

# Mobile Payment Systems: The Impact of Earmarked Savings on Sanitation Purchases\*

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## Abstract

We test whether access to a mobile money savings vehicle increases the propensity of households to purchase an improved sanitation service. Giving households the ability to save through the mobile money program whenever they have funds available increases the value of deposits by 19% and increases the probability that a household purchases the sanitation service from our program by 5.7 percentage points. The increase in purchase of the program desludgings was not accompanied by an overall increase in take-up: the option to save using mobile money caused households to substitute away from purchasing the improved service in the general market rather than substituting away from the unimproved service. Households with low levels of education, fluctuating incomes, and those who tend not to lend to others are the most likely to take advantage of the opportunity to save in the accounts, while households which already managed to use savings to pay for desludgings in the past are less likely to be affected by the ability to save at will.

Keywords: mobile money, savings, sanitation, earmarking.

JEL codes: G21, O16, Q53, Q56, Z18.

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# 1 Introduction

Households tend to be price elastic in their demand for health-enhancing technologies (Ashraf et al. 2010, Cohen & Dupas 2010, Dupas & Robinson 2013, Kremer & Miguel 2007). Potential causes of this high elasticity of demand include liquidity constraints (Dupas & Robinson 2013, Guiteras et al. 2016, Tarozzi et al. 2014), a lack of information (Dupas 2011, Jalan & Somanathan 2007, Madajewicz et al. 2007), and present-biased preferences.<sup>1</sup> Because health and sanitation purchases are associated with substantial externalities, understanding how to ease barriers to purchasing health products could have important impacts with spillovers throughout communities. See Dupas (2011) for a review.

More flexible payment plans are one way to increase take-up and thus welfare. Offering loans could increase take-up, but in practice it is difficult to provide loans for services because after the service is provided there is no collateral to encourage households to repay their loans. Alternatively, allowing individuals to make partial payments in advance could help households save for purchases that they know that they will eventually need to make. Partial advance payments will not necessarily lead to lower demand relative to loans. Guiteras et al. (2016) find that willingness to pay increases when households are able to pay over time regardless of whether payments are made in advance or through loans. Similarly, Afzal et al. (2017) find that microlending and microsavings are substitutes: individuals use both to finance lumpy purchases over time, and may even demand both loans and savings accounts at the same time.

Access to financial products and the ability to save remains a major problem for households in developing countries (Dupas et al. 2017, Karlan et al. 2014). Commitment savings mechanisms have been implemented to improve households' ability to save for important but infrequent expenditures, but they have had mixed success in a variety of settings (Ashraf et al. 2006, Blumenstock et al. 2017, Brune et al. 2016, Dupas & Robinson 2013, Karlan & Linden 2014, Kast et al. 2012). Dupas & Robinson (2013) find that earmarked savings mechanisms help individuals save for health emergencies, but are much less effective at helping people save for the type of preventative health purchases that we study. Layaway plans were common in the US before credit cards. But, there has been little use of layaway plans in developing countries.

Mobile money provides households with increased access to banking services, and thereby increase their ability to smooth income and save over time (Suri & Jack 2016). While MPESA

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<sup>1</sup>Ben Yishay et al. (2017) find that the willingness to pay for latrines increases substantially when households are offered the chance to pay for the latrine over time.

has been found to provide informal insurance and reduce exposure to risk in Kenya (Jack & Suri 2014, Suri et al. 2012), mobile money has quickly become more versatile, and little research studies its use for payment systems and savings accounts.

We offer households subsidized mechanized latrine pit desludgings. Households in peri-urban Dakar need to purchase this service approximately once every six months. They can choose a manual desludging which is cheaper but less sanitary, or a mechanized desludging which is more expensive but which involves a truck pumping the sludge from the pit and driving it to dump far away. We offer households the opportunity to sign up in advance for subsidized mechanized desludgings, paying only a small deposit when signing up.<sup>2</sup>

We then randomize the sample of individuals who have signed up for the subsidized sanitation product into one of three payment groups. One group ('pay in full') must pay the full amount at one time; another group ('save at will') is encouraged to deposit however much they want whenever they want in advance of the service; and the final group ('monthly billing') receives a monthly statement for how much they should deposit in advance of the service (though they may in fact deposit any amount).

Individuals in the 'save at will' group are significantly more likely to purchase the subsidized service; they take greater advantage of their ability to deposit amounts below the full price of the good; and conditional on purchasing they anticipatorily save over a longer period of time. The 'monthly billing' treatment has no such positive effect on purchase of the subsidized service, frequency of smaller deposits, and time spent saving in anticipation of purchase. This suggests that the save at will treatment gives people a way to dedicate their money to a specific service, and that individuals need the flexibility in payment terms that the save at will treatment offers them but the monthly billing treatment does not.

While the option to save at will increases the probability that a household purchases a subsidized mechanized desludging from our program, it does not increase the overall likelihood of the household purchasing a mechanized desludging.

We find that overall, it is those individuals with risky salaries, low levels of education, and who have had trouble saving in the past who are most likely to successfully use the accounts to save for a desludging. Although we do not have data on financial literacy per se, this is suggestive evidence that individuals are able to self-identify as needing to save over time and can take advantage of these interventions.

This paper proceeds as follows. In Section 2 we discuss the desludging decisions faced by households living in peri-urban Dakar and give details regarding the mobile money provider.

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<sup>2</sup>A small subset of households were randomly chosen to not be required to pay the deposit.

Section 3 discusses the details of the mobile money experiment. Section 4 describes the data from our baseline and endline surveys as well as the mobile money administrative data. Section 5 presents our estimation strategy and Section 6 our results. Finally, we conclude in Section 7.

## 2 Background

Sanitation issues have been widely studied in rural contexts, Communities face different, but equally complex, problems in urban environments. While latrine/toilet ownership is common in urban areas, the disposal of latrine waste can be problematic. Improper removal and disposal of latrine waste is common and leads to important health repercussions (Mara et al. 2010).

Almost two million people in peri-urban Dakar use latrines which are not connected to sewage systems. These pits fill up approximately once every six months and then need to be desludged, or emptied, for continued use.<sup>3</sup> When the latrine pit is full, households have two options: manual or mechanical desludging. In a manual desludging, a person enters the pit with a shovel and a bucket and dumps the sludge in the courtyard or in the street in front of the house. In our baseline survey, 56% of households chose this option for their most recent desludging. Of these, 53% of manual desludgings are done by a family member, usually for free (94% of the time); and 47% are done by a person hired for the task at an average price of \$29. Households who had a family member conduct a manual desludging reported dumping the sludge in their own courtyard 34% of the time, in front of their house 32% of the time, in the street 24% of the time, and in a vacant lot 6% of the time. For those who hired a non-family member to provide the service, the dumping patterns were similar (21%, 38%, 29%, and 7%). The second option, a mechanical desludging, is chosen by 44% of households. These households hire a truck to pump the sludge out of their pit and transport it to dump at a treatment center, for an average price of \$50.

Many households choose manual desludgings due to the high price of mechanized desludgings. We asked households who had gotten desludged in the past but *never* purchased a mechanized desludging the primary reason they had not purchased a mechanized desludging. The high price was cited by 62%, 26% were concerned about their house not being accessible by the desludging truck, and 6% said that they heard rumors that trucks leave sludge in the

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<sup>3</sup>Of those individuals in our survey who have had their current pit fill up at least twice, 79% of them say this happens at least once a year.

pits.

Although desludging is a regular maintenance need, typically required between once and twice a year, many households do not plan their desludging until the pit is full. When pits need to be desludged, it often comes on as an urgent necessity. A household may want to purchase a mechanized desludging, but end up doing a manual desludging instead due to liquidity constraints in their moment of need. Of those who had their current pit desludged, 83% stated that they did so because the toilet was backing up, the pit was overflowing, or there were pests or smell coming from the pit, 14% said they looked in the pit and saw it was getting full, while only 4% said it was a regularly scheduled or preventive action. Of those who had a desludging, 67% claimed they did it within two days of realizing they needed a desludging. For those who waited, 67% said that the reason they waited was lack of access to money and 16% said it was due to lack of access to labor. Thus liquidity appears to play a central role in households' desludging decisions.

## 2.1 Mobile Money in Senegal

Wari is the primary mobile money provider in Dakar. As of July 2014, Wari controlled 80% of the market for mobile money transfers in Senegal with an average of 125,000 daily remittances. Transactions are made through the 3,000 Wari stations, typically located in corner shops (Williams 2014).

Wari, like many money transfer services, offers services across Dakar by partnering with gas stations, internet cafes, and local corner stores. This provides them a much wider reach than a traditional bank, which may only have a few branches centered in wealthier areas of the city. Individuals can transfer money to other private individuals by visiting any Wari partner. A client gives some amount of money to a Wari station, the transfer is recorded and tracked using the phone number of the recipient, and the recipient receives an SMS text message letting him know the money is available. The recipient can then go to any Wari station to pick up the funds. Individuals can also use Wari to pay their utility bills or receive pension payments.

In our baseline survey 97% of respondents have heard of Wari and 86% have experience using it.<sup>4</sup> We see that 64% of households have used Wari to send money to another individual, 73% have received an inter-personal transfer via Wari, 30% have used Wari to pay a bill,

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<sup>4</sup>We ask respondents about all mobile money providers. Wari is the most commonly used. Runners-up include Joni Joni that 15% have used, Orange Money that 13% have used, and PosteOne that 10% have used.

and 3% have received a pension payment via Wari.

Before working with us, Wari had not offered mobile savings accounts but were interested in expanding their financial services. For the purposes of our project they created Wari savings accounts and allowed our subscribers (and only our subscribers) to save money in them.<sup>5</sup> Thus, although our sample was quite familiar with Wari in the baseline, they did not have experience saving money using Wari accounts.

### 3 Experimental Design

In an attempt to test whether mobile money savings accounts could alleviate households' liquidity constraints and increase the take-up of mechanized desludgings, we ran a mechanized desludging subscription intervention. Almost 4000 households in peri-urban Dakar were offered up to two discounted mechanized desludgings over a period of 12 months if they signed up for the subscription. Our survey showed that the average cost of an unsubsidized mechanized desludging is \$50 and the average cost of a manual desludging not conducted by a family member is \$29. We offered subsidized prices on mechanized desludgings, randomly offering half of the households a price of \$48 and half a price of \$34. All households received a \$6 payment for their participation in the survey. Of these, 87% were randomly required to leave this as a deposit if they signed up for the subscription (but could access the money immediately if they did not sign up for the subscription). If they still had not used the subscription by the end of the 12 months, they were given access to their original \$6 deposit and any funds saved in the account. The other 13% could sign up as purely cheap talk, with no commitment on their part.<sup>6</sup> The script which the enumerators used in the survey to introduce the subscription service can be found in Appendix A.

Households were selected by mapping the city of Dakar, excluding areas which were on the sewage network or part of military barracks, parkland, etc. We placed 410 equally spaced grid points across those areas and used the residences closest to each grid point as our starting points. Coming out the door of the first house, the teams would turn right, mapping households on both sides of the street, and turning right at every corner. If one circuit of the block was not enough to identify 25 households, they would return to the original household and spiral out to take the second right instead of the first right. We then began approaching

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<sup>5</sup>Wari was interested in working with us partially as an experiment to see if savings accounts were a business they wanted to get involved in more generally. After our intervention ended they decided to return any money left in our subscribers' savings accounts and not continue offering such products.

<sup>6</sup>We study the impacts of the varying subsidy levels and deposit requirement in a different paper.

those 25 mapped households in a pre-specified randomly determined order until we found 12 who had a functioning pit and for which the household made the desludging decision (e.g., not a renter if the owner was the one in charge of desludging decisions). A randomly selected ten of those were offered the subsidized desludging, with the other two surveyed to measure spillovers.

All transactions through the subscription service were made using Wari mobile money. Of the 3757 households which were offered the subscription, 1496 enrolled.<sup>7</sup> After making the enrollment decision, the 1496 households which signed up were randomized into one of three mobile money interventions. All 1496 subscribers received monthly SMS messaging, but the exact content of the message, and the functionality of their account, varied depending on the treatment group. We will call the three groups ‘save at will,’ ‘monthly billing,’ and ‘pay in full,’ though these names were not mentioned to participants. The three groups received the following text messages every month.

- Save at will: “Need to empty your latrine pit? Save bit by bit to have XX in the Wari account for each of your two desludgings, then call ZZ. Available until DD/MM/YY.”
- Monthly billing: “Need to empty your latrine pit? Pay YY each month in the Wari account then call ZZ. Your two desludgings are XX each. Available until DD/MM/YY.”
- Pay in full: “Need to empty your latrine pit? Your first two desludgings will cost you XX each, payable by Wari at the time of service. Call ZZ. Available until DD/MM/YY.”

The monetary amounts in the messages varied by treatment, whether the person paid a deposit, and their subsidy level. The pay in full treatment was enforced, such that individuals were not able to make deposits any smaller than the full amount.

In both the save at will and monthly billing treatments individuals were able to make deposits of any size whenever they wanted, so in terms of Wari capabilities they were logistically the same. But the monthly billing messages suggested to participants that deposits should be in the amount requested and suggested that the deposits were “payments.” The save at will messages instead suggested that the deposits were “savings.”<sup>8</sup>

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<sup>7</sup>Of those who did not sign up for the service, 31% stated that the primary reason they didn’t sign up was that the price was still too high, 28% stated that the primary reason was that they thought they wouldn’t need a desludging in the near future, and 23% stated that they could not sign up without first consulting other family members.

<sup>8</sup>The script we used with participants does not explicitly mention what happens to their funds at the end

There were small financial disincentives to making multiple deposits, and these disincentives were relatively larger for small deposits. Clients paid a \$0.20 fee to deposit any amount less than \$10 and a 2% fee for deposits larger than that. There were no fees for withdrawals or transfers to desludging operators. During the survey, subscribers were told that if they wanted to withdraw money they could call the phone number mentioned in the text messages Monday through Friday from 8 to 6. In practice, this never happened. The only time participants withdrew money other than to pay for a desludging or when the accounts were closed at the end was when they deposited the wrong amount (e.g., thought they had access to a third subsidized desludging when they did not or thought that they only needed to pay \$30 for a desludging when it actually cost more), figured it out, and took the money back out.

Although these accounts may seem like they have a relatively soft commitment, through mental accounting, and be close to the safeboxes in Dupas & Robinson (2013), there are some noteworthy differences which make them closer to the lockboxes in Dupas & Robinson (2013). First, the participants can only withdraw money Mon-Fri 8-6, which is limiting. Second, even during those hours they have to make a phone call and then go over to a Wari boutique. This takes time and involves both a monetary and time cost (since making phone calls is not free). They can not have immediate anonymous access the way they could with the safe box. Finally, although participants can withdraw from the account with no fee, there was a fee to deposit in the Wari. Since many people don't recognize the sunk cost fallacy, they may hesitate to withdraw money for some purpose other than a desludging when they remember the fee they paid to deposit the money originally.

People in Dakar often change their phone numbers, so we inquired whether the messages we sent were actually received. In our endline survey we asked subscribing households if they received the text messages. We find that 68% say they received messages every month, 14% say they received some messages, and 13% say they didn't receive any messages. There are an additional 5% who say they don't know, usually because the person responding to the endline survey was not the same person who responded to the baseline and whose phone number was set to receive the text messages. Thus, most people do seem to receive the monthly notifications.

In our original design we had planned to additionally study the impact of earmarking of the 12 months if they don't have enough to pay for a desludging or don't end up needing to purchase a desludging. We did explicitly tell individuals how they could withdraw money from their accounts if they wanted to. But, those in the monthly billing group could potentially have thought that they were paying in advance, rather than saving towards payment, and this could have acted as a deterrent to depositing.



and having multiple accounts. While all individuals were offered the account earmarked to pay for the mechanized desludging, in a cross-cutting randomization half of the individuals were additionally offered a general (not earmarked) account. Of those who had a non-earmarked savings account, 96% of them never touched it, 3% of them deposited into the non-earmarked savings account once, and 1% deposited multiple times. These numbers are not low relative to the literature (Dupas et al. 2017).<sup>9</sup> Given the lack of variation in use of the general savings account, in this paper we focus on the three payment options relevant for the earmarked desludging account.

It may be surprising that, of the 1496 subscribers, only 19% of them actually purchased at least one of the two possible subsidized desludgings. (Only 5% purchased two mechanized desludgings, and we do not analyze this outcome due to the small numbers.) Because our data on purchase of mechanized desludgings through the subscription comes from administrative data, we know this information for all 1496 households which subscribed to the service. For the 1380 subscribers who completed our endline survey, we asked them to self-report their use of desludgings over the previous twelve months. Of endline respondents, 20% purchased a mechanized desludging through the subscription, 21% purchased a mechanized desludging outside of the subscription, 8% hired a non-family member to do a manual desludging, 8% got a family member to do a manual desludging, and 43% did not end up needing any desludging over that time period.

We asked those subscribers who purchased a mechanized desludging outside the subscription why they didn't purchase our subsidized service, allowing them to choose as many options as they liked, and the most common (not mutually exclusive) responses were that they did not understand the subscription system (33%), they had trouble making a mobile money deposit (27%),<sup>10</sup> and they found a better price (23%). Less common explanations were that they lost their card (6%), they forgot (5%), or they wanted to use their usual desludging service provider (4%).

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<sup>9</sup>Dupas et al. (2017) randomly offer individuals in three countries no-cost bank accounts (as opposed to our accounts which had deposit fees and were with a mobile money transfer company). In Uganda, Malawi, and Chile, 42%, 41% and 6% of the individuals respectively made at least one deposit over the two years. Unlike our sample, their samples exclude households who already have an account and exclude households in which both spouses work for a regular wage. Their goal was to focus on unbanked self-employed individuals; which is precisely the subset of individuals for whom we find the largest impact.

<sup>10</sup>Because of the distributed nature of Wari's service network, and the fact that savings accounts were new for Wari, some clients reported service points which did not know how to deposit money in their accounts. We worked with Wari and directly with operators to resolve issues when they were reported, but many may have gone unreported at the time.

## 4 Data

We conducted a baseline survey offering the subscription to 3757 households between February and May 2014. As mentioned above, 1496 signed up for the subscription. We have administrative data on mobile money account usage and purchase of the mechanized desludging subscription for all of these households. We conducted an endline survey between March and May 2015 and were able to reach 1380 (92%) of the subscribers.

In the original full sample, individuals randomly chosen to have a high subsidy and no required deposit were more likely to sign up for the subscription. A full 50% of individuals offered the high subsidy subscribed, while only 30% of individuals offered the low subsidy subscribed. Similarly, 51% of individuals who were not required to leave a deposit subscribed, while only 38% of individuals who were required to leave a deposit subscribed. In this paper we focus on subscribers, since they are the population offered the mobile money interventions.

The sample of subscribers is split in close to even thirds across the payment treatments (save at will, monthly billing, and pay in full). Table 1 shows tests for balance in baseline values across the three treatment groups. We run regressions of the variable on the save at will treatment, the monthly billing treatment, and grid-point level fixed effects, also clustering at the grid-point level. The excluded category is the pay in full treatment. Out of 22 variables tested, only two are not balanced across the groups.

Table B-1 shows summary statistics for the variables used in the analysis. As mentioned previously, 19% of subscribers did purchase at least one of the subsidized desludgings, while 23% of subscribers deposited money in the account at least once. The average total value deposited in the desludging account (excluding the mandatory initial deposit, and including people who deposited nothing) is around \$9 (4700 CFA). We see that 41% of subscribers purchase a mechanized desludging between the baseline and the endline.

We call deposits into the earmarked desludging account which did not bring the balance up to the full price of the subsidized desludging ‘non-final deposits.’ Non-final deposits do not include the initial obligatory deposit for those who were required to leave their participation payment as a deposit. There was relatively low usage of non-final payments when it was an option, in the save at will and monthly billing treatments. Only 24% of individuals in those treatment groups used the earmarked account at all and of those 28% made a non-final payment (that is 26% of those in the monthly payment treatment group and 30% of those in the save at will treatment group). For those who made such deposits, the modal number of non-final payments was 1, the average number was 2, and the average value was \$19 (9700 CFA). We did not ask individuals how they chose when and how much to deposit, but we

Table 1: Randomization Balance

	Mean (SD)	Coefficient (SE)		<i>p</i> -values SW=MB=0	Total Obs.
	Pay in full (489 Obs.)	Save at Will (497 Obs.)	Monthly Billing (510 Obs.)		
Baseline Sources of Heterogeneity:					
Respondent has no regular pay (bl)	0.73 (0.44)	0.015 (0.03)	-0.016 (0.03)	0.60	1496
Respondent has no formal ed	0.31 (0.46)	0.0098 (0.03)	0.014 (0.03)	0.92	1496
Only lent $\geq$ 20,000 CFA (bl)	0.19 (0.39)	0.026 (0.03)	0.024 (0.03)	0.55	1496
Only borrowed $\geq$ 20,000 CFA (bl)	0.23 (0.42)	0.057 (0.03)	-0.0021 (0.03)	0.10	1496
Both lent and borrowed (bl)	0.28 (0.45)	-0.018 (0.03)	0.0025 (0.03)	0.79	1496
Neither lent nor borrowed (bl)	0.29 (0.46)	-0.065* (0.03)	-0.024 (0.03)	0.11	1496
Don't save for desludgings (bl)	0.46 (0.50)	0.038 (0.03)	0.011 (0.03)	0.48	1493
Control Variables:					
Deposit required	0.86 (0.35)	-0.053* (0.03)	-0.061* (0.03)	0.05*	1496
High subsidy	0.63 (0.48)	-0.019 (0.04)	-0.0043 (0.04)	0.86	1496
Ever used manual before bl	0.46 (0.50)	0.031 (0.03)	0.058 (0.03)	0.24	1496
Ever used mechanical before bl	0.54 (0.50)	-0.036 (0.04)	-0.030 (0.03)	0.56	1496
Ever used both before bl	0.24 (0.43)	-0.0042 (0.03)	0.042 (0.03)	0.30	1496
Desludged in year before bl	0.61 (0.49)	0.00053 (0.03)	0.0011 (0.04)	1.00	1496
Courtyard looks clean in bl	0.81 (0.39)	-0.0087 (0.03)	0.032 (0.03)	0.32	1479
Respondent years of education	6.75 (5.85)	0.16 (0.41)	0.22 (0.41)	0.86	1493
Respondent age	49.9 (13.13)	-0.21 (0.93)	-0.60 (0.98)	0.83	1482
Respondent male	0.70 (0.46)	-0.0067 (0.03)	-0.040 (0.03)	0.45	1496
Household size	9.96 (5.45)	0.16 (0.40)	1.21** (0.44)	0.02**	1479
Number of rooms in house	6.88 (3.85)	-0.18 (0.24)	0.18 (0.27)	0.34	1479
Own their house	0.81 (0.40)	-0.026 (0.03)	0.012 (0.03)	0.40	1479
House has two stories	0.31 (0.46)	-0.036 (0.03)	0.017 (0.03)	0.22	1496
Wealth index	-0.030 (1.47)	0.098 (0.10)	0.22 (0.11)	0.15	1479

Note: The first column shows the mean and standard deviation of observations in the pay in full treatment group. The second and third columns show the coefficient on save at will and monthly billing in a regression including grid-point level fixed effects and clustering at the grid-point level. The omitted treatment group in the regression is pay in full. Standard errors clustered at the grid-point level are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . The fourth column shows the *p*-values for tests of whether the coefficients in the second and third columns equal one another and equal 0.

hypothesize that the relatively low use of non-final deposits is either due to the fact that people did not have experience saving in Wari accounts in the past or that they weren't able to or didn't want to save.<sup>11</sup>

From administrative data we also know the timing of all deposits and purchased subsidized desludgings. On average, conditional on making a deposit, households waited 111 days after their interview before making their first deposit. Those who purchased a subsidized desludging waited an average of 14 days between making their first deposit and purchasing the desludging. Given that without our intervention individuals must pay for the service in full at the time of purchase, this means that our intervention allowed individuals to start saving in advance at a moment when they more conveniently had cash on hand. Individuals also waited an average of 3 days between making their last deposit and purchasing the desludging. Individuals in all three treatment arms could wait as long as they liked between when their account reached the balance necessary to purchase a desludging, and when they actually purchased it, potentially using the accounts as a safe place to keep earmarked savings. (Of course the pay in full group was required to deposit the full amount at one time, while the other two groups could deposit little by little if they so desired.)

We analyze heterogeneous impacts based on financial literacy and financial characteristics at baseline. We expect households that are more vulnerable and do not have access to other sources of savings to be most likely to be affected by the treatment. The first source of heterogeneity we explore is whether the person making the desludging decision and receiving the text messages has a job with a regular wage. We find that 27% of respondents have a regular job, which means a job as a civil servant, in the armed forces, or as a private sector employee with a monthly salary. A second source of heterogeneity is whether the respondent has any formal education, which 69% of respondents do. The third source of heterogeneity we focus on is whether the household tends to lend to others, borrow from others, both, or neither. The population is approximately evenly split across the four groups. A final source of heterogeneity comes from the response to whether, when asked how they find money to pay for timely expenses such as desludgings, they list savings as one of the sources. Around half of the population lists savings as a source of funds used for purchasing desludging services (with other options including borrowing and remittances).

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<sup>11</sup>Inflation in Senegal over this time period was slightly negative, so this should not act as a deterrent to saving.

## 5 Estimation Strategy

We estimate the impact of the three mobile money payment options on purchase of the subsidized desludging and use of the earmarked desludging savings account. Our regression equation is:

$$y_{ig} = \alpha + t'_{ig}\beta + x'_{ig}\gamma + \psi_g + \epsilon_{ig}$$

where  $y$  is the outcome of interest for household  $i$  which was selected using starting grid-point  $g$ ,  $t$  is a vector of treatment dummies,  $x$  is a vector of individual and household characteristics, and  $\psi_g$  are grid-point fixed effects. Standard errors are clustered at the grid-point level.

We also look for heterogeneous impacts on four dimensions: regularity of income; education; lenders and borrowers; and use of savings for past desludgings. In this case we use the following set of regressions:

$$y_{ig} = \alpha + t'_{ig}\beta + x'_{ig}\gamma + h_{ig}\rho + h_{ig}t'_{ig}\phi + \psi_g + \epsilon_{ig}$$

where  $h_{ig}$  represents the trait for which we are measuring heterogeneous impacts. The effect of the mobile money treatment group on the subset of people with a specific character trait equals  $\beta + \phi$ .

The first dimension of heterogeneity we look at, whether the individual who made the original decision to sign up for the subscription, has the Wari account in his name, and receives the text messages, has a job with a regular monthly salary, is suggested by Dupas et al. (2017). They focus their savings interventions on individuals who do not have regular wages under the assumption that these are the individuals who most urgently need access to savings accounts. Individuals with regular wage-paying jobs may benefit from the mobile money interventions less since they do not experience as much risk in their income as do individuals in self-employment or with less regular jobs.

The second dimension, whether the individual who has the Wari account has formal education, is suggested by the literature which posits that financial literacy is useful for taking advantage of relatively complicated financial services (Cole et al. 2014). If that is the case, individuals with formal education may benefit more from the mobile money interventions. On the other hand, if these interventions differentially affect the vulnerable who typically lack access to financial services, then it may be those without formal education who benefit most. Cole et al. (2011) find that after financial literacy training is provided, poor households with low levels of education are most likely to follow up by opening a savings account.

The third dimension, whether the household lends to or borrows from other individuals, is suggested by Dupas & Robinson (2013). We characterize households into four groups: those who lent a sum of at least 20,000 CFA (\$40, or close to the price of a mechanized desludging) in the past 12 months but did not borrow that amount, those who both lent and borrowed 20,000 CFA in the past year, those who only borrowed, and those who did neither. Individuals who lend are hypothesized to be more subject to the demands of friends and family and may have a greater need for a safe and relatively inaccessible way in which to store money to resist pressure to share with others. On the other hand, individuals who lend are usually the wealthier households.

The final dimension we consider is how well households are able to save for desludgings prior to the intervention. In the baseline we ask respondents from where they get the money when faced with a large ‘timely’ expenditure such as a desludging. We create an indicator variable for whether they get the money from savings, as opposed to other sources such as borrowing or transfers. Saving for past desludgings may suggest that a household has a lower discount rate and is therefore also more likely to save in the mobile money account; on the other hand, households already able to save enough money for desludgings have found their own solution to the problem of saving for a desludging and may not need our technical solution (with graduated deposit fees) to aid them in saving.

## 6 Results

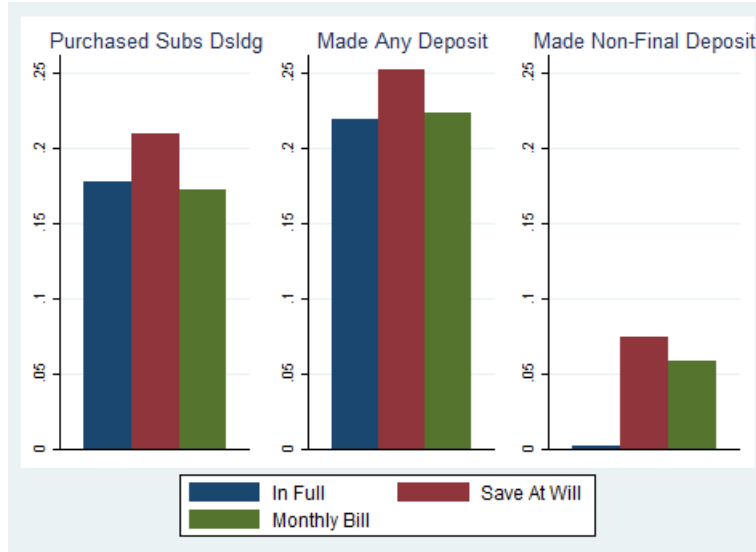
We first look at the average purchase of the subsidized mechanized desludging and usage of the account in Figure 1. In the first and second panels we can see that the save at will group purchases the subsidized desludging and uses the account at a higher rate than either the pay in full or monthly billing treatments. In the third panel, we see that individuals in the save at will group are more likely to make non-final deposits than those in the monthly billing group.<sup>12</sup>

In Table 2 we show the same results, but in a regression analysis controlling for other characteristics and grid-point fixed effects. In columns (1) and (2) we find that the save at will treatment increases the probability of purchasing the subsidized mechanized desludging and using the earmarked desludging account by six percentage points compared to being in the treatment group which was forced to pay in full. At the mean of 19% purchase of the

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<sup>12</sup>Individuals in the pay in full group were not supposed to be able to make non-final deposits, but one person did so before Wari successfully enforced that restriction.

Figure 1: Average Account and Desludging Use by Treatment Group



subsidized desludging, this is a 30% increase. Column (3) shows that the households allowed to save at will deposit almost 20% more than do the households in the other two treatment groups. Thus, we see that being in the save at will group increases purchase of the subsidized desludging.

On the other hand, there appears to be no impact of the monthly billing treatment on these outcomes. One explanation may be that monthly billing does not give individuals the flexibility they need. The monthly deposit schedule may also have failed because, given the fee structure of Wari deposits, it is more costly for clients to make the small monthly deposits encouraged by the monthly billing messages than to make periodic larger payments. Clients paid a \$0.20 fee to deposit any amount less than \$10 and a 2% fee for deposits larger than \$10. But, depending on the amount of the subsidy and whether the household had left a deposit, monthly billing messages requested people pay between \$4.50 and \$8.00 each month, which would lead to more fees than if they had made fewer larger payments.

Our results are similar in spirit to findings of Thaler & Sunstein (2008) and Stewart (2009) that when credit cards give information on minimum repayment amounts, information which was intended to help consumers, these nudges in fact lead them to repay less and incur higher interest. Only 19% of non-final deposits made in the save at will treatment group were under \$10. Of those individuals in the save at will group who made at least one non-final deposit, only 19% made at least one deposit that was under \$10. On the other hand, 57% of non-

final deposits in the monthly billing group were under the \$10 threshold at which the cost structure of deposits changed. Half of the individuals in that group who made non-final deposits made at least one deposit that was under \$10. In the end, the intervention may have inadvertently encouraged the monthly billing households to make frequent, more costly deposits. Ex ante we believed that the individuals in the monthly billing group might have benefited from the consistency of paying a specified amount each month, but no such benefit was found in practice.

Table 2: Average Impact of Treatment

	(1)	(2)	(3)	(4)	(5)	(6)
	Subs Desl	Any Deps	IHS(Deps)	Mech Desl	Any NF Deps	IHS(NF Deps)
Save at will	0.057** (0.028)	0.059** (0.030)	0.188* (0.109)	0.007 (0.034)	0.032 (0.021)	0.106* (0.062)
Monthly billing	-0.006 (0.026)	0.008 (0.029)	0.008 (0.103)	-0.032 (0.032)		
Deposit required	0.016 (0.029)	0.005 (0.033)	0.013 (0.119)	0.044 (0.035)	-0.047 (0.032)	-0.156 (0.097)
High subsidy	0.122*** (0.023)	0.122*** (0.025)	0.405*** (0.095)	0.028 (0.027)	0.018 (0.020)	0.058 (0.057)
Ever manual (bl)	-0.004 (0.039)	0.007 (0.045)	-0.003 (0.163)	-0.071 (0.047)	0.005 (0.042)	-0.012 (0.108)
Ever mechanical (bl)	-0.018 (0.046)	0.014 (0.050)	0.061 (0.177)	0.161*** (0.058)	0.018 (0.041)	0.056 (0.113)
Ever both (bl)	0.050 (0.049)	0.040 (0.055)	0.154 (0.197)	0.061 (0.060)	-0.008 (0.043)	-0.007 (0.122)
Desludge last year (bl)	0.066* (0.036)	0.033 (0.040)	0.183 (0.144)	0.195*** (0.044)	-0.043 (0.031)	-0.095 (0.082)
<i>N</i>	1462	1462	1462	1349	989	989
<i>R</i> <sup>2</sup>	0.090	0.083	0.087	0.177	0.041	0.049
Mean of Dependent Variable	0.187	0.233	0.833	0.403	0.068	0.185

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, a wealth index, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. Outcome variables for the full sample are (1) purchased the subscription desludging, (2) used the desludging account, (3) inverse hyperbolic sine (IHS) value deposited in the desludging account, and (4) purchased a mechanical desludging between the baseline and endline. Outcome variables for the save at will and monthly billing groups only are (5) number of non-final deposits and (6) IHS value of non-final deposits. In columns (1) through (4) the excluded treatment group control variable is payment in full. In columns (5) and (6) we drop the payment in full group, and the excluded treatment group control variable is monthly billing.

Does this increase in the purchase of the subsidized mechanized desludging imply an increase overall in the purchase of mechanized desludgings? Asked differently, is this increase due to households switching from unsubsidized *mechanized* to subsidized mechanized desludgings, or is it due to households switching from unsubsidized *manual* to subsidized mechanized desludgings? Because of the large negative externalities associated with man-



ual desludging, we are primarily interested in increasing the overall purchase of mechanized desludging rather than taking business away from the existing mechanized desludging market. To look at this outcome, we must use self-reported data rather than using Wari's administrative data and we only have this data for those individuals who completed the endline survey.

Column (4) shows that the impact of the save at will option on purchase of mechanized desludgings overall is small in magnitude and not significant. This suggests that the different payment treatments do not increase mechanized desludging overall, and so do not improve sanitation.<sup>13</sup> We did re-run the analysis in the other columns on the same subsample of endline survey responders found in column (4) and find that, if anything, the results are stronger in that subsample. So, the lack of treatment effect on purchase of mechanized desludgings should not be due to the change in sample across the columns. While we are unable to clearly identify why the savings program caused households to switch from the general market to our program, one potential explanation is that households unsure of whether they would be able to save enough for a mechanized desludging were unwilling to commit funds to an earmarked account. This would be in line with the results found in Dupas & Robinson (2013).

In order to explore whether the monthly text message reminders contribute to the large impact of the save at will treatment, we look at whether individuals are more likely to make deposits in the six days after receiving the text message, and whether this effect is larger for those in the save at will treatment group. All individuals received monthly reminders on different dates, with the first reminder arriving two weeks after their interview, new reminders sent monthly after that a total of 12 times, and then a final reminder one week before the account was closed. In results not shown here, deposits are 25% more likely in the six days after receiving a text message (excluding the final reminder message and the week following it).<sup>14</sup> But, there does not appear to be any differential effect of the save at will or monthly billing treatments on the impact of the timing of the text messages.

Why does the save at will treatment increase purchase of the subsidized mechanized

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<sup>13</sup>In another paper we examine the impact of the subsidy level on the purchase of mechanized desludgings. You may note that in column (4) the coefficient on high subsidy is positive but insignificant. This does not imply that the subsidy level did not have an impact on mechanized desludgings. The regressions in this paper are conducted on the subsample of subscribers. Being offered a high subsidy significantly increased the probability of subscribing and thus also significantly increased the probability of purchasing a mechanized desludging more generally.

<sup>14</sup>The probability of a deposit being made in any 3-day period is 0.27%, and deposits are 0.068 percentage points more likely to be made in the 6 days after receiving a message.

desludging so dramatically? One reason might be because it allows individuals to make non-final deposits whenever they have cash on hand. Columns (5) and (6) look at whether households in the save at will treatment were more likely to make non-final deposits or saved a higher value of non-final deposits compared to the monthly billing group. Note that all households in the pay in full treatment group are dropped in these regressions since they were not allowed to make non-final deposits. Individuals in the save at will group deposit 11% more money in the form of non-final deposits than do individuals in the monthly billing group. This is suggestive evidence that the flexibility afforded by the save at will treatment encourages people to make non-final deposits and then makes it more likely that they purchase the subsidized desludging. Next we look for heterogeneous impacts across the four dimensions discussed above.

## 6.1 Heterogeneous Effects by Job Stability

In Table 3 we look for heterogeneous impacts with respect to whether the decider has a job with a regular monthly salary (for example a civil servant or a private sector employee who is paid monthly). In 27% of households, the person charged with decision making for the desludging has a job with a monthly salary at baseline. To the extent that the mobile money accounts are particularly useful for the more vulnerable households that are unable to save on their own, we may expect households in which the decision maker does not have a regular monthly salary to be more affected by the ability to save at will.<sup>15</sup> This may be a particularly important target group in terms of increasing the overall purchase of mechanized desludging: households in which the decision maker for desludging is not formally employed are 9.8 percentage points less likely to purchase a mechanized desludging than households in which the decision maker has consistent employment.

Individuals with a regular job have a regular source of money which they could potentially deposit into the save at will Wari account. But, since they do not experience as much volatility in their income flows, they may have less use for an account since they do not periodically have irregularly high income flows.

Conforming with our hypothesis that the ability to save whenever funds are available may be particularly important for those without a regular salary, we find that the effects of the mobile money treatment are particularly large for this group. Households in which the decider has no consistent monthly salary are 7.3 percentage points more likely to purchase the

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<sup>15</sup>This was suggested by Dupas et al. (2017) who specifically focus savings interventions on the population of individuals who do not have regular wage-paying jobs.

Table 3: Heterogeneous Impacts: Decider has no Regular Pay

	(1)	(2)	(3)	(4)	(5)	(6)
	Subs Desl	Any Deps	IHS(Deps)	Mech Desl	Any NF Deps	IHS(NF Deps)
Save at will	0.013 (0.056)	-0.034 (0.059)	-0.109 (0.210)	-0.090 (0.068)	-0.003 (0.041)	0.043 (0.115)
Monthly billing	0.033 (0.054)	0.016 (0.055)	0.041 (0.199)	-0.079 (0.061)		
No regular pay	-0.030 (0.048)	-0.084* (0.051)	-0.273 (0.179)	-0.098* (0.055)	-0.016 (0.032)	-0.015 (0.088)
Save at will × No regular pay	0.061 (0.063)	0.126* (0.068)	0.406* (0.243)	0.132* (0.074)	0.049 (0.049)	0.086 (0.137)
Monthly billing × No regular pay	-0.056 (0.065)	-0.014 (0.068)	-0.055 (0.245)	0.064 (0.072)		
<i>N</i>	1462	1462	1462	1349	989	989
<i>R</i> <sup>2</sup>	0.094	0.089	0.092	0.180	0.043	0.050
Mean of Dependent Variable	0.187	0.233	0.833	0.403	0.068	0.185
Combined Effects:						
At will if no regular pay	0.073** (0.031)	0.093*** (0.034)	0.297** (0.126)	0.042 (0.037)	0.046* (0.026)	0.129* (0.074)
Monthly if no regular pay	-0.023 (0.032)	0.002 (0.035)	-0.013 (0.127)	-0.015 (0.037)		

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, desludged in the year before the baseline, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Having regular employment is measured in the baseline. Outcomes are (1) purchased the subscription desludging, (2) used the desludging account, (3) value deposited in the desludging account, (4) purchased a mechanical desludging between the baseline and endline, (5) number of non-final deposits, and (6) value of non-final deposits. In columns (1) through (4) the excluded treatment group control variable is payment in full. Columns (5) and (6) drop the payment in full group, and the excluded treatment group control variable is monthly billing. In the lower panel, ‘At will if no regular pay’ shows the value of the sum of the coefficient on ‘Save at will’ and ‘Save at will x No regular pay,’ the heterogeneous treatment effect.

subsidized desludging when they have access to an account that allows them to deposit money whenever it is available. The save at will treatment causes these more vulnerable households to be 9.3 percentage points more likely to deposit money in the account, and deposit 30% more in the account overall. The save at will treatment also has a 4 percentage point positive (though statistically insignificant) impact on purchases of mechanized desludgings more generally. We also see that individuals without regular salaries are more likely to save over time; when they are in the save at will treatment they are 4.6 percentage points more likely to make non-final deposits in the account prior to their desludging than those in the monthly billing group.

Table 4: Heterogeneous Impacts: Decider Has No Formal Education

	(1)	(2)	(3)	(4)	(5)	(6)
	Subs Desl	Any Deps	IHS(Deps)	Mech Desl	Any NF Deps	IHS(NF Deps)
Save at will	0.019 (0.034)	0.047 (0.036)	0.130 (0.129)	-0.039 (0.040)	0.025 (0.027)	0.081 (0.076)
Monthly billing	-0.018 (0.033)	0.020 (0.037)	0.032 (0.132)	-0.042 (0.039)		
No formal ed	-0.013 (0.055)	-0.004 (0.060)	0.038 (0.217)	0.026 (0.067)	-0.035 (0.039)	-0.000 (0.108)
Save at will × No formal ed	0.127** (0.064)	0.040 (0.071)	0.195 (0.256)	0.159** (0.073)	0.023 (0.045)	0.079 (0.131)
Monthly billing × No formal ed	0.044 (0.056)	-0.036 (0.063)	-0.071 (0.228)	0.039 (0.072)		
<i>N</i>	1462	1462	1462	1349	989	989
<i>R</i> <sup>2</sup>	0.095	0.084	0.089	0.184	0.042	0.050
Mean of Dependent Variable	0.187	0.233	0.833	0.403	0.068	0.185
Combined Effects:						
At will if no formal ed	0.146*** (0.053)	0.087 (0.059)	0.326 (0.217)	0.119* (0.062)	0.048 (0.035)	0.160 (0.106)
Monthly if no formal ed	0.026 (0.044)	-0.016 (0.049)	-0.038 (0.178)	-0.003 (0.059)		

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, desludged in the year before the baseline, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Outcomes are (1) purchased the subscription desludging, (2) used the desludging account, (3) value deposited in the desludging account, (4) purchased a mechanical desludging between the baseline and endline, (5) number of non-final deposits, and (6) value of non-final deposits. In columns (1) through (4) the excluded treatment group control variable is payment in full. Columns (5) and (6) drop the payment in full group, and the excluded treatment group control variable is monthly billing. In the lower panel, ‘At will if no formal ed’ shows the value of the sum of the coefficient on ‘Save at will’ and ‘Save at will x No formal ed,’ the heterogeneous treatment effect.

## 6.2 Heterogeneous Effects by Education Level

Education levels may affect the extent to which a mobile money account is useful for a household through both the probability that a household is unbanked (Johnston & Morduch 2008), and through the level of financial literacy level in the household (Cole et al. 2014, 2011). The decision maker on household sanitation matters has no formal education in 31% of households at baseline. Households with low initial levels of education and financial literacy may find mobile money accounts to be an easy and inexpensive introduction to using savings accounts since they do not need to open their own account, interact with formal banks, or worry about complicated fee structures.

Consistent with our hypothesis that the flexible mobile money option may be particularly important to households with low baseline education levels, in Table 4 we see that the effect of the save at will treatment is positive on all outcomes for deciders with no formal education. Households in which the decision maker has no formal education are 14.6 percentage points

more likely to purchase the subsidized desludging, and 11.9 percentage points more likely to purchase a mechanized desludging overall, when they are offered the ability to save at will in the mobile money accounts. Thus, at least for this subgroup, our interventions did significantly increase use of mechanized desludgings and improve their sanitation. Non-final deposits for those with no formal education are also higher in the save at will treatment, but not statistically significantly so. These results are consistent with our general findings that it is the individuals who are most vulnerable who benefit most from the flexibility that mobile money interventions provide.

### **6.3 Heterogeneous Effects by Whether the Household is a Lender or Borrower**

We may expect households that tend to lend money to others to be particularly impacted by the mobile money savings accounts since the intervention provides them with an opportunity to hide funds from others (Dupas & Robinson 2013). Conversely, households that typically need to borrow from others may be able to save through the program over time, and as a result reduce the amount that they borrow from others.

In Table 5 we look at heterogeneous treatment effects for individuals who claimed in the baseline to have borrowed from and/or lent money inter-personally. Table 5 shows that the save at will treatment was only effective in increasing the purchase of subsidized desludgings and non-final deposits for individuals who were not lenders at baseline (it is effective both for the group which only borrows, and for the group who neither borrows nor lends). There is a 10 percentage point increase in the probability that households that either only borrow or neither lend nor borrow purchase the subsidized desludging when they are given the option to save at will. This is accompanied by a similar (7-10 percentage point) increase in the probability that they use the mobile money accounts. The ability to save over time is particularly important to this group: we see a 7-8 percentage point increase in the probability that they make non-final deposits in the mobile money account, and the amount of their non-final deposits prior is 19-27% larger than the households in the monthly savings group.

This is in contrast to the result found by Dupas & Robinson (2013). While we find that being able to save at will only helps those who *do not lend*, they find that lockboxes only help those individuals who *do lend* save for preventative health expenses. The difference in our results may be due to the difference in setting. Dupas & Robinson (2013) study rural Kenya whereas we study peri-urban Senegal. In rural areas, social pressure from neighbors may be stronger and so commitment devices may reduce social pressures to share. In rural

areas, neighbors and friends are also more likely to be aware of the ongoing commitment savings project and may thus be more likely to understand that a household's funds are not available, additionally increasing the value of the commitment device. Conversely, in urban areas, commitment devices may simply give individuals a place to save money when they have extra funds on hand, which would be most useful for those individuals who do not distribute extra funds as inter-personal loans.

## 6.4 Heterogeneous Effects by Past Savings Activity

During the baseline survey, we asked households how they financed 'timely' expenses such as desludgings in the past and 51% of households reported using some form of savings. We hypothesize that the mobile money intervention will have the largest impact on households which have not already come up with a way to save for their desludging. The ability to simply deposit funds whenever they are available in an account earmarked for desludgings, even if it comes with a costly fee structure, may be particularly useful to households which have not been able to save successfully in the past.

In Table 6 we test directly for differences in impacts of the save at will treatment based on whether the household reports having used savings for past desludgings. Individuals who have not been able to save for desludgings in the past are significantly more likely to take advantage of the option to save at will. When allowed to save at will, those who don't save to desludge are 11.2 percentage points more likely to make at least one deposit in the account, and save 41 percent more in the accounts, which leads to an 11.2% increase in the probability that they purchase a subsidized mechanized desludging and a 5% (insignificant statistically) increase in the probability that they purchase a mechanized desludging at all. This large effect on households who have had trouble saving in the past may be because these individuals have not already come up with an effective means of saving at home or in bank accounts and so find the Wari savings device particularly helpful.

## 6.5 Timing of Deposits

If the save at will treatment helps individuals to save and therefore be better able to purchase the subsidized desludging, we should see an effect of the treatment on the timing of deposits and purchase of the desludging. The option to save at will could thus decrease the time between interview and first deposit (decreasing the time it takes individuals to start saving) or increase the time between first deposit and desludging (increasing the amount of time the

money is saved in anticipation in the mobile money account).

We conduct such an analysis, but the results are only descriptive because they suffer from sample selection. Data is only available on timing of deposits and timing of desludging for those who actually deposit and those who purchase the subsidized desludging. Still, the results provide suggestive evidence on the extent to which households are taking advantage of the accounts to save anticipatorily before they purchase their desludging.

We look at the average treatment effects on timing in Table 7. Given that households usually wait until they need a desludging to purchase one, we do not expect to see any effect of the treatments on the days between the interview and the desludging. This is confirmed in column (1). Neither do we see large significant differences between the groups in terms of the time from the interview to the first deposit (column (2)) or last deposit to first desludging (column (4)). In contrast, households in the save at will group wait on average 51% more days (approximately 7 days longer) between their first deposit and their desludging (column (3)). This suggests that a benefit of the save at will treatment is that it allows subscribers to engage in ‘anticipatory savings,’ putting money away in advance of when they actually plan on making the purchase.

In Table 8 we look to see how this increase in anticipatory savings varies across our main groups of interest: those without a regular salary, those without a formal education, non-lenders, and those who do not save for a desludging. The table gives suggestive evidence that the save at will treatment has the largest impact on individuals who do not have a regular-wage paying job (column (1)), who neither borrow nor lend (column (5)), and who have not been able to use savings to pay for desludgings in the past (column (7)). This is consistent with the hypothesis that it is precisely those most vulnerable individuals who see the most positive impacts of the save at will treatment, and that this is due to the fact that it allows them to partake in anticipatory savings rather than being required to pay in full at the time of purchase.

## 6.6 Other Financial Tools

Mobile money accounts can increase total savings levels by providing an additional mechanism for households to use to save, or they can displace savings and lending activity in which the households would otherwise have engaged. There is some disagreement in the existing literature over the extent to which access to new financial intermediation displaces informal or existing savings and lending opportunities. Banerjee et al. (2015) find displacement of informal borrowing when a new bank enters a village while Angelucci et al. (2015) find

evidence of increased borrowing across a variety of sources following the entrance of a new bank.

Note that our accounts are different from those studied by most other researchers. By the time the endline survey was conducted, all mobile money savings accounts had been closed and any money remaining in them had been returned to the household. Thus, we do not necessarily expect to see effects of the treatments on endline *stocks* of saving. We would only expect to see effects if, for example, households become more accustomed to saving, and increase their savings in other places after they have had the opportunity to save in the mobile money accounts.

We may expect to see some effect of the mobile money accounts on financial *flows* such as borrowing and lending in the interim. People with access to the at will savings accounts may have been less likely to need to borrow since they could save for their desludging over time, and would therefore be less likely to need to find money at the last minute for their desludging. The ability to keep money in their savings accounts may also protect households from requests to lend money to friends and family, so they may be less likely to lend money when they have access to the savings accounts.

In Table 9 we look at whether the interventions had any differential impacts on saving stocks, borrowing flows, and lending flows outside of the Wari account. The saving, borrowing, and lending is reported in the endline: the year during which the Wari accounts were offered had passed, the intervention had ended, all Wari accounts were closed, and any money remaining in them had been returned to the respondents. Savings includes savings in accounts, around the house, in jewelry, and in tontines. Borrowing includes any loans to the household over \$40 in the past 12 months from friends or banks, whether or not the amount has been paid back. Lending includes any loans from the household over \$40 in the past 12 months.

We do not find that households used the opportunity to save in the Wari account to augment their savings or to reduce the need to borrow and lend. The savings interventions had no statistically significant impact on overall savings stocks or borrowing or lending flows.

## 7 Conclusion

We run a randomized intervention in peri-urban Senegal among individuals who subscribe for a subsidized mechanized desludging. We have three payment groups, all using Wari mobile money and all receiving monthly text message reminders. One-third of the people must



pay in full with no savings component through the project similar to the existing payment mechanism in the market (although the usual method to pay is in person in cash rather than using mobile money); one-third of the people may save at will whenever they want; and, one-third of the people are sent monthly bills informing them how much they should pay each month.

We find that the save at will treatment significantly increases the purchase of the subsidized desludging compared to both the pay in full and monthly billing treatments. It also increases the use of non-final deposits compared to the monthly billing treatment (excluding the pay in full treatment since they are not allowed to make non-final deposits). The impact is strongest among individuals who, in the past, have not used savings to pay for their desludgings and who do not have a job paying a regular salary. There is no impact on those who already use savings or have regular paying employment, presumably because they have figured out systems which work for them to allow themselves to save adequately (and without being subject to deposit fees).

While the subgroup that was affected by the save at will treatment was relatively small, such an intervention could be scaled up without much expense by a utility company or other organization interested in facilitating mechanized desludging services, increasing the ability of households to pay for the desludging services when they need it.

Overall, purchases of the subsidized mechanized desludging were relatively rare. While approximately 20% of subscribers purchased the subsidized mechanized desludging we offered them, another 14% purchased a mechanized desludging at a higher unsubsidized price, outside the system (and 7% purchased a mechanized desludging outside the system at an equal or lower to price than our offer). The most common reasons given for doing this were that the subscriber did not understand the subscription service or that he tried but had trouble making a mobile money deposit.<sup>16</sup> This speaks to the fact that ensuring participant understanding is key for the success of any intervention. Nevertheless, the fact that our intervention was most useful for those with less education and less regular wages suggests that those who needed it and wanted it to work were able to make it happen.

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<sup>16</sup>Remember, these accounts were a new service only offered to participants in our survey, which Wari had not rolled out more generally. Some Wari providers were not sufficiently acquainted with the new product and had trouble depositing subscribers' money.

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Table 5: Heterogeneous Impacts: Lending and Borrowing

	(1)	(2)	(3)	(4)	(5)	(6)
	Subs Desl	Any Deps	IHS(Deps)	Mech Desl	Any NF Deps	IHS(NF Deps)
Save at will	0.011 (0.057)	0.030 (0.059)	0.129 (0.218)	-0.001 (0.072)	-0.035 (0.032)	-0.099 (0.090)
Monthly billing	-0.008 (0.052)	0.042 (0.056)	0.171 (0.202)	-0.004 (0.064)		
Only lent	0.020 (0.064)	0.058 (0.072)	0.178 (0.257)	0.016 (0.082)	-0.027 (0.044)	-0.108 (0.121)
Only borr	-0.060 (0.061)	-0.042 (0.064)	-0.124 (0.231)	-0.019 (0.073)	-0.060* (0.032)	-0.216** (0.088)
No borr + No lent	-0.026 (0.057)	-0.001 (0.063)	0.007 (0.232)	0.061 (0.067)	-0.070** (0.035)	-0.260** (0.105)
Save at will × Only lent	-0.004 (0.082)	-0.011 (0.090)	-0.040 (0.329)	0.056 (0.109)	0.060 (0.059)	0.198 (0.176)
Save at will × Only borr	0.091 (0.080)	0.075 (0.086)	0.179 (0.308)	0.006 (0.098)	0.104* (0.054)	0.284* (0.145)
Save at will × No borr + No lent	0.092 (0.078)	0.043 (0.086)	0.077 (0.313)	0.002 (0.088)	0.112** (0.055)	0.369** (0.162)
Monthly billing × Only lent	-0.050 (0.088)	-0.092 (0.094)	-0.350 (0.340)	-0.053 (0.109)		
Monthly billing × Only borr	0.043 (0.077)	-0.010 (0.084)	-0.102 (0.299)	-0.027 (0.096)		
Monthly billing × No borr + No lent	0.002 (0.077)	-0.058 (0.087)	-0.280 (0.318)	-0.043 (0.085)		
<i>N</i>	1462	1462	1462	1349	989	989
<i>R</i> <sup>2</sup>	0.094	0.087	0.091	0.181	0.049	0.060
Mean of Dependent Variable	0.187	0.233	0.833	0.403	0.068	0.185
Combined Effects:						
At will if only lend	0.007 (0.057)	0.020 (0.067)	0.089 (0.246)	0.055 (0.079)	0.026 (0.050)	0.099 (0.152)
At will if only borrow	0.102* (0.057)	0.105* (0.061)	0.308 (0.218)	0.005 (0.064)	0.069* (0.038)	0.185* (0.097)
At will if neither	0.103** (0.052)	0.073 (0.057)	0.206 (0.206)	0.001 (0.055)	0.077* (0.046)	0.270* (0.140)
Monthly if only lend	-0.058 (0.066)	-0.050 (0.072)	-0.179 (0.259)	-0.057 (0.083)		
Monthly if only borrow	0.035 (0.055)	0.032 (0.060)	0.068 (0.210)	-0.031 (0.067)		
Monthly if neither	-0.006 (0.052)	-0.016 (0.060)	-0.110 (0.219)	-0.047 (0.059)		

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, desludged in the year before the baseline, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Borrowing and lending are measured in the baseline. The excluded group is ‘both borrowed and lent’. Outcomes are (1) purchased the subscription desludging, (2) used the desludging account, (3) value deposited in the desludging account, (4) purchased a mechanical desludging between the baseline and endline, (5) number of non-final deposits, and (6) value of non-final deposits. In columns (1) through (4) the excluded treatment group control variable is payment in full. Columns (5) and (6) drop the payment in full group, and the excluded treatment group control variable is monthly billing. In the lower panel, ‘At will if only lend’ shows the value of the sum of the coefficient on ‘Save at will’ and ‘Save at will x Only lent,’ the heterogeneous treatment effect.

Table 6: Heterogeneous Impacts: Households Reporting They Don't Save for Desludgings

	(1)	(2)	(3)	(4)	(5)	(6)
	Subs Desl	Any Deps	IHS(Deps)	Mech Desl	Any NF Deps	IHS(NF Deps)
Save at will	0.007 (0.040)	-0.008 (0.042)	-0.013 (0.155)	-0.027 (0.050)	0.033 (0.032)	0.149 (0.093)
Monthly billing	-0.036 (0.037)	-0.024 (0.041)	-0.101 (0.149)	-0.042 (0.049)		
Don't save to dslg	-0.062 (0.042)	-0.069 (0.044)	-0.237 (0.161)	-0.040 (0.050)	0.054 (0.035)	0.193** (0.096)
Save at will × Don't save to dslg	0.105* (0.056)	0.139** (0.062)	0.424* (0.222)	0.077 (0.071)	-0.004 (0.044)	-0.090 (0.121)
Monthly billing × Don't save to dslg	0.066 (0.055)	0.072 (0.059)	0.244 (0.216)	0.029 (0.069)		
<i>N</i>	1460	1460	1460	1347	987	987
<i>R</i> <sup>2</sup>	0.094	0.088	0.091	0.179	0.048	0.057
Mean of Dependent Variable	0.188	0.234	0.834	0.404	0.068	0.186
Combined Effects:						
At will if don't save	0.112*** (0.039)	0.132*** (0.044)	0.410*** (0.156)	0.050 (0.048)	0.029 (0.028)	0.059 (0.079)
Monthly if don't save	0.030 (0.039)	0.048 (0.042)	0.143 (0.150)	-0.012 (0.044)		

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, desludged in the year before the baseline, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. Saving to desludge is measured in the baseline. Outcomes are (1) purchased the subscription desludging, (2) used the desludging account, (3) value deposited in the desludging account, (4) purchased a mechanical desludging between the baseline and endline, (5) number of non-final deposits, and (6) value of non-final deposits. In columns (1) through (4) the excluded treatment group control variable is payment in full. Columns (5) and (6) drop the payment in full group, and the excluded treatment group control variable is monthly billing. In the lower panel, 'At will if don't save' shows the value of the sum of the coefficient on 'Save at will' and 'Save at will x Don't save to dslg,' the heterogeneous treatment effect.

Table 7: Timing of Deposits and Desludging: Outcome is 'Log of Days from...'

	Int to 1st Dslgd	Int to 1st Dep	1st Dep to 1st Dslgd	Last Dep to 1st Dslgd
	(1)	(2)	(3)	(4)
Save at will	0.189 (0.168)	-0.061 (0.164)	0.507*** (0.182)	-0.103 (0.133)
Monthly billing	0.200 (0.159)	-0.174 (0.166)	0.236 (0.199)	-0.238* (0.133)
<i>N</i>	274	341	274	274
<i>R</i> <sup>2</sup>	0.121	0.061	0.135	0.095
Mean of Dependent Variable in Logs	4.439	4.223	0.921	0.575
Mean of Dependent Variable in Levels	129	111	14	3

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, and desludged in the year before the baseline. Standard errors clustered at the grid-point level are in parentheses: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. The excluded treatment group control variable is payment in full.

Table 8: Timing of Deposits and Desludging: Outcome is 'Log of Days from Last Deposit to 1st Desludging'

	Regular Pay		Formal Education		Lend and Borrow		Save to Desludging	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Save at Will	Monthly Bills	Save at Will	Monthly Bills	Save at Will	Monthly Bills	Save at Will	Monthly Bills
Combined Effects:								
...if no regular pay	0.634***	0.381*						
	(0.192)	(0.226)						
...if regular pay	0.293	0.002						
	(0.381)	(0.354)						
...if no formal ed			0.290	-0.033				
			(0.420)	(0.469)				
...if formal ed			0.538**	0.285				
			(0.219)	(0.227)				
...if only lend					0.093	-0.448		
					(0.443)	(0.416)		
...if only borrow					0.771*	0.765		
					(0.393)	(0.463)		
...if neither					0.852**	0.371		
					(0.389)	(0.419)		
...if both					0.308	0.228		
					(0.300)	(0.354)		
...if don't save to dslg							0.717***	0.680**
							(0.258)	(0.301)
...if save to dslg							0.383	-0.058
							(0.250)	(0.266)
<i>N</i>	274		274		274		274	
<i>R</i> <sup>2</sup>	0.138		0.137		0.153		0.144	
Mean of Dep Var	0.921		0.921		0.921		0.921	

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, and desludged in the year before the baseline. Standard errors clustered at the grid-point level are in parentheses: \* p<0.10, \*\* p<0.05, \*\*\* p<0.01. Each set of two columns shows the heterogeneous treatment effects for one regression looking at that source of heterogeneity. So, for example, in the first column the first number shows the value of the sum of the coefficient on 'Save at will' and 'Save at will x No regular pay,' the heterogeneous treatment effect. In the second column the first number shows the value of the sum of the coefficient on 'Monthly billing' and 'Monthly billing x No regular pay' in the same regression. The coefficients themselves are not shown to save space.

Table 9: Impact on Financial Transactions in the Endline

	(1)	(2)	(3)	(4)	(5)	(6)
	Savings	IHS(Sav)	Borrow 20k 0/1	IHS(Amt Borr)	Lent 20k 0/1	IHS(Amt Lent)
Save at will	-24935.2 (25515.1)	-0.0382 (0.166)	-0.00451 (0.0401)	0.0322 (0.231)	-0.0401 (0.0362)	-0.183 (0.189)
Monthly billing	-27914.5 (27004.6)	0.176 (0.159)	-0.0000378 (0.0390)	0.122 (0.239)	-0.0266 (0.0364)	-0.130 (0.184)
Savings (bl)	0.361*** (0.0698)					
IHS(savings) (bl)		0.265*** (0.0306)				
Borrowed 20k 0/1 (bl)			0.301*** (0.0334)			
IHS(amt borr) (bl)				0.350*** (0.0337)		
Lent 20k 0/1 (bl)					0.191*** (0.0324)	
IHS(amt lent) (bl)						0.260*** (0.0312)
<i>N</i>	1352	1352	1352	1352	1352	1352
<i>R</i> <sup>2</sup>	0.226	0.168	0.102	0.133	0.104	0.145
Mean of Dependent Variable	1.75e+05	4.090	0.466	2.842	0.424	2.445

Note: Controls in all regressions include: respondent age, education, and sex, hhd size, own house, two-story house, clean house, rooms in house, wealth index, deposit required, high subsidy, had a manual desludging at any time before the baseline, had a mechanical desludging before the baseline, had both types of desludging before the baseline, desludged in the year before the baseline, and fixed effects at the grid-point level. Standard errors clustered at the grid-point level are in parentheses: \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ . Outcome variables are (1) total saving, (2) inverse hyperbolic sine (IHS) of saving, (3) whether the household borrowed from others in the past year, (4) IHS of amount the household borrowed, (5) whether the household lent to others in the past year, and (6) IHS of amount the household lent. All outcomes are measured in the endline, and regressions control for the same variable measured in the baseline (bl).



## A Script Explaining Subscription in Surveys

*The below script is translated from Wolof to English. It appeared on the portable devices used by the enumerators with the different wordings automated by treatment group.*

Today, we are going to offer you a subscription to mechanical desludging. Mechanical desludging, it's very important, for you, your family, and your neighbors. When you use a truck to desludge your pit, the truck takes all of the filth from the pit, takes it far away from the house, so that you're sure that your house and the area around it is all very clean, and your children and other children in the neighborhood will not play in that filth.

The subscription that we're offering, it is very useful: it will help you plan for when you will need to desludge your pit, and it is thanks to the subscription that we will be able to subsidize the cost of a desludging over time, and it will enable you to have access to a quality desludging.

If you agree to subscribe, when you need a desludging, you will call ZZ, identify yourself as a subscriber, and say that you need a desludging. We'll then find a truck to desludge your pit within about 2 to 3 hours of the call. The subscription for desludging includes 1 truck, which will do 1 trip, getting about 8 m<sup>3</sup> from the pit, without 'curage'.

Of the twelve houses that we chose to participate in the research, ten will be offered subsidized mechanized desludging. There are small subsidies and large subsidies, and of those 10 households, each has a 50% chance to have a large subsidy. The other two households will not be offered the chance to subscribe to the desludging service. We randomly selected the households' subsidies and wrote them on a piece of paper that I'll leave with you, but the amount of the subsidy for each household will not be known to the other households. [Alt: We randomly selected the households' subsidies and wrote them on a piece of paper. I will list to you the subsidy of each household, and when we're done, I'll leave the list with you.]

*[Enumerator: Pause, give the list to the respondent, and read it aloud with him.]*

You can use the subsidy twice to desludge your pit, within the next 9 months. [*Note: Later changed to 12 months.*] If you need more than two desludgings within that period, these additional desludgings will not be subsidized. Also, if you do not desludge your pit twice during this period, you will not be able to use the subsidy after those 9 [*Note: Later 12*] months.

In a few weeks, we will come back to the households that decide to sign up for the subscription to put on their door a sticker signaling that the house is a subscriber.

The undiscounted price of a desludging is 25000 fcfa. Your discount is: [discval]. So, you

will pay [25000 - discval] for each of your first 2 desludgings over the next 9 months.

If you would like to sign up for a desludging, you will have to leave a deposit of 3000 fcfa. We will take this 3000 fcfa from your participation fee, so you will not have to give us any money out of pocket if you sign up. Would you like to sign up? [*Alt: Would you like to sign up for a mechanized desludging? You do not have to pay anything now.*]

[*Enumerator records whether the respondent signed up. The rest of the script is only read to subscribers.*]

The total remaining you will have to pay for a desludging is 25000 minus your discount of [discval]. [*Alt addition: You have made an initial deposit of 3000, that will be applied to the first desludging.*]

[*For save at will and monthly billing.*] If you wanted to save money for nine months to get your two desludgings by the end, you would have to save roughly XX each month.

[*For pay in full.*] If you wanted to get both desludgings in 9 months, you would pay XX for the first desludging and XX for the second desludging.

Wari is an option to save, receive, and send money through the telephone. Wari service points are all over Dakar: some are in banks or other places like PAMECAS; others are in places like Total gas stations, cybercafes, or corner boutiques. It is easy to identify these points because of the Wari sign on the door.

To deposit money in your Wari account, you can go to a Wari point, bringing your ID card and your Wari account number that I will give you. In order to deposit money you will pay a small fee: 100 fcfa for a deposit less than 5000 fcfa, and 2% if the deposit is 5000 fcfa or more.

When you deposit money, you will receive a message that confirms that you deposited. To withdraw money as well, meaning take part of your money out, you'll have to call this phone number: ZZ, and they'll tell you how it works. You can call this number from Monday to Friday between 8AM and 6PM."

We will sign you up for a Wari mobile money account that you will use for your desludging.

[*For save at will.*] Whenever you want, you can deposit small or large amounts of money in your Wari desludging account. When you are ready for your desludging and you have enough money in your Wari account you can call our phone number to order the desludging. We will send you a text message every month to remind you how the account works.

[*For monthly billing.*] Every month we will message you a bill telling you how much you owe for your monthly payment of expected desludging expenses. When you are ready for your desludging and you have enough money in your Wari account you can call our phone

number to order the desludging. We will send you a text message every month to remind you how the account works

*[For pay in full.]* When you are ready for your desludging, you can deposit the full fee in your Wari desludging account and then call our phone number to order the desludging. We will send you a text message every month to remind you how the account works.

*[The script then asks the respondent details necessary to set up the Wari account such as his official name, phone number, id number, and address.]*

You must leave a deposit of 3000 fcfa, which will come from the participation fee that we discussed earlier. Your desludging Wari account now has 3000 fcfa in it. Any additional deposits can be made directly at Wari points in Dakar. Your 3 closest Wari points are: [Waript1, Waript2, Waript3] *[Enumerator, please write 3000 for the initial value of the desludging Wari account and give the card to the respondent.]* *[Alt: You don't have to deposit any money towards the desludging now, but you can go deposit money directly at Wari points anywhere in Dakar. Your 3 closest Wari points are: [Waript1, Waript2, Waript3]. [Enumerator, please write 0 for the initial value of the desludging Wari account and give the card to the respondent.]*

Please take good care of this card. When depositing or withdrawing, you will need to give this account number. If you lose the card, you may call the number on your consent form to request that we send you the number. Be aware that no one will be able to deposit to or withdraw from the account without presenting the ID card of the person/people whose name is associated with the account. Also know that all transactions on this account will be confirmed with texts to the phone number associated with the account.

## **B Appendix Tables**

Table B-1: Summary Statistics

Variable	Mean	Std Dev	Min	Max	# of Obs.
<b>Outcome Variables</b>					
Used subsidized desludging	0.186	0.390	0	1	1496
Deposited in desludging account	0.231	0.422	0	1	1496
Value deposited in desludging account	4683	9854	0	70000	1496
Got mechanized desludging between bl and el	0.405	0.491	0	1	1377
Made non-final deposits	0.067	0.249	0	1	1007
Value of non-final deposits	646	3063	0	39000	1007
Days from interview to 1st desludging	128	102	0	364	279
Days from interview to 1st deposit	111	98	0	364	346
Days from 1st deposit to 1st desludging	14	49	0	340	279
Days from last deposit to 1st desludging	3	16	0	189	279
<b>Treatment Variables</b>					
Save at will	0.332	0.471	0	1	1496
Monthly billing	0.341	0.474	0	1	1496
Pay in full	0.327	0.469	0	1	1496
<b>Baseline Sources of heterogeneity</b>					
Respondent has no regular pay (bl)	0.735	0.442	0	1	1496
Respondent has no formal ed (bl)	0.313	0.464	0	1	1496
Only lent $\geq$ 20,000 CFA (bl)	0.185	0.389	0	1	1496
Only borrowed $\geq$ 20,000 CFA (bl)	0.254	0.435	0	1	1496
Both lent and borrowed (bl)	0.293	0.455	0	1	1496
Neither lent nor borrowed (bl)	0.268	0.443	0	1	1496
Don't save for desludgings (bl)	0.484	0.500	0	1	1493
<b>Control Variables</b>					
Deposit required	0.840	0.367	0	1	1496
High subsidy	0.626	0.484	0	1	1496
Ever used manual before bl	0.501	0.500	0	1	1496
Ever used mechanical before bl	0.509	0.500	0	1	1496
Ever used both before bl	0.253	0.435	0	1	1496
Desludged in year before bl	0.616	0.487	0	1	1496
Courtyard looks clean in bl	0.812	0.391	0	1	1479
Respondent years of education	6.724	5.832	0	22	1493
Respondent age	49.48	13.17	19	94	1482
Respondent male	0.710	0.454	0	1	1496
Household size	10.38	6.09	1	63	1479
# of rooms in house	6.803	3.628	1	33	1479
Own their house	0.815	0.389	0	1	1479
House has two stories	0.301	0.459	0	1	1496
Wealth index	0.000	1.564	-3.857	5.569	1479