CAN MOBILE-LINKED BANK ACCOUNTS BOLSTER SAVINGS? EVIDENCE FROM A RANDOMIZED CONTROLLED TRIAL IN SRI LANKA

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Abstract—We introduce a new mobile money interface that permits Sri Lankans to deposit mobile airtime balances directly into a formal bank account. Randomizing access and prices, we find a small increase in savings deposits with the partner institution and formal banks more generally, but no change in overall savings. When the deposit transaction costs are completely removed, only 26% use the mobile deposit service and only 7% use it frequently. Our results imply that deposit transaction costs are not a significant barrier to increasing savings, limiting the potential gains of mobile-linked savings products for financial inclusion.

I. Introduction

A majority of the world's poor are unbanked. This is troubling given well-identified studies showing that inducing the unbanked to use bank accounts causes large impacts on business investment (Dupas & Robinson, 2013), health and education (Prina, 2015), income (Schaner, 2018), and labor supply (Callen et al., 2019). Given the benefits of savings accounts, how can we stimulate their active use among the unbanked? Dupas et al. (2018) show that simply reducing the fixed cost of opening a bank account is not sufficient to generate widespread use. This raises the possibility that the key barrier is the high transaction costs of using the accounts rather than the fixed costs of opening the accounts. Given the small size of typical deposits the working poor, the time and pecuniary costs of traveling to the bank may make regular use of formal savings accounts impractical.

We report on a field experiment in Sri Lanka that reduced ongoing banking deposit transactions costs by allowing participants to make deposits into regular bank savings accounts through any mobile phone agent using their mobile phone. Because mobile agents far outnumber bank branches, the mobile-linked bank accounts reduce the time and travel costs of making deposits. More broadly, mobile money typically allows free deposits but charges for withdrawals. This focus on minimizing deposit transaction costs is well founded: deposits tend to be more frequent than withdrawals, and asymmetric deposit and withdrawal costs may serve as an efficient commitment device. If deposit transaction costs are a key barrier to savings, then mobile-linked accounts could increase formal savings. This promise of mobile-linked financial services has led to significant resources being devoted to facilitating their spread.[1] Despite the push to link mobile money to conventional interest-bearing bank accounts (Goss et al., 2011), progress in building these products has been slow (Suri, 2017), and experimental evidence on the impact of mobile savings is scarce.[2] This slow growth raises questions of whether mobile-linked saving products will generate significant demand and increase savings mobilization, and whether the willingness to pay for these services can support their development and sustainability.

Participants in our experiment were randomly assigned to a control group or one of four treatment groups that differed in the fees charged to make a mobile deposit. Our largest treatment group paid no fee to use the service, providing a measure of the increase in demand for formal savings when deposit-related transactions costs are reduced nearly to 0.[3] As such, our study complements Dupas et al. (2018) in reducing the ongoing deposit transaction costs associated with using a bank account. By varying the fees across our treatment arms from 8% of the deposit (slightly more than the partner's estimated cost) to 0, we are able to provide evidence on the willingness to pay for mobile banking services and estimate the related elasticity of demand. Using high-frequency household income and expenditure surveys, we examine the effect of accounts on overall household savings, consumption, and labor earnings.

We have three main findings. First, use of the service was limited, even for those assigned to the zero-fee treatment group. While 80% of participants opened the bank account and participated in demonstrations on how to make deposits, only 26% made at least one deposit through the mobile service, and only 7% made ten or more deposits. Though we find some heterogeneity in usage in expected directions—women and those living at intermediate distances from bank branches were more frequent users—the usage levels remain low in all subgroups.[4] In addition, total saving deposits are

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[1] For example, the Bill and Melinda Gates Foundation's strategy for financial inclusion focuses on broadening "the reach of low cost digital financial services," and India's 2016 demonitization is often justified as a push to transition to a digital economy.

[2] Fewer than one in four households globally use any moble money service. Moreover, mobile money systems are rarely integrated with formal banks (or even integrated across telecom companies), limiting options for true mobile banking services (Suri, 2017).

[3] To confirm the mobile deposit service reduced the effective deposit transaction costs, our intervention included measures to eliminate other potential barriers to savings deposits: assistance with opening the partner bank account, including payment of the $4.55 minimum balance requirement, a mobile phone and SIM card, and personalized demonstrations on using the service, including two transfers of $.45 into the participant's own account.

[4] Women theoretically have greater concern for other-control (Ashraf, 2009), more restricted mobility, and smaller average deposits, all features potentially addressed by the technology. Those living at intermediate distances would arguably most value reduction in transaction costs for deposits but not be deterred by excessive withdrawal costs.

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not significantly greater as a function of gender or distance, though we cannot rule out potentially large effects. The modest adoption rates are in line with those found in several other studies introducing innovations designed to reduce transaction costs (Dupas et al., 2018; Flory, 2011; Ashraf, Karlan, & Yin, 2006).

Second, we find that the mobile-linked deposit service caused a 44% increase in saving deposits in the partner bank and a 29% increase in savings in the formal banking sector more generally. However, there was no increase in total household savings. Moreover, these percentage gains are relative to a very small control-group mean, and hence do not correspond to meaningful increases in the amount deposited into formal savings, even with the partner bank. Not surprisingly, then, we see no change in household welfare measures, such as household consumption or labor earnings. Furthermore, a significant proportion of the gain in bank saving deposits comes through the traditional channel of depositing savings at the bank branch. This suggests that once the account was opened, those interested in using it were willing to incur the in-person deposit transaction costs even when the mobile-deposit service was free to use. This provides our strongest evidence that ongoing deposit transactions costs are not a barrier to the use of savings accounts.

Third, and consistent with the account access itself playing a larger role than the mobile channel, we find a general lack of responsiveness to the (randomly assigned) price levied for the mobile deposit service. The amount deposited through the mobile channel does not decrease consistently as the fee increases. Only at the 8% fee do we observe reduced use of the mobile deposit service. But even then, our data suggest that the fee simply shifted the deposits from the mobile channel to the traditional in-person channel, with no overall difference in the amount deposited with the partner bank.

Taken together, these three findings suggest that deposit transaction costs are unlikely to be the major barrier inhibiting formal savings in this context. Our modest impacts from providing an ever-present, private, and free mobile deposit service can be seen as bounding the counterfactual deposit cost. While it is true that adoption of the mobile deposit service involves both trust and cognitive costs, we aimed to minimize these costs by designing an interface that closely mimicked the common practice of putting minutes on a mobile phone. We provide evidence that learning costs and lack of trust are unlikely to be driving our results: the majority who use the service once did not continue to use it, we observe no heterogeneity in savings by education or familiarity with mobile technology, and survey responses indicate that users have trust in the service. Thus, our results suggest that the benefits of removing deposit transaction costs were not greater than overcoming relatively small learning and trust costs. On the other hand, we find suggestive evidence that withdrawal transaction costs are an important part of the story: the strongest impacts are found at intermediate distances (2–5 km) from a bank branch, a distance at which more individuals are unbanked, but the transaction costs associated with withdrawals[5] may not be prohibitively high.

With the strong push for financial inclusion built on the premise of reducing market imperfections in formal financial markets, understanding the impact of digital finance is particularly important. Our intervention focuses on reducing deposit transaction costs, mirroring the typical structure of mobile money and mobile saving products. Our analysis is based on a large, individual-level, randomized controlled trial with high-frequency panel data on savings for over two years. The significant sample size and length of study, near-perfect compliance with the randomization, and low attrition all bolster the internal validity of our causal interpretation. In addition, our measures not only capture savings with the partner institution, but also estimate impact on total savings and formal savings, which have implications on financial intermediation and economic growth.

This experiment provides one of the first estimates of the effect of mobile-deposit services on savings, contributing to growing literatures on the uses of mobile money and the importance of transaction costs for savings mobilization. The handful of studies examining mobile-linked savings generally find results consistent with ours, despite being in settings where mobile money is more popular.[6] These studies observe no significant increases in total savings: increases in the mobile-linked savings product are directly offset by reductions in alternative saving devices. Similarly, studies of mobile-money savings products not linked to formal banks find similarly modest results. Batista and Vincente (2016) conduct a field experiment introducing mobile money alone in Mozambique. Consistent with earlier findings of Jack and Suri (2014) in Kenya, they find that mobile money increased consumption smoothing through remittances but not through increased savings.[7] In each of these products studied, deposits are free and withdrawals incur a fee, highlighting the prevalence of mobile-linked services primarily reducing deposit transaction costs.

Batista and Vicente (2017) and Bastian et al. (2018) identify the marginal demand for formal banking features and savings relative to existing mobile money. The mirroring studies by Batista and Vincente (2016) and Jack and Suri (2014) identify the effect of eliminating deposit transaction costs for a saving device that is absent many of the features of formal savings (e.g., mobile money). We add to the literature by estimating an intervention that combines these two components.

[5] Analogous to our description of deposit traction costs, withdrawal transaction costs refer to all costs related to withdrawals, such as the time and pecuniary costs of traveling to the bank for making a withdrawal.

[6] For example, Bastian et al. (2018) measure the marginal effect of connecting a formal saving option to the mobile platform in a context of existing mobile money users, and Batista and Vicente (2017) measure the marginal effect of providing a remunerated savings account through mobile money relative to mobile money alone.

[7] In their follow-up work, Jack and Suri (2016) find that savings were higher in places with mobile money but are unable to identify whether this is a direct effect of mobile money or an indirect downstream effect from intermediary outcomes (e.g., reduced vulnerability to shocks may also yield increased savings in the long run).

The combination is key to identifying the barrier of deposit transaction costs in facilitating formal savings, a particularly relevant question given the focus financial inclusion initiatives place on "banking" individuals due to concerns that informal savings are higher risk, higher cost, and less convenient. The marginal effects found in previous studies identify each component separately and therefore provide lower bounds to an intervention like ours, which estimates a combined effect that captures potential complementarities. Our results are consistent with their modest impacts and suggest that the marginal gain from the interaction is small.

More broadly, our results contribute to understanding the role of deposit costs as a barrier to efficient savings mobilization. Studies eliminating the pecuniary costs of opening bank accounts have found mixed results, with the largest and most representative (Dupas et al., 2018) finding modest effects (Dupas et al., 2016; Dupas & Robinson, 2013; Prina, 2015; Cole, Sampson, & Zia, 2011). The heterogeneity in this literature may arise because some of these interventions also introduce features that address salience or commitment concerns or are implemented in contexts where the benefit of formal savings is low (e.g., respondents in Dupas et al., 2016, list risk of embezzlement and high withdrawal costs as explanations for their lack of demand). Our results support what we see as the growing consensus in this literature: that deposit transaction costs determine where a person saves, but are unlikely to be a primary barrier responsible for inefficiently low overall savings.

II. Study Context and Details

The Sri Lankan setting is particularly well suited for estimating the effect and price elasticity for mobile-linked financial savings. First, Sri Lanka is typical of most low- and lower-middle-income countries in that mobile phones are ubiquitous but electronic financial services (e.g., ATMs) are more limited, mobile money was absent at the time of the intervention and continues to have very low penetration, and a large proportion of savings continues to be held in informal saving devices (World Bank, 2013). For example, at baseline, only 23% of our sample had made a deposit into a formal bank account in the previous month. Second, there is high trust in the banking system in Sri Lanka, helping to overcome market imperfections related to informational asymmetry and institutional uncertainty that may dampen the benefit of reducing transaction costs in other contexts. And finally, previous research in Sri Lanka confirmed significant latent demand for formal banking services and provided compelling reasons to suspect transaction costs were an important market imperfection resulting in undersaving: Callen et al. (2019) find that a weekly door-to-door deposit collection service increased total savings by over 15%.[8] In general, however, Sri Lanka has decent access to formal savings, a variety of heavily used informal savings vehicles, and relatively good transportation infrastructure, indicating that financial exclusion may be less severe in our context than in the poorest parts of the developing world.

A. Product Description

In 2009, we began working with a large mobile operator in Sri Lanka to develop a savings product allowing deposits to be made directly through a mobile phone to a savings account in a large, government-owned bank (referred to as the partner bank). Customers could deposit funds into the bank account with scratch cards using the standard procedure for adding airtime minutes to their mobile phone.[9] The product allowed the user to dial a number, enter the scratch card serial number, deposit the amount on the card into an m-purse account linked to the phone, and move the money from the m-purse account to a linked savings account by entering a PIN. Scratch cards were available in denominations from 50 LKR to 1,000 LKR (0.45 USD to 9.09 USD). In our baseline survey, 66% of our primary sample (described in the following section) reported that their typical deposit into any formal saving devices was 1,000 LKR or less, suggesting that the scratch card denominations available would not have been unduly burdensome.[10] In addition, mobile agents are numerous, and the transaction is identical to adding minutes to one's mobile phone, allowing a person to shroud their savings behavior from any given agent to protect privacy around saving deposits. This was the first product of this type offered in Sri Lanka.

While loading airtime through scratch cards is becoming less common, the time and effort costs of scratch cards are not materially different from newer methods, which continue to require interacting with a local agent. Most important, at the time of this study, scratch cards were very common, ensuring that the mobile-deposit service mimicked a process very familiar to the sample. In addition, in places that currently have connectivity between mobile money and linked saving accounts, a PIN is a common method for transferring mobile money into an account. Finally, at the time of the experiment, the majority of our sample were adding minutes to their mobile phone at least once a week, suggesting that the marginal time and effort costs associated with the process were small.

The mobile operator agreed not to market the product in the region where we were conducting the research during the term of the project, ensuring perfect compliance with the randomized controlled trial. This unusual degree of control over access to the product is a major advantage for estimating causal effects relative to other studies of mobile banking products.

[8] Our results are robust to limiting our sample to be similar to the sample selection process used in this earlier work.

[9] Fifty-eight percent of our sample added minutes to their phone at least once a week. In contrast, only 23% had made a bank deposit in the previous month at baseline.

[10] The PIN offers protection for the account in the event the phone is lost or stolen. It also allowed other members of the household to use the phone without having access to the account, a feature that may be important in some households.

We took a series of steps to stimulate use of the product and overcome any barriers to realizing the service's benefits. First, we worked with the mobile operator to inform and train customer service representatives so that someone knowledgeable of the product was always available at the service call center. Second, we offered participants a free basic phone and SIM card. Third, we helped them open the savings account linked to the phone, including providing the 500 LKR (4.55 USD) minimum balance required to open a savings account at the bank.[11] Fourth, we arranged a demonstration of how to use the service, which included making two deposits of 50 LKR (0.45 USD) each into the individual's account. And finally, for two months in each municipality, we conducted a lottery among users to encourage use of the service.[12] We provided these incentives to all treated individuals to eliminate constraints to account use arising from pecuniary costs (e.g., bank fees), material costs (e.g., phone costs), or lack of experience using the service (e.g., generating experience with the service though the demonstration and lottery incentives).

B. Distribution Time Line

The introduction of the product was subject to several delays. We delivered the first offer letters in December 2011, one year after our baseline survey. The delays meant that we had an additional year of baseline savings data prior to households being aware of the intervention. Demonstrations began by February 2012 in one municipality, by April 2012 in four more municipalities, and by September 2012 in the remaining municipality. In all cases, participation in the demonstration implies that the individual's account was opened and the mobile conduit was functional. By September 2012, 86% had accepted the offer (i.e., opened an account and received the phone and SIM card). Appendix figure A1 provides a summary of the time line for the rollout of the mobile-deposit service intervention and the data collection.

C. Sample Selection and Randomization

To select the sample for the study, we conducted a listing exercise in August 2010 in six municipalities[13] in central Sri Lanka. The household listing identified 13,435 economically active adults from 10,300 households. This initial listing was stratified by distance to the nearest town (i.e., to a bank branch): urban (under 2 km), semiurban (2 km to 5 km), and rural (over 5 km). We then narrowed this sample based on characteristics predicted to have high demand for the mobile-deposit service: households with members paid on a daily or weekly basis (therefore having higher value for frequent deposits) and stated willingness to have an interest-bearing savings account. Imposing these restrictions narrowed the potential sample to 3,102 individuals (2,372 households), from which we selected 2,006 individuals from unique households as our final sample. This final selection oversampled individuals with characteristics that would arguably have a greater likelihood of adopting the savings service (those who lived within .5 km of the nearest mobile phone agent, who used their phones to send SMS messages regularly, who had previously changed a SIM card, and who were under 50 years of age) or were of particular interest (female). However, given that we selected an individual from 85% of the households (2,006 out of 2,372), these oversampling criteria mostly determined which individual in the household (rather than which households) we selected.

The mobile-deposit service (along with the bundled activities described in the previous section) was randomly offered to 1,625 individuals from the baseline sample of 2,006 individuals. Within this treatment group, individuals were randomly assigned a fee to be deducted from each deposit made through the mobile channel: free (683 individuals), 2% fee (316 individuals), 4% fee (310 individuals), and 8% fee (316 individuals). Those in the free service were further randomized to be surveyed annually (227 individuals) or monthly (435 individuals), as described in further detail in the following section. The control sample received no offer or the promotional activities surrounding the offer but were surveyed monthly. The treatment randomization was stratified on quartiles of baseline saving balances and terciles of a test score based on the ability to read a text message. Appendix figure A2 provides an overview of the sample selection.

D. Data

We conducted an initial baseline survey in November and December 2010 (see appendix figure A1). From 2011 to 2013, three detailed annual surveys were conducted each November. To improve the precision of our estimates, we surveyed the control sample and 456 randomly selected individuals from the free mobile-deposit service treatment arm every month from January 2011 to December 2012 and in January and May 2013 (i.e., 25 waves of the survey). We refer to this as the monthly surveyed sample. This high-frequency panel has the advantage of increasing statistical power for detecting the causal effect of the free mobile-deposit service offer. Due to the unforeseen delay on rolling out the service, our baseline data cover more than a year of monthly surveys and two annual surveys. These surveys provide rich detail on savings behavior prior to the intervention, with detailed information on individual savings deposits using a monthly recall period.

We also observe deposits made through the mobile-deposit service from the start of the intervention until May 2013. We do not observe institutional data from the bank on account balances and withdrawals, and thus rely on the self-reported savings behavior from surveys for our primary outcomes of

[11] The bank account provided 4% interest annually, which is comparable to saving accounts at banks in general at this time.

[12] Each mobile deposit into the account generated one chance of winning a deposit of 5,000 LKR (45.5 USD) for the account holder. Our primary results are robust to excluding the months in which an incentive is offered in a municipality.

[13] Kandy, Katugastota, Pelimathalawa, Matale, Kurunegala, and Kegalle.

interest, similar to Callen et al. (2019).[14] Given our design, the core analysis focuses on the comparison of the free treatment to the control using the monthly surveyed sample, and the estimation of price elasticities uses the annually surveyed sample within which the service fee was randomized.

E. Validity: Attrition and Balance

Given the length of time between the initial baseline survey and the rollout of the intervention, there is some attrition in the sample. Since participants were unaware of their treatment status until they received an offer letter in December 2011, we take this attrition as random with respect to treatment. We define a panel sample of individuals surveyed at least once after the treatment offer letters were delivered and use this sample for our analysis. Online appendix table A1 tests for differential attrition into the panel sample and differential response rates to the multiple surveys by treatment status. We find attrition is low and balanced across treatment status among those surveyed monthly, even among subgroups of interest for heterogeneity. Although there are some statistically significant differences in attrition across treatment arms in the annual sample, the response rate in the period after the mobile-deposit service is offered relative to the months before differs only for the 8% fee group. The remainder of the paper limits analysis to the observations to the panel sample to be consistent with the sample used in the key impact regressions.

The panel sample is balanced on baseline characteristics (online appendix table A2) and on baseline savings outcomes of interest[15] as measured in the monthly surveys prior to the intervention rollout (online appendix table A3). We confirm balance for both (a) the monthly sample (used to estimate the causal effect of the mobile-deposit service), comparing those who received the mobile-deposit service for free with those in the control group, and (b) the annual sample (used to estimate the price elasticity for the mobile-deposit service), comparing those randomly assigned to different mobile transaction fees.

F. Sample Characteristics: Banking and Mobile Phones

Our sample selection is stratified on distance to the nearest town, a proxy for bank access: 44% live within 2 km, 40% live between 2 and 5 km and the remaining 16% live more than 5 km away from a bank. The average time to make a deposit at the closest bank is 53 minutes: 32 minutes for round trip travel and 21 minutes at the bank for making the deposit. The accompanying travel costs are 9 LKR (0.08 USD). In contrast, 72% of our sample is able to top up their phone within 200 meters, and the average time for adding airtime to their mobile phone, including travel time, is 10 minutes.

A significant proportion of our sample is not actively using formal bank accounts, despite having an account in their name: only 12% report using a formal savings account more frequently than once a month. Among those who made any saving deposits in a given month, only 11% of the savings were deposited into a formal account. During the baseline period, total monthly saving deposits were 5,989 LKR (54.84 USD). Average monthly formal bank saving deposits were 1,533 LKR (14.04 USD), with the remainder deposited in informal savings: 2,330 LKR (21.18 USD) per month in cash, 1,355 LKR (12.32 USD) per month in *seetus*, rotating savings and credit associations (ROSCA), and 770 LKR (7 USD) per month in other informal devices. These average amounts hide a very skewed distribution: over 75% of subjects in a given month report no formal deposits and the median monthly total savings is 2,075 LKR (19.00 USD). In our baseline questionnaire, 69% report having a formal account balance of less than 10,000 LKR (92 USD), just 42% of their reported mean monthly household consumption.[16] Consistent with the focus on deposit transaction costs, we observe that deposits into saving products are more frequent than withdrawals among our sample: 36% per month make a savings deposit at a financial institution, whereas only 19% per month make withdrawals.[17] Given our sampling rules, we observe a high penetration of mobile phones (89%), though capacity to use various functions on a mobile phone is more limited. See online appendix table A2 for additional descriptive summary statistics.

Our selective sample reflects the broader Sri Lankan context: despite significant penetration of formal bank accounts, frequent use of formal banks for saving deposits is low, and informal savings methods remain common. In general, 83% of Sri Lankans have a bank account, but only 31% save at a financial institution and only 45% report "[having] saved or set aside money for any reason" in the previous year (World Bank, 2013). On average, in the monthly baseline surveys, 21% of our control sample report making formal savings deposits, though 89% report accumulating some savings (see appendix table A3). Cash is the most common vehicle: 73% per month report a saving deposit as cash holdings, 38% per month report making a deposit into a seetu, and 24% per month report making a deposit into another informal saving

[14] While self-reported savings may be prone to measurement error or overreporting, this will affect our estimates only if reporting errors differ by treatment status. In addition, for errors driven by self-reported data to explain our results, it must be that treated households were consistently overreporting formal savings but *underreporting* savings in other devices. Such a pattern is unlikely and inconsistent with standard concerns raised for self-reported data.

[15] The survey questions used to generate the savings data are shown in the appendix. We use an inverse hyperbolic sine (IHS) transformation of savings amounts to account for the skewed nonnormal distribution of savings deposits (Burbidge, Magee, & Robb, 1988). The same balance test using outcomes without the IHS transformations confirms the validity of the research design.

[16] See appendix for more details on variable definitions and balance tests.

[17] This question asked about deposits and withdrawals in the previous month into the following types of financial institutions: private banks, government banks, microfinance organizations, development banks, National Savings Bank, Samrurdhi Bank, Sanasa Bank, Development project, Farmer's organization, or other. It was asked only of the monthly sample in eight survey rounds during the baseline period.

TABLE 1.—MOBILE DEPOSIT SERVICE ADOPTION BY FEES CHARGED

	(1) 0%	(2) 2%	(3) 4%	(4) 8%
Letter Delivered	0.979	0.990	0.990	0.969
Account Accepted	0.910	0.903	0.921	0.873
Demonstration completed	0.800	0.733**	0.760	0.702***
Used Service	0.258	0.203*	0.226	0.178***
Frequent User	0.070	0.050	0.045*	0.024***
Amount Deposited, LKR	389.027	305.597	354.507	125.712**
Observations	656	300	292	292

Letter Delivered and Account Accepted are based on enumerator reports. Demonstration Completed, Used Service, Frequent User, and Amount Deposited are based on institutional data provided by the partner bank. Demonstration Completed indicates that the individual is observed in the partner bank's data set as having used the service. Frequent User is an indicator of individuals who used the service ten times or more. Amount Deposited refers to the total amount deposited through the mobile-deposit system. The 0% sample combines those surveyed annually and monthly. Statistical significance is based on regressions that include variables on which the random assignment were stratified and uses robust standard errors. Observations are limited to individuals in the panel sample. Comparisons to the free mobile service offer are indicated by $^{*}p < 0.01$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

device. While we do not have information on how many times a respondent saves within the month, 73% are self-employed and 25% are engaged in employment that is paid either daily or weekly, suggesting that they may save more than once a month. The low use of financial institutions suggests a potentially substantial unmet demand for formal bank accounts.

G. Implementation of the Mobile-Deposit Service

We analyze each of the steps of product adoption in turn. First, treated participants were offered the service at the randomly designated price by letter (Letter Delivered). The participant then decided whether to accept the offer by coming to the partner bank branch during a designated time window to open an account and receive the phone and SIM card (Account Accepted). Finally conditional on opening the account, the project team arranged a demonstration at the participant's house in which 100 LKR (0.91 USD) was deposited in the account using the mobile-deposit service (Demonstration Completed). Table 1 provides summary statistics on the take-up for each stage of this process. Because these events happen in succession, a later stage can only occur if the previous stage was completed. All treated participants could make deposits on their own into their account.

Subjects were unaware of the product until the first offer letters were sent in December 2011, a year after the initial baseline survey. We were able to reach 98% of the panel sample to make the initial offer (row 1). Among those provided the service for free, 91% accepted the offer and 80% completed the demonstration. The service was used at least once by 26% of those who received the mobile-deposit service for free (Used Service); 7% made ten or more mobile deposits. We consider this usage rate to be low, but similar to take-up rates of savings products in several other studies (e.g., Dupas et al., 2018; Flory, 2011; Ashraf et al., 2006).[18] On average, the total amount deposited per person from the start of the intervention until May 2013 through the free mobile-deposit service was 389 LKR (USD 3.53). We observe similar deposit rates among those charged 2% and 4% fees, but deposits drop to LKR 126 (USD 1.15) at the 8% fee level. Appendix figure A3 provides a histogram of the total mobile deposits made over the period of the project for those offered the service for free and made at least one deposit (Used Service), highlighting that the majority of users deposited very small amounts.

In November 2013, almost two years after the product was launched, we asked treated respondents questions about their experience with the service. When asked an open-ended question on what they liked about the service, the most common responses, by far, were the ability to save at any time of day and the ability to save even a small amount. This suggests that individuals were well aware of and understood the direct benefits of a mobile-deposit service. Of the 1,156 respondents who were surveyed, 62% said they had "high" or "somewhat high" confidence in their ability to use the service. However, 53% also agreed at least "to some extent" that the mobile bank saving service was complicated or difficult. This suggests that despite the high levels of self-reported confidence, learning how to use the service imposed a cognitive cost. However, 26% of those who used the service frequently (ten or more times) also said that it was complicated or difficult (compared with 57% of the nonusers), suggesting this was not a primary barrier to adoption. When asked why they hadn't used the service more, the two leading responses were that the respondent forgot to save or didn't have time to save (48%) and lack of interest in the method of saving (39%). Thirty-three percent did agree, at least to some extent, that they disliked the service for technical problems or issues. We expect that this comment on technical problems likely combines a person's own difficulty in using the service with system-wide service issues that occurred shortly after the launch of the service. No respondent voiced a lack of trust in the banking system or mobile phone companies as an explanation for lack of use, and only 9% agreed, at least to some extent, with the statement, "I do not trust this mobile phone bank saving service." Consistent with our finding that respondents continue to use the traditional channel to make deposits, 32% said at least "to some extent" they preferred to deposit directly at the bank rather than using the mobile channel. This preference was only slightly greater among those who did not use the service at all versus those who used it frequently (34% versus 21%). Overall, our survey responses suggest that individuals understood well that the service reduced transaction costs for saving deposits, but that this benefit may not have been appealing enough to overcome the learning costs of a service that closely mimicked a well-known process.

III. The Savings Effects of a Mobile-Deposit Service

A. Primary Estimating Equations

Our primary question of interest is whether the intervention resulted in an increase in total savings, a reallocation toward

[18]Ninety-nine percent recalled receiving a demonstration in subsequent surveys, allowing us to rule out lack of awareness of the service as a potential explanation for low demand.

formal savings, or at a minimum, a diversion of formal savings to the partner institution. We estimate the standard experimental intention to treat using the random assignment to treatment with the following linear regression specification:

$$Deposits_{si} = \beta_0 + \beta_1 MobileFree_{si} + \mu_s + \epsilon_{si}, \quad (1)$$

where *Deposits* are the monthly mean of the following: an indicator for making a savings deposit at the partner bank, the amount of total savings deposits at the partner bank, an indicator for making a formal saving deposit, the amount of formal savings deposits, an indicator for having any saving deposit, and the amount of total savings deposits. These dependent variables have a monthly recall. We collapse the data at the individual level, using the mean response over all surveys conducted in months after the baseline period (i.e., December 2011 onward). *MobileFree* is an indicator for whether the individual was assigned to the free mobile-deposit service offer, and μ_s reflect fixed effects for the randomization stratification variables; *s* represents the strata used in the randomization and *i* represents individual. For the impact estimation, we use only observations in the monthly survey sample, meaning that individuals are in either the control arm or the free treatment arm. Robust standard errors are used.

Additionally, we estimate a difference-in-difference model using the monthly responses and including individual fixed effects, α. These regressions include the one year of data prior to the initial offer letters,

$$Deposits_{sit} = \beta_1 MobileFree \times Post_{sit} + w_t + \alpha_i + \epsilon_{sit}, \quad (2)$$

where *Post* is an indicator for the period after the initial letters introducing the mobile deposit service were delivered (December 2011); w are fixed effects for each survey wave; and *t* reflects the monthly recall period of the survey. Standard errors are clustered at the individual level. Table A3 confirms that savings deposits are statistically similar across treatment status prior to the offer letters being sent. We use probability weights to ensure that each individual is given equal weight in our estimates regardless of differential response rates by individuals to a given survey wave.[19] In earlier survey waves, we did not specifically ask for savings in the partner bank, and so we do not include this outcome in the individual fixed-effects specification. Equation (2) is our preferred estimating model due to the increased precision from controlling for average individual behavior, but we include Equation (1) primarily to estimate effects on savings with the partner institution, which we do not observe in initial pretreatment months.

We focus on the free mobile-deposit service for the core impact analysis because the free service removes all financial frictions levied on the consumer and therefore provides an upper bound of the effect of a mobile-deposit service. Moreover, the control sample and a randomly selected subset of the free-treatment sample were surveyed monthly, while the fee-treatment samples were interviewed only annually. Because the survey frequency may affect responses, we focus our treatment-control comparison on the samples surveyed monthly. The increased survey frequency also provides a high-powered estimate of a frictionless mobile-deposit service offer.[20] Section IIID uses the annual survey sample to estimate price elasticities.

B. *Variable Transformations and Robustness Statistics*

Given that savings deposits follow a highly skewed nonnormal distribution, we follow the recent financial services impact literature in analyzing our primary outcomes of interest using the inverse hyperbolic sine transformation (Burbidge, Magee, & Robb, 1988). This transformation retains the interpretation of a log (i.e., impacts are in percent changes) but can handle zero values. Because absolute savings deposits are still the relevant measure for bank profits and purchasing power, we also report effects on nontransformed total amounts in the text of the paper (with the complete tables presented in the appendix).

To overcome this sensitivity to scale, we augment our results by testing whether the distribution of savings is significantly different in the control and treatment groups. We use average monthly saving deposits at the individual level[21] to test for differences in the distribution with the Kolmorogov-Smirnov (KS) statistic. Change in saving deposits is measured by calculating an individual's average monthly savings deposits during the preperiod and postperiod and taking the difference between the two, akin to our individual fixed-effects difference-in-difference approach in the regression framework (i.e., equation [2]). Because savings deposits with the partner bank were not measured in the preperiod, we instead use the average monthly savings deposited with the partner bank in the postperiod for the months in which this question was asked. The benefit of the KS statistic is that it is nonparametric, insensitive to scale, and robust to nonnormal distributions.

We also illustrate the impact on saving deposits across the distribution by plotting the cumulative distribution function by treatment status of average monthly deposits with the partner bank and the change after the intervention in average monthly formal deposits and total saving deposits.[22] This provides a transparent and graphical representation of how saving deposits are changing along the distribution.

Given the relatively low take-up of the mobile deposit service, the large number of zero deposits, and the large variance

[19] Results from equation (2) are robust to using unweighted data.

[20] Results from equations (1) and (2) are relatively robust to including subjects surveyed annually and comparing those who received the free service to the control, and comparing those who received the service at any fee to the control.

[21] We calculate the mean monthly savings for each individual to abstract away from the issue of frequency of deposits versus total amount of savings.

[22] Specifically, an individual's monthly savings deposit is transformed using the inverse hyperbolic sine transformation. We then calculate the average in the months prior to the intervention and the average after the start of the intervention, and take the difference between the two.

TABLE 2.—EFFECT OF FREE MOBILE DEPOSIT OFFER

	(1) 1[Partner deposit]	(2) Partner savings	(3) 1[Formal deposit]	(4) Formal savings	(5) 1[Any deposit]	(6) Total savings
	A: Postperiod (December 2011–November 2013)					
Free Mobile Deposit Offer	0.0651***	0.442***	0.0249*	0.131	−0.00539	−0.0248
	(0.00925)	(0.0758)	(0.0145)	(0.135)	(0.00760)	(0.0952)
Observations (Ind)	790	790	803	803	803	803
	B: All months with individual fixed effects					
Free Mobile Deposit Offer × Post			0.0382***	0.287**	−0.00521	−0.0282
			(0.0138)	(0.120)	(0.0113)	(0.106)
Observations			20028	20028	20027	20027
Control Mean	0.0367	0.329	0.189	1.703	0.933	8.138
KS Statistic	.207	.207	.097	.0929	.037	.051
p-value	0.00	0.00	.042	.059	.940	.664
SP Statistic	.356	.358	.544	.535	.376	.464
p-value	.007	.013	.126	.174	.790	.740

Estimates are conducted on the monthly panel sample. Savings variables are analyzed using the inverse hyperbolic sine, so the interpretation is as a log (percent impact). Outcomes are monthly flows over the month prior to the survey wave, and the unit of observation is individual in panel A and individual-month in panel B. All regressions control for the stratification variables used in the randomization protocol. Panel A conducts a cross-sectional comparison of treatment and control outcomes using all posttreatment survey waves and uses robust standard errors. Panel B uses the full set of monthly surveys, includes individual and survey wave fixed effects, uses inverse propensity weights for the attrition across survey waves to retain representation of the overall panel sample, and clusters standard errors at the individual. The control mean is the mean of control individuals' means across posttreatment survey waves for the given outcome variable. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

in savings deposits, we do not expect that the distribution of changes in savings deposits in the treated group to first-order dominate the distribution of those in the control group. Instead, we test whether, for those offered the service, the probability of observing a higher amount of savings deposits with the partner bank, or a more positive change in formal and total average monthly saving deposits, is greater than one would expect by chance.[23] We estimate this probability by randomly drawing an observation from the control sample and the treatment sample and comparing which of the two experienced the higher gain in average formal and total monthly savings deposits from the baseline period to the posttreatment period; for the partner bank deposits, we observe which is higher in the posttreatment period. We repeat this 1,000 times, with replacement, to estimate the probability of observing a larger change in savings among the treatment relative to the control (Savings Probability, SP, Statistic). We bootstrap standard errors for the SP statistic by arbitrarily reassigning treatment status and estimating the SP statistic for 1,000 different pairs with this arbitrary treatment assignment.[24] We then compare the SP statistic given the true treatment assignment to the distribution of simulated SP statistics, providing us with the likelihood, or *p*-value, of observing our SP statistic by chance.

The KS statistic, CDF, and SP statistic are all methods that are scale invariant and identify distributional shifts that may not be detected when simply comparing means.

[23]This test is analogous to the Mann-Whitney test (Mann & Whitney, 1947). However, to account for the large number of "ties" due to zero deposits, we test whether the probability is higher than it would be by chance rather than testing whether the probability of a random draw from the treated distribution is greater than the control is higher than 50%.

[24]We estimate the SP statistic using 100 draws for each arbitrary treatment assignment when estimating the bootstrapped standard errors.

C. *Estimated Impacts on Savings*

Table 2 provides the intent-to-treat estimates on the causal effect of the free mobile-deposit service offer estimated by equation (1), panel A, and equation (2), panel B. We observe a significant increase in monthly savings deposits with the partner bank (44%) and formal banks more generally (13% to 29%). However, we find no increase in total saving flows.[25] Appendix table A5 estimates the effect on the free mobile-deposit service offer on other saving devices and finds no statistically significant reductions, though point estimates suggest reductions in all other saving sources: cash, seetus, and other informal devices. This suggests that increases in formal savings are too small to cause meaningful percentage reductions in savings in other forms. Appendix table A6 further shows that there are also no effects on consumption or labor earnings.[26]

Less than half of the 44% increase in savings with the partner bank is deposited through the mobile-deposit channel. We observe gains in partner savings even among treated individuals who never used the mobile-deposit service. Moreover, the share of deposits attributable to the mobile-deposit channel increases as a function of frequency of use. These patterns provide some reassurance that the traditional channel for depositing savings is concentrated among those who chose not to use the mobile-deposit channel. In addition, among both infrequent and frequent users of the mobile-deposit service, a significant proportion expressed a preference for the traditional channel.

That the increase in partner savings is driven largely by the use of the traditional method of depositing savings

[25]Appendix table A4 shows that results are robust to an ANCOVA specification.

[26]Consumption is a measure of total monthly expenditure by the household and individual, and labor earnings is total monthly income earned from economic activity by the household and individual.

suggests that a main effect of the intervention was to increase access to formal saving accounts by facilitating the opening the bank accounts. These findings are consistent with Dupas et al. (2018), who estimate the effect of simply opening bank accounts. Also consistent with Dupas et al. (2018), we find small changes in the use of the account with the partner bank (a 6.5 percentage point increase) and no increase in total savings. Thus, even if deposit transaction costs were not a primary barrier, the opening of the account itself is likely to increase formal savings. Our December 2011 survey reveals that despite low use of formal savings, respondents have a strong preference for bank savings; respondents overwhelmingly report that banks are the most secure (82%) and easiest (48%) vehicle for savings. The continued use of the traditional deposit channel suggests that participants were willing to incur deposit transaction costs despite having an alternative option to avoid these costs.[27]

In regressions using levels rather than IHS transformations, we find no significant increase in savings, even with the partner bank. The magnitude of increased savings in the partner bank is small (95 LKR/month, 0.86 USD/month), and even the sign of formal bank savings and total savings changes across the two specifications (see appendix table A7). The differences between the IHS and level results reflect the influence of outliers. Winsorizing at the 99th percentile of deposits is enough to produce a statistically significant increase in deposits with the partner bank of 94 LKR and a statistically significant reduction in nonpartner formal deposits of 277 LKR. However, we continue to observe no significant difference in the other saving devices or in total savings (see appendix table A8).[28]

Appendix figure A4 shows the CDF of the mean in monthly saving deposits with the partner bank and change in mean monthly formal and total savings deposits, by treatment status. We find strong evidence of increased savings with the partner bank; figure A4a highlights significant movement along the extensive margin into saving with the partner bank. Averaging at each percentile ranking, the CDF of the treatment sample first order stochastically dominates the control group's savings in the partner bank. This is corroborated by both the KS statistic of .207 and the SP statistic of .369, both of them statistically significant.

We find less robust support for increased formal savings: the KS statistic is statistically significant at the 10% level, but the SP statistic is not. Appendix figure A4b shows that formal savings of those offered the free mobile deposit service lie primarily to the right of the control. We find the expected increase in formal savings along the extensive margin and small savers, but this difference is small and easily dominated by the behavior of larger savers. In contrast, we find no support for increased total savings, and the distributions lie virtually on top of one another at almost every savings amount (appendix figure A4c).

These results suggest that the intervention was effective in diverting savings toward the partner bank but not in generating a meaningful increase in total savings. Although the intervention yielded no significant increase in partner savings deposits on average, there were shifts along the distribution, particularly by small and marginal savers. Given subjects' preference for bank savings, the shift toward saving in the formal sector may have welfare benefits that are not captured in outcomes such as household consumption.

Of course, an alternate explanation for these muted results is that the interface was difficult to use. To address this concern, we note several facts. First, the interface mimicked the ubiquitous method of adding airtime to a mobile phone. Second, we provided training to every willing individual, successfully making a demonstration deposit to three-quarters of the treatment. Suggestive evidence that learning was not the main cause of low usage is that even the majority of those who successfully used the service once on their own (and thus overcame the initial learning costs) did not become frequent users of the mobile channel. We also find no heterogeneity of usage along characteristics that we expect would be associated with lower learning costs: the ability to change a sim or read text messages, or measures of mobile phone usage for calls and texts, or more general ability measures and education. Thus, while learning may have decreased usage of the product, the data do not indicate that learning costs are the primary reason for the low level of mobile deposits.

D. Sensitivity to Price

Table 3 tests for differences in savings behavior as a function of the service fees. We run regressions equivalent to equations (1) and (2), replacing the dummy for treatment with the inverse hyperbolic sine of the deposit fee assigned to that individual. The sample is limited to those offered the service and surveyed annually, meaning that we compare across randomized fee amounts among those offered the treatment.[29] We include the outcome variables *Mobile Savings*, the amount deposited through the mobile platform, and *Mobile Proportion*, the ratio of saving deposits observed through the mobile platform to the total savings deposits reported to the partner bank.[30] We use the inverse hyperbolic sine transformation for both the fee and the savings deposits to provide an elasticity interpretation.

[27] Note that a treatment effect on the treated cannot be estimated based on identifying subjects who used the mobile service. This is because we observe treated individuals using the savings accounts but not using the mobile service, thereby violating the exclusion restriction required when estimating the treatment effect on the treated.

[28] Appendix table A8 finds a statistically insignificant positive estimate for total savings, suggesting that the negative point estimate observed in table 2 is most likely a reflection of random chance and the large variance of savings.

[29] Unlike the previous analysis using high-frequency (primarily monthly) survey data, these estimations have two observations in the baseline period (i.e., prior to the offer letters) and two observations after the mobile deposit service was introduced (i.e., after the offer letters).

[30] For those who do not report any deposits to the partner bank, we record *Mobile Proportion* as 0. Assuming that the fee deterred use of the partner bank, this will bias our estimates in favor of finding a significant price elasticity for the service.

TABLE 3.—PRICE SENSITIVITY TO FEES OFFERED

	(1) Mobile savings	(2) Mobile proportion	(3) Partner deposit]	(4) 1[Partner] savings	(5) 1[Formal deposit]	(6) Formal savings	(7) 1[Any deposit]	(8) Total savings
	A: Postperiod (December 2011–November 2013)							
Fee (IHS)	−0.0196	−0.000630	−0.00117	−0.0124	−0.000604	−0.0435	−0.00505	−0.0978
	(0.223)	(0.768)	(0.886)	(0.845)	(0.954)	(0.635)	(0.400)	(0.110)
Obs (Ind)	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104
	B: All months with individual fixed effects							
Fee (IHS) × Post					0.00725	0.0396	0.000400	−0.0558
					(0.632)	(0.759)	(0.972)	(0.584)
Obs (Ind-month)					4,317	4,317	4,317	4,317
Free Mean	.19	.01	.16	1.18	.27	2.35	.94	8.26

Estimation conducted on the annual sample within which mobile transfer fees were randomized. Savings variables and fees are analyzed using inverse hyperbolic sine, so the interpretation is as an elasticity (percent impacts). Outcomes are monthly flows over the month prior to the survey wave, and the unit of observation is individual in panel A and individual-month in panel B. Mobile proportion is recorded as 0 for those who did not deposit any partner savings. All regressions control for the stratification variables used in the randomization protocol. Panel A conducts a cross-sectional comparison of the different treatment arms' outcomes in the postperiod and uses robust standard errors. Panel B uses the full set of monthly surveys, includes individual and survey wave fixed effects, uses inverse propensity weights for the attrition across survey waves to retain representation of the overall panel sample, and clusters standard errors at the individual. Free mean is the mean of the individuals' mean of those in the annual sample who received the deposit service for free across posttreatment survey waves. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

We observe a price elasticity not statistically different from 0.[31] We do not observe any statistically significant differences in monthly deposits in the partner bank (even when limited to just mobile deposits), in formal savings, or in total savings when using savings deposit level amounts (see appendix table A13).

Combined with table 2, this suggests that the mobile-deposit offer resulted in increased partner savings and formal savings deposits regardless of the price charged. The lack of price sensitivity we observe is largely driven by the low fees; at 2% and 4% fees, we do not observe a consistent decrease or statistically significant difference in use of the mobile service. However, we do observe that the total amount deposited through the mobile channel is significantly lower for those charged 8% (see table 1), though total deposits in the partner bank are not. This suggests that those in the 8% group were still interested in the partner bank account but sidestepped the mobile deposit service. Coupled with the mobile-deposits being a relatively small percent of total reported deposits with the partner bank, these results suggest that deposit costs are not driving overall savings behavior.

IV. Examining Heterogeneity in Demand

Given the relatively low average adoption rates and moderate impacts on savings, we explore whether targeting the baseline characteristics that predicted demand would have yielded a greater impact on savings. Table 4 explores a number of theoretically motivated baseline characteristics on demand for the service. We limit the sample to those who were successfully delivered the offer letter, to ensure that the results are driven by demand for the service rather than an inability to offer the service. These covariates were not prespecified and are instead motivated by our review of the theoretical literature and our own priors as reflected in the sampling design. We therefore consider these correlations to be exploratory in providing potential direction in targeting subgroups that may have higher demand and greater marginal benefits from mobile-linked financial services. Appendix table A14 estimates a model predicting adoption of the service with additional covariates.

In general, we find women, those living at intermediate distances from a bank branch and those owning a mobile phone at baseline, were significantly more likely to use the service. This suggests that those who were most likely to benefit from a reduction in deposit transaction costs (e.g., women who save smaller amounts more frequently relative to men and those living farther from the bank), and those already familiar with the technology's interface, were most likely to use the service. But we fail to find support for other characteristics predicting demand, including those supported by our sampling hypothesis (e.g., a reported willingness to pay for the service) or theoretically motivated: phone capacity (reduced effort costs), present biasedness (asymmetric costs for depositing versus withdrawing), bank familiarity (trust-related information asymmetry), and baseline savings (higher value for the service).

Those living 2 to 5 km from a bank branch are 11 percentage points more likely to try the service and deposited 70% more through the service. This suggests that those living closer may not value the reduction in distance costs as much and that this benefit tapers off at greater distances, perhaps due to the transaction costs of withdrawals. Hence, this intermediate distance appears to be the sweet spot for mobile saving; too close and deposit costs were already negligible, too far and withdrawals are too difficult to make.

Among women, we observe an 8 percentage point greater likelihood of trying the service and a 40% increase in the

[31] Appendix table A11 confirms no consistent or meaningful differences in savings deposits with the partner bank, bank savings deposits, or total savings deposits as a function of the percentage point increase in the fee, and appendix table A12 finds these results are robust to the use of probability weights based on the predicted likelihood of being in the panel sample as a function of baseline characteristics, confirming that our results are unlikely to be driven by differential attrition.

TABLE 4.—DETERMINANTS OF TAKEUP OF THE MOBILE DEPOSIT SERVICE

	(1) Accepted Account	(2) Demonstration Completed	(3) Used Service	(4) Amount deposited, IHS	(5) Amount deposited, LKR	(6) Deposited in Partner Bank self-reported
Female	0.0377**	0.0917***	0.0740**	0.396**	−23.67	0.00541
	(0.0173)	(0.0267)	(0.0303)	(0.191)	(141.1)	(0.0302)
Married	0.0263	0.0690**	−0.0333	−0.206	−236.0	0.0353
	(0.0214)	(0.0332)	(0.0335)	(0.217)	(301.6)	(0.0335)
Owns mobile phone	0.0100	0.0489	0.0713**	0.523**	180.6	0.0439
	(0.0262)	(0.0403)	(0.0360)	(0.220)	(109.8)	(0.0365)
Phone savvy	0.00547	0.00377	−0.000104	−0.00657	9.246	0.00651
	(0.00338)	(0.00476)	(0.00442)	(0.0283)	(26.07)	(0.00473)
Minutes to mobile agent	0.00117	0.00150	0.0000573	−0.00218	−12.42**	−0.00143
	(0.000854)	(0.00138)	(0.00149)	(0.00979)	(6.234)	(0.00142)
2 to 5 km from bank	0.00731	0.0517**	0.0950***	0.649***	302.2**	0.0800***
	(0.0153)	(0.0234)	(0.0244)	(0.157)	(149.9)	(0.0248)
More than 5 km from bank	−0.00336	−0.0409	−0.0401	−0.190	68.23	0.0487
	(0.0208)	(0.0328)	(0.0285)	(0.184)	(141.1)	(0.0330)
Bank experience	0.0170**	0.000851	−0.0112	−0.0273	94.57	0.00952
	(0.00724)	(0.0109)	(0.0108)	(0.0705)	(61.61)	(0.0113)
Present-biased	0.0299**	0.00464	−0.0201	−0.126	−11.42	−0.0144
	(0.0152)	(0.0242)	(0.0239)	(0.153)	(124.9)	(0.0253)
Discount rate	−0.0509	−0.0212	0.0675	0.684	523.4	0.0106
	(0.0679)	(0.0971)	(0.103)	(0.677)	(501.0)	(0.105)
Willingness to take risks	−0.00109	−0.00383	−0.00865**	−0.0542**	2.165	−0.00908**
	(0.00264)	(0.00401)	(0.00410)	(0.0260)	(11.37)	(0.00415)
Formal savings	0.00117	0.0000613	0.00444	0.0368	26.82	0.00900**
	(0.00210)	(0.00335)	(0.00349)	(0.0231)	(20.25)	(0.00374)
Total savings	−0.00147	0.00112	0.00166	0.00146	−26.61	0.00163
	(0.00211)	(0.00330)	(0.00319)	(0.0204)	(23.12)	(0.00334)
Household consumption	−0.0405***	−0.0541***	−0.00181	−0.0280	−123.0	0.00943
	(0.0149)	(0.0209)	(0.0197)	(0.125)	(144.8)	(0.0203)
Observations	1,503	1,503	1,503	1,503	1,503	1,497

Account Accepted is based on enumerator reports. Demonstration Completed, Used Service, and Amount Deposited are based on institutional data provided by the partner bank. Deposited in Partner Bank is an indicator of whether the respondent self-reported depositing savings to the partner bank in the previous month on one of the two annual surveys conducted after the roll out of the mobile-deposit service. IHS refers to amounts transformed using the inverse hyperbolic sine function. Demonstration Completed indicates that the individual is observed in the partner bank's data set as having used the service. Regressions pool monthly, and annual samples and all variables are demeaned. Regressions are conditional on the letter being delivered and being in the panel sample, include treatment status and frequency of being surveyed as additional covariates, and use robust standard errors. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

amount deposited through the mobile-deposit service relative to men. The lack of a difference in total amount deposited is due to the nonnormal distribution of savings deposits and is consistent with gender patterns at baseline: women are more likely than men to save some amount, but conditional on saving, men save larger amounts. This baseline difference suggests women may value the service more as smaller and more frequent savers, with arguably higher mobility costs and other-control concerns.

Finally, the 89% of the sample who owned a mobile phone at baseline were no more likely to go through the steps of learning the service, but were more likely to use the service (7 percentage points) and deposited 58% more through the service, an increased amount of 190 LKR (1.73 USD). This suggests that despite the simplicity of the product, the learning costs did dampen demand for the service for those who were not previously exposed to the underlying technology.

Given the significant number of nonadopters and evidence of a distributional shift even in the absence of large differences in means, we explore whether targeting the intervention among women and those living at intermediate distances would have been more effective. We do this by expanding equation (1) to be a difference-in-difference and equation (3), with respect to the baseline characteristic of interest:

$$Deposits_{si} = \beta_0 + \beta_1 MobileFree_{si} + \beta_2 Target_{si} + \beta_3 MobileFree \times Target_{si} + \mu_s + \epsilon_s i, \quad (3)$$

where *Target* is the characteristic of interest. Analogous to equation (2), we expand equation (3) to be a triple difference and interact *Post* with the above covariates. β_3 signifies the additional marginal effect of the intervention of belonging to the subgroup of interest relative to the average effect of those not belonging (β_1). Our primary hypothesis of interest tests for the intervention's total effect on the potentially targeted subgroup ($H_0 : \beta_1 + \beta_3 = 0$).[32]

Table 5, columns 1 and 2 show that the likelihood of depositing and the amount deposited into the partner bank are both significantly higher among women offered the mobile-deposit service. The mean increase among women is twice

[32] We show heterogeneity by mobile phone ownership at baseline in appendix table A15 rather than the main text, as this is a significant portion of the sample and is unlikely to be a characteristic that would be used for targeting to improve financial inclusion.

TABLE 5.—DIFFERENTIAL IMPACTS, BY GENDER

	(1) 1[Partner deposit]	(2) Partner savings	(3) 1[Formal deposit]	(4) Formal savings	(5) 1[Any deposit]	(6) Total savings
	A: Postperiod (December 2011–November 2013)					
Free Mobile	0.0539***	0.352***	0.0182	0.0715	−0.00929	−0.104
Deposit Offer (β_1)	(0.0103)	(0.0859)	(0.0157)	(0.151)	(0.00854)	(0.108)
Free Mobile	0.0603**	0.482**	0.0465	0.387	0.0225	0.411*
Deposit Offer × Female(β_3)	(0.0247)	(0.194)	(0.0397)	(0.339)	(0.0189)	(0.227)
Observations	790	790	803	803	803	803
$\beta_1 + \beta_3$	0.114	0.834	0.0647	0.459	0.0132	0.307
Prob > F-statistic	0.000	0.000	0.0754	0.130	0.432	0.121
	B: All months with individual fixed effects					
Free Mobile Deposit			0.0316**	0.221*	−0.00957	−0.102
Offer × Post (β_1)			(0.0150)	(0.133)	(0.0128)	(0.119)
Free Mobile Deposit			0.0293	0.308	0.0194	0.347
Offer × Post × Female (β_3)			(0.0368)	(0.304)	(0.0272)	(0.263)
Observations			20028	20028	20027	20027
$\beta_1 + \beta_3$			0.0609	0.528	0.00986	0.245
Prob > F-statistic			0.0708	0.0536	0.682	0.295
KS Statistic	.375	.375	.184	.237	.079	.118
p-value	.000	.000	.152	.028	.973	.664
SP Statistic	.455	.477	.552	.579	.377	.530
p-value	.000	.002	.159	.118	.614	.346

Savings variables are analyzed using the inverse hyperbolic sine, so the interpretation is as a log (percent impact). Outcomes are monthly flows over the month prior to the survey wave, and the unit of observation is individual in panel A and individual-month in panel B. All regressions control for gender and the stratification variables used in the randomization protocol. Panel A conducts a cross-sectional comparison of treatment and control outcomes using all post-treatment survey waves and uses robust standard errors. Panel B uses the full set of monthly surveys, includes individual and survey wave fixed effects, uses inverse propensity weights for the attrition across survey waves to retain representation of the overall panel sample, and clusters standard errors at the individual. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, and $^{***}p < 0.01$.

as large as that of men. Though women are not statistically different from men, we do observe that when they are offered the free mobile-deposit service, they are more likely to make a monthly deposit into formal savings (6 percentage point increase) and have higher formal savings (53%). We observe no statistically significant change in total savings, though the point estimates are positive. The magnitudes suggest that women, relative to men, were more likely to generate savings deposits to the partner bank from sources other than alternative savings vehicles. In fact, the negative point estimate suggests a potential of men substituting at a rate greater than 1-to-1 such that there is a net decline in total savings when offered the mobile-deposit service. Overall, our results suggest that the mobile-deposit service was more useful to women, who on average save small amounts more frequently. Nonetheless, we find no support for increased total savings even among women.

Similarly, table 6 shows that among those at the intermediate distance (2 km to 5 km from a bank), we observe higher partner bank and formal savings deposits, with no robust corresponding increase in total savings. Though panel A finds an increase in total savings, this is not robust to controlling for savings deposited in the period prior to the intervention. Our results by distance suggest that though substitution from formal savings may be comparatively less than those living closer and farther, it is still the case that the increased deposits in the partner bank are being sourced from alternative savings. The lack of effect among those living 5 km or farther from the bank reiterates the concern that withdrawal transaction costs may inhibit the use of services that reduce only deposit transaction costs.

Though we do not observe present biasedness as being correlated with demand for the service, we still explore heterogeneous effects given the strong theoretical foundation of commitment devices and present biasedness in savings decisions. Appendix table A16 shows that those who were present biased were no more likely to deposit with the partner bank. However, we do observe that they were marginally more likely to increase their formal saving deposits overall. This suggests that those who were present biased were less likely to be substituting savings from other formal saving devices. Nonetheless, we continue to see no support for increased total saving deposits.

These differences by gender, distance, and present biasedness are echoed in our measures for changes in the distribution of savings. Appendix figures 5, 6, and 7 depict the CDF of savings in the partner bank and changes in formal and total savings by gender, intermediate distance, and present bias, respectively. They show an increase to the partner bank in both the extensive and intensive margin. These effects are corroborated by the KS statistics and the SP statistics, all of which are statistically significant with p-value $< .03$. They also illustrate some support for increased savings in formal banking among these subgroups, with corresponding KS statistics and SP statistics that have relatively low p-values. However, the figures suggest no difference in the distribution of total savings in any subgroup.

Similar to the total sample, when estimating impact on deposit amounts, as opposed to percent changes, results are generally statistically insignificant. Winsorizing at the 99th percentile of deposits, women experience a marginally greater increase of 177 LKR (1.61 USD) in monthly savings

TABLE 6.—DIFFERENTIAL IMPACTS, BY DISTANCE TO THE BANK

	(1) 1[Partner deposit]	(2) Partner savings	(3) 1[Formal deposit]	(4) Formal savings	(5) 1[Any deposit]	(6) Total savings
	A: Postperiod (December 2011–November 2013)					
Free Mobile	0.0371***	0.208*	0.00371	−0.0790	−0.0301***	−0.223
Deposit Offer (β_1)	(0.0140)	(0.117)	(0.0222)	(0.205)	(0.0115)	(0.147)
Free Mobile Deposit	0.0684***	0.577***	0.0528	0.512*	0.0546***	0.514**
Offer × Intermediate Distance (β_3)	(0.0206)	(0.168)	(0.0326)	(0.303)	(0.0165)	(0.209)
Free Mobile Deposit	0.0111	0.0762	0.00588	0.0801	0.0236	0.0421
Offer × Far Distance	(0.0255)	(0.213)	(0.0393)	(0.358)	(0.0213)	(0.262)
Observations (Ind)	790	790	803	803	803	803
$\beta_1 + \beta_3$	0.106	0.785	0.0565	0.433	0.0245	0.291
Prob > F-statistic	7.12e-12	1.22e-10	0.0176	0.0527	0.0363	0.0499
	B: All months with individual fixed effects					
Free × Post (β_1)			0.0348*	0.290*	−0.0157	−0.0934
			(0.0197)	(0.170)	(0.0158)	(0.151)
Free × Post × Intermediate (β_3)			0.00255	−0.0305	0.0331	0.266
			(0.0296)	(0.258)	(0.0250)	(0.237)
Free × Post × Far			0.0160	0.0521	−0.00619	−0.167
			(0.0448)	(0.385)	(0.0310)	(0.285)
Observations (Ind-month)			20028	20028	20027	20027
$\beta_1 + \beta_3$			0.0373	0.259	0.0174	0.173
Prob > F-statistic			0.0914	0.180	0.371	0.346
KS Statistic	.320	.320	.155	.142	.074	.118
p-value	.000	.000	.042	.079	.748	.206
SP Statistic	.448	.454	.557	.544	.455	.487
p-value	.001	.000	.103	.163	.236	.600

Intermediate distance refers to households 2–5 km from the nearest bank, and Far Distance refers to households located greater than 5 km from the nearest bank. Estimations are conducted on the monthly panel sample. Savings variables are analyzed using the inverse hyperbolic sine, so the interpretation is as a log (percent impact). Outcomes are monthly flows over the month prior to the survey wave, and the unit of observation is individual in panel A and individual-month in panel B. All regressions control for Intermediate and Far Distance and the stratification variables used in the randomization protocol. Panel A conducts a cross-sectional comparison of treatment and control outcomes using all posttreatment survey waves and uses robust standard errors. Panel B uses the full set of monthly surveys, includes individual and survey wave fixed effects, uses inverse propensity weights for the attrition across survey waves to retain representation of the overall panel sample, and clusters standard errors at the individual. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, and *** $p < 0.01$.

deposits with the partner bank, statistically significant at the 10% level. Similarly, those living at intermediate distances deposit 280 LKR (2.55 USD) more with the partner bank, significant at the 1% level. In contrast, we observe no marginal difference in saving with the partner bank among those that are present biased. For women and those living at the intermediate distance, we observe no statistically significant marginal difference, or overall increase, in formal or total saving deposits. Among the present biased, we do estimate a significant increase in formal savings deposits (671 LKR, 6.10 USD, statistically significant at the 5% level), but see no corresponding increase in total savings.[33]

Appendix tables A9 and A10 similarly find no significant effect on consumption and labor supply by gender, distance, or present biasedness.

V. Conclusion

Our experiment is one of the first to examine the potential for using mobile phone–linked bank accounts to encourage savings. We find that the introduction of a mobile-deposit service with zero deposit transaction fees significantly increased the share of savings deposited with the partner institution and in the formal banking sector more generally. However, we observe no increase in total savings or in downstream welfare measures, such as consumption or labor earnings. Moreover, while the effect on partner bank deposits is large as a proportion of prior balances, the increases were driven by small savers, and, hence, aggregate deposits do not increase meaningfully from the bank's perspective. We find that the groups we expected to benefit most from the reduced deposit transaction costs (such as women and those living at intermediate distances from banks) did indeed have higher demand for and a greater impact from the service. However, even for these subgroups, we find no evidence that the service increased total savings.

Overall, we do not find a transformative effect on total savings from providing a mobile-deposit service. This is despite a concentrated effort to reduce barriers to a minimum (e.g., by removing bank account fees and offering demonstrations of the service) and the intervention being a combined effect of mobile money and formal savings benefits. Our results suggest limited effects from increasing convenience and reducing deposit transaction costs for savings deposits. This is further supported by the lack of responsiveness to the price of using the service and the large share of deposits made to accounts via traditional channels.

[33] The estimates for saving amounts with the partner bank use the estimating equation in panel A, and estimates for formal and total savings amount use the estimating equation in panel B. Estimates for formal and total savings are not meaningfully different between the two estimating equations.

The recent work by Dupas et al. (2018) finds similarly modest effects from increasing bank access by eliminating pecuniary costs for opening bank accounts. Our results suggest it is unlikely that the additional reduction in deposit transaction costs gained from introducing mobile savings will transform saving rates. This is consistent with studies in contexts more integrated with mobile money that focus on the impact of savings from mobile money or connecting formal accounts to existing mobile-money users, which also typically have the feature of reducing deposit transaction costs and levying fees on withdrawals (Batista & Vicente, 2017; Bastian et al., 2018; Jack & Suri, 2016; Batista & Vincente, 2016). While it still may be the case that the impact on savings would be greater in places that are more familiar and integrated with mobile money or where banks are more remote, our findings highlight that a "build it and they will come" solution is not enough for people to internalize the benefits of reduced deposit transaction costs related to formal saving devices.

Our results highlight two potential explanations for why reducing transaction costs for formal deposits may generate modest marginal gains in increasing savings. First, though removing transaction costs is critical for savings efficiency, the marginal gain from reduced transaction costs may be relatively small due to the presence of easily accessed informal saving methods. While we do not find support for heterogeneous effects with respect to informal savings access (e.g., seetu membership), this may reflect lack of variation in our limited measures of informal finance and that Sri Lanka has greater financial access than other contexts. In general, an area of future research is to consider the marginal benefits to formal savings products relative to the status quo provided by informal saving devices. This may also explain heterogeneity observed in the savings mobilization literature. Perhaps interventions that address behavioral constraints are especially promising as they may not be solved by either formal or informal saving methods.

Consistent with the importance of behavioral constraints, while we do not find that reductions in deposit transaction costs resulted in increased saving deposits, Callen et al. (2019) find that a door-to-door deposit collection increased formal savings in a similar context. This differential finding suggests that salience and habit formation were more important than reductions in deposit transaction costs. Indeed, Callen et al. (2019) find results similar to ours when the door-to-door collection is replaced by a lock box collected at the same frequency. The lock box, missing the personal feature of a face-to-face collection, increased savings deposits with the institution but had no effect on total savings. Further progress in generating financial inclusion by banking the unbanked will depend on improving our understanding of behavioral constraints that inhibit savings and the ways that formal financial services differ from and can improve on informal financial options.

Second, the gains from reducing transaction costs in saving may be mediated by other constraints. Specifically, our paper, along with others on mobile money, focuses on reducing the transaction costs of deposits. But it may be that withdrawal costs are an important transaction cost that inhibits greater use of savings accounts (consistent with the fact that those far from banks are less likely to save using our mobile product than those at intermediate distances). For example, Schaner (2016) finds that providing ATM cards that reduced withdrawal fees by 50% increased account use. Indeed, the empirical pattern of greater frequency of deposits relative to withdrawals we observe may be a reflection of the high cost of withdrawal that is present in mobile money and many informal devices (e.g., ROSCAs and seetus). This is a characteristic missing in most saving devices and warrants further research, especially given its natural trade-off with addressing behavioral constraints. In general, our modest results suggest that a better understanding of technology's role in altering substitutability across saving mechanisms is important in understanding the promise and limitations of digital finance.

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