Improving Access to Savings through Mobile Money: Experimental Evidence from African Smallholder Farmers*

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Abstract

Investment in improved agricultural inputs is infrequent for smallholder farmers in Africa. One barrier may be limited access to formal savings. This is the first study to use a randomized controlled trial to evaluate the impact of using mobile money as a tool to promote savings and agricultural investment. For this purpose, we designed and conducted a field experiment with a sample of smallholder farmers in rural Mozambique. This sample included a set of primary farmers and their closest farming friends. We work with two cross-randomized interventions. The first treatment gave access to a remunerated savings account through mobile money. The second treatment targeted closest farming friends and gave them access to the exact same interventions as their primary farmer counterparts. We find that the remunerated mobile savings account increased savings, and agricultural investment, in particular fertilizer usage. We also show that the savings account increased household expenditures, in particular non-frequent ones. Our results suggest that the network intervention not including access to remunerated savings decreased incentives to save and invest in agricultural inputs - likely due to network free-riding allowed by lower network transfer costs. Overall our research shows that mobile money can be used effectively to increase financial inclusion in countries of low agricultural productivity like Mozambique.

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1. Introduction

African farmers have a hard time saving. First, they are typically poverty-ridden smallholder farmers. Second, they are usually unbanked. Without access to formal financial products, namely those entailing some degree of commitment, they are easy prey to the pressures of their families and neighbors, and to their own temptations. In this context, saving may be crucial to break the cycle of low investment and low agricultural productivity that is typical of many rural settings in Africa. Improved agricultural technologies, with the potential to have clear impacts on productivity, have yet to be widely adopted in the African continent, where fertilizer use is the lowest in the world. Enabling access to formal savings may be part of the solution to this important development challenge.

At the same time, the so-called mobile money revolution is making its way across Africa. The first mobile money service, M-PESA, was launched in 2007 in Kenya and was quickly adopted by a majority of the adult population of the country.[1] Other countries have followed, even if at lower rates of adoption. Based on a network of agents, standard mobile money platforms enable users to save money in their accounts and to send money to other people. All they need is a mobile phone with network coverage. Mobile money has an enormous potential to expand access to formal financial products. However, the way to tailor mobile money services to help farmers to save is not obvious. Indeed, it is possible that mobile money by itself de-incentivizes savings by facilitating transfers to other people, making them more vulnerable to social pressure within their social networks. Clear incentives to save, starting with interest-bearing savings accounts, are yet to be introduced in most mobile money platforms, often because regulators have limited knowledge about their potential impact.

In this paper, we report on a field experiment we designed and conducted in rural Mozambique between 2013 and 2015 with a sample of smallholder farmers cultivating maize in non-irrigated plots. Mobile money had recently been launched in Mozambique. Our experimental design aims at investigating the role of offering remunerated mobile money savings accounts to farmers on their financial behavior and investment. We assess changes in saving behavior, investment in improved inputs, with an emphasis on fertilizer, and household expenditures. We also examine

[1] See Jack and Suri (2011) and Mbiti and Weil (2011) for a detailed description of the introduction of M-PESA in Kenya.

the role of exogenously introduced network adoption of mobile money on the same outcomes, and evaluate any type of interaction effects between the two interventions.

Specifically, we study a sample of smallholder farmers, our experimental subjects, which is divided between a group of primary farmers and their two closest farming friends. Our experimental design is a 2×2 design, based on two cross-randomized treatments: access to a remunerated savings account through mobile money; and the (symmetric) treatment of the two closest farming friends of the primary experimental subjects. Note that all primary subjects were given an introduction to mobile money services, which comprised a free mobile phone, mobile money registration, and service trials including seed money. They also received an information module on the use of urea fertilizer, which included the opportunity to sell maize and to purchase urea fertilizer. This design implies that the closest farming friends, when treated symmetrically to their primary counterparts, were given not only access to the mobile savings account, but also to the introduction to mobile money and the information on fertilizer use.

Our measurement of the outcomes of the randomized interventions is based on: (i) administrative data for mobile money transactions, made available by the mobile money operator that partnered with us in our experiment; (ii) survey data on savings behavior, fertilizer use, household expenditures, and transfers sent and received. Since we conducted both baseline and follow-up surveys, we estimate Ancova regressions for most of our outcomes of interest.

We find clear positive effects of the remunerated savings treatment on savings in the mobile money platform, especially during the first year, when interest payments were made. The role of transfers received in the mobile money system seems to be particularly important in mediating this effect. Overall household savings seem to increase as well. In terms of agricultural inputs, we report that the probability of using fertilizer increased very significantly between 34 and 36 percentage points. The use of other improved inputs also increased as a result. Importantly, we see that household expenditures increased, in particular non-frequent ones that are more likely to be financed by savings. Our results show an increase in the likelihood that individuals receive money transfers from their connections with the savings treatment.

The second dimension of our experiment varied whether close farming friends were given access to the same opportunities offered to primary experimental subjects. Beyond the savings account, these opportunities included being introduced to mobile money and being given information about fertilizer use. The effects of this network intervention on savings and investment are less strong and clear to interpret than those of the incentivized savings intervention. The network treatment decreased savings (at least partly due to a decrease in transfers received) and, as a consequence, also reduced agricultural investment in fertilizer usage (namely decreasing the likelihood of using fertilizer by about 7 percentage points). No statistically significant effect on expenditures could be detected. These results are consistent with the network treatment giving rise to network free riding effects, where treated farmers save less as the transactions costs of transfers are reduced by the network access to mobile money, thereby discouraging saving behavior. Alternative hypotheses such as the network treatment shielding farmers from social pressure or promoting network information/imitation do not gather empirical support from our experiment.

Our work contributes to the growing experimental literature on financial and behavioral interventions to promote agricultural productivity,[2] while also relating to the more established literature on risk sharing within social networks in rural settings. In particular, this is the first paper to use a randomized controlled trial to evaluate the impact of using mobile money as a tool to promote savings and agricultural investment.

In an influential study, knowing that fertilizer could boost agricultural productivity (e.g., Duflo et al., 2008), Duflo et al. (2011) showed how small discounts for fertilizer purchases just after harvest time could significantly increase agricultural investment in fertilizer, particularly among unsophisticated present-biased farmers who had enough liquidity right after harvest, but no longer at the time of fertilizer use. The intervention we implemented in our work is similar to the one presented by Duflo et al. (2011) in the sense that it also nudges farmers into early (self-) commitment of resources for agricultural investment, thereby protecting their resources from spending due, for example, to lack of self-control or social pressure to share resources.[3]

Using financial tools with various degrees of commitment to counteract these behavioral biases and social pressures has been documented to increase savings and investment in different settings,

[2] A recent literature review is provided by de Janvry et al. (2017).

[3] Social pressure to share resources within networks is a powerful force at work in many developing countries. Indeed, a study of credit cooperatives in Cameroon by Baland et al. (2011) shows members bearing significant costs to protect their savings from friends and relatives. Consistently, Jakiela and Ozier (2016) find that, in the context of a lab experiment in Kenya, women reduce their income in order to keep it hidden. Goldberg (2017) finds clear effects of redistributive pressure on the timing of expenditures in Malawi.

most notably by Ashraf et al. (2006), and Dupas and Robinson (2013). Similarly, but in an agricultural setting in Malawi, Brune et al. (2016) explore an experimental design giving access to direct deposits of crop earnings to a commitment savings account, finding increased savings and agricultural input usage. Specifically for Mozambique, recent contributions have tested the impact of input subsidies and saving incentives (Carter et al., 2013). These authors find that a matched savings program can be particularly effective at raising farmer consumption while controlling risk.

Our experimental design does not explicitly examine the role of other factors, such as information and its network diffusion, which have been shown to play an important role in agricultural technology adoption.[4] In order to focus on the role of offering savings accounts though mobile money to individuals and their networks, we exclude these considerations from our experimental evaluation by providing all primary farmers, regardless of their treatment status, with an information module on best practices in the use of fertilizer.

A different branch of literature is related to the expansion of mobile money use in Africa. The recent literature has focused mostly on the Kenyan success story of M-PESA, and its risk sharing consequences. Jack et al. (2012) and Jack and Suri (2014) show that the consumption of households with access to M-PESA is not hurt by idiosyncratic shocks, which implies that decreased transaction costs for transfers promote risk sharing. This evidence is confirmed by Riley (2018), who analyzes a panel of households in Tanzania, and by the experimental results of Batista and Vicente (2018) on the introduction of mobile money in rural areas of Mozambique. These contributions extend the seminal work by Townsend (1994) and Udry (1994), who first documented the importance of informal risk sharing in rural settings for insuring against idiosyncratic risk, followed by Fafchamps and Lund (2003) and De Weerdt and Dercon (2006). Blumenstock et al. (2016) examine the nature of transfers using cell phone airtime (which may be thought of as an early version of mobile money) before and after an earthquake in Rwanda. They also find evidence supportive of risk sharing.

[4] For example, Conley and Udry (2010) showed how information transmission between farmers was particularly important for investment especially by inexperienced farmers who looked mostly at the experience of more seasoned farmers facing similar circumstances. More recently, Beaman et al. (2015), and Ben Yishay and Mobarak (2018) have further detailed how farmer networks and network theory may be used to promote agricultural investment in a policy relevant manner.

Batista and Vicente (2018) show that the randomized introduction of mobile money in rural areas of Mozambique decreased the transaction costs of migrant remittances so that these not only improved insurance to shocks, but also prompted less agricultural investment and increased migration out of rural areas. In light of these results, our paper suggests that providing simultaneous access to networks of mobile money users may reinforce the disinvestment effects of introducing mobile money in the first place.

Other work has described the potential of mobile money as a tool to promote economic development in different areas. The more recent paper by Jack and Suri (2016) documents positive effects of mobile money on savings in Kenya, along with impacts on occupational choices of women. Their overall poverty-reduction result is in line with Aker et al. (2016), who describe the positive poverty-reduction impact of a cash transfer program implemented using mobile money in Niger after a natural disaster. In a different context, Blumenstock et al. (2018) show how mobile salary payments can increase savings due to default enrollment in the program, even beyond its duration.

Most related to our work, Jack and Habyarimana (2018) examine the impact of randomizing access to a mobile money savings account in Kenya as a way to successfully increase savings and access to high school. Batista, Sequeira and Vicente (2018) also facilitate access to a mobile money savings account, but as a tool to promote microenterprise development in Mozambique. In the same line, but taking into account the specificities of the timing constraints and behavioral biases associated with agricultural investment, our paper tests the impact of offering mobile money interest-bearing savings accounts to individual farmers and their networks.

The paper is organized as follows. In section 2 we present the context of our field experiment. In section 3 we fully develop the experimental design, with treatments, hypotheses, sampling and assignment to treatment, measurement, and estimation strategy. The following section provides the econometric results, including balance tests, treatment effects on use of mobile money, savings, agricultural inputs use, expenditures, and transfers from/to closest farming friends. We conclude in section 5.

2. Context

Mozambique, a country with 25.8 million inhabitants, is one of the poorest countries in the world with GDP per capita of 1105 USD (current, PPP) in 2013 - it ranks 175 in 181 countries in terms of GDP per capita. Despite substantial natural resource discoveries and exploration in recent years, it is still a country with clear dependence on official aid assistance, which accounts for 57 percent of central government expenses. Agriculture is considered the key sector in Mozambique for those interested in pro-poor economic policies, as it accounts for 81 percent of the employment in the country. Despite this impressive figure, the contribution of the agricultural sector for the value added of the country is only 29 percent.[5]

Cereal agricultural productivity for 2011 in Mozambique was 10.4 thousand hectograms per hectare, well below the world average, 36.6, and even below the African average, 14.4.[6] Two factors may help explaining this particularly low agricultural productivity. First, smallholder farmers constitute the vast majority of farmers in the country: data from the National Agricultural Survey (TIA) in 2008 indicate that only 0.58 percent of Mozambican farmers cultivate more than 10 hectares of land. Second, investment in improved inputs is very limited: for example, the FAO Statistical Yearbook reports that in 2011 the Mozambican average for nitrogen fertilizer use was 6.4 kilograms per hectare, which is well below both the world average (73.3 Kg/ha) and the African average (13.3 Kg/ha). In an extremely poor setting like rural Mozambique, it is likely that smallholder farmers have difficulties in saving resources, from harvest to planting, for investing in improved agricultural inputs like fertilizers.[7]

Access to financial services is very limited in Mozambique, specifically in rural areas. In 2013, only 24 bank accounts existed for each 100 Mozambican adults, and the number of bank branches per 100,000 adults was 3.9. Both figures were below their corresponding African averages, which were 55 and 7.7, respectively.[8] Saving methods for the rural population are often limited to keeping money at home, keeping money informally with someone, and to participating in savings

[5] World Development Indicators, 2015, latest available years.
[6] FAO Statistical Yearbook, 2014.
[7] Cunguara and Darnhofer (2011) show that improved agricultural technologies are associated with higher household incomes for smallholder farmers in Mozambique, when these farmers have secured access to markets. In addition to fertilizers, Batista, Bryan and Karlan (2018) report that farm productivity of smallholder farmers in northern Mozambique is especially improved when they adopt techniques such as pit planting and using hybrid seeds – relative to other agricultural practices, such as mulching or using OPV seeds.
[8] IMF, Financial Access Survey, 2015.

groups.[9] The introduction of mobile money in 2011 created expectations that the level of financial inclusion could improve quickly in the country. Mozambique had around five million subscribers of mobile phone services in a competitive market, and geographical coverage included 80 percent of the population.[10] mKesh became the first mobile money service operating in Mozambique: it is offered by Carteira Móvel, a financial institution created by Mcel, the main mobile telecommunication operator in the country. During the first years most of mKesh's expansion efforts, specifically in terms of agent coverage, were concentrated in urban locations.[11] Even though the Mozambican Central Bank does not allow mobile money operators to offer saving products of their own (i.e., earning interest paid by the mobile money operator), mobile money can still be seen as an attractive saving method, namely for farmers who live far from bank branches.

3. Experimental design

3.1. Design

Our experiment encompasses two interventions, cross-randomized in a 2×2 design, submitted at the individual level. The pool of primary experimental subjects includes 196 farmers at the baseline. All primary experimental subjects, regardless of their treatment status, were given two information modules after the baseline, one on mobile money and one on the use of fertilizer.

The first randomized intervention is an incentivized savings treatment, which allows individuals to receive a bonus (or, more precisely, interest) depending on the average balance they held on their mobile money account over a pre-specified period. The second intervention is a network treatment that gives the two closest farming friends of primary subjects the exact same interventions that their primary counterparts received. Specifically, the (network-treated) farming friends were given the information modules on mobile money and fertilizer use. In addition, the

[9] Batista and Vicente (2018) report for a large sample of rural Mozambican households surveyed in 2012 the following statistics: 63 percent save money at home, 30 percent save money informally with someone, and 21 percent participate in a savings group. Only 21 percent report any money saved in a bank account. Numbers are not very different for an urban sample of market vendors (Batista, Sequeira and Vicente, 2018).

[10] Computed from data made available by Mcel and Vodacom, the two existing Mozambican mobile telecommunication operators in 2011. In 2012 a third operator entered the mobile phone market (Movitel).

[11] M-PESA, operated through a financial institution controlled by Vodacom, entered the mobile money market in late 2013, after our experiment had started, and was only serving urban areas at that point.

interaction of the savings and network interventions provided primary farmers' connections with access to the mobile money savings bonus.

The experimental design offered by our structure of treatments is depicted in Figure 1. Farmers subject to the incentivized savings intervention are denoted by *S*, whereas control farmers not subject to the same intervention are represented by *C*. *N* stands for the group of farmers subject to the network intervention, and *I* corresponds to the group of individual farmers not subject to this network intervention. In light of this notation, we can define four treatment groups: the control group not subject to either the savings or the network interventions is labeled CI (standing for control, i.e., no savings treatment, and for individual, i.e., no network treatment); the group that is exposed to the savings treatment, but not to the network treatment is labeled SI; the group that is not exposed to the savings treatment, but is exposed to the network treatment is labeled CN; finally, the group facing the interaction between the two treatments is labeled SN.

<Figure 1 near here>

3.2. Implementation

The information module was a general introduction to mKesh, the only mobile money service being offered in Mozambique at the time of the experiment. Even though there was clear familiarity with mobile phone communication at the baseline, mobile money services were not previously available in the experimental locations. The information module on mobile money therefore started by offering a basic mobile phone (worth 750 Meticais, close to USD 30 at the time, in an Mcel shop) and a leaflet explaining how to use mKesh and giving an overview of all possible services on offer. This leaflet is reproduced in Figure 2. Verbally, enumerators focused on explaining the meaning of saving, what a bank is, and some details about mKesh (ability to save using the service, safety based on a PIN, no need to go to a bank branch). After this verbal introduction, enumerators registered each individual on mKesh using the self-registration feature of the service, and gave 55 Meticais (close to USD 2) for cash-in (deposit) in mKesh. In the process of the cash-in operation, enumerators introduced the local mKesh agents to the experimental subjects. After the cash-in operation, enumerators assisted each individual to check his/her mKesh balance. Enumerators also explained how to cash-out (withdraw) the money from mKesh (making sure individuals understood that they had to pay a fee of five Meticais for that operation).

<Figure 2 near here>

The information module on fertilizer use was based on a leaflet (Figure 3), which was delivered by enumerators and explained verbally. It focused on maize production and its main message was ‘Using fertilizer is good! This year take good care of your *machamba* [agricultural plot]. Increase your production by increasing your soil fertility’. Details about fertilizer use were explained on one side of the leaflet: they included information on what farmers already do well (preparing the soil, placing seeds after first rains, using organic fertilizer, removing unwanted plants from plot during maize growth), and added information on how to apply urea as inorganic fertilizer two to three weeks after germination. These details were verbally discussed at length with experimental subjects. At the end of the module on fertilizer use, farmers were given information on the possibility of selling their maize to a local buyer (Desenvolvimento e Comercialização Agrícola - DECA). Note that our field team was available to mediate these sales, i.e., they were available to help farmers sell their maize from the recent harvest (July 2013) to DECA. Importantly, the proceeds of this sale could be paid to their mKesh account should the farmer so choose. Our team was also available to mediate the purchase of fertilizer for the planting season starting in November 2013. These resources were available to all farmers during team visits performed before the planting season.

<Figure 3 near here>

The savings treatment was based on offering 20 percent interest on the average mKesh balance held by an individual over the period from the end of the research team visits before planting season to just before the follow-up survey in January/February 2014 (when urea fertilizer should be applied). This bonus was paid in urea fertilizer. The leaflet that was distributed announcing this treatment scheme is shown in Figure 4. Even though experimental subjects could cash-out the money on their mobile money account, this intervention provided a strong incentive to keep a high balance for as much time as possible until the end of the interest-paying period. Interest rates paid by banks in Mozambique approached but did not reach 10 percent on a full year in 2013 (as given by the reference rate of the Bank of Mozambique), and banking services were not available in these rural areas. In this sense, the savings treatment can be understood as a strong incentive to save.

<Figure 4 near here>

The network treatment gave the two closest farming friends of each treated primary experimental subject the modules on mobile money and fertilizer use. In addition to these modules, when interacted with the savings treatment, the network treatment also enabled access of those closest friends to the bonus for their average mKesh balances. Closest farming friends were defined through questions on identifying a primary experimental subject's (i) closest friends in the same community that farm non-irrigated plots, (ii) connections that farm non-irrigated plots in the same community from whom that individual had a loan granted, and (iii) connections that farm non-irrigated plots in the same community to whom that individual granted a loan. The selected closest friends could not be in the list of primary experimental subjects. When more than two farming friends were mentioned across the referred questions, priority was given to connections that were mentioned in more than one of the (i) to (iii) lists for a given individual.

3.3. Theoretical hypotheses

Our experimental design was originally developed to investigate the role of incentivized mobile money savings accounts on financial behavior and investment, while also examining the role of network adoption of mobile money on the same outcomes, and any type of interaction effects between the two interventions.

Our first testable hypothesis is that the remunerated savings intervention promotes adoption of mobile money services, savings in particular. As a result, this treatment may promote investment on improved inputs, with a potential impact on household expenditures because of this investment. These effects are expected to arise because the savings treatment provides experimental subjects with a clear incentive to save - which may provide farmers with the otherwise unavailable resources to invest in their farming businesses. Note that all primary experimental subjects are subject to the information modules on mKesh and on fertilizer use, which guarantee that these farmers are familiar with the specific savings treatment proposed and with the benefits of using fertilizer. Following the treatment notation introduced in Section 3.1.

above, and denoting our outcome variables of interest by Y, this first testable hypothesis can be written as: $Y(S) - Y(C) > 0$.

Our second experimental intervention is the network treatment of triplets of farming friends. It is possible that our experimental subjects faced with the network treatment change their usage of mobile money services, triggering potential changes in savings, investment and expenditure outcomes. We propose three different possible mechanisms of change.

The first is that subjects treated individually face more social pressure from their network connections to lend them money, as primary individuals were given a set of opportunities (the mKesh information and fertilizer modules) that is not available to their network connections. In this context, the network treatment reduces social pressure, and thereby allows treated individuals to retain more resources and increase their usage of mobile money and, in particular, their mobile savings – with ensuing potential positive impact on investment and (infrequent) expenditures. This is what we call the *social pressure mechanism*. It may be written as $Y(N) - Y(I) > 0$.

A second possibility is that primary individuals feel more confident about using mKesh services when other people in their network have mobile money accounts and are likely users as well. These farmers will therefore increase their utilization of mobile money, and may therefore increase their mobile savings balance. This is what we call the *network imitation/information mechanism*.[12] It may be written as $Y(N) - Y(I) > 0$.

A third possible mechanism triggered by the network treatment is related to a decrease in mobile money transaction costs and possible *free-riding* within the network. When the farmer network is jointly treated with access to mobile money, transaction costs for transfers are reduced. This may encourage free-riding behavior that discourages farmers from saving. Because these farmers are typically liquidity constrained, lower savings are likely to have negative consequences on their investment behavior. This is what we call the *network free-riding mechanism*. It may be written as $Y(N) - Y(I) < 0$.

[12] Note that a positive effect of the network treatment could also be due to an increased perception of the value of the network in face of the introduction of mobile money. It is however unlikely that there is an increased network externality at the level of closest (locally) farming contacts.

In line with this discussion of possible effects of the savings and network interventions, a variety of effects may arise from their combination. Specifically, if the main mechanism of change triggered by the network intervention is social pressure, we anticipate a negative interaction effect on our main outcomes of interest. However, if other mechanisms dominate, the sign of the interaction effect is unclear.[13]

3.3. Sampling and assignment to treatment

This project was implemented in the districts of Manica, Mossurize, and Sussundenga, in the Mozambican province of Manica. In each district, a set of localities, 15 in total, was identified as having farmer associations. We asked for lists of farmers in each of the localities and surveyed these farmers in a pre-project survey. 240 farmers operating non-irrigated plots, who also provided information about their connections, were surveyed at that point in June-July 2013. Within this set of farmers, we were able to identify a set of 196 farmers in the same 15 localities with two connections each (both willing to participate in the study). These 196 farmers were interviewed during our baseline survey, which took place in July-August 2013, and form our set of primary experimental subjects. There were 392 additional farmers in our baseline sample, who form our pool of secondary experimental subjects.

Each triplet at the baseline (defined as one primary experimental subject and his/her two connections) was assigned to one of the four comparison groups (control, savings treatment only, network treatment only, and interaction between savings and network treatments). The procedure was the following. We first composed blocks of four triplets within the same locality and using observable characteristics of primary farmers collected in the pre-project survey (type of secondary occupation, whether he/she operated irrigated plots, whether he/she had used fertilizer). We then randomly assigned each member of each block to a different comparison group.

The post-intervention survey was implemented in January-February 2014, after the planting season was over, and after the urea fertilizer could be applied in that season. Of the 196 primary

[13] The savings treatment gives primary subjects access to strongly incentivized savings, which can also be used as a shield against social pressure to share resources. This could happen when $[Y(SN)-Y(CN)]-[Y(SI)-Y(CI)]<0$, i.e., when the effect of the savings treatment on our main outcomes of interest is lower in the presence of the network treatment (than without this treatment) due to lower social pressure to share resources. The network imitation/information mechanism and the network free riding mechanism do not imply any specific sign of $[Y(SN)-Y(CN)]-[Y(SI)-Y(CI)]$.

farmers, we were able to survey 186 individuals, which entails an attrition rate of 5%. We check below for balance in the respondents' observable characteristics for both baseline and post-intervention samples.

3.4. Measurement

Our measurement includes different types of data: (i) administrative data from the mobile money operator (mKesh); (ii) survey data from pre-project, baseline, and post-intervention surveys.

The administrative data from mKesh includes balance and transaction data for all experimental subjects for the relevant period of study, starting with the end of the survey team visits before planting season in 2013 to the end of June 2015, for a total period of approximately two years.

The baseline and post-intervention survey data include information on respondent and household characteristics, mobile phone use and mKesh literacy, agricultural practices, financial literacy and practices (including savings), household expenses and assets, relationship with the two connected farmers, and information on financial transfers sent/received.

3.5. Estimation strategy

Our empirical approach is based on estimating treatment effects on our outcome variables of interest. We now describe the main econometric specifications we employ for the estimation of these parameters.

Our design allows us to estimate average treatment effects in different ways. Most simply, the effect of interest (β) is estimated through the single-difference specification:

$$Y_{l,i,1} = \alpha + \beta T_{l,i} + \varepsilon_{l,i,1} \tag{1}$$

where Y is an outcome of interest, $l, i, 1$ are identifiers for location, individual, and time period (specifically, 1 represents the follow-up measurement), $\beta = [\, \beta_S \quad \beta_N \quad \beta_{SN} \,]$ is the vector of effects of interest, and $T_{l,i} = [\, S_{l,i} \quad N_{l,i} \quad S_{l,i} \times N_{l,i} \,]'$ is a vector of dummy variables representing the treatments (savings, S, and network, N) and their interaction.

In this setting, because of the limited sample size, we add controls to our main specification: although controls do not generally change the estimate for the average treatment effect, they can help explaining the dependent variable, and therefore typically lower the standard error of the coefficient of interest. We then estimate the following core specification:

$$Y_{l,i,1} = \alpha + \theta X_{l,i} + \beta T_{l,i} + \varepsilon_{l,i,1} \quad (2)$$

where $X_{l,i}$ is a vector of location and individual (demographic) controls.

We also employ an Ancova specification, where baseline values for the dependent variable are included. We use specifications with location fixed effects, or with location fixed effects and individual controls. The latter specification is given by:

$$Y_{l,i,t} = \alpha_0 + \theta X_{l,i} + \alpha_1 Y_{l,i,0} + \beta T_{l,i} + \varepsilon_{l,i,t} \quad (3)$$

where $Y_{l,i,0}$ is the baseline value of the outcome of interest.

For ease of interpretation and transparency, we employ OLS estimations throughout the paper. Given our randomization procedure at the individual level, we estimate robust standard errors in all regressions.

4. Econometric results

4.1. Balance

We begin by showing balance tests for the primary farmers in the comparison groups of our experiment. These are displayed in Tables 1. We present average values for a wide range of observable individual characteristics of the control group (CI), and differences of this group to the other three groups. We test the statistical significance of these differences. We also test the overall significance of all differences by employing a joint F-test, for which we report p-values. Note that in the first columns of the tables, we focus on the full baseline sample of primary farmers. Because we have some attrition regarding this sample in the follow-up survey (186 out of 196 individuals were surveyed at that point), we focus on the follow-up sample in the second set of columns in the tables. This allows us to check for differential attrition.

<Tables 1 near here>

In all the 38 individual characteristics tested across the four treatment groups, we only observe small non-systematic unbalances for age, number of children, number of plots, and whether the farmer used improved seeds. These differences relative to the control group concern the network or the interaction groups. They are significant at the 10% level, except for the number of children, which is significant at the 5% level. The F-stat on the null hypothesis of joint no differences is only rejected for the numbers of household members and children.

In the follow-up sample, we obtain similar results: gender becomes significant for both the savings and network differences relative to the control group, and whether the farmer saves at home becomes significant for the network difference to the control group, but several statistically significant differences in the baseline disappear, namely for age, number of plots, and whether the farmer used improved seeds.

Overall, we do not detect differences across comparison groups beyond what is statistically acceptable: in the baseline, only 4 out of 114 differences tested are found to be statistically significant. In any event, we employ demographic controls in our regressions including the variables for which we found statistically significant differences across comparison groups.

An additional note goes to the characterization of our sample of primary farmers. We can observe in Tables 1 that the control group is mainly male (90 percent), with an average age of 43 years. Most farmers were born in the Manica province (92 percent), the average number of household members is 6.9, and the average number of children is 4.3. On average, this group of farmers has been cultivating a plot for 10 years, has 2 different plots, and their main plots have 4.3 hectares. In the year before the experiment took place, 22 percent used improved seeds for maize, 16 percent used fertilizer for maize, and 76 percent of the maize produced was sold. On finance-related variables, 26 percent of farmers report having a bank account for 7 years on average; 82 percent save at home, and 14 percent contribute to a saving group. In terms of housing conditions, 25 percent of these households have an improved latrine, 28 percent have access to electricity, and 50 percent have access to piped water or a protected spring. Finally, all farmers owned a mobile phone at baseline.

4.2. Administrative data: mobile money savings and transactions

We now turn to our analysis of treatment effects. We begin by showing results related to the use of mKesh by exploring administrative data on all transactions, including transaction type, date of transaction and value of transaction, made available by the mKesh operator. These results are displayed in Table 2 and Figure 5. These data concern the period from the last visit of the survey team before planting season in 2013 to the end of June 2015, spanning approximately two years. We start by examining the log average daily savings in mKesh (distinguishing between the first and the second years of data), while also looking at the different types of mKesh transactions – specifically, cash-ins, transfers received, transfers sent, payments, airtime top-ups, and cash-outs. Importantly, note that trial transactions made as part of the information module introducing mobile money to farmers are excluded from our analysis.

In Table 2, we examine single treatment-control difference specifications for the sample of primary farmers, since there is no available baseline mKesh – as mobile money was not previously available in the rural areas where we worked. For each year with available data, we test two main specifications: one where we separately estimate the impact of the incentivized savings intervention and of the network intervention – columns (1)-(2) and (5)-(6) of Table 2 – and another where, in addition to estimating the impact of the two main interventions, we explicitly identify the impact of the interaction between the savings and the network interventions – columns (3)-(4) and (7)-(8) of Table 2. For each of these specifications, we estimate two versions: one controlling only for district fixed effects, and a second adding individual controls.[14]

<Table 2 near here>

As shown in columns (1) and (2) of Table 2, we obtain that the savings treatment significantly increased average daily savings in mKesh by 32 percent in the first year of the experiment, when the experimental savings account was active. This effect is specifically for the sample of primary

[14] Individual controls include basic demographic variables: gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children.

experimental farmers that received the savings treatment, regardless of whether they received or not the network treatment. If we focus on those that only received the savings treatment, the magnitude of this effect increases to 38-44 percent, statistically significant at the 5 or 10% levels, as shown in columns (3) and (4) of Table 2. Note that the point estimates for the effect of the savings intervention in the second year shown in columns (5)-(8) are still positive and sizeable, even though no longer statistical significant. We interpret these estimates as supportive of the effectiveness of the incentivized mobile savings intervention in promoting savings, as expected from our theoretical hypothesis. The network intervention and its interaction with the savings intervention do not have a clear impact on mobile savings: all our estimates of this impact have a negative sign, but cannot be precisely estimated.

In order to explain how the increased mobile savings level was achieved by the incentivized savings intervention, we examine the impact of the different treatments on the log value of the different types of transactions – displayed in Figure 5. As shown in Panel A, the incentivized savings treatment produced a significant positive impact on the value of transfers received. The increased transfers received account for most of the increase in mKesh savings as other inflows into the system (cash-in's) have a positive point estimate that is not statistically significant (at the 5% level), whereas all mKesh outflows have point estimates very close to zero.

Panel B of Figure 5 shows that the sample of individuals receiving the network treatment did not exhibit systematic statistically significant differences in their mobile money transactions relative to the control group. Consistent with the negative point estimate on the average mobile savings of these farmers, we however note a significant increase in the value of mKesh transfers sent by farmers subject to the network intervention. This effect may be the result of the reduction in transaction costs allowed by mobile money, which can trigger free-riding behavior by farmers subject to the network treatment as explained in our discussion of the potential theoretical hypotheses.

<Figure 5 near here>

4.3. Survey-based measures: savings and transfers

We now complement our analysis of mobile savings by using additional survey measures of savings. In Table 3 we show treatment effects on the intensive margin of aggregate savings - in log value at the time of surveying. This measure adds together several reported measures of savings, namely kept at home, in a bank account, with a local shopkeeper, and with friends or family. Hence, we are including here the main alternatives to saving in mKesh.

Since we have baseline data available for savings, we estimate Ancova specifications including both district dummies and full individual controls.

<Table 3 near here>

We expect that the savings treatment effect is not as clearly positive as it is for mKesh savings: in fact it could even be negative if there is substitution between savings in mKesh and other types of savings. Indeed, the savings treatment has a positive impact on the aggregate value of savings, but this is not as precisely estimated as the effect on the value of mKesh savings. As shown in Table 3, the impact of the savings treatment on aggregate savings is statistically significant at the 10% level when considering the full sample of primary experimental subjects that received the savings treatment, including those who were subject to the network intervention: the magnitude of this effect is 76 percent. This effect is particularly strong for those who received both the savings and the network treatment.

We estimate significant negative effects of the network treatment on aggregate savings of primary farmers – between 67 and 72 percent for the full sample subject to the network treatment, including those also given the savings treatment. This negative impact is consistent with the negative point estimates of the effect of the network treatment on mKesh savings, and may be due to some form of free-riding on networks savings, as discussed in our discussion of the theoretical motives potentially driving our results. Note that the negative impact of the network treatment on savings is somehow counteracted when this intervention is implemented together with the savings intervention: the interaction effect of these two interventions is actually positive and marginally significant at the 10% level. This positive interaction is evidence against the network treatment acting as a shield against social pressure, and is consistent with both network imitation/information mechanisms and with the free-riding hypothesis discussed in Section 3.3.

In order to understand the mechanisms underlying the impact of our experimental interventions on aggregate savings, we examine the behavior of transfers received and sent, as reported in the baseline and follow-up surveys. Figures 6 displays the Ancova point estimates and confidence intervals at the 5% confidence level.

<Figures 6 near here>

We expect the savings treatment to increase transfers received and to decrease transfers sent, as farmers respond to the savings incentives that provide them with an attractive option for their savings. The estimates displayed in Panels A of Figures 6a and 6b are consistent with our hypothesis for transfers received – the likelihood of receiving a transfer increases for treated farmers, although the positive point estimate for the value of transfers received is small and not statistically significant. Transfers sent do not seem to respond to the savings treatment.[15]

When considering the sample that was subject to the network intervention, we find a strong negative effect on both the likelihood and the value of transfers received, while transfers sent do not seem to be significantly affected. These results provide at least partial explanation for the decrease in savings observed for farmers subject to the network intervention.

4.4. Agricultural inputs

We now report the treatment effects related to the use of agricultural inputs by the primary experimental farmers in our sample. Table 4a shows the effects on synthetic fertilizer use (as reported in the endline survey about the previous season), both in terms of extensive and of intensive (measured in kilograms) margins. Table 4a also displays treatment effects on knowledge about using urea fertilizer. This is assessed through an index of four equally weighted binary variables constructed from four different survey questions: one asking about the appropriate distance to the plant for the application of fertilizer; one asking about the appropriate depth for the application of fertilizer; one asking about the appropriate quantity of fertilizer per plant; and one asking about the appropriate timing for the application of fertilizer. Table 4b additionally presents the estimated effects of the randomized interventions on the use of improved seeds, number of workers employed in the subject's farm, and on ownership of irrigation pumps.

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[15] In face of the savings treatment, farmers not exposed to the network treatment could possibly share access to the new savings account with their closest friends. Evidence on borrowing from closest farming friends suggest that possibility did not materialize.

All data on these outcomes were obtained from the endline survey questions about the use of inputs in the previous season.

We estimate single-difference or Ancova specifications depending on the baseline data availability of each outcome variable. Baseline data are available, and so Ancova estimation is used for fertilizer use (extensive margin), improved seeds use (extensive margin), number of workers employed in farm, and irrigation pumps ownership. For the remaining outcomes, we employ single-difference specifications.

<Tables 4 near here>

We expect that incentivized mKesh savings treatment produces a clear positive effect on the take-up of fertilizer. Table 4a confirms this hypothesis. We find that the likelihood that fertilizer was used clearly increased with the savings treatment. This effect ranges between 34 and 36 percentage points, when considering the whole sample including those facing the network treatment in addition to the savings treatment, and between 28 and 31 percentage points for farmers in the sample not facing the network intervention. This effect is significant at the 1% level for all specifications employed. We also find statistically significant positive treatment effects between 13.8Kg and 14.6Kg on the intensive margin of fertilizer use, when considering all primary subjects offered the incentivized mobile savings account – including those also facing the network treatment. This is clear evidence indicating that the savings treatment was particularly effective at increasing fertilizer use.

As explained in the description of the experimental implementation, the research team mediated purchases of fertilizer in the rural areas where the experiment took place – which made it available for purchase to all treated and control farmers in the sample. The research team also distributed saving bonuses in fertilizer. A valid concern is therefore that the positive savings treatment effect on fertilizer use is driven by the distribution of fertilizer by the research team - either through saving bonuses, or by fertilizer sales. This concern is however mitigated by the fact that the average report of urea fertilizer acquired was 47.3Kg in the endline survey, while the average quantity of urea fertilizer given in bonuses for the savings treatment was 0.9Kg, and the average quantity of urea fertilizer purchased from the research team was 2.8Kg. We also note that in the group of farmers that received a bonus in fertilizer, i.e., through the savings treatment, only 51 percent reported having used fertilizer. In face of this evidence, it is unlikely that the impact of the savings treatment on fertilizer use was driven by the fertilizer distributed as saving bonuses, or by the fertilizer available for sale through the research team.

The outcome variable related to knowledge about using urea fertilizer reinforces this picture: we find a statistically significant positive effect of the savings treatment on the likelihood of knowing about how to use urea fertilizer ranging between 13 and 18 percentage points.

While there is no clear pattern on the interaction effects of the savings and network interventions on use/knowledge of fertilizer, there are negative significant effects of the network intervention alone. Indeed, Table 4a shows that farmers given the network intervention are between 7 and 14 points less likely to use fertilizer. The point estimates for this decrease in terms of intensive margin are not precisely measured, but range between -6Kg and -10Kg of fertilizer used. Farmers treated with the network intervention are also less knowledgeable about fertilizer usage. Although the estimated negative effects of the network intervention are less strong than the positive effects of the savings intervention, it is clear that these are counteracting effects that do not seem to be offset by any significant synergies between the two interventions.

The strong statistical significance (at the 1% level) of the positive sum of all estimated coefficients together implies that the strength of the investment effects of the savings incentives intervention is larger than any potential negative free-riding effects (net of imitation or social pressure shield effects) arising from the network treatment.

We also tested the hypothesis that our experimental interventions may have affected agricultural investment in agricultural inputs other than fertilizer. Table 4b shows that the incentivized savings treatment is associated with positive effects on using improved seeds, employing more workers in the farm, and owning irrigation pumps. These effects are generally not precisely estimated, although there are some marginally statistically significant results of the savings intervention (at the 15% significance level) on improved seeds and (at the 10% level) on the ownership of irrigation pumps.

4.5. Household expenditure

Table 5 presents treatment effects for different types of household expenditure, specifically day-to-day and non-frequent expenditures, as well as total expenditures. These data were collected in both the baseline and endline surveys conducted before and after our experiment. We estimate Ancova specifications to measure treatment effects.

<Table 5 near here>

We expect that the intervention offering the remunerated mKesh savings account increases the level of non-frequent expenditures more strongly than the level of day-to-day expenditures. This is because it is more likely that increased savings are used for buying non-frequent goods and services, including agricultural inputs. This hypothesis is confirmed by the results shown in Table 5. Indeed, the savings treatment increased non-frequent expenditures between 48 and 51 percent – and by even more (between 58 and 63 percent) when considering the sample that was not given access to the network treatment. These are statistically significant effects at the 1 and 5% levels. Day-to-day expenditures yield smaller positive effects of the savings treatment, that are only statistically significant at the 10% level when considering the whole sample of farmers that received the savings treatment, including those who also received the network treatment.

Overall, this is evidence that the savings treatment was more effective at increasing non-frequent purchases of goods and services. Interestingly, we also find robust effects of the savings treatment on total expenditures. The magnitude of these effects ranges between 69 and 77 percent for the sample without the network treatment, and between 60 and 69 percent for the sample including the network treatment, all of these effects being statistically significant at the 1% level.

The network treatment had no substantial or statistically significant effect on any type of expenditures, similarly to the effect of the interaction between savings and network interventions.

5. Concluding remarks

In this paper, we analyzed the results of a randomized field experiment where a remunerated mobile money savings account was introduced to smallholder farmers in rural Mozambique. Consistent with our theoretical hypothesis, we find that access to the savings account increased the amount of money saved in mobile money, as well as aggregate household savings. This increase in savings is obtained at least partially via increased transfers being received. Likely as a consequence of the increased savings relaxing farmer liquidity constraints, this incentivized savings intervention promoted agricultural investment (especially the likelihood of usage of fertilizer, which increased by about 30 percentage points) and non-frequent expenditure (whose value increased by about 50 percent).

The experiment also varied whether close farming friends were given access to the same opportunities offered to primary experimental subjects. Beyond the savings account, these opportunities included being introduced to mobile money and given information about fertilizer use. The effects of this network intervention on savings and investment are less strong and clear to interpret than those of the incentivized savings intervention. The network treatment decreased savings (at least partly due to a decrease in transfers received) and, as a consequence, also reduced agricultural investment in fertilizer usage (namely decreasing the likelihood of using fertilizer by about 7 percentage points). No statistically significant effect on expenditures could be detected. These results are consistent with the theoretical hypothesis that the network treatment may give rise to network free riding effects, where treated farmers save less as the transactions costs of transfers are reduced by the network access to mobile money, thereby discouraging saving behavior. Alternative hypotheses such as the network treatment shielding farmers from social pressure or promoting network information/imitation do not gather empirical support from our experiment. It would however be interesting to design further experiments that can distinguish more explicitly between the different potential mechanisms underlying this type of network treatment.

This piece of research shows that mobile money can be used effectively to increase financial inclusion in a country like Mozambique where indicators of financial inclusion are particularly low. Farmers are particularly in need of financial products that enable them to save resources from harvest to planting, namely to invest in improved inputs like fertilizer. Access to a tailored savings account can lead to higher levels of investment by farmers. Since many central banks in developing countries regard mobile money as a risky innovation, in need of tight regulation, many promising possibilities of mobile money are still not allowed. Our evidence suggests that enabling remunerated saving accounts to be offered through mobile money platforms is a promising pro-poor policy.

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Appendix

Figure 1: 2x2 experimental design

	Individual Treatment - I	**Network Treatment - N**
Control – C	CI	CN
Savings Treatment – S	SI	SN

Figure 2: mKesh leaflet

Front.

Main operations conducted:

Self-registration.

Deposit.

Figure 3: Leaflet on fertilizer use

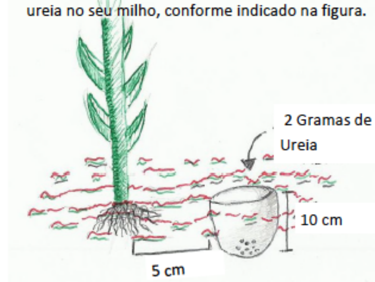
O QUE O SENHOR SABE E FAZ BEM...		
1	PREPARAR O SOLO.	-Remoção da vegetação existente. -Deixar o capim acumular no terreno (até 30 cm de altura).
2	SEMENTEIRA	-Esperar as primeiras chuvas e fazer sementeira 4 dias depois destas. Não deixe passar esta altura! -Fazer sementeira directa, ou seja, mexer na coberta da terra apenas no local de semeio. Isto evita que o seu terreno fique exposto. -Mesmo em solos férteis, é benéfico o uso de adubos orgânicos como por exemplo o estrume de boi.
3	SACHA	-Retire as ervas daninhas da machamba para que não prejudiquem a qualidade do solo e dessa forma a quantidade de milho aumente.
4	ADUBAÇÃO/ FERTILIZANTE	-Use fertilizante de topo, UREIA, porque apesar da elevada fertilidade dos solos de Moçambique, existem processos da natureza que ao longo do tempo vão prejudicando a machamba. -Mantenha as características naturais do solo enquanto aumenta os níveis de produção!

O QUE PODE FAZER MELHOR...

Use um fertilizante de topo: UREIA.

Esta é importante mesmo que o solo seja fértil. A Ureia é rica em nitrogénio que é um componente vital para a vida da planta e que é escasso nos solos de Moçambique.

Assim sendo, 2 a 3 semanas após a germinação espere pela chuva. Quando esta cessar, aplique ureia no seu milho, conforme indicado na figura.



Este fará o seu Milho crescer forte, com cores vivas e sem manchas!

EXPERIMENTE ESTA CAMPANHA EM 0,25HECTARES E VEJA A DIFERENÇA!

Figure 4: Leaflet on savings bonus

Figure 5: mKesh use - administrative data, type of transaction

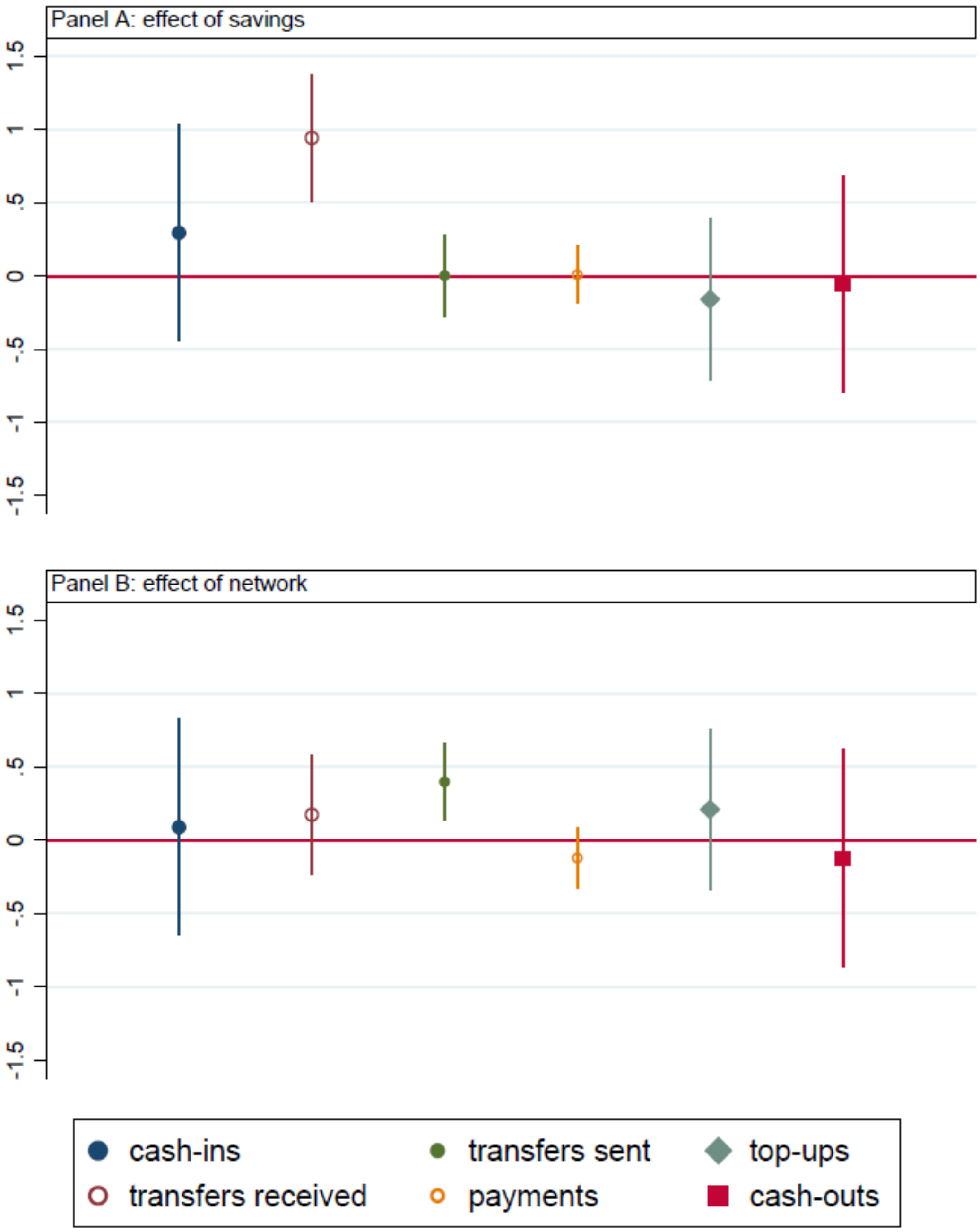


Figure 6a: Likelihood of transfers

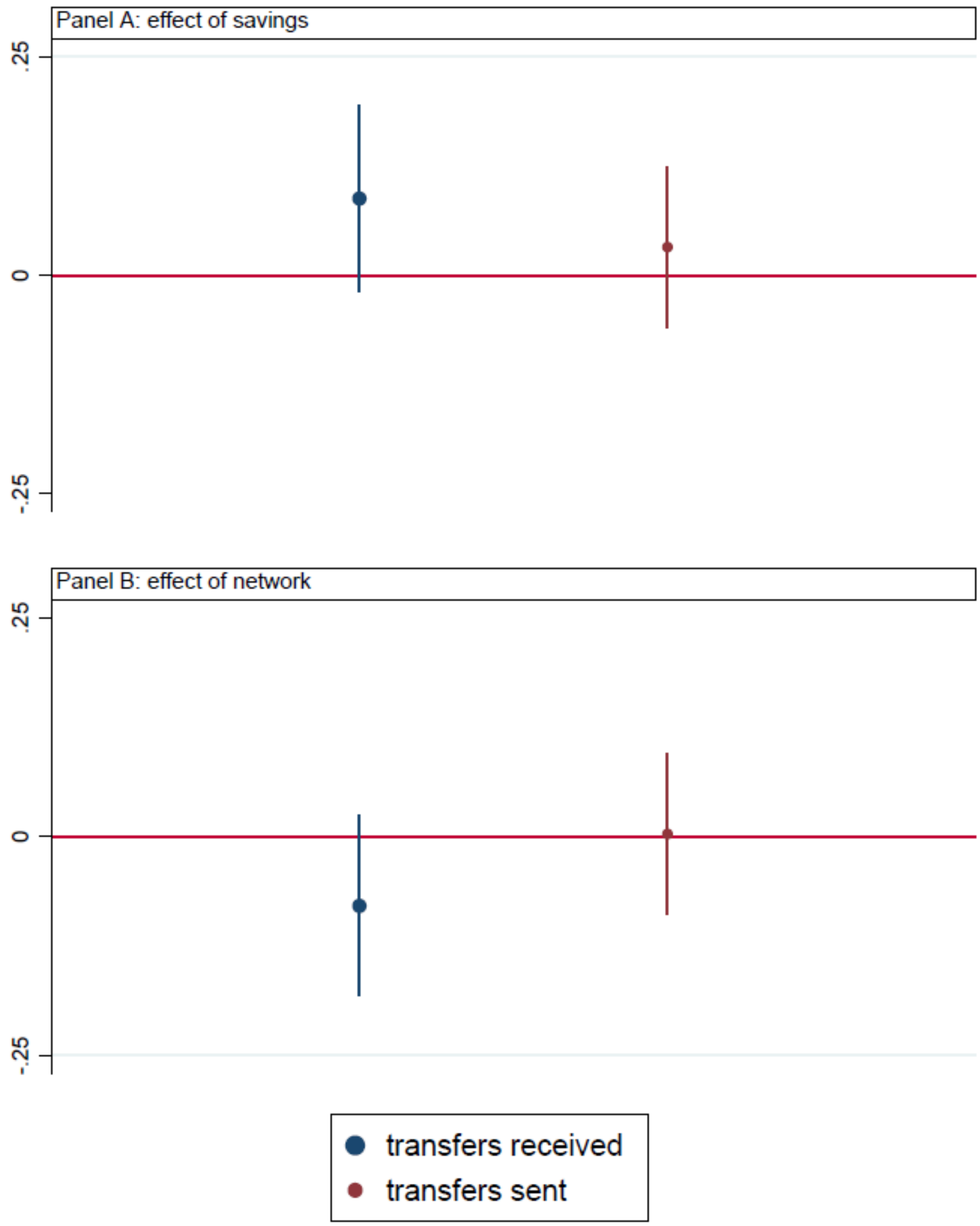


Figure 6b: Value of transfers

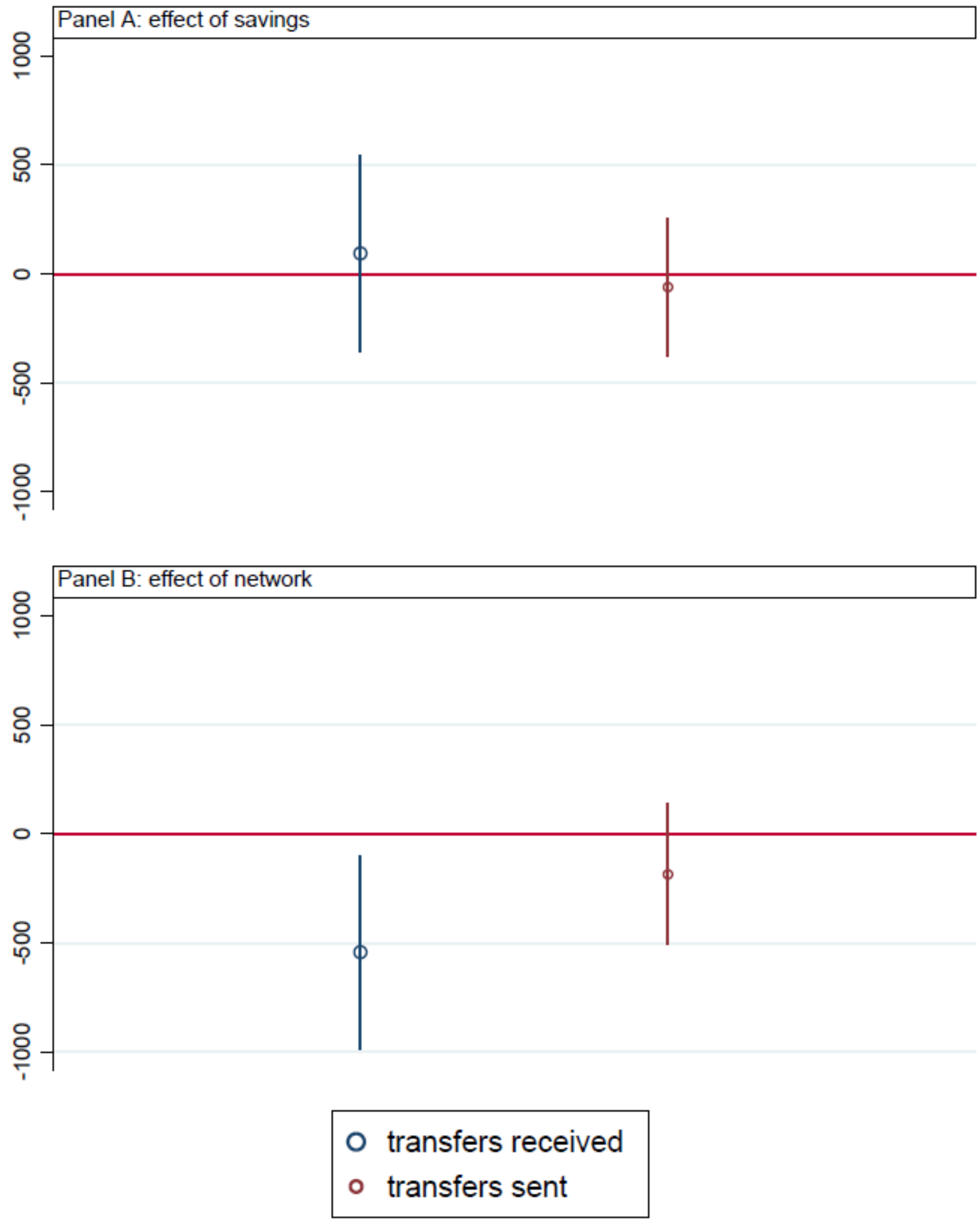


Table 1a: Primary farmers' individual characteristics - differences across treatment and control groups; for both baseline and follow-up samples

		baseline sample					follow-up sample				
		CI	savings	network	savings * network	joint F-stat p-value	CI	savings	network	savings * network	joint F-stat p-value
basic demographics	female	0.100	0.124	0.057	0.052	0.499	0.045	0.167**	0.111*	0.091	0.132
			(0.085)	(0.072)	(0.064)			(0.082)	(0.067)	(0.067)	
	age	43.388	3.910	4.436*	-0.127	0.165	44.568	2.810	3.255	-0.318	0.379
			(2.410)	(2.646)	(2.673)			(2.506)	(2.757)	(2.814)	
	born in Manica province	0.920	-0.048	-0.038	-0.007	0.845	0.909	-0.020	-0.027	-0.000	0.966
			(0.060)	(0.060)	(0.051)			(0.064)	(0.064)	(0.056)	
	complete primary school	0.280	0.047	-0.005	0.003	0.946	0.273	0.046	0.002	0.000	0.949
			(0.100)	(0.092)	(0.091)			(0.101)	(0.092)	(0.095)	
	number of household members	6.820	0.343	1.317	-0.711	0.054	6.864	0.434	1.274	-0.614	0.065
			(0.786)	(0.825)	(0.666)			(0.820)	(0.881)	(0.658)	
	number of children	4.340	0.742	1.738**	-0.557	0.013	4.568	0.602	1.510*	-0.636	0.026
			(0.667)	(0.732)	(0.624)			(0.736)	(0.776)	(0.649)	
agriculture	time cultivating plot (months)	116.851	34.924	16.443	29.460	0.462	122.595	27.469	10.699	28.847	0.618
			(22.854)	(21.462)	(25.010)			(24.143)	(22.559)	(26.912)	
	number of plots	2.220	-0.077	-0.220	-0.437*	0.340	2.114	0.057	-0.114	-0.295	0.551
			(0.282)	(0.216)	(0.259)			(0.275)	(0.290)	(0.222)	
	size of main plot (hectares)	4.293	-0.508	0.763	-0.091	0.527	4.329	-0.504	0.728	-0.073	0.564
			(0.670)	(0.996)	(0.765)			(0.727)	(1.031)	(0.826)	
	number of crops last year	2.520	0.092	-0.108	0.176	0.701	2.386	0.273	0.025	0.295	0.637
			(0.267)	(0.267)	(0.283)			(0.329)	(0.261)	(0.280)	
	land fertility (1-4)	2.900	-0.063	-0.057	-0.117	0.905	2.909	-0.079	-0.066	-0.136	0.878
			(0.127)	(0.128)	(0.160)			(0.137)	(0.138)	(0.171)	
	used improved seeds for maize last year	0.220	0.127	0.172	0.193*	0.292	0.250	0.112	0.142	0.182	0.443
			(0.095)	(0.112)	(0.111)			(0.099)	(0.116)	(0.118)	
	used organic fertilizer for maize last year	0.200	0.147	0.035	0.104	0.330	0.205	0.136	0.031	0.114	0.362
			(0.094)	(0.090)	(0.098)			(0.098)	(0.095)	(0.105)	
	used fertilizer for maize last year	0.160	-0.058	0.016	0.014	0.475	0.182	-0.075	-0.005	-0.000	0.502
			(0.067)	(0.075)	(0.068)			(0.071)	(0.078)	(0.072)	
	maize production last year (Kgs)	2,555.789	287.589	178.655	27.446	0.965	2,662.222	237.921	72.222	-73.434	0.978
			(559.173)	(566.536)	(577.998)			(584.756)	(576.931)	(598.421)	
	maize production value last year (MZN)	21,050.357	2,466.071	2,365.310	10,570.512	0.818	21,780.400	2,295.896	1,635.267	9,840.470	0.859
			(7,920.370)	(6,615.428)	(11,176.000)			(8,447.872)	(7,083.919)	(11,358.225)	
	% maize for sale last year	0.760	0.036	0.044	0.044	0.918	0.750	0.059	0.054	0.045	0.856
			(0.074)	(0.074)	(0.084)			(0.072)	(0.077)	(0.089)	

Note: Robust standard errors of the differences reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 1b: Primary farmers' individual characteristics - differences across treatment and control groups; for both baseline and follow-up samples

		baseline sample					follow-up sample				
		CI	savings	network	savings * network	joint F-stat p-value	CI	savings	network	savings * network	joint F-stat p-value
savings	has bank account	0.260	0.128	0.054	0.066	0.586	0.273	0.132	0.041	0.068	0.637
			(0.094)	(0.071)	(0.077)			(0.104)	(0.077)	(0.085)	
	time having a bank account (months)	79.154	-28.321	-10.621	-14.354	0.752	82.750	-31.917	-14.217	-17.950	0.720
			(29.651)	(39.861)	(34.955)			(31.547)	(41.830)	(36.878)	
	contributes to a saving group	0.140	0.044	0.036	0.012	0.921	0.136	0.034	0.040	0.023	0.947
			(0.064)	(0.077)	(0.054)			(0.065)	(0.078)	(0.053)	
	number of saving groups	2.143	-0.921	-1.032	-1.000	0.375	2.333	-1.083	-1.222	-1.190	0.294
			(0.998)	(1.005)	(0.869)			(1.157)	(1.157)	(1.023)	
	time contributing to saving groups (months)	48.857	-18.302	-17.857	-21.143	0.560	50.500	-16.875	-19.500	-22.786	0.428
			(19.522)	(18.080)	(18.092)			(22.558)	(21.041)	(21.216)	
	saving at home	0.820	-0.106	-0.140	0.024	0.167	0.864	-0.119	-0.184**	-0.003	0.104
			(0.087)	(0.085)	(0.066)			(0.087)	(0.086)	(0.068)	
expenditure and assets	total expenditure (MZN/month)	1,407.204	261.097	589.231	-109.973	0.396	1,373.589	329.716	622.845	-47.557	0.403
			(479.768)	(411.227)	(290.928)			(507.955)	(422.624)	(316.114)	
	owns barn	0.880	0.059	0.061	0.077	0.417	0.864	0.073	0.078	0.091	0.373
			(0.049)	(0.055)	(0.051)			(0.054)	(0.059)	(0.056)	
	owns fridge	0.040	0.062	-0.020	0.003	0.372	0.045	0.040	-0.025	0.000	0.522
			(0.050)	(0.034)	(0.040)			(0.051)	(0.038)	(0.044)	
	owns sewing machine	0.200	-0.016	-0.020	-0.004	0.994	0.159	0.011	0.021	0.045	0.959
			(0.086)	(0.096)	(0.086)			(0.067)	(0.086)	(0.087)	
	owns radio	0.820	-0.004	0.060	0.071	0.695	0.841	-0.032	0.039	0.045	0.726
			(0.069)	(0.073)	(0.081)			(0.075)	(0.075)	(0.083)	
	owns tv	0.429	0.020	-0.109	-0.016	0.581	0.364	0.083	-0.044	0.023	0.675
			(0.104)	(0.098)	(0.106)			(0.099)	(0.094)	(0.106)	
	owns bike	0.700	-0.027	-0.140	0.061	0.183	0.682	-0.001	-0.122	0.068	0.233
			(0.099)	(0.093)	(0.079)			(0.102)	(0.096)	(0.086)	
	owns motorcycle	0.100	-0.018	0.080	0.030	0.361	0.068	0.017	0.112	0.045	0.337
			(0.066)	(0.077)	(0.055)			(0.059)	(0.069)	(0.063)	
	owns generator	0.060	0.062	0.020	0.070	0.226	0.045	0.082	0.035	0.068	0.256
			(0.060)	(0.051)	(0.045)			(0.061)	(0.049)	(0.046)	
	owns animals	0.900	0.018	0.000	-0.030	0.862	0.886	0.029	0.014	0.000	0.954
			(0.060)	(0.062)	(0.065)			(0.064)	(0.065)	(0.066)	
	owns pump	0.020	-0.020	-0.020	0.023	0.209	0.023	-0.023	-0.023	0.023	0.207
			(0.020)	(0.020)	(0.036)			(0.023)	(0.023)	(0.039)	
	owns improved latrine	0.245	0.020	-0.025	0.038	0.929	0.273	0.004	-0.053	0.023	0.876
			(0.098)	(0.098)	(0.102)			(0.106)	(0.102)	(0.110)	
	has access to electricity	0.280	0.026	0.020	0.003	0.991	0.250	0.048	0.050	0.045	0.925
			(0.089)	(0.090)	(0.080)			(0.090)	(0.096)	(0.081)	
	has access to piped water or protected spring	0.500	0.031	0.040	0.043	0.969	0.523	0.009	0.017	0.045	0.973
			(0.105)	(0.100)	(0.101)			(0.108)	(0.097)	(0.096)	
	owns mobile phone	1.000	-0.020	-0.039	-0.022	0.275	1.000	-0.021	-0.039	-0.023	0.274
			(0.020)	(0.028)	(0.022)			(0.021)	(0.028)	(0.023)	

Note: Robust standard errors of the differences reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2: mKesh savings - administrative data

dependent variable ------>		average daily savings							
		first year				second year			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
savings - β_S	coefficient	**0.315****	**0.318****	**0.444****	**0.376***	**0.058**	**0.121**	**0.348**	**0.301**
	standard error	**(0.147)**	**(0.150)**	**(0.204)**	**(0.207)**	**(0.230)**	**(0.229)**	**(0.281)**	**(0.314)**
network - β_N	coefficient	**-0.128**	**-0.114**	**-0.001**	**-0.059**	**-0.333**	**-0.263**	**-0.052**	**-0.095**
	standard error	**(0.147)**	**(0.151)**	**(0.226)**	**(0.220)**	**(0.230)**	**(0.234)**	**(0.309)**	**(0.302)**
savings*network - β_{SN}	coefficient			**-0.263**	**-0.115**			**-0.581**	**-0.353**
	standard error			**(0.297)**	**(0.299)**			**(0.462)**	**(0.486)**
mean dep. variable (control)		4.333	4.343	4.333	4.343	4.018	4.018	4.018	4.018
$\beta_S + \beta_N = 0$	F-stat p-value	0.324	0.302			0.409	0.653		
$\beta_S + \beta_{SN} = 0$	F-stat p-value			0.400	0.231			0.524	0.882
$\beta_N + \beta_{SN} = 0$	F-stat p-value			0.162	0.397			0.067	0.231
$\beta_S + \beta_N + \beta_{SN} = 0$	F-stat p-value			0.339	0.309			0.393	0.646
r-squared adjusted		0.037	0.059	0.035	0.052	-0.004	0.028	0.000	0.024
number of observations		146	142	146	142	144	140	144	140
controls		no	yes	no	yes	no	yes	no	yes

Note: All regressions are OLS. Dependent variable is log savings. Data was made available by the mKesh operator for the period between June 2013 and June 2015. All regressions include district fixed effects. Controls are gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 3: Savings - survey

dependent variable ------>		overall savings (aggregate)			
		(1)	(2)	(3)	(4)
savings - β_S	coefficient	**0.641**	**0.760***	**0.135**	**0.028**
	standard error	**(0.408)**	**(0.415)**	**(0.464)**	**(0.461)**
network - β_N	coefficient	**-0.672***	**-0.718***	**-1.185****	**-1.474*****
	standard error	**(0.410)**	**(0.413)**	**(0.593)**	**(0.560)**
savings*network - β_{SN}	coefficient			**1.037**	**1.545***
	standard error			**(0.808)**	**(0.822)**
mean dep. variable (control)		7.715	7.715	7.715	7.715
$\beta_S + \beta_N = 0$	F-stat p-value	0.957	0.942		
$\beta_S + \beta_{SN} = 0$	F-stat p-value			0.082	0.024
$\beta_N + \beta_{SN} = 0$	F-stat p-value			0.790	0.907
$\beta_S + \beta_N + \beta_{SN} = 0$	F-stat p-value			0.982	0.867
r-squared adjusted		0.079	0.114	0.083	0.129
number of observations		151	149	151	149
controls		no	yes	no	yes
ancova		yes	yes	yes	yes

Note: All regressions are Ancova. Dependent variable is the log value of aggregate savings, based on survey questions asked in both the baseline and endline surveys. All regressions include district fixed effects. Controls are gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4a: Agricultural inputs

dependent variable ------>		used fertilizer (binary)				kgs fertilizer used				knowledge about using fertilizer			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
savings - β_S	coefficient	**0.361***	**0.338***	**0.307***	**0.280***	**13.750**	**14.628**	**13.176**	**12.020**	**0.132**	**0.137**	**0.154***	**0.175**
	standard error	**(0.060)**	**(0.063)**	**(0.085)**	**(0.090)**	**(6.992)**	**(7.431)**	**(11.602)**	**(10.982)**	**(0.056)**	**(0.054)**	**(0.080)**	**(0.078)**
network - β_N	coefficient	**-0.084**	**-0.074***	**-0.136**	**-0.129***	**-5.865**	**-7.410**	**-6.421**	**-9.916**	**-0.105***	**-0.096***	**-0.084**	**-0.059**
	standard error	**(0.060)**	**(0.061)**	**(0.066)**	**(0.072)**	**(6.952)**	**(7.677)**	**(5.595)**	**(6.306)**	**(0.055)**	**(0.055)**	**(0.076)**	**(0.075)**
savings*network - β_{SN}	coefficient			**0.106**	**0.113**			**1.135**	**5.152**			**-0.044**	**-0.075**
	standard error			**(0.123)**	**(0.130)**			**(14.461)**	**(13.305)**			**(0.112)**	**(0.114)**
mean dep. variable (control)		0.227	0.227	0.227	0.227	9.857	9.857	9.857	9.857	0.545	0.545	0.545	0.545
$\beta_S + \beta_N = 0$	F-stat p-value	0.003	0.007			0.367	0.432			0.726	0.600		
$\beta_S + \beta_{SN} = 0$	F-stat p-value			0.000	0.000			0.087	0.056			0.160	0.210
$\beta_N + \beta_{SN} = 0$	F-stat p-value			0.772	0.984			0.689	0.716			0.124	0.106
$\beta_S + \beta_N + \beta_{SN} = 0$	F-stat p-value			0.003	0.010			0.369	0.433			0.728	0.605
r-squared adjusted		0.245	0.238	0.244	0.237	0.058	0.054	0.053	0.049	0.031	0.089	0.026	0.086
number of observations		186	182	186	182	177	174	177	174	184	180	184	180
controls		no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
ancova		yes	yes	yes	yes	no	no	no	no	no	no	no	no

Note: All regressions are ANCOVA or OLS. All dependent variables are based on survey questions asked in the endline survey or both the basline and endline surveys, depending on data availability. All regressions include district fixed effects. Controls are gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4b: Agricultural inputs

dependent variable ------>		improved seeds usage				number of workers employed in farm				irrigation pumps ownership			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
savings - β_S	coefficient	**0.077**	**0.087**	**-0.009**	**0.032**	**0.533**	**0.866**	**0.254**	**0.507**	**0.034***	**0.039***	**0.040**	**0.045**
	standard error	**(0.071)**	**(0.070)**	**(0.102)**	**(0.106)**	**(0.740)**	**(0.753)**	**(1.139)**	**(1.099)**	**(0.019)**	**(0.022)**	**(0.030)**	**(0.033)**
network - β_N	coefficient	**-0.062**	**-0.026**	**-0.143**	**-0.079**	**0.501**	**0.346**	**0.234**	**0.006**	**-0.009**	**-0.010**	**-0.003**	**-0.005**
	standard error	**(0.070)**	**(0.069)**	**(0.101)**	**(0.106)**	**(0.719)**	**(0.702)**	**(1.100)**	**(0.999)**	**(0.019)**	**(0.019)**	**(0.004)**	**(0.006)**
savings*network - β_{SN}	coefficient			**0.168**	**0.108**			**0.549**	**0.702**			**-0.013**	**-0.011**
	standard error			**(0.141)**	**(0.146)**			**(1.563)**	**(1.435)**			**(0.039)**	**(0.042)**
mean dep. variable (control)		0.523	0.523	0.523	0.523	7.386	7.386	7.386	7.386	0.000	0.000	0.000	0.000
$\beta_S + \beta_N = 0$	F-stat p-value	0.885	0.567			0.377	0.306			0.297	0.245		
$\beta_S + \beta_{SN} = 0$	F-stat p-value			0.102	0.150			0.429	0.221			0.281	0.230
$\beta_N + \beta_{SN} = 0$	F-stat p-value			0.801	0.757			0.445	0.485			0.685	0.695
$\beta_S + \beta_N + \beta_{SN} = 0$	F-stat p-value			0.879	0.567			0.376	0.306			0.306	0.253
r-squared adjusted		0.105	0.157	0.107	0.155	0.201	0.218	0.197	0.214	0.005	0.003	0.000	-0.002
number of observations		185	181	185	181	186	182	186	182	183	179	183	179
controls		no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
ancova		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: All regressions are ANCOVA. All dependent variables are based on survey questions asked in the baseline and endline surveys, depending on data availability. All regressions include district fixed effects. Controls are gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 5: Household expenditures

dependent variable ------>		day-to-day expenditures				non-frequent expenditures				total expenditures			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
savings - β_S	coefficient	**0.315***	**0.380****	**0.184**	**0.270**	**0.509*****	**0.482*****	**0.634*****	**0.583****	**0.603*****	**0.686*****	**0.693*****	**0.766*****
	standard error	**(0.182)**	**(0.182)**	**(0.263)**	**(0.275)**	**(0.174)**	**(0.177)**	**(0.227)**	**(0.228)**	**(0.141)**	**(0.134)**	**(0.214)**	**(0.194)**
network - β_N	coefficient	**-0.050**	**-0.093**	**-0.169**	**-0.189**	**-0.008**	**0.013**	**0.113**	**0.109**	**-0.066**	**-0.097**	**0.018**	**-0.023**
	standard error	**(0.181)**	**(0.179)**	**(0.227)**	**(0.231)**	**(0.173)**	**(0.176)**	**(0.214)**	**(0.215)**	**(0.137)**	**(0.129)**	**(0.170)**	**(0.171)**
savings*network - β_{SN}	coefficient			**0.249**	**0.206**			**-0.241**	**-0.193**			**-0.177**	**-0.157**
	standard error			**(0.374)**	**(0.407)**			**(0.331)**	**(0.328)**			**(0.287)**	**(0.276)**
mean dep. variable (control)		6.896	6.896	6.896	6.896	6.060	6.060	6.060	6.060	7.261	7.261	7.261	7.261
$\beta_S + \beta_N = 0$	F-stat p-value	0.322	0.276			0.038	0.051			0.008	0.003		
$\beta_S + \beta_{SN} = 0$	F-stat p-value			0.098	0.083			0.121	0.125			0.007	0.002
$\beta_N + \beta_{SN} = 0$	F-stat p-value			0.785	0.955			0.625	0.752			0.483	0.388
$\beta_S + \beta_N + \beta_{SN} = 0$	F-stat p-value			0.324	0.278			0.035	0.048			0.009	0.003
r-squared adjusted		0.187	0.156	0.183	0.150	0.093	0.082	0.089	0.077	0.211	0.266	0.208	0.262
number of observations		120	118	120	118	144	143	144	143	164	162	164	162
controls		no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
ancova		yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Note: All regressions are ANCOVA. All dependent variables are in logs. They are based on survey questions asked in both the baseline and endline surveys. All regressions include district fixed effects. Controls are gender, age, whether the individual was born in Manica province, whether the individual has completed primary school, number of household members, and number of children. Robust standard errors reported in parenthesis. * significant at 10%; ** significant at 5%; *** significant at 1%.