA9508

Fabregas, R., Kremer, M., & Schilbach, F. (2019). Realizing the Potential of Digital Development: The Case of Agricultural Advice. *Science*, *Forthcomin*, 1–21.

FAO. (2015). *Country Fact Sheet on Food and Agriculture Policy Trends: Ghana. Food and Agriculture Policy Decision Analysis*. Rome.

Flax, V. L., Negerie, M., Ibrahim, A. U., Leatherman, S., Daza, E. J., & Bentley, M. E. (2014). Integrating Group Counseling, Cell Phone Messaging, and Participant-Generated Songs and Dramas into a Microcredit Program Increases Nigerian Women's Adherence to International Breastfeeding Recommendations. *Journal of Nutrition*, *144*(7), 1120–1124. https://doi.org/10.3945/jn.113.190124

Ghana Statistical Services, Ghana Health Services, & ICF International. (2015). *Ghana Demographic and Health Survey 2014*. Rockville, Maryland.

Government of Ghana. (2014). *Government of Ghana: National Community Health Worker (CHW) Program*. Accra.

Jensen, R. (2007). The digital provide: Information (technology), market performance, and welfare in the south Indian fisheries sector. *Quarterly Journal of Economics*, *CXXII*(3), 879–924.

Jiang, H., Li, M., Wen, L. M., Hu, Q., Yang, D., He, G., … Qian, X. (2014). Effect of short message service on infant feeding practice: findings from a community-based study in Shanghai, China. *JAMA Pediatr*, *168*(5), 471–478. https://doi.org/10.1001/jamapediatrics.2014.58

Kramer, B., & Lambrecht, I. (2019). *Gender and preferences for non-farm income diversification: A framed field experiment in Ghana*.

Kremer, M., & Holla, A. (2009). Pricing and Access: Lessons from Randomized Evaluations in Education and Health. In W. Easterly & J. Cohen (Eds.), *What Works in Development? Thinnking Big and Thinking Small*. Washington, D.C.: Brookings Institution Press.

Lee, S. H., Nurmatov, U. B., Nwaru, B. I., Mukherjee, M., Grant, L., & Pagliari, C. (2016). Effectiveness of mHealth interventions for maternal, newborn and child health in low– and middle–income countries: Systematic review and meta–analysis. *Journal of Global Health*, *6*(1).

McNamara, P., Dale, J., Keane, J., & Ferguson, O. (2012). *Strengthening pluralistic agricultural extension in Ghana*.

Miguel, E., & Kremer, M. (2004). Worms: Identifying impats on education and health in the presence of treatment externalities. *Econometrica*, *72*(1), 159–217.

Nakasone, E., Torero, M., & Minten, B. (2014). The Power of Information: The ICT Revolution in Agricultural Development. *Annual Review of Resource Economics*, *6*, 533–550.

Rubin, D. (2006). *Matched sampling for causal effects*. Cambridge University Press.

Stephani, V., Opoku, D., & Quentin, W. (2016). A systematic review of randomized controlled trials of mHealth interventions against non-communicable diseases in developing countries. *BMC Public Health*. https://doi.org/10.1186/s12889-016-3226-3

Udry, C. (1996). Gender, Agricultural Production, and the Theory of the Household. *Journal of Political Economy*, *104*(5), 1010. https://doi.org/10.1086/262050

World Bank. (2016). *World Development Report 2016: Digital Dividends*. Washington, D.C.: World Bank.

World Bank. (2017). *Ghana Agriculture Sector Policy Note: Transforming Agriculture for Economic Growth, Job Creation and Food Security*. Washington, D.C.

World Bank. (2018). *World Development Indicators Online*. Washington, D.C.

Figure 1: Share of farmers on the VFC service and share of voice calls answered

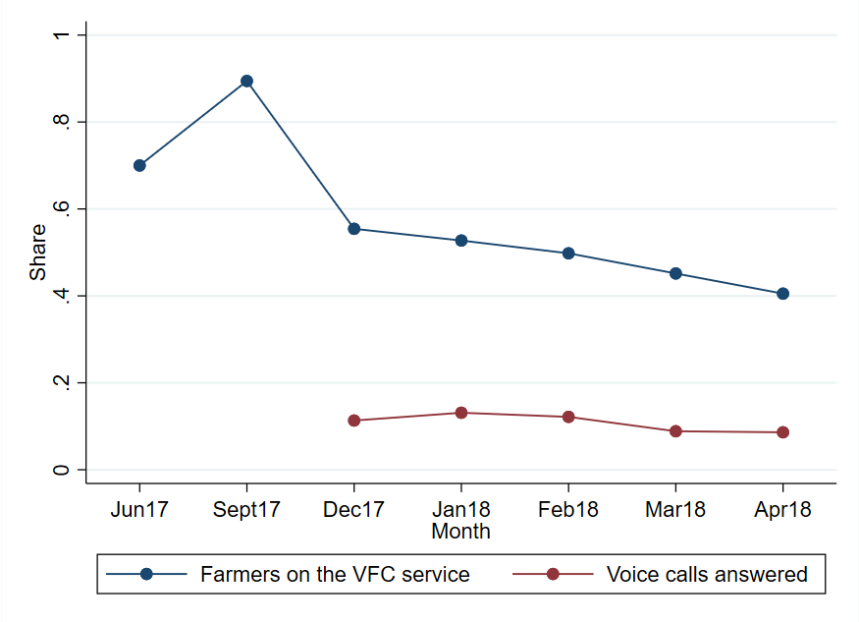
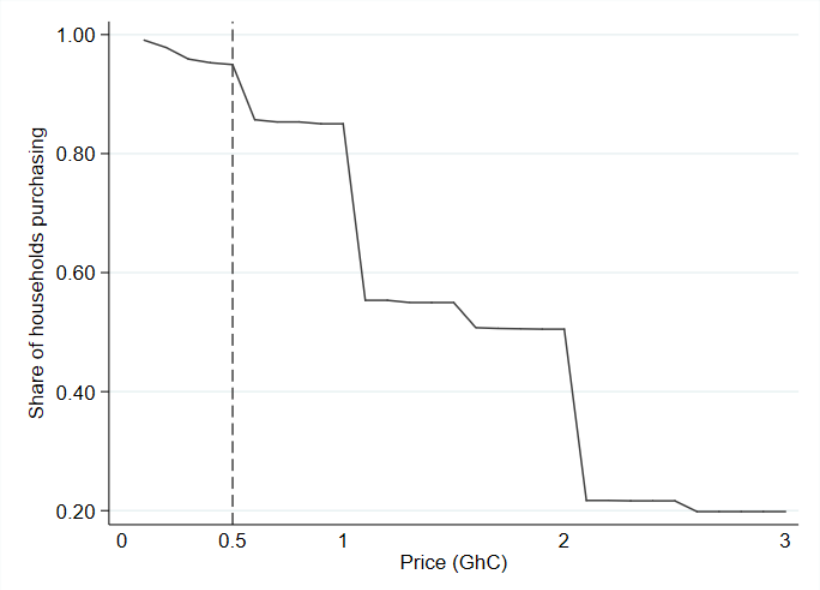


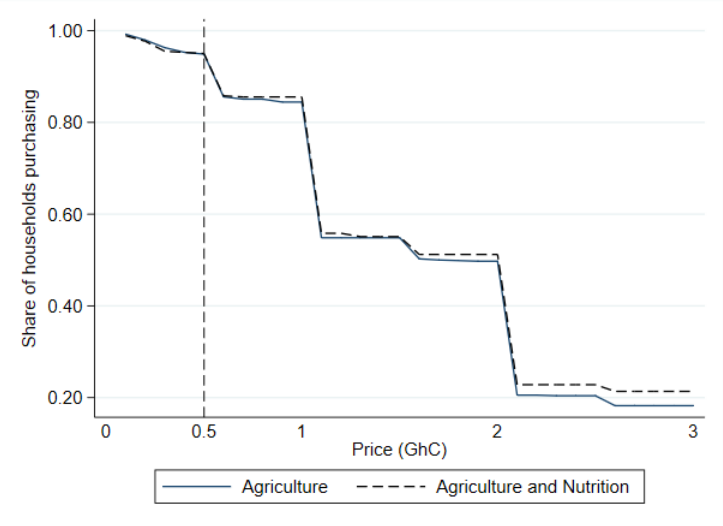
Figure 2: Inverse Demand Curve for Vodafone Farmers' Club service



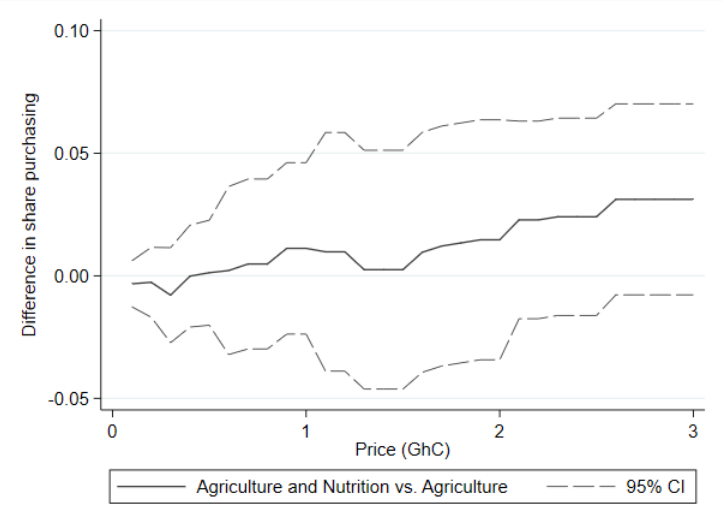
Notes: Figure 2 plots the share of sample respondents that would be willing to register for the Vodafone Farmers' Club (VFC) at prices between 0 and 3 GHC. At each price, respondents are categorized as being willing to register for the VFC if their WTP elicited through the BDM exercise is greater than or equal to the price being considered. A horizontal dashed line is also shown at the monthly market price of the VFC.

Figure 3: WTP and VFC Framing

Panel A: Inverse Demand for the VFC service by framing treatment arm



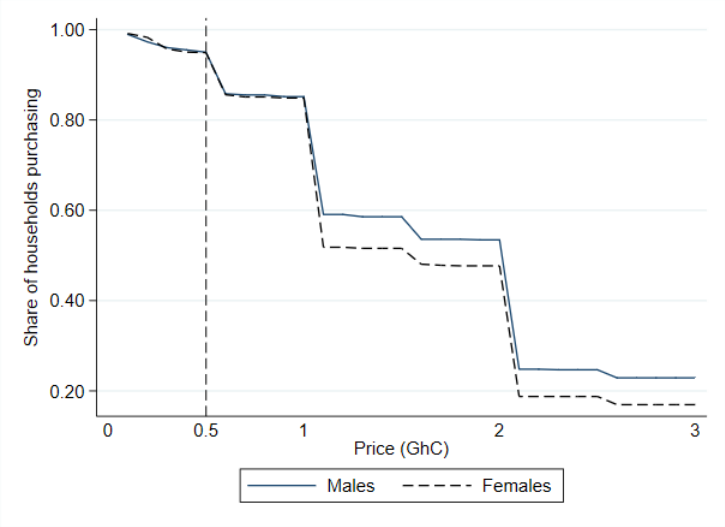
Panel B: Difference in share purchasing by framing treatment arm



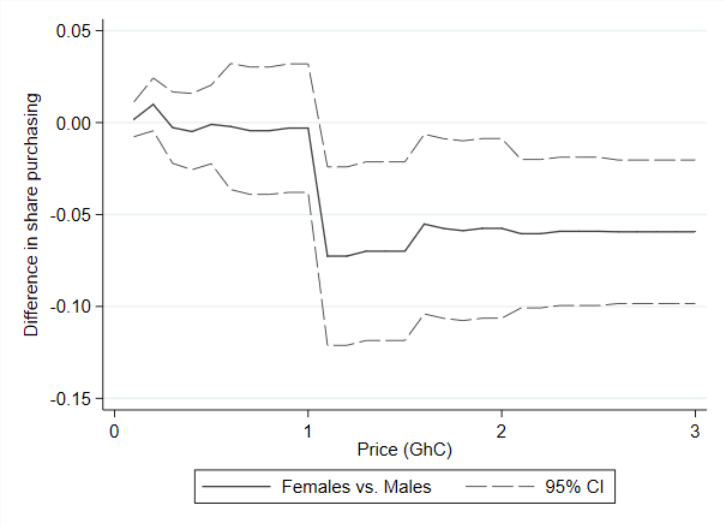
Notes: Figure 3a plots the share of sample respondents that would be willing to register for the Vodafone Farmers' Club (VFC) at prices between 0 and 3 GHC separately by whether they were randomly assigned to receive the agriculture VFC marketing script or the agriculture and nutrition VFC marketing script. At each price, respondents are categorized as being willing to register for the VFC if their WTP elicited through the BDM exercise is greater than or equal to the price being considered. A horizontal dashed line is also shown at the current monthly market price of the VFC. Figure 2b plots the difference in the share of respondents that would be willing to register for the VFC at each price between those in the agriculture marketing arm and those in the agriculture and nutrition marketing arm (as a solid line) and the 95% confidence interval from a test of whether the difference is equal to zero. The difference and confidence interval are based on regressions of an indicator for whether respondents would register at each price between 0.1 GHC and 3.0 GHC (at increments of 0.1 GHC) on an indicator for whether the respondent was randomly assigned to the agriculture and nutrition marketing script with heteroskedasticity robust standard errors.

Figure 4: WTP and Respondent Gender

Panel A: Inverse demand for the VFC service by gender



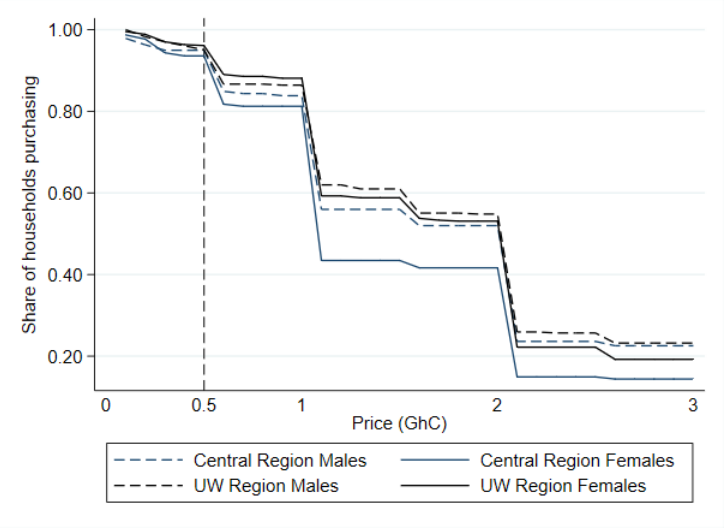
Panel B: Difference in share purchasing by gender



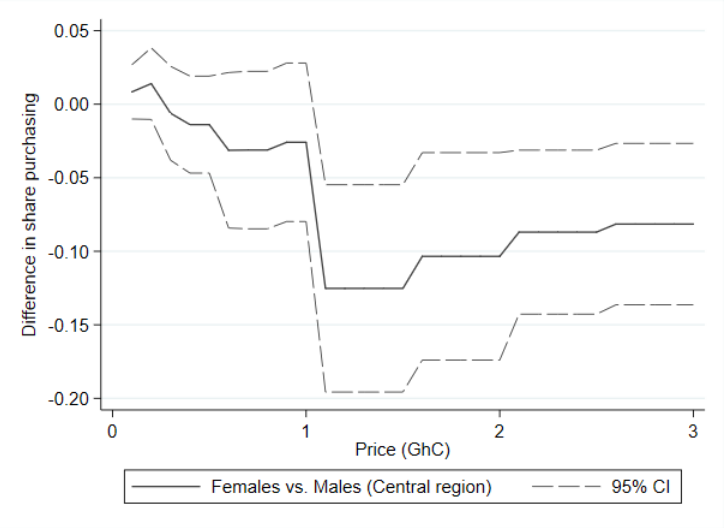
Notes: Figure 4a plots the share of sample households that would be willing to register for the Vodafone Farmers' Club (VFC) at prices between 0 and 3 GHC separately by whether they were randomly assigned to the female targeted arm or the male targeted arm. At each price, respondents are categorized as being willing to register for the VFC if their WTP elicited through the BDM exercise is greater than or equal to the price being considered. A horizontal dashed line is also shown at the current monthly market price of the VFC. Figure 3b plots the difference in the share of respondents that would be willing to register for the VFC at each price between those in the female targeted arm and those in the male targeted arm (as a solid line) and the 95% confidence interval from a test of whether the difference is equal to zero. The difference and confidence interval are based on regressions of an indicator for whether the respondent would register at each price between 0.1 GHC and 3.0 GHC (at increments of 0.1 GHC) on an indicator for whether the respondent was randomly assigned to the female targeted arm with heteroskedasticity robust standard errors.

Figure 5: WTP by respondent gender and region

Panel A: Inverse Demand for the VFC service by respondent gender and region



Panel B: Gender differences in share purchasing, Central Region



Panel C: Gender differences in share purchasing, Upper West Region

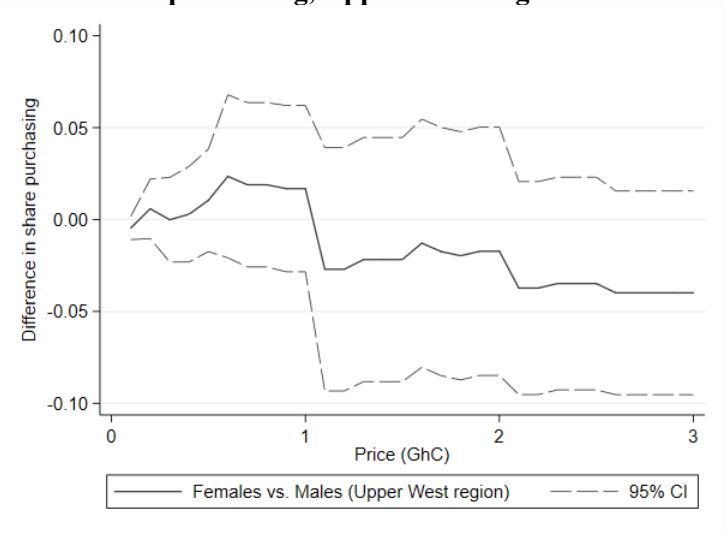
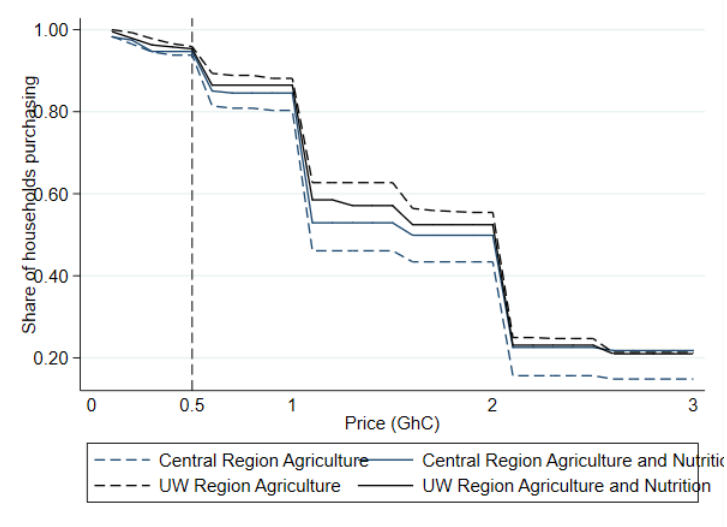
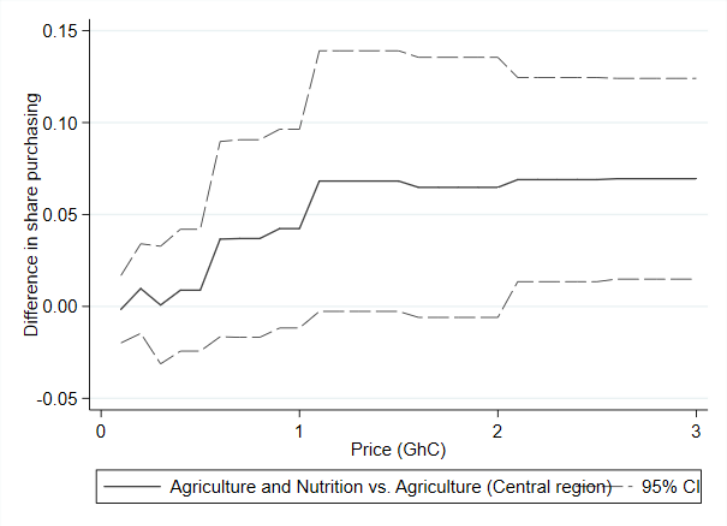


Figure 6: WTP by Script and Region

Panel A: Inverse Demand by Script and Region



Panel B: Marketing differences in share purchasing, Central Region



Panel C: Marketing differences in share purchasing, Upper West Region

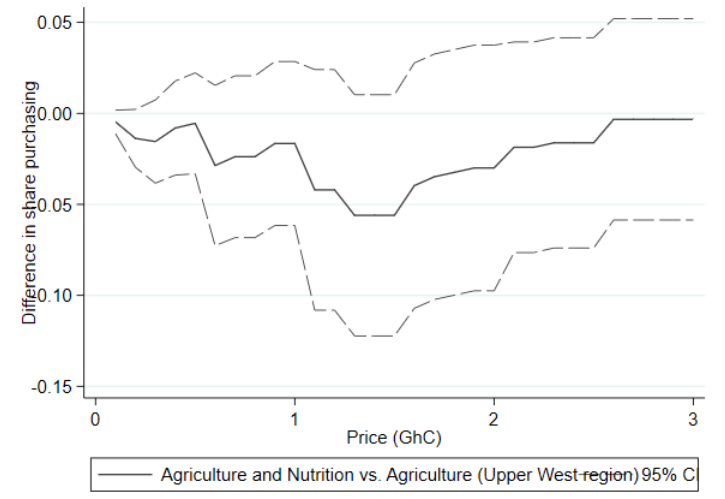


Figure 7: Association between WTP and share of farmers on the VFC service over time

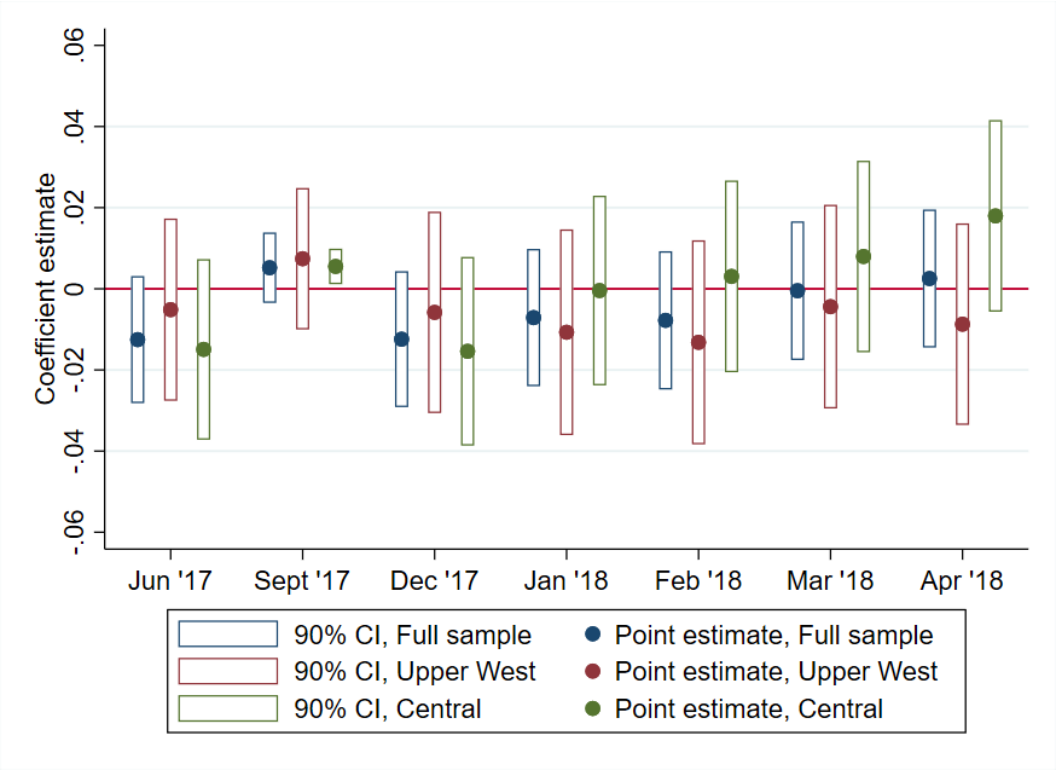


Figure 8: Association between WTP and the share of voice calls answered

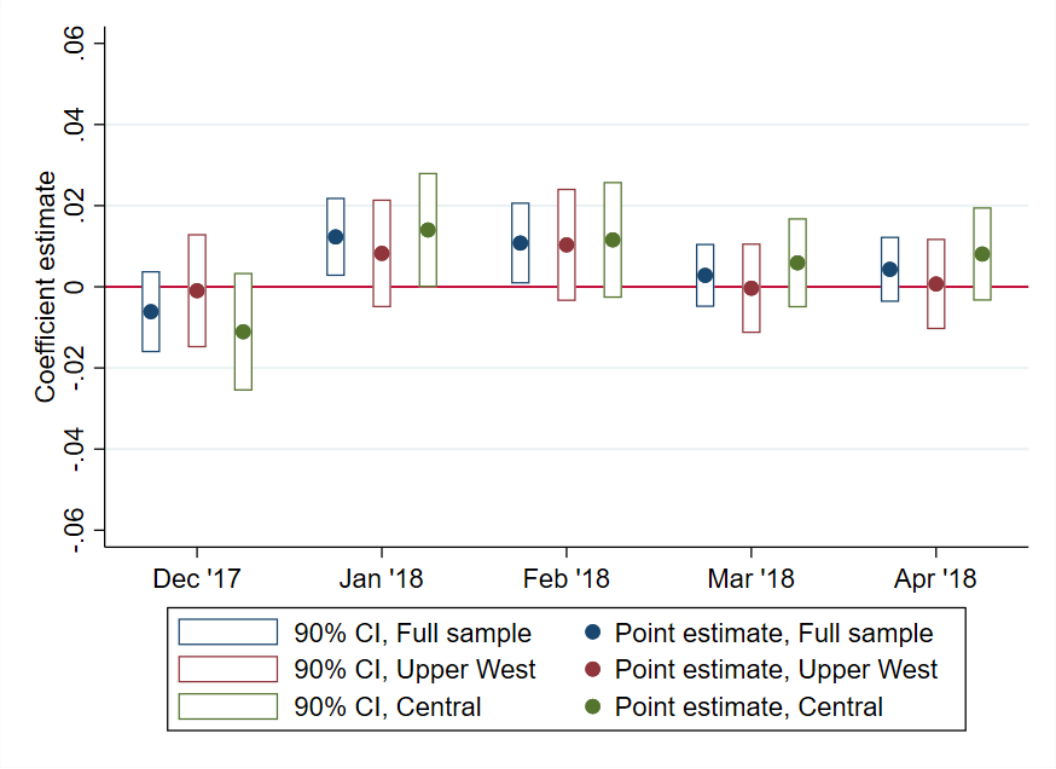


Table 1: Summary statistics, by treatment status

		Script randomization				Gender randomization			
	N	Ag script	Ag+Nut script	Norm. diff.	P-Value	Male targeted	Female targeted	Norm diff.	P-Value
Attrition									
Did not consent or finish WTP exercise	1,703	0.06	0.06	0.00	0.95	0.05	0.06	0.06	0.21
Household level Characteristics									
Household size	1,608	5.68	5.45	-0.10	0.05	5.60	5.53	-0.03	0.54
Number children under 5	1,608	0.63	0.66	0.04	0.37	0.65	0.65	-0.00	0.94
Total PPI score	1,608	59.56	60.80	0.09	0.08	60.29	60.10	-0.01	0.79
Household total asset index	1,608	0.12	0.09	-0.03	0.50	0.11	0.10	-0.02	0.72
Total value of production (GhC)	1,568	3,820.25	3,753.70	-0.01	0.87	3,903.98	3,674.88	-0.03	0.56
Number of crops cultivated	1,589	3.11	3.06	-0.04	0.44	3.11	3.06	-0.04	0.47
Household Dietary Diversity Score (1-12)	1,528	5.98	5.86	-0.07	0.17	5.89	5.95	0.03	0.50
Household has a Vodafone SIM card	1,608	0.43	0.41	-0.05	0.32	0.42	0.42	-0.01	0.86
Primary male and female characteristics									
Primary Female has some education	1,560	0.39	0.44	0.09	0.07	0.41	0.43	0.04	0.43
Primary Male has some education	1,515	0.57	0.59	0.03	0.52	0.59	0.57	-0.03	0.51
Primary female is literate	1,560	0.18	0.21	0.06	0.21	0.19	0.20	0.03	0.56
Primary male is literate	1,515	0.41	0.41	-0.01	0.83	0.41	0.42	0.02	0.75
Share of assets owned solely by primary female	1,470	0.16	0.16	0.00	0.97	0.15	0.16	0.07	0.19
Share of assets owned solely by primary male	1,470	0.67	0.68	0.05	0.34	0.68	0.67	-0.03	0.57
Primary female nutrition knowledge, % correct	1,561	60.79	59.85	-0.06	0.22	59.70	60.86	0.08	0.13
Primary male nutrition knowledge, % correct	1,515	55.72	55.31	-0.03	0.62	54.28	56.82	0.16	0.00
Primary female farming knowledge, % correct	1,561	54.27	54.51	0.01	0.78	53.38	55.30	0.11	0.03
Primary male farming knowledge, % correct	1,514	58.03	58.70	0.04	0.45	58.04	58.73	0.04	0.44
Primary female owns a mobile phone	1,562	0.42	0.42	-0.01	0.89	0.43	0.42	-0.01	0.84
Primary male owns a mobile phone	1,515	0.82	0.81	-0.01	0.83	0.83	0.81	-0.05	0.32
Enumeration area characteristics									
Strong Vodafone network coverage	1,608	0.72	0.76	0.08	0.11	0.72	0.76	0.07	0.15
Distance to market (minutes)	1,608	34.52	32.75	-0.08	0.12	32.93	34.25	0.06	0.25

Notes: Estimates are from the mNutrition Ghana Baseline Survey Encouraged Group, two person sample. Normalized difference is the difference in means between the two groups scaled by the average of the within group standard deviations. P-value is from the test of difference of means between the relevant treatment groups.

Table 2: Impact of framing and targeting on WTP

Dependent variable=WTP	(1)	(2)	(3)
Female targeted	-0.167	-0.164	-0.136
	(0.061)***	(0.061)***	(0.084)
Agriculture and nutrition script	0.083	0.109	0.137
	(0.061)	(0.061)*	(0.090)
Central region	-0.095	-0.254	-0.254
	(0.061)	(0.085)***	(0.085)***
Household size		0.021	0.021
		(0.018)	(0.018)
Household has a child under 5 years		-0.061	-0.062
		(0.062)	(0.062)
Total PPI score		0.003	0.003
		(0.003)	(0.003)
Household total asset index		-0.013	-0.013
		(0.038)	(0.038)
Number of crops cultivated		0.022	0.022
		(0.028)	(0.028)
Household has a Vodafone SIM card		-0.012	-0.011
		(0.067)	(0.067)
Log total value of production		-0.014	-0.014
		(0.022)	(0.022)
Household Dietary Diversity Score (1-12)		0.133	0.133
		(0.019)***	(0.019)***
Strong Vodafone network coverage		-0.084	-0.085
		(0.076)	(0.076)
First quartile - Distance to market		-0.056	-0.057
		(0.082)	(0.082)
Second quartile - Distance to market		-0.044	-0.045
		(0.088)	(0.088)
Third quartile - Distance to market		-0.045	-0.045
		(0.089)	(0.089)
Female targeted*Nutrition script			-0.054
			(0.121)
Constant	1.896	1.051	1.036
	(0.060)***	(0.269)***	(0.269)***
R^2	0.01	0.04	0.05
N	1,608	1,608	1,608

Notes: All specifications control for region. Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$

Table 3: Impact of framing and targeting on WTP, by region

	Upper West			Central		
Dependent variable=WTP	(1)	(2)	(3)	(4)	(5)	(6)
Female targeted	-0.059	-0.081	-0.063	-0.285	-0.242	-0.241
	(0.079)	(0.080)	(0.113)	(0.094)***	(0.095)**	(0.128)*
Agriculture and nutrition script	-0.074	-0.065	-0.047	0.256	0.287	0.288
	(0.079)	(0.079)	(0.117)	(0.093)***	(0.093)***	(0.138)**
Household size		0.039	0.039		-0.010	-0.010
		(0.024)*	(0.024)*		(0.025)	(0.025)
Household has a child under 5 years		-0.051	-0.052		-0.024	-0.024
		(0.082)	(0.082)		(0.094)	(0.094)
Total PPI score		0.001	0.001		0.004	0.004
		(0.004)	(0.004)		(0.004)	(0.004)
Household total asset index		0.012	0.012		-0.128	-0.128
		(0.041)	(0.041)		(0.120)	(0.120)
Number of crops cultivated		-0.058	-0.058		0.111	0.111
		(0.039)	(0.039)		(0.045)**	(0.045)**
Household has a Vodafone SIM card		0.132	0.132		-0.154	-0.154
		(0.086)	(0.086)		(0.116)	(0.117)
Log total value of production		-0.019	-0.019		-0.012	-0.012
		(0.044)	(0.044)		(0.026)	(0.026)
Household Dietary Diversity Score (1-12)		0.126	0.127		0.168	0.168
		(0.026)***	(0.026)***		(0.030)***	(0.030)***
Strong Vodafone network coverage		0.076	0.075		-0.211	-0.211
		(0.108)	(0.108)		(0.112)*	(0.112)*
First quartile - Distance to market		-0.029	-0.030		-0.083	-0.083
		(0.111)	(0.111)		(0.120)	(0.120)
Second quartile - Distance to market		0.093	0.092		-0.213	-0.213
		(0.113)	(0.113)		(0.144)	(0.144)
Third quartile - Distance to market		0.082	0.081		-0.116	-0.116
		(0.109)	(0.109)		(0.150)	(0.150)
Female targeted*Nutrition script			-0.034			-0.002
			(0.158)			(0.185)
Constant	1.921	1.099	1.091	1.772	0.425	0.425
	(0.070)***	(0.414)***	(0.415)***	(0.082)***	(0.443)	(0.441)
R^2	0.00	0.05	0.05	0.02	0.09	0.09
N	842	842	842	766	766	766

Notes: Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$.

Table 4: Explaining the Gender Gap in WTP and the nutrition premium in the central region

Dependent variable=WTP	HH and Indiv controls	PDS Lasso	PDS Lasso with female interaction
Female targeted	-0.342	-0.354	0.606
	(0.123)***	(0.118)***	(0.495)
Agriculture and nutrition script	0.290	0.269	0.251
	(0.092)***	(0.089)***	(0.133)*
HH level controls			
Household size	-0.006		
	(0.026)		
Household has a child under 5 years	-0.039		
	(0.100)		
Total PPI score	0.004		
	(0.005)		
Household total asset index	-0.074		
	(0.120)		
Number of crops cultivated	0.095		
	(0.045)**		
Household has a Vodafone SIM card	-0.140		
	(0.119)		
Log total value of production	-0.001		
	(0.027)		
Household Dietary Diversity Score (1-12)	0.152		
	(0.031)***		
Strong Vodafone network coverage	-0.210		
	(0.112)*		
First quartile - Distance to market	-0.087		
	(0.125)		
Second quartile - Distance to market	-0.276		
	(0.144)*		
Third quartile - Distance to market	-0.155		
	(0.152)		
Individual level controls			
Age	-0.002		
	(0.004)		
Has some education	-0.003		0.967
	(0.127)		(0.392)**
Not married	-0.227		
	(0.143)		
Literate	0.014		
	(0.113)		
Share of household assets owned	-0.354		

	(0.172)**		
Nutrition knowledge	0.003		
	(0.004)		
Farming knowledge	0.009		
	(0.003)***		
Owns a mobile phone	-0.090		0.425
	(0.170)		(0.395)
Log monthly amount spent on airtime	-0.001		
	(0.055)		
Targeted member has heard of VFC	0.068		
	(0.096)		
Main activity is crop production	-0.176		
	(0.118)		
Trust agriculture information from SMS	0.006		
	(0.156)		
Trust nutrition information from SMS	-0.030		
	(0.152)		
Met with agriculture extension worker in last month	-0.049		
	(0.124)		
Met with community health worker in last month	-0.413		
	(0.098)***		
Interactions with female indicator			
Household Dietary Diversity Score squared*Female targeted			0.030
			(0.016)*
First quartile - Distance to market *Female targeted			-0.282
			(0.167)*
Second quartile - Distance to market*Female targeted			-0.435
			(0.178)**
Has some education*Female targeted			-0.475
			(0.238)**
Trust nutrition information from SMS*Female targeted			-0.395
			(0.218)*
Met with community health worker in last month*Female targeted			-0.443
			(0.125)***
Constant	0.621	1.989	1.239
	(0.535)	(0.137)***	(0.277)***
R^2	0.14		
N	765	765	765

Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$. Column 1 includes household level and individual level baseline. Columns 2 displays estimates based on implementing the Post Double Selection Lasso method of Belloni et al. (2012; 2013; 2014; 2015; 2016) with the full set of first- and second-order terms based on the controls in Column 1 with no treatment interactions. Column 3 does the same but includes interactions between the female treatment and each first-order and second order term as potential controls. Only first order controls picked in the final PDS lasso specification and significant interactions with the female indicator are shown in columns 2 and 3.

Appendix A: Marketing scripts

Agriculture script

I would like to talk with you, _*NAME OF SELECTED TARGETED INDIVIDUAL*___, about Vodafone's Farmers Club package. Farmers Club is an association for farmers in Ghana, with a special SIM made only for farmers and other agric people. If you have this SIM, you can call an agric expert for free. This expert can give you agricultural information and tips that are useful for your crops and region, like an agricultural extension worker that you can contact at your convenience and for free on your mobile phone. The package also gives you weather, farming advice and helps you find best prices for your crops, all from your phone. The advice is tailored to your geographic region, in the language of your choosing for the 2 crops you are most interested in. Once you are a member, you can call any other farmer in the association for free.

Additional nutrition information for Agriculture+nutrition script

Farmers Club also sends at least one recorded nutrition tip every month so that members can learn about how to grow and prepare certain foods that support health and nutrition. The nutrition tips help members learn about the health properties of different crops and how to preserve, store, and prepare food for the health for their family.

Both scripts

Do you have any questions about the Farmers' Club package?

Appendix B: Willingness to Pay Script

Module M: Willingness to pay – BDM

ENUMERATOR: Ask the questions below to randomly selected primary male or female respondent.

M1_ ID	Respondent ID		MID

Enumerator: READ TO RESPONDENT:
Thank you for your responses to the survey questions. We are now done with the interview. Your household has been selected at random to receive information on the Vodafone's Farmers' Club service and to play a short game that may give you the opportunity to sign up for the service if you choose.

M1_ 00a	Have you, [name of selected respondent],heard of Vodafone's Farmer Club service?	☐	Yes .....1 No.....2
M1_ 00	Do you consent to receive this additional information and participate in the game?	☐	Yes .....1 No.....2 >>end survey

If script= agriculture then read:
I would like to talk with you, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, about Vodafone's Farmers Club package. Farmers Club is an association for farmers in Ghana, with a special SIM made only for farmers and other agric people. If you have this SIM, you can call an agric expert for free. This expert can give you agricultural information and tips that are useful for your crops and region, like an agricultural extension worker that you can contact at your convenience and for free on your mobile phone. The package also gives you weather, farming advice and helps you find best prices for your crops, all from your phone. The advice is tailored to your geographic region, in the language of your choosing for the 2 crops you are most interested in. Once you are a member, you can call any other farmer in the association for free. Do you have any questions about the Farmers Club package?

If script= agriculture and nutrition then read:
I would like to talk with you, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, about Vodafone's Farmers Club package. Farmers Club is an association for farmers in Ghana, with a special SIM made only for farmers and other agric people. If you have this SIM, you can call an agric expert for free. This expert can give you agricultural information and tips that are useful for your crops and region, like an agricultural extension worker that you can contact at your convenience and for free on your mobile phone. The package also gives you weather, farming advice and helps you find best prices for your crops, all from your phone. The advice is tailored to your geographic region, in the language of your choosing for the 2 crops you are most interested in. Once you are a member, you can call any other farmer in the association for free.
Farmers Club also sends at least one recorded nutrition tip every month so that members can learn about how to grow and prepare certain foods that support health and nutrition. The nutrition tips help members learn about the health properties of different crops and how to preserve, store, and prepare food for the health for their family. Do you have any questions about the Farmers' Club package?

READ EXACTLY FROM SCRIPT. DO NOT SAY ANYTHING THAT IS NOT IN SCRIPT:
We would like to offer you, *NAME OF SELECTED TARGETED INDIVIDUAL*, the opportunity to become a Farmers' Club member. Members may pay a small monthly fee for the service, but you will not have to spend any more for the service than you believe it is worth. You can discontinue your membership at any time if you are not satisfied with the product.
We will play a game to determine the monthly fee you would be charged if you become a Farmers Club member. Remember, you will not have to pay any more than you want to for the service and you may even pay less than your selected price. Before we begin to play the game, I would like you to think about how much you would be willing and able to pay for the Farmers' Club service per month. I will ask you for this amount when we begin to play the game.

Here is how the promotion works:
I will ask you to tell me the maximum monthly price you are willing and able to pay for the Farmers' Club service.
This price should represent what you are willing and able to have deducted from your phone credit each month, in return for receiving the Farmers' Club service.
You must be willing and able to pay the price for the first month of the Farmers' Club service today.

In this cup, I have buttons with different numbers on them that represent monthly prices (in Cedis) for the Farmers' Club service.
I will ask you to pick a button from the cup, and we will look at the price together.
If the number you draw is less than your bid, you _NAME OF SELECTED TARGETED INDIVIDUAL, can become a Farmers' Club member and pay the price you pick from the cup each month.
If the number you draw is greater than your bid, then you cannot become a Farmers' Club member.
You will have one chance to play for the Farmers' Club service.
You cannot change your bid after you draw from the cup.
You must state a price that you are actually able to pay now for the first month of service.
We will practice in one moment, but for now, do you have any questions?
Answer any questions the respondent has.

REMEMBER: get the respondent to state the highest price they are willing and able to pay right now.
Before we play for the Farmers' Club product, lets practice the game. We'll play the same game, but instead of playing for the Farmers' Club product, we will play for this bar of soap. (Show respondent soap)

M1_01	What is the maximum amount that you, *name of selected targeted individual,* are willing and able to pay for this soap now?	☐	GHC

Now, if you pick a button with a price that is less than or equal to *M1_01*, you will buy the soap at the price you pick. If you pick a button with a price greater than *M1_01*, you will not be able to purchase the soap, even if you are willing to pay the greater number. You cannot change your bid after you pick a price. Do you understand? And if you pick button with a price [*M1_01*-0.1 cedis] now, what happens?

M1_02	[Enumerator: Did the respondent indicate that they were going to win?]	☐	Yes…….1 >> Ask the respondent how much they need to pay. No……..2 >> move back to M1_01 and explain the rules again
M1_03	[Enumerator: Did the respondent give the correct answer? The correct answer is M1_01-0.1 cedis]	☐	Yes…….1 No……..2 >> move back to M1_01 and explain the rules again

Please, tell me – if you pick a button with a price [*M1_01*+1 Cedis] now, what happens?

M1_04	[Enumerator: Did the respondent indicate that they were going to win?]	☐	Yes…….1 >> move back to M1_01 and explain the rules again No……..2
M1_05	If you draw a button with a price [M1_01+1 Cedis], will you want to purchase the soap for [M1_01+1 Cedis]?	☐	Yes…….1 No……..2 >> skip to M1_07
M1_06	Do you want to change your bid to M1_01+1 cedis?	☐	Yes…….1 >> move back to M1_01 using M1_01+1 as the new M1_01 (record both) No……..2
M1_07	So, is M1_01 truly the most you are willing and able to pay for the soap?	☐	Yes…….1 No……..2 >> move back to M1_01
M1_08	If you pick M1_01, you must be able to pay M1_01. Are you able to pay M1_01 now?	☐	Yes…….1 No……..2 >> move back to M1_01
M1_09	[Enumerator: Record the respondent's final bid		GHC

Could you please fetch the amount you have stated you are willing to pay and show it to me?
Wait for respondent to fetch money and check to see he/she has enough funds for the Final Bid, but don't take money until after the button is drawn.
Are you ready to pick a button?
Mix buttons in cup, hold cup above eye level of respondent.
Now you can draw a button from the cup.
Let respondent draw button while ensuring that he/she is not looking. Together, look at the button and read the price picked.

M1_10	What price did you draw?	☐	GHC
M1_11	[Enumerator: Record if drawn price is lower than, equal to, or higher than the final bid.]	☐	Price drawn is less than or equal to willingness to pay …….1 Price drawn is higher than willingness to pay…….2

If M1_11=1: "**The price drawn is less than or equal to the amount you said you would be willing and able to pay for this soap. You can now buy the item at this price."** Exchange the soap for M1_10.
If M1_11=2: "**The price drawn is greater than the amount you said you would be willing to pay for this soap. You cannot purchase this soap."**

M1_12	Do you have any questions about the game? [Enumerator: Address any questions or concerns the respondent has. Make sure he/she understands the rules of the game.]		

Enumerator: REMEMBER: Get the respondent to state the highest price they are willing and able to pay right now for the first month of farmers' club service.

Now you, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, will play for the Farmers' Club service. You _*NAME OF SELECTED TARGETED INDIVIDUAL*_, will have the opportunity to purchase the Farmers' Club service for a monthly price between 0 and 3 GHCX. Have you thought about how much you are willing and able to pay monthly for the Farmers' Club service? Do you have the funds available for the first month now? Let's begin:

M1A_01	What is the maximum amount that you, *name of selected targeted individual,* are willing and able to pay for the Farmers' Club service?	☐	GHC

Now, if you pick a button with a price that is less than or equal to *M1A_01*, you will buy the Farmers' Club service at the price you pick. If you pick a button with a price greater than *M1A_01*, you will not be able to purchase the Farmers' Club service, even if you are willing to pay the greater number. You cannot change your bid after you pick a price. Do you understand? And if you pick button with a price [*M1A_01*-0.1 cedis] now, what happens?

M1A_02	[Enumerator: Did the respondent indicate that they were going to win?]	☐	Yes…….1 >> Ask the respondent how much they need to pay. No……..2 >> move back to M1A_01 and explain the rules again
M1A_03	[Enumerator: Did the respondent give the correct answer? The correct answer is M1A_01-0.1 cedis]	☐	Yes…….1 No……..2 >> move back to M1A_01 and explain the rules again

Please, tell me – if you pick a button with a price [*M1A_01*+1 Cedis] now, what happens?

M1A_04	[Enumerator: Did the respondent indicate that they were going to win?]	☐	Yes…….1 >> move back to M1A_01 and explain the rules again No……..2
M1A_05	If you draw a button with a price [M1A_01+1 Cedis], will you want to purchase the Farmers' Club service for [M1A_01+1 Cedis]?	☐	Yes…….1 No……..2 >> skip M1A_06
M1A_06	Do you want to change your bid to M1A_01+1 cedis?	☐	Yes…….1 >> move back to M1A_01 using M1A_01+1 as the new M1A_01 (record both) No……..2
M1A_07	So, is M1A_01 truly the most you are willing and able to pay monthly for the Farmers' Club service?	☐	Yes…….1 No……..2 >> move back to M1A_01

M1A_08	If you pick M1A_01, you must be able to pay M1A_01 for the first month of service. Are you able to pay M1A_01 now?	☐	Yes…….1 No……..2 >> move back to M1A_01
M1A_09	[Enumerator: Record the respondent's final bid		GHC

Could you please fetch the monthly amount you have stated you are willing to pay and show it to me?
Wait for respondent to fetch money and check to see he/she has enough funds for the Final Bid, but don't take money until after the button is drawn.
Are you ready to pick a button?
Mix buttons in cup, hold cup above eye level of respondent.
Now you can draw a button from the cup.
Let respondent draw button while ensuring that he/she is not looking. Together, look at the button and read the price picked.

M1A_10	What price did you draw?	☐	GHC
M1A_11	[Enumerator: Record if drawn price is lower than, equal to, or higher than the final bid.]	☐	Price drawn is less than or equal to willingness to pay …….1 Price drawn is higher than willingness to pay…….2

If M1A_11=2: "**The price drawn is greater than the amount you said you would be willing to pay for the Farmers' Club service. You cannot purchase the Farmers' Club service."**

If M1A_11=1:
The price drawn is less than or equal to the amount you said you would be willing and able to pay for the Farmers' Club service. You can now buy the item at this price.

For all:
We are running an additional promotion which will enable you, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, to receive the Farmers' Club service for less than the monthly price you drew during the game. You will not have to pay an amount greater than the amount you bid (if you lost) or the amount you won for per month and you may be able to pay less.

M1A_12A	[Enumerator: Is the respondent ready to do the 2nd stage randomization?]	☐	Yes…….1 No…….2

Take out the cup with the four 2nd stage buttons.
In this cup are four buttons. Each of these buttons corresponds to another monthly price. I will ask you to select one of these buttons, read me the letter written on the button, and I will then enter the letter you selected into this tablet. The tablet will then reveal what monthly price that letter corresponds to. If you would like, you, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, can subscribe to the Farmers' Club service for the monthly price shown by the tablet.

M1A_12B	[Enumerator: Record the letter written on the 2nd stage button picked.]	☐	A…….1 B…….2 C…….3 D…….4

You, _*NAME OF SELECTED TARGETED INDIVIDUAL*_, have been selected to receive an additional discount! You are being offered the Farmers' Club service for no monthly fee.
Inform the respondent that they will need a valid government ID to register a new SIM line. If the respondent does not have their own ID they can register the SIM in the name of another household member or neighbor. Record the ID information in in questions MIA_16 through MIA_21.

M1A_12	Would you, *name of selected targeted individual*, like to register for Farmers' Club service?	☐	Yes…….1 No…….2 >> end section

Appendix C: Tables

Appendix Table C1: Summary statistics, treatment status, Upper West region

		Script randomization				Gender randomization			
	N	Ag script	Ag+Nut script	Norm. diff.	P-Value	Male targeted	Female targeted	Norm diff.	P-Value
Attrition									
Did not consent or finish WTP exercise	904	0.06	0.07	0.04	0.55	0.06	0.07	0.05	0.49
Household level characteristics									
Household size	842	6.00	5.77	-0.09	0.18	5.97	5.81	-0.06	0.36
Number children under 5	842	0.65	0.72	0.10	0.17	0.74	0.63	-0.14	0.04
Total PPI score	842	56.65	56.75	0.01	0.92	56.32	57.05	0.06	0.41
Household total asset index	842	0.74	0.61	-0.12	0.09	0.69	0.65	-0.04	0.59
Total value of production (GhC)	827	3,295.93	2,542.42	-0.12	0.09	2,618.51	3,177.52	0.09	0.20
Number of crops cultivated	837	3.25	3.08	-0.13	0.06	3.17	3.16	-0.01	0.89
Household Dietary Diversity Score (1-12)	795	5.48	5.40	-0.05	0.49	5.34	5.54	0.12	0.10
Household has a Vodafone SIM card	842	0.63	0.62	-0.02	0.77	0.63	0.62	-0.02	0.77
Primary male and female characteristics									
Primary Female has some education	820	0.19	0.26	0.15	0.03	0.23	0.23	0.00	0.99
Primary Male has some education	800	0.33	0.33	0.01	0.92	0.32	0.34	0.05	0.48
Primary female is literate	820	0.10	0.16	0.16	0.02	0.13	0.14	0.04	0.59
Primary male is literate	800	0.23	0.23	-0.00	0.96	0.21	0.24	0.07	0.30
Share of assets owned solely by primary female	779	0.10	0.11	0.05	0.47	0.10	0.11	0.07	0.33
Share of assets owned solely by primary male	779	0.76	0.76	-0.01	0.91	0.77	0.75	-0.08	0.27
Primary female nutrition knowledge, % correct	820	65.30	63.97	-0.08	0.23	63.69	65.43	0.11	0.11
Primary male nutrition knowledge, % correct	801	58.55	59.09	0.03	0.67	57.16	60.53	0.19	0.01
Primary female farming knowledge, % correct	820	58.84	59.27	0.02	0.74	57.90	60.08	0.12	0.09
Primary male farming knowledge, % correct	801	62.16	63.52	0.08	0.28	62.98	62.73	-0.01	0.85
Primary female owns a mobile phone	820	0.34	0.32	-0.03	0.63	0.33	0.33	0.00	0.98
Primary male owns a mobile phone	801	0.80	0.76	-0.08	0.24	0.80	0.76	-0.08	0.23
Enumeration area characteristics									
Strong Vodafone network coverage	842	0.82	0.83	0.04	0.60	0.81	0.84	0.07	0.34
Distance to market (minutes)	842	36.04	35.03	-0.04	0.55	34.44	36.54	0.09	0.22

Notes: Estimates are from the mNutrition Ghana Baseline Survey Encouraged Group, two person sample.

Appendix Table C2: Summary statistics, treatment status, Central Region

		Script randomization				Gender randomization			
	N	Ag script	Ag+Nut script	Norm. diff.	P-Value	Male targeted	Female targeted	Norm diff.	P-Value
Attrition									
Did not consent or finish WTP exercise	799	0.05	0.04	-0.05	0.49	0.03	0.05	0.08	0.27
Household level characteristics									
Household size	766	5.31	5.10	-0.11	0.15	5.20	5.21	0.00	0.96
Number children under 5	766	0.61	0.60	-0.01	0.87	0.55	0.66	0.15	0.04
Total PPI score	766	62.83	65.26	0.17	0.02	64.61	63.58	-0.07	0.33
Household total asset index	766	-0.56	-0.48	0.19	0.01	-0.51	-0.53	-0.05	0.49
Total value of production (GhC)	741	4,405.41	5,105.61	0.08	0.29	5,287.52	4,249.37	-0.11	0.12
Number of crops cultivated	752	2.95	3.04	0.07	0.30	3.04	2.95	-0.07	0.31
Household Dietary Diversity Score (1-12)	733	6.53	6.36	-0.11	0.15	6.48	6.40	-0.05	0.49
Household has a Vodafone SIM card	766	0.22	0.18	-0.09	0.21	0.20	0.19	-0.02	0.76
Primary male and female characteristics									
Primary Female has some education	741	0.62	0.64	0.04	0.58	0.61	0.65	0.10	0.18
Primary Male has some education	715	0.84	0.87	0.09	0.26	0.87	0.83	-0.11	0.15
Primary female is literate	741	0.27	0.26	-0.02	0.77	0.26	0.27	0.03	0.66
Primary male is literate	715	0.62	0.61	-0.02	0.77	0.62	0.62	0.00	0.99
Share of assets owned solely by primary female	691	0.22	0.22	-0.03	0.69	0.21	0.23	0.10	0.20
Share of assets owned solely by primary male	691	0.56	0.60	0.10	0.17	0.58	0.58	-0.01	0.87
Primary female nutrition knowledge, % correct	741	55.76	55.34	-0.03	0.66	55.36	55.70	0.03	0.72
Primary male nutrition knowledge, % correct	714	52.54	51.09	-0.11	0.15	51.19	52.47	0.10	0.21
Primary female farming knowledge, % correct	741	49.19	49.28	0.01	0.93	48.46	49.94	0.10	0.16
Primary male farming knowledge, % correct	713	53.37	53.30	-0.00	0.95	52.73	54.00	0.09	0.26
Primary female owns a mobile phone	742	0.52	0.53	0.02	0.81	0.53	0.52	-0.02	0.82
Primary male owns a mobile phone	714	0.84	0.87	0.08	0.26	0.86	0.86	0.00	0.97
Enumeration area characteristics									
Strong Vodafone network coverage	766	0.62	0.68	0.13	0.08	0.63	0.67	0.07	0.32
Distance to market (minutes)	766	32.82	30.28	-0.12	0.09	31.32	31.69	0.02	0.80

Notes: Estimates are from the mNutrition Ghana Baseline Survey Encouraged Group, two person sample.

Appendix Table C3: Share of farmers on the VFC service and WTP

	Jun 17	Sept 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18
Willingness to pay for VFC	-0.01	0.01	-0.01	-0.01	-0.01	-0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Female targeted	-0.01	-0.00	-0.06	-0.05	-0.06	-0.07	-0.06
	(0.02)	(0.01)	(0.02)**	(0.03)**	(0.03)**	(0.03)***	(0.02)**
Agriculture and nutrition script	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.00
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Central region	0.05	0.09	0.09	0.08	0.09	0.10	0.09
	(0.03)	(0.02)***	(0.04)***	(0.04)**	(0.04)**	(0.04)***	(0.04)**
Constant	0.63	0.96	0.46	0.43	0.33	0.27	0.13
	(0.10)***	(0.05)***	(0.11)***	(0.11)***	(0.11)***	(0.11)**	(0.10)
R^2	0.01	0.08	0.03	0.03	0.03	0.03	0.03
N	1,608	1,608	1,608	1,608	1,608	1,608	1,608

Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$

All specifications control for region fixed effects, household and EA-level controls.

Appendix Table C4: Share of farmers on the VFC service and WTP, by region

	Upper West							Central						
	Jun 17	Sept 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	Jun 17	Sept 17	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18
Willingness to pay for VFC	-0.01	0.01	-0.01	-0.01	-0.01	-0.00	-0.01	-0.01	0.01	-0.02	-0.00	0.00	0.01	0.02
	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.00)**	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Female targeted	0.02	-0.00	-0.04	-0.03	-0.03	-0.03	-0.02	-0.04	-0.00	-0.09	-0.07	-0.09	-0.10	-0.09
	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)**	(0.04)**	(0.04)**	(0.04)***	(0.04)***
Agriculture and nutrition script	0.01	-0.02	-0.01	-0.01	-0.01	-0.02	0.00	0.00	-0.01	-0.01	-0.01	-0.03	-0.03	-0.02
	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Constant	0.72	1.08	0.42	0.39	0.34	0.22	0.16	0.58	0.97	0.73	0.68	0.59	0.57	0.37
	(0.15)***	(0.10)***	(0.16)**	(0.16)**	(0.17)**	(0.17)	(0.16)	(0.15)***	(0.05)***	(0.17)***	(0.17)***	(0.18)***	(0.18)***	(0.17)**
R^2	0.01	0.07	0.04	0.03	0.03	0.02	0.02	0.03	0.03	0.06	0.06	0.06	0.07	0.09
N	842	842	842	842	842	842	842	766	766	766	766	766	766	766

Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$

All specifications control for household and EA-level controls.

Appendix Table C5: Share of voice calls answered and WTP

	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18
Willingness to pay for VFC	-0.01	0.01	0.01	0.00	0.00
	(0.01)	(0.01)**	(0.01)*	(0.00)	(0.00)
Female targeted	-0.04	-0.03	-0.01	-0.01	-0.02
	(0.02)***	(0.01)***	(0.01)	(0.01)	(0.01)
Agriculture and nutrition script	-0.02	-0.00	-0.00	-0.01	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Central region	0.03	0.06	0.03	0.02	0.02
	(0.02)	(0.02)***	(0.02)	(0.01)	(0.01)
Constant	0.01	0.03	-0.01	-0.06	-0.02
	(0.06)	(0.05)	(0.06)	(0.05)	(0.04)
R^2	0.03	0.04	0.03	0.05	0.05
N	1,392	1,592	1,595	1,591	1,591

Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$

All specifications control for region fixed effects, household and EA-level controls

Appendix Table C6: Share of voice calls answered and WTP, by region

	Upper West					Central				
	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18	Dec 17	Jan 18	Feb 18	Mar 18	Apr 18
Willingness to pay for VFC	-0.00	0.01	0.01	-0.00	0.00	-0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Female targeted	-0.05	-0.03	-0.02	-0.02	-0.03	-0.04	-0.03	-0.00	-0.00	-0.00
	(0.02)***	(0.02)*	(0.02)	(0.02)	(0.01)*	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Agriculture and nutrition script	-0.01	-0.02	-0.01	-0.01	-0.02	-0.02	0.01	0.01	-0.01	-0.02
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Constant	-0.04	-0.02	-0.07	-0.10	-0.11	0.07	0.07	0.04	-0.05	0.06
	(0.09)	(0.08)	(0.09)	(0.08)	(0.07)	(0.11)	(0.08)	(0.10)	(0.07)	(0.07)
R^2	0.04	0.05	0.03	0.06	0.06	0.05	0.04	0.05	0.05	0.04
N	771	831	833	834	834	621	761	762	757	757

Robust Standard errors in parenthesis. * $p<0.1$ ** $p<0.05$; *** $p<0.01$

All specifications control for household and EA-level controls.

Appendix D: Figures

Figure D1: Difference in share purchasing by early vs. late surveys

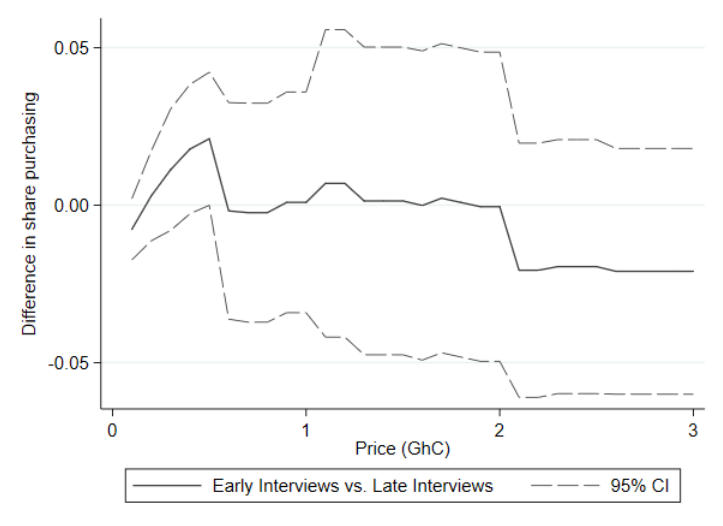
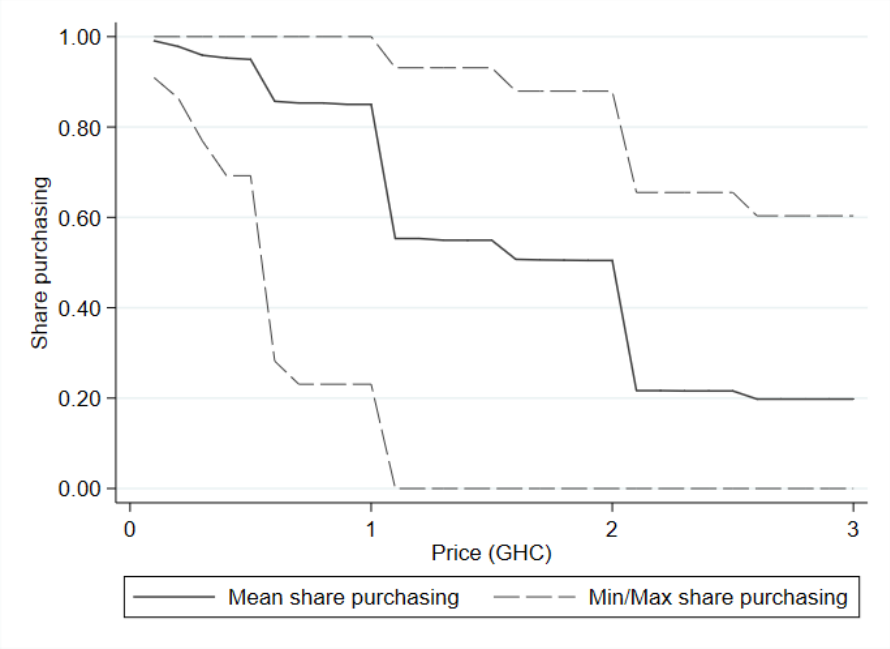
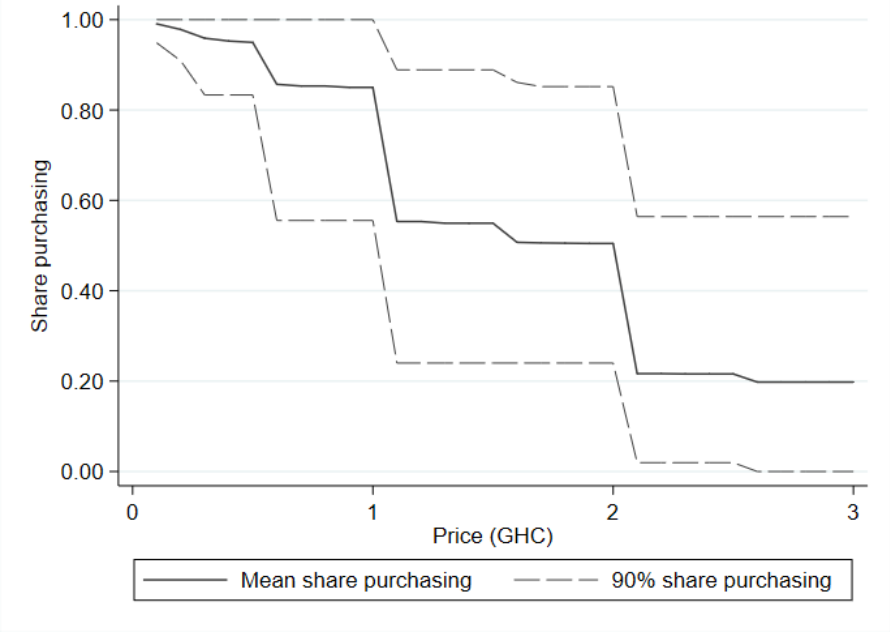


Figure D2: Accounting for WTP differences across enumerators

Panel A: Enumerator-Specific Min-Max Bounds on Inverse Demand



Panel B: Enumerator-Specific 90% Bounds on Inverse Demand



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