Financing Smallholder Agriculture: An Experiment with Agent-Intermediated Microloans in India *

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Abstract

We explore the hypothesis that traditional joint-liability microfinance programs fail to increase borrower incomes in part because they cannot screen out unproductive borrowers. In randomly selected villages in West Bengal, India, we implemented trader-agent-intermediated lending (TRAIL), in which local trader-lender agents were incentivized through repayment-based commissions to select borrowers for individual liability loans. In other randomly selected villages, we organized a group-based lending (GBL) program in which individuals formed 5-member groups and received joint liability loans. TRAIL loans increased the production of the leading cash crop by 27% and farm incomes by 22%. GBL loans had insignificant effects. We develop and test a theoretical model of borrower selection and incentives. Farmers selected by the TRAIL agents were more able than those who self-selected into the GBL scheme; this pattern of selection explains 30–40% of the observed difference in income impacts.

Key words: Agricultural Finance, Agent-based Lending, Group Lending, Selection, Repayment

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1 Introduction

Microcredit promised to be a solution to global poverty; yet a large number of experimental evaluations have found no evidence that it increases borrower incomes or production (Kaboski and Townsend, 2011, Banerjee, Karlan, and Zinman, 2015). This is true for both joint liability and individual liability loans (Giné and Karlan, 2014, Attanasio, Augsburg, De Haas, Fitzsimons, and Harmgart, 2015). In other experiments, when rigid repayment schedules were relaxed, microloans increased farm activity and business incomes. However default rates also rose (Field, Pande, Papp, and Rigol, 2013, Feigenberg, Field, and Pande, 2013). Thus far, no study has found evidence that microcredit simultaneously increases borrower incomes and maintains high repayment rates. The reasons for this are not well understood.

In this paper we examine the hypothesis that one reason traditional group-based microfinance schemes fail to increase borrower incomes is that they are unable to screen out unproductive borrowers. Given their greater likelihood of default, unproductive borrowers pay high interest rates in the informal credit market. As a result they have a strong incentive to apply for MFI loans. MFI loan officers typically lack fine-grained information about the risk and productivity of poor borrowers, and cannot screen them with sufficient precision.

Against this backdrop, we designed an alternative mechanism for formal lenders to leverage the information about borrower characteristics that exists within the local community. We call this agent-intermediated lending. This paper considers a variant (called trader-agent intermediated lending or TRAIL) in which the formal lender delegates borrower selection to an agent randomly chosen from the informal traders/lenders in the community. The agent earns commissions that depend on the interest paid by recommended clients. This motivates him to select borrowers who are less likely to default. If default risk and productivity are negatively correlated, the borrower pool has high average productivity.

To test this mechanism, we conducted a field experiment in two districts of the Indian state of West Bengal. We implemented TRAIL in 24 randomly selected villages, and an alternative credit delivery model called group-based lending (GBL) in another set of 24 randomly selected villages. In each TRAIL village one agent was randomly selected from a list of established trader-lenders within the village, and was asked to recommend as potential borrowers 30 poor households; in particular, households that owned at most 1.5 acres of land. Ten of these 30 recommended households were randomly chosen to receive individual liability loans at below-market interest rates. The loans were repayable in a single lumpsum at the end of four months, to facilitate their use in the cultivation of potatoes, the main cash crop in this region. The agent was promised a commission equal to 75 percent of the interest payments received from borrowers he had recommended. He also incurred penalties for borrower defaults. Borrowers were incentivized to repay because future growth in credit access was tied to repayment. The scheme also provided insurance against covariate risks.

A Kolkata-based microfinance institution (MFI) called Shree Sanchari implemented the GBL scheme.[1] In each GBL village, households owning less than 1.5 acres of cultivable land could form 5-member groups. Groups were required to meet with loan officers each month and make

[1] Our version of GBL resembles Shree Sanchari's joint liability lending model, but may differ from the group-based lending schemes that other MFIs implement, either in India or elsewhere.

savings deposits for the six months before the loan scheme began.[2] Two groups were randomly selected from those that completed this initiation process and offered joint liability loans. GBL loans featured the same interest rate, loan duration, growth in credit access and covariate risk insurance as the TRAIL loans. The MFI received a commission equal to 75 percent of the interest payments that GBL borrowers paid. Neither the TRAIL agents, nor the MFI, were responsible for providing loan capital.

Besides using different methods for borrower selection, the two schemes also generate different borrower incentives.[3] In a joint liability contract the borrower may be called upon to pay up on behalf of a defaulting group member, thus facing a higher effective interest rate than on an individual liability loan. This could limit group members' incentives to expand the scale of borrowing. Equally, to avoid incurring this "joint liability tax", group members might monitor each other and discourage risky projects, such as the adoption of high-value high-risk cash crops (Fischer, 2013). The TRAIL agent might also help and/or monitor the borrower differently from how GBL group members help and monitor each other. For these reasons TRAIL and GBL may generate significantly different impacts, even if there were no selection differences.

It is therefore necessary to distinguish between selection and incentives as explanations for the difference between the performance of TRAIL and GBL. To this end, we develop and test a theoretical model of borrower heterogeneity and incentives that extends Ghatak (2000). Borrower ability is negatively correlated with default risk and positively correlated with productivity. Our model includes an informal credit market characterized by different segments in which each segment consists of at least two competing lenders who are informed about the types of borrowers in their segment.[4] Informal lenders, therefore, have an informational advantage over formal lenders who are outsiders to the village. However, they face a higher cost of capital. The formal lender can then appoint one of the informal lenders as a TRAIL agent and offer him interest-based commissions to leverage his information about borrower types.

Our model shows that TRAIL can generate larger increases in borrower incomes than GBL. This is because the TRAIL agent selects low-risk high-ability borrowers, who are better able to convert the loans into income increases. In contrast, the GBL scheme attracts both low and high ability borrowers, because both borrower types find that GBL loans are cheaper than their informal loans.

We call the difference in average treatment effects caused by this selection difference the *selection effect*. This is compounded by the *incentive effect*: for a borrower of given ability, a TRAIL loan increases income by more than a GBL loan does, because the joint liability tax raises the effective interest rate the GBL borrower faces. Since both selection and incentive effects work in the same direction, the TRAIL scheme creates larger average treatment effects on production and farm incomes than the GBL scheme does.

[2] Many group-lending schemes in different parts of the world require that members save regularly for a pre-assigned duration or meet a savings target before they can begin to borrow. It is often argued that this builds the financial discipline required to repay regularly.

[3] The rationale for bundling selection with liability features stems from practical considerations: Informal lenders only give out individual liability loans, and Shree Sanchari had only implemented joint liability lending schemes. Neither wished to become involved in a loan scheme with liability rules that they had no experience with.

[4] This is necessary to model the borrower selection choices of the TRAIL agent, who is a local informal lender and observes borrower types within his own segment. We explain the connection with Ghatak's analysis in more detail below.

The model generates a number of other predictions which can be tested using estimates of household ability. In order to obtain these estimates, we impose a Cobb-Douglas functional form on the farm production function, and postulate that farmer ability is a composite of fixed factors owned, other household attributes and household level unobservables. We also impose a constant elasticity relationship between ability and crop failure risk. This enables us to back out ability estimates for each household. In particular, the model allows us to estimate each household's ability from a regression of the logarithm of cultivation scale or of output on household and year dummies. Our model can therefore be viewed as a special case of the models in Olley and Pakes (1996) and Levinsohn and Petrin (2003), in which household ability is fixed over time.

We then test the following predictions of the model: (1) The TRAIL agent is incentivized to recommend the more able borrowers from his own segment; (2) More able borrowers pay lower interest rates on the informal market; (3) Borrowing costs, and therefore cultivated area and crop output, vary less with ability for treated households than for control households; (4) Loan treatment effects on borrowing, cultivation, output and farm incomes are larger for more able borrowers; (5) Under weak conditions, the TRAIL scheme selects more able borrowers than the GBL scheme does. If these predictions hold, the differences in borrower selection patterns cause the average treatment effect (ATE) of the TRAIL scheme to be larger than the ATE of the GBL scheme. The differences in the borrower incentives also work in the same direction. Importantly, the model provides a way to decompose the difference in the ATE into the contributions of selection and incentive differences.

Our first experimental finding is that the TRAIL loans generated significant ATEs on farm production and incomes: average farm value-added increased by 22 percent over the mean. This is driven by TRAIL households' increased cultivation of potatoes. GBL loans had a statistically non-significant effect, estimated at negative 1 percent. The difference in these two ATEs is statistically significant.

The model makes no definite predictions about how the repayment rates of the TRAIL and GBL schemes should compare. On the one hand, the average GBL borrower is less able and therefore has a higher risk of crop failure. On the other hand, conditional on borrower ability, a joint liability loan is more likely to be repaid than an individual liability loan. This is because other group members have an incentive to pay even if the borrower's crop fails. In the data we find that repayment rates were an equally high 95% over the 3 years in both schemes. However, loan take-up rates were significantly higher in the TRAIL scheme.

Turning to the detailed predictions of the model, we find definite evidence for predictions 2, 4 and 5, and weaker evidence for predictions 1 and 3. The distribution of estimated ability among households recommended by TRAIL agents first order stochastically dominated the distribution of households who self-selected into GBL groups, indicating superior ability selection under TRAIL. This higher ability of selected borrowers in TRAIL contributed positively to the observed higher average treatment effect of the TRAIL scheme, so that the selection effect is positive. Our decomposition indicates that the selection effect is responsible for 30–40 percent of the difference in ATEs.

We also address a number of other issues. First, one might be concerned that TRAIL agents abused their power to extract benefits from the borrowers they recommended. We find no evidence that the agents manipulated the terms of other trading relationships with treated borrowers to siphon off their benefits. Neither do we find evidence that the agents helped the TRAIL borrowers that they recommended by subsidizing their inputs or enabling them to realize higher prices for output sales. Second, the administrative costs of the TRAIL scheme were lower than those of the GBL scheme. This is because the MFI incurred substantial costs on high-frequency group meetings in the GBL scheme, which were not part of the TRAIL design. Since the TRAIL scheme had a higher take-up rate than and a similar repayment rate to the GBL scheme, TRAIL outranked GBL on financial performance.

Our focus on borrower heterogeneity and selection patterns is shared by the theoretical analysis of Ghatak (2000), who considers a model with two borrower types that vary in risk levels and productivity, but has no informal lenders. In his model, an uninformed outside lender cannot achieve first best allocations with individual liability contracts, but can do so using joint liability contracts. In contrast, we model an informal credit market with informed lenders, one of whom is randomly chosen to be the TRAIL agent. As a result in our model both high and low ability types can borrow in the absence of an outside lender. We do not examine whether entry by an outside lender increases high ability borrowers' access to credit, but instead examine whether group loans can selectively target such borrowers.

Beaman, Karlan, Thuysbaert, and Udry (2015) are also interested in endogenous borrower selection. Their eld experiment in Mali compares a group lending program with self-forming groups, and a grant program with randomly selected recipients. They find that borrowers self-selecting into the group lending program had higher ability on average than randomly chosen recipients. We find that on average borrowers self-selecting into groups had lower ability than those recommended by the TRAIL agent.

2 Experimental Design and Data

We designed loan schemes to facilitate the cultivation of a high-value cash crop. In particular we selected potatoes, the highest-value cash crop in the state of West Bengal, India. Hugli and West Medinipur are among the largest producers of potatoes in the state. Accordingly, we conducted our experiment in these two districts.

In both TRAIL and GBL, borrowers were offered repeated loans of 4-month durations at an annual interest rate of 18%, substantially below the prevailing market rate of 25 percent. The first loans were capped at ₹2000 (equivalent to approximately $US40 at the prevailing exchange rate), and were disbursed in October-November 2010, to coincide with the potato-planting season. Repayment was due in a single lumpsum after 4 months. In each subsequent cycle, borrowers who repaid the entire amount that was due became eligible for a 33 percent larger loan on the same terms as before. Those who repaid less than 50 percent of the repayment due were not allowed to borrow again. Others were eligible to borrow 133 percent of the principal repaid.[5] Both schemes had an in-built index insurance scheme, according to which the required repayment would be revised downwards if the revenue per acre for potatoes fell 25 percent below a three year average

[5]To facilitate credit access for post-harvest storage, borrowers were allowed to repay the loan in the form of cold storage receipts (or "bonds") instead of cash. In that case the repayment was calculated at the prevailing price of the bonds.

in the village, as assessed through a separate village survey.[6]

Each sample village was at least 10 kilometers away from all other sample villages, to minimize contamination of the experimental interventions through the spread of information. The MFI had not operated in any of the sample villages before our project started, and in general MFI penetration was low in these regions. A research grant held by the project team provided the funds for all loans in the two schemes.

As we explained above, we rationed loan offers to 10 borrowers in each village. Therefore, we are able to estimate loan treatment effects while controlling for selection into the scheme, either through recommendation by a TRAIL agent or through participation in a GBL group. This is possible because only a randomly selected subset of households that were recommended (in the TRAIL villages) or joined groups (in the GBL villages) were offered the program loans. In TRAIL villages, the agent recommended 30 individuals, and 10 of these were randomly chosen through a public lottery and offered the loans. In GBL villages, two of the groups that had survived a 6-month initiation period were randomly chosen through a public lottery to receive loan offers. The small scale of our interventions implies that spill-overs on non-beneficiaries in the experimental villages were unlikely. The loan treatment effects are then estimated as differences in outcomes between those randomly chosen to receive a loan offer (we call these Treatment households), and those who were recommended or formed a group, but were unlucky in the lottery and did not receive the loan offer (we call these Control 1 households). Our approach resembles that of Karlan and Zinman (2011), in which loan assignment was randomized among borrowers deemed marginally creditworthy by a credit scoring algorithm. To examine whether households that were selected into the scheme were different from those not selected, we can compare the Control 1 households with Control 2 households. Control 2 households are those who fell below the land threshold, but were not recommended in TRAIL villages, or did not form groups in GBL villages.

2.1 The Trader-Agent-Intermediated Lending (TRAIL) Scheme

Project activities began in TRAIL villages in September 2010. The project team consulted with prominent persons in each village to draw up a list of traders and business people who had operated a business in the village for at least three years, and had at least 50 clients. One person from this list was randomly chosen and invited to become a TRAIL agent.[7] The agent was asked to (confidentially) recommend as potential borrowers 30 village residents who owned no more than 1.5 acres of agricultural land. In October 2010, our project officer selected 10 out of these 30 names through a public lottery. Loan officers visited the treated households in their homes to explain the loan terms and later to disburse the loan if it was accepted.

At the beginning of the scheme, the agent was required to put down a deposit of ₹50 per borrower. The deposit was refunded to the agent at the end of two years, in proportion to the loan repayment

[6] In yet another 24 villages, an alternative version of the agent intermediated lending scheme (called GRAIL) was implemented, where a member of the village council (*Gram Panchayat*) was appointed as the agent. The GRAIL agent is likely to have been motivated by the political benefits of participating in the scheme. The treatment effects of the GRAIL program will be analysed in a separate paper.

[7] The experimental protocol stated that if the person approached rejected the offer, the position would be offered to another randomly chosen person from the list. However the first person offered the position accepted in every village.

rates of his recommended borrowers. At the end of each loan cycle he received as commission 75% of the interest received on these loans. The agent's contract was terminated at the end of any cycle in which 50% of borrowers whom he had recommended failed to repay. Agents were also promised an expenses-paid holiday at a local sea-side resort if they survived in the program for two years.

Loan officers' interactions with borrowers were limited to single visits to the borrowers' residences at the beginning of each cycle to disburse loans and at the end of each cycle to collect loans. They were not required to engage in any monitoring or collection effort beyond this. Borrowers were also not required to report to the loan officers their intended or actual use of the loan.[8]

A potential concern with the TRAIL intervention is that agents might have acted in ways that undermined the scheme. For instance, they might have asked for bribes to recommend borrowers, selected unsuitable borrowers (with high default risk, less productive individuals, wealthy individuals, or cronies in exchange for bribes or favors), extracted borrower benefits by manipulating other transactions with them, colluded with borrowers (encouraged them to default and divide up the loan funds instead) or coerced them to repay. To help guard against these possibilities, all loan transactions took place directly between the loan officers and the borrower. The research team verified that the agent followed the protocol and that households with landholding above the stipulated threshold did not receive program loans. The team also communicated clearly to all borrowers that the interest rate was fixed, there were no other charges for participation, and that all payments were to be made only to the loan officers. Later we examine the borrower recommendation patterns in the data, and also check for evidence that the TRAIL agent manipulated his transactions with the treated households. We find no evidence that this is the case.

2.2 The Group-based Lending (GBL) Scheme

The MFI began operations in the GBL villages in February-March 2010 by inviting residents who owned no more than 1.5 acres of land to form 5-member groups, and then organizing bi-monthly group meetings, where each member was expected to deposit ₹50 per month into the group account. Of the groups that survived until October 15, 2010, two were randomly selected into the scheme through a public lottery. Each group member received a loan of ₹2,000 in Cycle 1, repayable in a single lump sum at the end of four months. Thus the entire group received ₹10,000. All group members shared liability for the entire sum: if less than 50% of the due amount was repaid in any cycle, all members were disqualified from future loans; otherwise the group was eligible for a new loan, which was 33% larger than the previous loan. Bi-monthly group meetings continued throughout, in keeping with the MFI's standard protocol for joint liability lending. At the end of each loan cycle the MFI received as commission 75% of the interest received on these loans.[9]

[8] However in our household surveys we did ask respondents to tell us how they used each loan.

[9] Thus, the incentives provided to TRAIL agents and to the MFI were identical. Both faced the same formula for commissions. The paid holiday for TRAIL agents who were not terminated was akin to the internal bonus that Shree Sanchari loan officers could expect if their job performance was considered satisfactory.

2.3 Data and Descriptive Statistics

The villages where the experiment was conducted had an average of 393 households per village. Three-quarters of villages had a primary school, 23% had a primary health centre, 8% had a bank branch and 33% of the villages had access to a metalled road. Households had 5 members on average. The majority of the households were Hindu, and among them, there were roughly equal proportions of high and low castes. The average landholding of village households was 0.46 acres. Nearly 95% of households had male heads, about 42% of the household heads had completed primary schooling and about half reported that agricultural cultivation was their primary occupation. Panel A in Table 1 provides checks of balance across the villages randomly assigned to the TRAIL versus GBL treatment arms. As can be seen, there were almost no significant differences in village-level characteristics across the two groups.

Table 2 describes the mean characteristics of the major categories of crops grown by sample farmers during the three years of our study. It is clear that potatoes were the highest-value crop in these villages: they accounted for a significant proportion of acreage, had the highest working capital needs, and generated nearly three times as much value-added per acre as other major crops.

In each village, the sample consisted of 50 households, composed of three sub-groups. First, we included all 10 borrowers who were randomly chosen to receive the loan (Treatment households). Second, of the remaining 20 recommended individuals, we included a random subset of 10 (Control 1 households). Finally, we included 30 households randomly chosen from the non-recommended (Control 2) households. In the GBL villages, of all the groups that formed, two groups were randomly selected and offered the loan. We included all 10 households from these two groups in the sample (Treatment households). Two groups that had formed but were not offered loans were also randomly chosen into the sample (Control 1). Finally, we randomly chose 30 households that did not form groups (Control 2).

Treatment households in both schemes received their first loan in October 2010. The first round of household surveys was conducted in December 2010. The surveys collected data about household demographics, assets, landholding, cultivation, land use, agricultural input use, sale and storage of agricultural output, credit received and given, incomes, and economic relationships within the village. Loans were repayable at the end of four months, and new loans could be taken immediately after repayment. Subsequent survey rounds were also conducted at four-monthly intervals. Surveys had a recall period of four months. The high frequency of the data collection helped minimize measurement error. There was no attrition in the sample over the three years. In each sample household the same respondent answered survey questions in each round.

Our analysis is restricted to the 2070 sample households who owned less than, or equal to, 1.5 acres of land.[10] Panel B of Table 1 checks whether the selected households (recommended households in TRAIL villages/participating households in GBL villages) were evenly assigned to Treatment and

[10]Only households that owned no more than 1.5 acres of land could be recommended, so that Treatment and Control 1 groups were almost entirely made up of households below the threshold. However the Control 2 group included households that owned more than 1.5 acres of land. For the sake of a clean comparison we do not include these households in our estimation sample. This explains why our estimation sample of 2070 households is smaller than the sample of 2400 households for whom we collected data.

Control 1 groups. For most characteristics, we see only minor differences across the two groups. The F-statistic shows that we cannot reject the joint hypothesis of no differences across the two arms in either the TRAIL or GBL villages.

Table 3 describes credit transactions for all sample households that owned less than 1.5 acres of land. We present here both total borrowing and borrowing for agricultural purposes from September–December 2010, which is when potatoes are planted.[11] We do not include loans received through the TRAIL or GBL schemes. Since potato cultivation is working capital-intensive, column (2) of the table depicts the main sources of agricultural credit, and characteristics of agricultural loans. About 67% of sample households borrowed during this 4-month period. Traders and moneylenders were the most important source: they provided 63% of all agricultural credit. Credit cooperatives provided about a quarter, but they loaned mainly to households with relatively larger landholdings (statistics available upon request). Consistent with low MFI penetration, MFIs and other sources provided only 3% of the total credit.

The average interest rate on loans from traders and moneylenders was 25%, substantially above the 18% interest rate charged on the TRAIL and GBL program loans. The average duration of these loans was a little over 120 days, reflecting the 4-month agricultural cycles in this area. Loans from family and friends were also more expensive than the program loans, and were given for about 6 months.[12] It was extremely rare for any of the informal loans to be secured by collateral. Cooperatives and government banks charged substantially lower interest rates and provided longer-duration loans. However, they were more likely to require collateral, which may explain why their share became progressively smaller as household landholding decreased. Landless households received 87% of their agricultural credit from informal lenders, and only 6% from cooperatives (statistics available upon request).

3 Theoretical Model of Selection

Our model is based on two key features: borrower heterogeneity, and a segmented informal credit market. Borrowers vary in (exogenously-determined) ability; more able borrowers have lower default risk and higher productivity. Ability variations could reflect either differences in total factor productivity, such as experience or farming skill or in the ownership of complementary fixed factors, such as land or household labor stock. Any selection-based exploration of output or income effects of microcredit must incorporate such heterogeneity in borrower ability.[13] The model abstracts from moral hazard, although similar results can be obtained in extensions that incorporate moral hazard (presented in previous versions of this paper). Defaults arise from incidents of crop failure (such as a pest attack) combined with limited liability: when their crop

[11] We use our detailed survey data documenting the purchase of inputs to ensure that all trade credit used for input purchases is included in our measure of borrowing.

[12] We do not consider loans where the repayment amount due was reported to be equal to the principal, since these interest-free loans are likely to be gifts from altruistic lenders, and thus lie outside the ambit of the informal credit market.

[13] Thus "ability" in our model represents more than just intrinsic characteristics of a farmer, but also includes human capital that could have been acquired over time (before the study began), and physical capital (which we assume remains fixed during the study), all of which may contribute to higher productivity and higher likelihood of crop success.

fails, farmers do not have the means to repay their loans. More able farmers are less likely to experience crop failure because they are better at preventing the pest attack. The risk of crop failure is not correlated across farmers. Besides productivity, the model incorporates associated variations in default risk in order to explain the TRAIL agent's induced selection choices.

Each farmer endogenously chooses the scale of cultivation, measured by area cultivated or expenditure on variable inputs. Conditional on their crop succeeding, more able farmers are more productive insofar as they produce more output from a given scale of cultivation. Specifically, a farmer of ability i experiences crop failure with probability $(1 - p_i) \in (0, 1)$ and produces nothing; otherwise he produces $\theta_i f(l)$ where l denotes the level of input ($\equiv$ loan size) chosen by the farmer. The production function f is smooth, strictly increasing and strictly concave with $f'(0)$ large enough to ensure interior production for all parameter values and ability levels. Both p_i and θ_i are non-decreasing in i, while their product (or expected productivity) $\bar{\theta}_i \equiv p_i\theta_i$ is strictly increasing. It will turn out that the limited liability constraint will never bind in the absence of a crop failure: farmers will always cultivate on a scale that generates sufficient output to repay their loans. Informal lenders are able to monitor whether their borrower's crop succeeds, and can impose sufficient penalties to deter voluntary default. Hence the default risk of a farmer of ability i is $1 - p_i$.

In the simplest version of the model, there are only two possible ability levels: high ($i = H$) and low ($i = L$), with $H > L$. A given proportion μ_H of borrowers are highly able. Extension to the case of more types is straightforward. To keep the exposition simple we restrict attention to the two-type case for the time being. In Section 3.5 we allow for specific functional forms and for ability to vary continuously.

3.1 Pre-Intervention Informal Credit Market

Each village is partitioned into S different segments on the basis of physical or social proximity. These can be thought of as hamlets, neighborhoods or networks. There are N borrowers in the village divided equally across these S segments, and each segment has the same proportion of H type borrowers. Each segment also has at least two informal lenders who can distinguish borrower types in their own segment, but not in any other segment. All lenders have the same cost of capital ρ per unit loaned, and face no capacity constraints. They compete with one another in Bertrand fashion to make credit offers consisting either of an interest rate (with the borrower deciding how much to borrow), or of a loan size and interest rate pair. The location of each agent in the village is determined exogenously.

Standard arguments imply that the lenders in any given segment will specialize in lending to highly able borrowers in their own segment, and will compete with each other so that in equilibrium they will offer them any amount at interest rate $\frac{\rho}{p_H}$. Low ability borrowers will be able to borrow from any lender in the village at the interest rate $\frac{\rho}{p_L}$, because all lenders will be willing to lend to any borrower in the village at this rate.[14]

[14] An informal lender will not be willing to lower the interest rate below $\frac{\rho}{p_L}$ for any low ability borrower in his own segment. He will not offer borrowers from other segments an interest rate below $\frac{\rho}{p_L}$ because the only borrowers who would accept that offer would be the low ability ones, resulting in losses.

Thus, before the MFI intervention, borrower of type i will borrow $\bar{l}_i$ where

$$\bar{\theta}_i f'(\bar{l}_i) = \rho \tag{1}$$

which is a Walrasian allocation. The segmentation of the market has no consequence for the allocation. However, segmentation affects the outcomes of the TRAIL intervention, to which we now turn.

3.2 TRAIL Intervention

Suppose now that the MFI enters and offers loans at interest rate r_T which is below ρ, the cost of capital for informal lenders. The MFI's comparative advantage over the informal lenders is its lower capital cost. However, it suffers from an informational disadvantage: it is unable to identify the ability of any given borrower. To overcome this, it randomly selects an informal lender, and appoints him as its agent. The agent is asked to recommend to the MFI n borrowers from the village as potential borrowers for TRAIL individual liability loans at interest rate r_T. The MFI then offers loans to a randomly selected fraction of those recommended. The agent is paid a commission at the rate of $m \in (0, 1)$ per unit of interest repaid by the borrowers he recommended. This incentivizes the agent to recommend borrowers who have a lower risk of crop failure. As with informal loans, we assume that the borrower always has the incentive to repay the loan, so that there is no voluntary default.[15]

The TRAIL agent's selection incentives are as follows. Assuming for now that he does not collude with borrowers, he tries to maximize the likelihood that the TRAIL loans are repaid. To achieve this, his most-preferred borrowers are the H-type borrowers from his own segment. His second preference is for randomly chosen borrowers from other segments, and this is followed finally by L-type borrowers in his own segment. If $n \leq \frac{N}{S}\mu_H$, then all the borrowers he recommends are H-type from his own segment. Otherwise, he recommends all the H-type borrowers from his own segment and then fills the remaining slots with randomly chosen borrowers from other segments.[16]

Note that, in the more general model where ability varies continuously (Section 3.5), among the own-segment borrowers there will exist a threshold type such that the agent will be indifferent between recommending him, or instead recommending someone from outside the segment. If the set of borrowers the agent chooses from is not large, then it is difficult to predict how the realized average ability of these randomly chosen out-of-segment borrowers will compare with the recommended and not-recommended own-segment individuals. Hence, our only definite prediction is that among the own-segment individuals, those recommended have higher ability than those not recommended.

We assume that the TRAIL loans do not crowd out the informal loans that the borrowers already have from informal lenders.[17] In Section 4.1.1 we shall verify the validity of this assumption in

[15] This can be because defaulting borrowers are cut off from future access to TRAIL loans, or because the informal lender pressurizes the borrower to repay.

[16] This is under the reasonable assumption that the total population of other segments exceeds n.

[17] This could be because TRAIL loans may not be close substitutes for informal loans, which have more flexible durations or repayment terms. Alternatively, borrowers are uncertain about how long the TRAIL intervention will be available and so are reluctant to disrupt their pre-existing credit channels.

the data. We also simplify by assuming that the TRAIL credit limit is not binding: each farmer's desired TRAIL loan size is smaller than the amount the MFI offers. The main conclusions continue to apply when the limit is binding for some borrowers.[18]

We can now predict the impact of the TRAIL intervention. A selected farmer of ability i will select a TRAIL loan l_i^T satisfying

$$\bar{\theta}_i f'(\bar{l}_i + l_i^T) = p_i r_T \tag{2}$$

Conditions (1) and (2) can easily be used to compare *levels* of borrowing, output and farmer income across types, both before and after the intervention, as stated in the lemma below.

Lemma 1 Comparison of Levels: *Higher ability types borrow, produce and earn more than lower ability types, both before and after being offered the TRAIL loan.*

The less trivial question is how treatment effects on borrowing, output or income vary by borrower type. This is ambiguous in general. Starting with the loan treatment effect, the question is: will more able farmers take larger TRAIL loans? There are three relevant forces here:

(a) Productivity Difference: More able farmers have higher productivity, so they derive larger benefits from expanding the scale of cultivation;

(b) Diminishing Returns: More able farmers produced more before the intervention, and so they have a lower marginal rate of return to expanding cultivation, controlling for productivity differences;

(c) Subsidy Difference: More able farmers paid a lower interest rate on the informal market before the intervention, so the intervention lowers their interest rate by less.

The productivity difference induces more able farmers to take larger TRAIL loans, but the diminishing returns and smaller interest rate subsidy work in the opposite direction. As a result it is unclear whether the overall treatment effect would be larger for more able types.

Consider the case where high and low ability farmers are equally productive, so that they only vary in default risk. Then it follows from the above that the loan treatment effect will be decreasing in ability.[19] Now introduce productivity differences, so that θ_i increases in i. Then

[18] A binding credit ceiling will not affect the default risk, so leaves the TRAIL agent's selection incentives unaffected. If the ceiling were binding for both high and low ability borrowers, the TRAIL loan size would be the same for both, while the higher ability type would borrow more before the TRAIL scheme was introduced. This would imply that the loan treatment effect is decreasing in ability. Instead we see that the loan treatment effect is increasing in ability. It follows that even if the ceiling is binding at all, it cannot bind for the low ability type. In this case it can be readily be verified that parts (a) and (b) in Lemma 2 will continue to apply. In the empirical analysis these are the two parts that turn out to be relevant.

[19] To see why, note that any given borrower of type i selects the TRAIL loan size $l = l_i^T$ to maximize net income conditional on crop success $\theta_i f(\bar{l}_i + l) - r_T l$. If there are no productivity differences, θ_i does not vary with i: then all ability types would have the same aggregate borrowing, cultivation, output and income (conditional on crop success). Since higher ability types borrow more before the credit intervention, the loan treatment effect would decrease in i.

higher ability borrowers who are offered TRAIL loans borrow a larger total volume $(\bar{l}_i + l_i^T)$. The pre-intervention scale of borrowing depends entirely on expected productivity $\bar{\theta}_i$. Therefore if expected productivity $(\bar{\theta}_i)$ is constant and productivity (θ_i) accounts for more of it, so that the crop success rate (p_i) accounts for less of it, then total borrowing after the intervention $(\bar{l}_i + l_i^T)$ increases more steeply in ability i than pre-intervention borrowing $(\bar{l}_i)$ does. This means that loan treatment effects increase in ability. In the limiting case where crop risk does not vary at all with ability, we show below that the loan treatment effect must increase in i. Hence the relative importance of productivity variations relative to crop risk variations in ability determines how loan treatment effects vary with ability.

In the following result, we restrict attention to production functions satisfying a *Regularity Condition* (RC): $\frac{-f''}{f'}$ is decreasing. This condition is satisfied by the constant elasticity function $f(l) = \frac{1}{\alpha} l^\alpha$ with $\alpha < 1$, $\alpha \neq 0$, which corresponds to the logarithmic function, as well as the exponential function $(f(l) = \Gamma[1 - \exp(-al)]$ with $a > 0)$.

Lemma 2 Comparisons of TRAIL Impacts Across Types*: Suppose that the production function satisfies RC, and that expected productivity $\bar{\theta}_i$ is strictly increasing in ability i.*

(a) If the loan treatment effect is rising in ability, the output treatment effect will also be rising in ability.

(b) If variation in productivity accounts for all (or most) of the variation in expected productivity (so that the crop success probability p_i is entirely or nearly independent of ability), then loan, output and income treatment effects will be rising in ability,

(c) If all (or most) of the variation in expected productivity is accounted for by variation in the probability of crop success (so that productivity is entirely or nearly independent of ability), then loan and output treatment effects will be falling in ability.

The proof of Lemma 2 is in the Appendix. Parts (b) and (c) show that how the treatment effects vary with ability depends on whether productivity or crop risk is more sensitive to variations in ability.[20]

The empirical analysis in subsequent sections will examine how loan, cultivation and income treatment effects vary with ability. The results above help to see why the model must incorporate variations in both default risk and productivity. If we had assumed farmers vary only in default risk, part (c) of Lemma 2 shows that TRAIL treatment effects would be falling in ability, which would have unduly restricted the predictions of the model and rendered it unable to accommodate the opposite pattern. If instead farmers vary only in productivity, then we would be unable to explain the TRAIL agents' selection patterns, because the agent is incentivized on repayment rates and not on the borrower's output.

Importantly the model enables us to empirically disentangle the two sources of variation: differences in informal interest rates reflect variations in default risk, and, given Lemma 2, the pattern

[20] In case (c) we are not able to provide a definite result about how treatment effects on farm income vary across types. It can be shown that they decrease in ability if the scale of the TRAIL loans is small enough, i.e., when $[\frac{\rho}{p_L} - r_T]$ is not too large.

of variation of TRAIL treatment effects then reveals the importance of productivity differences. For example, if we find that treatment effects are rising while interest rates are falling in ability, then we can infer that higher ability farmers have lower default risk and are also significantly more productive.

3.2.1 Collusion between the TRAIL agent and borrowers

Now consider the consequences of corruption, where the TRAIL agent can charge bribes in return for recommendations. Loan sizes could also be collusively chosen, so that recommended TRAIL borrowers internalize the larger commissions that the agent would earn if the loan were to become larger.

In this case, the effective interest rate on the loan for the coalition would be $(1-m)r_T$ (where m is the agent's commission rate) instead of the r_T from the non-collusive equilibrium. Lemma 2 would continue to hold, with the effective TRAIL interest rate adjusted from r_T to $(1-m)r_T$, as above. If productivity variations are larger than default risk variations, case (b) applies and the borrower income treatment effects increase in ability. Then high ability borrowers benefit more from the loan than low ability borrowers, and are willing to pay larger bribes. Thus collusion reinforces the agent's incentive to recommend high ability borrowers.[21]

3.3 GBL Intervention

As is standard in the literature (see for example Besley and Coate, 1995, Ghatak, 1999, 2000), we simplify the analysis by assuming that each GBL group consists of two members. The MFI requires individuals to self-select into groups. Group members then apply for a joint liability loan, which is offered at the same interest rate r_T as the TRAIL loan. Each member is potentially liable for the loans of both members. In addition, the GBL program requires members to periodically attend group meetings and meet savings targets. The cost of meeting these requirements varies idiosyncratically in the population and is uncorrelated with their type: we assume the cost for any borrower c is drawn from a distribution with positive density g over the nonnegative reals. As in the analysis of the TRAIL scheme, we abstract from repayment incentives, and assume that borrowers honor their obligations whenever their own project does not fail.

In contrast to Ghatak (1999, 2000), the scale of cultivation and hence the loan size is variable. Consistent with Ghatak's formulation we assume that members of a group cooperate, i.e. can make side payments without any friction in order to internalize externalities they exert on each other. Then the loan size choices $l_i^G = l_{ij}^G, l_j^G = l_{ji}^G$ for any group (whose members have types i, j) will maximize the sum of their respective *ex ante* payoffs: $\bar{\theta}_i f(\bar{l}_i + l_i^G) + \bar{\theta}_j f(\bar{l}_j + l_j^G) - r_T[p_i\{l_i^G + (1-p_j)l_j^G\} + p_j\{l_j^G + (1-p_i)l_i^G\}]$, implying

$$\bar{\theta}_i f'(\bar{l}_i + l_{ij}^G) = [p_i + (1-p_i)p_j]r_T \quad (3)$$

[21] This would obtain regardless of whether the collusion game were modeled cooperatively with stable matching followed by Nash Bargaining, or non-cooperatively, where either side makes a take-it-or-leave-it offer to the other. We omit the details here.

The expected value of the extra liability that group member j bears in the event that i's crop fails is $(1-p_i)p_j r_T l_i$. This "joint liability tax" raises the effective cost of the GBL loan relative to the TRAIL loan. So the GBL borrower chooses a lower scale of borrowing than the TRAIL borrower of the same ability. Hence we obtain

Lemma 3 Comparison of TRAIL and GBL Impacts for a Given Borrower Type*: For any given ability type, the TRAIL treatment impact on loan size, cultivation scale, output and income is larger than the GBL treatment impact.*

Treatment effects on borrowing and income will therefore be smaller for GBL loans than for TRAIL loans, controlling for ability. A similar effect would arise if the model were extended to incorporate help or monitoring by the TRAIL agent that enhances productivity by more than similar services by other group members, or MFI officers.

As they have similar costs of attending group meetings and meeting savings requirements, *both* high and low ability borrowers have an incentive to participate in the GBL scheme. To see this, consider first a homogenous group, i.e. one in which both members are of type i. Each group member faces an expected interest rate of $p_i(2-p_i)r_T$, which is lower than what she pays in the informal market, since $r_T < \frac{\rho}{p_i(2-p_i)}$.[22] Hence, homogenous groups of either type would prefer a GBL loan to the status quo. If positive assortative matching does not obtain, heterogenous (H, L) groups could also form.[23] Either way, both low and high risk types would join groups and apply for GBL loans.

The composition of the GBL applicant pool would depend on how the benefits to different groups were rank-ordered. However, the key point is that the proportion of low ability GBL applicants will be bounded away from zero: even with positive assortative matching and the resulting homogenous groups, both high ability groups and low ability groups have an incentive to borrow, and with negative assortative matching even mixed groups would form. Thus, unlike the TRAIL scheme where the agent acts as gate-keeper, there is no mechanism in the GBL scheme that keeps low ability borrowers out. We therefore expect the TRAIL agent to recommend a larger proportion of high ability borrowers than those who self-select into the GBL scheme.[24]

Lemma 4 Differences in Selection Patterns between TRAIL and GBL*:*

(a) If $n \leq \frac{N}{S}\mu_H$, all TRAIL borrowers are H-type, but only a fraction of GBL groups are of H-type.

(b) If $n > \frac{N}{S}\mu_H$, the proportion of borrowers who are H-type in the TRAIL scheme is weakly larger than μ_H. The TRAIL scheme also has more H-type borrowers than the GBL scheme, unless GBL treatment effects are rising in ability and n is sufficiently large relative to $\frac{N}{S}\mu_H$.

[22]This follows from the fact that $p_i(2-p_i) < 1$, for any i.

[23]In this setting where loan sizes are endogenously chosen, it is difficult to pin down the exact conditions under which positive assortative matching would result.

[24]This is provided the number of recommendations required does not greatly exceed the number of high ability borrowers in the agent's own segment of the informal credit market.

3.4 Decomposing TRAIL-GBL Differences in Impacts into Selection and Incentive Effects

We can express the average treatment effect on any given outcome of intervention v (where v = T if the scheme is TRAIL, and v = G if the scheme is GBL) as an average of the treatment effects for different borrower types, using as weights the proportion of selected borrowers that belong to the type, as follows:

$$T^v \equiv \omega^v T^v_H + (1 - \omega^v) T^v_L \tag{4}$$

where for intervention v, T^v_i denotes the treatment effect on a type i borrower, T^v denotes the average treatment effect and ω^v denotes the fraction of H types selected. The difference between TRAIL and GBL average treatment effects can then be expressed as

$$T^T - T^G \equiv \quad [\omega^G(T^T_H - T^G_H) + (1 - \omega^G)(T^T_L - T^G_L)] + (\omega^T - \omega^G)(T^T_H - T^T_L) \tag{5}$$

The difference in average treatment effects is the sum of two terms. We call the first term the Incentive Effect. It is a weighted average of the differences in treatment effects of the two schemes for a given borrower type, using as weights the selection likelihoods for each type in the GBL scheme. We refer to the second term as the Selection Effect. It is the product of the difference in TRAIL treatment effects between the two types, and the difference in the proportion of H-types between the two interventions. Thus it captures the extent to which differences in borrower selection patterns cause the treatment effects of the two schemes to differ. From this and the preceding lemmas it follows that

Lemma 5 Sufficient Condition for Comparing Average Treatment Effects: *The average treatment effect of TRAIL loans is larger than the average treatment effect of GBL loans if TRAIL treatment effects increase in ability, and the TRAIL agent's recommendations contain a larger proportion of H types than the borrowers who self-select into the GBL scheme (e.g. if n is smaller than $\frac{N}{S}\mu_H$, or is not much larger).*

Note that this is a sufficient condition, but not necessary. The purpose of this lemma is to show that the model provides a possible explanation for the larger average treatment effects of the TRAIL scheme than the GBL scheme.

3.5 Specific Functional Forms

The results in the lemmas above depend on assumptions on unknown parameters, and on covariations between observable variables and farmer ability, which is unobserved by the researcher. As a result they are not directly testable. For the empirical analysis we therefore impose a specific functional form that allows us to estimate ability from data we do observe, so that we obtain testable predictions. This also allows us to evaluate the respective roles of selection and incentive effects in driving the difference between the treatment effects of the TRAIL scheme and the treatment effects of the GBL scheme.

We assume the production function is Cobb-Douglas:

$$Y = \theta^{1-\gamma}[\frac{1}{1-\alpha}l^{1-\alpha}] \tag{6}$$

where θ denotes ability, l the scale of cultivation chosen by the farmer, and parameters $\gamma, \alpha \in (0, 1)$.

The probability of crop success is given by

$$p(\theta) = P\theta^{1-\nu} \tag{7}$$

where $\nu \in (0, 1)$ and P is the average crop success rate or yield within the village. To keep probabilities between zero and one, we impose an upper bound $\Theta < \infty$ on ability and then restrict $P \leq [\Theta]^{\nu-1}$. A particular example of this is $P = \chi[\bar{a}]^{\nu-1}$ for some $\chi \in (0, 1)$, so that

$$p(\theta) = \chi[\frac{\theta}{\Theta}]^{1-\nu} \tag{8}$$

Note the following features of this specification:

(a) If ν is close to 1 while γ is not close to 1, most of the variation in expected productivity is driven by variation in productivity rather than default risk, corresponding to case (b) of Lemma 2. Conversely, if γ is close to one while ν is not, most of the variation is accounted by default risk, and case (c) holds.

(b) Previously we considered only two borrower types: high and low. In this version ability varies continuously. So we keep track of how pre-, post- and treatment effects vary with ability, and can construct a continuous ability index.

A control group farmer of ability θ borrows from informal lenders, and so maximizes $\theta^{1-\gamma}p(\theta)\frac{1}{1-\alpha}l^{1-\alpha} - \rho l$. This gives us an expression for the scale of cultivation l^C.

$$\log l^C = \frac{1}{\alpha}\log A + \frac{1}{\alpha}[\log P - \log \rho] \tag{9}$$

where

$$A \equiv \theta^{2-\gamma-\nu} \tag{10}$$

varies monotonically with ability, which varies across households. In what follows below we will therefore use A or θ interchangeably to measure ability. The second term on the right-hand-side of (9) includes covariate shocks to yields and the cost of capital, which varies at the village-year level, but not across households within a given village-year.

A TRAIL treated farmer of ability θ (or equivalently measured by A as in equation (10) above) selects the TRAIL loan l^* to maximize $p(\theta)\theta^{1-\gamma}\frac{1}{1-\alpha}[l^C + l^*]^{1-\alpha} - p(\theta)r_T l^*$, implying that

$$\log l^* = \delta\frac{1}{\alpha}\log A - \frac{1}{\alpha}\log r_T \tag{11}$$

where $l^T \equiv l^C + l^*$ denotes aggregate scale of cultivation for treated farmers, and

$$\delta \equiv \frac{1-\gamma}{2-\gamma-\nu} \tag{12}$$

which lies between 0 and 1. We see here that the expected cost of borrowing increases in ability for treated borrowers but not for control borrowers. As a result the scale of cultivation varies less sharply with ability for TRAIL treated borrowers than for control borrowers. The intuitive reason is that informal lenders are able to offer more able borrowers lower interest rates, unlike the MFI.

Returning to condition (a) from the above, if ν is close to 1 while γ is not close to 1, then most of the variation in expected productivity is driven by variation in productivity rather than default risk and case (b) of Lemma 2 applies. We see from equation (12) above that this also implies that δ is close to 1. Therefore in the empirical analysis we will check the value of δ, and if we find that it is close to 1 we will expect TRAIL treatment effects to be larger for households with greater ability.

Averaging across groups, the effective borrowing cost for a member with ability θ_i is $p(\theta_i)[1-\bar{p}]+\bar{p}$ which is increasing linearly in $p(\theta_i)$. Here $\bar{p}$ denotes the average success probability.

Similar expressions also arise for the expected output of treated and control households. For control households:

$$\log E[Y^C] = \frac{1}{\alpha}\log A + \frac{1}{\alpha}[\log P - (1-\alpha)\log\rho] - \log(1-\alpha) \tag{13}$$

while for TRAIL treated households:

$$\log E[Y^T] = [\delta\frac{1}{\alpha} + (1-\delta)]\log A + \log P - \frac{(1-\alpha)}{\alpha}\log r_T - \log(1-\alpha) \tag{14}$$

and again we see that log output varies less with ability for treated households than for control households.

In GBL villages, expressions (9) and (13) continue to apply for control households. For treated households, however, the expressions for effective cost of borrowing depend on the pattern of matching and do not have closed-form solutions. Therefore we cannot estimate the ability of GBL treated households without making additional assumptions. Fortunately for our subsequent analysis we do not need ability estimates for these households.

3.5.1 Estimating Ability

From this point onwards, we denote households by h. We assume that the ability of household h depends on observable farmer characteristics $X_{kh}, k = 1, \ldots$ such as land owned, number of household members engaged in cultivation, gender, caste and religion of head:

$$A_h = T_h X_{1h}^{\psi_1} X_{2h}^{\psi_2} \ldots \tag{15}$$

where $\psi_k > 0$ are unknown parameters to be estimated, and T_h is a household specific component which is unobservable to us and MFI officials, although it may be observed by borrowers and agents. Household characteristics are assumed to be time-invariant.

From equations (15) and (7), the scale of cultivation or output of control group household h located in village v in year t satisfies:

$$\log l_{ht}^C = \frac{1}{\alpha}[\log T_h - \log \rho_{vt} + \log P_{vt}] + \frac{1}{\alpha}\sum_k \psi_k \log X_{kh} \tag{16}$$

thereby generating the regression specification

$$\log l_{ht}^C = u_h + \mu_{vt} + \sum_k \beta_k X_{kh} + \epsilon_{ht} \tag{17}$$

which can be estimated by ordinary least squares or random effects regressions. Under the strong assumption that observable household characteristics are uncorrelated with unobservable characteristics or the error term, the coefficients $\beta_k \equiv \frac{1}{\alpha}\psi_k$ provide consistent estimates of the correlates of ability. They can be used to construct a continuous ability index equal to the predicted value

$$\frac{1}{\alpha}\log A_h = \hat{u}_h + \sum_k \hat{\beta}_k X_{kh} \tag{18}$$

for *both* control and treated households. An alternative procedure that allows for both observable and unobservable components of ability and requires weaker assumptions, estimates ability as the household fixed effect in regressions of cultivation scale or output, as follows:

$$\log l_{ht}^C = \zeta_h + \mu_{vt} + \epsilon_{ht} \tag{19}$$

$$\log l_{ht}^T = \delta\zeta_h + K + \mu_{vt} + \epsilon_{ht} \tag{20}$$

where K is a constant representing the mean difference $\log \bar{\rho} - \log r_T$ in the cost of borrowing between control and treated households, and subscript v denotes the village in which h resides. We then obtain estimates of ability

$$\frac{1}{\alpha}\log A_h \equiv \zeta_h \tag{21}$$

For control households, equation (19) delivers estimates of ζ_h, but for treated households equation (20) delivers estimates of $\pi_h \equiv \delta\zeta_h + K$. To isolate ζ_h for treated households we utilize the fact that households recommended by the TRAIL agent were randomly assigned to treatment, so that Treatment and Control 1 households are drawn from the same distribution of ζ_h. It follows that both the Treatment and Control 1 groups must have the same mean and variance of ζ_h. Hence

$$E[\pi_h|h \in T] = K + \delta E[\zeta_h|h \in T] = K + \delta E[\zeta_h|h \in C1] \tag{22}$$

and

$$\text{Var}[\pi_h|h \in T] = \delta^2\text{Var}[\zeta_h|h \in T] = \delta^2\text{Var}[\zeta_h|h \in C1] \tag{23}$$

These two moment conditions allow us to estimate δ and K (where hats denote sample estimates) as follows:

$$\hat{\delta} = \left[\frac{\hat{\text{Var}}[\pi_h|h \in T]}{\hat{\text{Var}}[\zeta_h|h \in C1]}\right]^{\frac{1}{2}} \tag{24}$$

$$\hat{K} = \hat{E}[\pi_h|h \in T] - \hat{\delta}\hat{E}[\zeta_h|h \in C1] \tag{25}$$

$$\hat{\zeta}_h = \frac{\hat{\pi}_h - \hat{K}}{\hat{\delta}} \tag{26}$$

We can then examine how the estimated TRAIL treatment effect on farm value-added varies with $\hat{\zeta}_h$, by regressing the farm value-added in TRAIL villages on the treatment dummy, interacted with ability. This reveals the heterogeneity of the TRAIL treatment effect with respect to ability, denoted by $T^v(\zeta)$.

The exact analytical expression for $T^v(\zeta)$ is somewhat cumbersome; it is neither linear or log-linear in ζ. We can estimate a "non-parametric" version by discretizing the ability index. We divide the range of estimated ability values into quartiles and then replace the ability index $\hat{\zeta}$ with dummy variables indicating the quartile it belongs to ($q_i = 1$ if and only if $\hat{\zeta}_i \in (\hat{Z}_i, \hat{Z}_{i+1}), i = 1, \ldots, 4$). From a regression of farm value-added on interactions of the treatment dummy with the ability quartile q_i, we can estimate TRAIL treatment effects $Tr^T(q_i)$ within each quartile q_i.

Finally, the difference between the TRAIL and the GBL treatment effects can be decomposed as follows. If we denote the loan scheme with v, the average treatment effect is

$$\mathrm{Tr}^v \equiv \int \sigma^v(\zeta) T^v(\zeta) d\zeta \tag{27}$$

where $\sigma^v(.)$ denotes the density of the ability distribution of households selected to participate in scheme v. Hence the difference between the two average treatment effects can be decomposed:

$$\mathrm{Tr}^T - \mathrm{Tr}^G = \int [\sigma^T(\zeta) - \sigma^G(\zeta)] T^T(\zeta) d\zeta + \int \sigma^G(\zeta)[T^T(\zeta) - T^G(\zeta)] d\zeta \tag{28}$$

where v takes value T for the TRAIL scheme and G for the GBL scheme. We compute the first term on the right-hand-side, the Selection Effect. The second term is the Incentive effect. A discrete approximation of the Selection effect is

$$S = \sum_i [\sigma^T(q_i) - \sigma^G(q_i)] Tr^T(q_i) \tag{29}$$

Note that this requires only an estimate of difference in selection proportions between the TRAIL and GBL schemes and the heterogenous TRAIL treatment effects. Specifically, we do not need to estimate heterogeneous GBL treatment effects.

3.6 Summary of Testable Predictions

Before proceeding to the empirical analysis, it is helpful to summarize the theoretical predictions that can be tested.

Prediction 1 ***TRAIL Selection Patterns:*** *Among borrowers in his own segment, those the TRAIL agent recommends are more able than those whom he does not recommend.*

Prediction 2 ***Ability-Informal Interest Rate Relationship:*** *Higher ability borrowers pay lower interest rates in the informal market.*

Prediction 3 ***Compression:*** *$\delta < 1$; or, the scale of cultivation varies less with ability for treated borrowers than for control borrowers.*

This follows from a comparison of equations (9) and (11).

Prediction 4 ***Treatment Effect Heterogeneity:*** *If the TRAIL treatment effect on borrowing is rising in ability, so is the TRAIL treatment effect on output.*

This follows from part (a) of Lemma 2.

Prediction 5 ***Selection Effect:***

(a) The Selection Effect is smaller than the average treatment effect difference.

(b) If the ability distribution among TRAIL selected borrowers first order stochastically dominates the ability distribution among GBL selected borrowers, and TRAIL treatment effects are rising in ability, then the Selection Effect is positive, and the average treatment effect in the TRAIL scheme is larger than in the GBL scheme.

Part (a) of this prediction holds because Lemma 3 implies that the Incentive Effect is positive. Part (b) follows from equation (28).

4 Empirical Results

We start in Section 4.1 by estimating the average treatment effects of the two types of loans on borrowers' cultivation, output and farm value-added. This is followed in Section 4.2 by an examination of the repayment and take-up rates of the loans and the administrative costs and overall financial performance of the two schemes. Next, in Section 4.3 we test the model's predictions, and examine whether, and to what extent the difference in selection patterns can explain the difference in the average treatment effects. Finally, in Section 4.4 we address some ancillary issues, such as the changes in treatment impacts over time, and concerns that TRAIL agents and borrowers might have entered into side-transactions that changed the benefits to borrowers.

4.1 Empirical Results About Loan Treatment Impacts on Borrower Production and Income

To examine the average treatment effects of the two lending mechanisms, we rely on the fact that only a randomly chosen subset of the selected borrowers were offered the loans. Any difference between households that were both selected and offered loans (Treatment households) and that were selected but not offered loans (Control 1 households) must be caused by the loans. Clearly, this estimate is conditional on the selection of these borrowers into the scheme.

Our regression specification takes the form:

$$
\begin{aligned}
y_{hvt} &= \beta_0 + \beta_1 \text{TRAIL}_v + \beta_2(\text{TRAIL}_v \times \text{Control } 1_{hv}) + \beta_3(\text{TRAIL}_v \times \text{Treatment}_{hv}) \\
&+ \beta_4(\text{GBL}_v \times \text{Control } 1_{hv}) + \beta_5(\text{GBL}_v \times \text{Treatment}_{hv}) + \gamma \mathbf{X}_{hvt} + \varepsilon_{hvt} \qquad (30)
\end{aligned}
$$

Here y_{hvt} denotes the outcome variable of interest for household h in village v in year t. The omitted category is the Control 2 group in GBL villages, so that $\hat{\beta}_0$ estimates the mean y_{hvt} for Control 2 households in GBL villages. The other coefficients each estimate the level of y_{hvt} for a different group, relative to these GBL Control 2 households. The treatment effect in the TRAIL scheme is estimated by $\hat{\beta}_3 - \hat{\beta}_2$ and the treatment effect in the GBL scheme is estimated by $\hat{\beta}_5 - \hat{\beta}_4$. All treatment effects are intent-to-treat estimates because they compare the outcomes of households *assigned* to Treatment and Control 1 groups, regardless of actual take-up.[25]

The coefficients $\hat{\beta}_2$ and $\hat{\beta}_4$ measure differences between Control 1 and Control 2 households within TRAIL and GBL villages, respectively. $\mathbf{X}_{hvt}$ is a set of additional controls, including land owned by the households, caste, gender and educational attainment of the household head, two year dummies to control for secular changes over time and a dummy variable indicating whether the village received a separate intervention informing residents about the prevailing market price for potatoes.[26]

Our sample consists of 2070 households across 24 TRAIL and 24 GBL villages. Since agricultural activity involves a long delay from planting to harvest, and the harvest could be sold over several months, we aggregate our data to the annual level in order to correctly compute the costs and revenues of each crop. Our unit of observation is then household-year. Standard errors are clustered at the hamlet level.[27]

4.1.1 Treatment effects on Agricultural Borrowing, Cultivation and Farm Incomes

Table 4 presents the treatment effects on agricultural borrowing estimated using equation (30). Treatment effects on cultivation of, and incomes from, potatoes are in Panel A of Table 5, effects

[25]Results are qualitatively unchanged if we instead estimate the treatment effects only on households that took up the loans, using assignment to treatment as an instrument for actual participation in the scheme. These results are presented in Table A-4 in the Appendix.

[26] The information intervention was undertaken for a separate project aimed at examining the effect of providing information about potato prices to farmers and is similar to the public information treatment described in Mitra, Mookherjee, Torero, and Visaria (2017). Villages were assigned to the information treatment randomly and orthogonally to the credit intervention that is the focus of this paper. The results are unchanged if we do not include this information village dummy in the regression specification.

[27] The administrative definition of a village in our study corresponds to a collection of hamlets or *paras*. Households within the same *para* tend to be more homogenous, are more likely to interact with each other, and arguably experience geographic shocks to cultivation and market prices that are highly correlated. The results are robust to clustering at the village-level instead (see columns 1 and 2 of Table A-1 and Table A-2). The treatment effects are also unchanged qualitatively if we restrict the sample to the Treatment and Control 1 households only (see columns 3 and 4 of Table A-1 and Table A-3).

on cultivation of and incomes from other crops are in Panel B of Table 5, and effects on total farm income are in Table 6.

Since we analyze a large number of outcome variables, the null hypothesis of no treatment effect could be rejected by mere chance, even if it were actually true. To correct for this, in each table we follow Hochberg (1988) and report a conservative p-value for an index of variables in a family of outcomes taken together (see Kling, Liebman, and Katz, 2007).[28]

Effects on Agricultural Borrowing

In column 1 of Table 4 we see that participation in the TRAIL scheme increased the overall agricultural borrowing of Treatment households by ₹7568, which is a 135% increase over the ₹5590 mean borrowing by TRAIL Control 1 households. The overall borrowing of Treatment households in the GBL scheme also increased by a statistically significant ₹5465, which is a 134% increase over the mean for GBL Control 1 households.

In column 2 of Table 4 we examine if program loans crowded out agricultural loans from other sources. There is no evidence that this happened in either scheme: the treatment effects on non-program loans are small and statistically insignificant.

When we consider an index of both borrowing outcomes together in column 3, we find that TRAIL loans caused a 0.36 standard deviation increase in agricultural borrowing, which is significant according to the more conservative Hochberg test (p-value = 0.000). The effect of the GBL treatment is also statistically significant (effect = 0.27 sd, Hochberg p-value = 0.003).[29]

Effects on Cultivation and Farm Incomes

We now check if the increase in agricultural borrowing led to increased agricultural activity, output and incomes. Since the loan cycles matched the potato production cycle, we first present the estimated effects on potato cultivation. From column 1 in Panel A of Table 5 we see that 72 percent of TRAIL Control 1 households cultivated potatoes per year. Although the TRAIL loans did not increase this likelihood of cultivation significantly, column 2 shows that they did increase the amount of land placed under potatoes by a statistically significant 28 percent. TRAIL loans also caused borrowers to increase their expenditure on inputs (column 4) and to produce 27 percent greater output (column 3). As a result TRAIL treatment borrowers earned 28% higher revenue (column 5) and 37% higher value-added (column 6) than they otherwise would have.[30] In

[28] The variables are normalized by subtracting the mean in the control group and dividing by the standard deviation in the control group; the index is the simple average of the normalized variables. To adjust the p-value of the treatment effect for an index, the p-values for all indices are ranked in increasing order, and then each original p-value is multiplied by $(m - 1 + k)$, where m is the number of indices and k is the rank of the original p-value. If the resulting value is greater than 1, we assign an adjusted p-value of > 0.999.

[29] As Table A-5 in the Appendix shows, both schemes also had statistically significant treatment effects on total borrowing, which includes all loans taken by the household, whether for agricultural or non-agricultural purposes. Thus, there is no evidence that the schemes crowded out non-agricultural borrowing.

[30] Value added is computed as the difference between the revenue earned by the household from the crop, and the cost of all physical inputs purchased for this crop (either through cash or trade credit). If any of the output

column 7 we report the treatment effect on imputed net profit from potato cultivation, which is calculated as value-added net of the imputed cost of family labor employed. Net profit increased by ₹1939, or 41% above the mean.

Although the GBL loans did not significantly affect households' decisions as to whether to plant potatoes and how much land to plant, they did increase expenditure on potato cultivation by 27%. However the average effect this had on revenue, value-added and profits is both relatively small in magnitude and imprecisely estimated, indicating large variation across GBL borrowers. The point estimate of percent growth in value-added and imputed profit was 14%, but it was not statistically different from zero.

In Panel B of Table 5 we consider the acreage and value-added of the other main crops: sesame, paddy and vegetables. TRAIL loans significantly increased the acreage that Treatment households allocated to paddy and sesame. The TRAIL treatment effect on value-added is also positive for all three crops, but it is significantly different from zero only for sesame. GBL loans did not have significant effects on the acreage, or value-added, for any of the crops.

Finally, column 1 of Table 6 presents the treatment effects on the household's total farm value-added, computed by aggregating across the four crop categories. We find that TRAIL loans led to a 22% increase in overall farm value-added over the Control 1 mean. The GBL treatment effect was statistically insignificant, and estimated at -1%. As the lower panel shows, the TRAIL treatment effect on farm value-added was significantly larger than the GBL treatment effect (p-value = 0.064).[31]

In column 2 we see that neither the TRAIL nor the GBL loans significantly affected borrowers' non-agricultural incomes. However, when we take both farm and non-farm income into account in column 3, we see that TRAIL loans increased borrower incomes by 9.5 standard deviations (Hochberg p-value = 0.113). GBL loans had no effect (Hochberg p-value > 0.999).

4.1.2 Comparing Productivity of Selected TRAIL and GBL borrowers

Next, we compute the rate of return on program loans, defined as the ratio of the treatment effect on value-added to the treatment effect on cultivation cost. Since this is the ratio of two treatment effect estimates, we estimate cluster-bootstrapped standard errors with 2000 replications. As we see in column 4 of Table 6, in the TRAIL scheme, the rate of return on potato cultivation expenses was a statistically significant 110%. The corresponding rate of return in the GBL scheme is estimated at 45%, and is not statistically significant. Across all major crops, TRAIL borrowers earned a statistically significant rate of return on investment in cultivation expenditure of 101%.

was not sold, a value is imputed to that amount at the median price at which sample farmers in that villages sold that crop in that year. Given the difficulty of apportioning the household's annual agricultural borrowing across the different crops that it planted, we do not subtract interest payments when we compute the value added for individual crops. However we do subtract all interest payments due on agricultural borrowing when we compute aggregate farm value added (see Table 6.)

[31] In Figure A-1 we present the quantile treatment effects for farm value added. The TRAIL treatment effects are positive and statistically significant for all quantiles above the 35^{th}; the GBL treatment effects are never statistically significant. Hence, the TRAIL scheme generated increased farm value-added significantly for a wide range of treated borrowers.

The estimate for GBL borrowers was negative, but again, was not statistically different from zero. The estimated rate of return to GBL loans is too imprecisely estimated for us to infer if the two rates of return are significantly different.

4.2 Loan Performance

4.2.1 Comparing Repayment and Take-up Rates

The financial sustainability of a lending program critically depends on the repayment rates on its loans. Our model does not make clear predictions about how the repayment rates on TRAIL loans and GBL loans would compare. TRAIL borrowers are likely to be more able and therefore have a lower risk of project failure. On the other hand, GBL borrowers have the benefit of joint liability so that even if their own projects fail, their group members might repay on their behalf.[32]

In Table 7, we consider a loan to be repaid if the entire amount due was paid within 30 days of the due date. Column 1 in Panel A presents the sample means for this variable. Loans were repaid on time in more than 95% of instances across the three years of the intervention. The difference between the two schemes is small. A t-test indicates that it is not statistically significant.[33]

Loan take-up rates can tell us how attractive the loan product is to potential borrowers. We measure take-up by the number of households who accepted a program loan in a given cycle as a proportion of those that were offered one in that cycle. Column 2 in Panel A shows that 86% of the loans offered in the TRAIL scheme and 75% of the loans offered in the GBL scheme were accepted. This difference is statistically significant, suggesting that selected borrowers in the TRAIL scheme expected to gain more from the loans than selected borrowers in the GBL scheme did.[34]

We also measure continuation rates, defined as the number of households who took a loan in a given cycle as a proportion of those who were eligible in cycle 1. Households may have failed to continue in the scheme either because they had repaid less than 50% of the amount due in a previous cycle and become ineligible, or because they chose not to take a loan in the particular cycle being analyzed. Column 3 shows that 81% of TRAIL Treatment borrowers and a significantly lower 69% of GBL Treatment borrowers continued on average.

[32] A TRAIL loan given to a borrower of ability i would be recovered with probability p_i, whereas a GBL loan given to her would be recovered with probability $p_i + (1 - p_i)p_j$ if this borrower's group member had ability j. Hence controlling for ability, the GBL loan has a higher repayment rate. However if TRAIL borrowers are more able on average, this tilts the comparison the other way, so that the net effect is ambiguous.

[33] As a robustness check we also considered an alternative definition of repayment where a loan is considered to be repaid if more than 50% of the amount due was paid within 30 days of the due date. The results are nearly identical to those presented in Table 7 because in the majority of instances borrowers either repaid the entire amount or nothing at all. This could be because there was a direct link between the amount repaid and the loan size that borrowers could receive in the subsequent cycle. Results are available on request.

[34] Note that since loans in our study were only offered to households that had been pre-selected to participate (through recommendation or self-selection), these take-up rates cannot be compared with take-up rates from other studies where the entire village population is included in the set of eligible borrowers.

A more rigorous test of the difference in these indicators would control for seasonal variations that might affect loan take-up or repayment. Accordingly, we estimate the equation

$$y_{hvt} = \alpha_0 + \alpha_1 \text{TRAIL}_v + \gamma \mathbf{X}_t + \varepsilon_{hvt} \tag{31}$$

on a dataset of household-cycle level observations, where in the repayment regression $y_{hvt} = 1$ if treatment household h in village v repaid entirely a loan taken in cycle t within 30 days of the due date; in the take-up regression $y_{hvt} = 1$ if treatment household h in village v who was eligible to receive a loan in cycle t accepted it; and in the continuation regression $y_{hvt} = 1$ if household h assigned to treatment in village v accepted the program loan in cycle t. Cycle dummies X_t control for seasonal differences. Column 1 in Panel B of Table 7 confirms that the difference in repayment rates is negligible and not statistically significant. Columns 2 and 3 show that loan take-up and continuation rates were about 12 percentage points higher in the TRAIL scheme than the GBL scheme, and that this difference is statistically significant at the 10% level. This result holds whether we use as the denominator the households that were offered the loan in that cycle (take-up, Column 2), or instead all households that were offered the loan at the beginning of the intervention (continuation, Column 3).

4.2.2 Administrative Costs and Overall Financial Performance

Administrative costs were lower for the TRAIL scheme. The per-month cost to the MFI of operating the GBL scheme in a village was ₹1463. The cost of running the TRAIL scheme was substantially lower, at ₹68 per village. This difference is largely explained by the fact that the TRAIL scheme did not require group meetings and so had lower personnel and transport costs. Recall that in both schemes the intermediary (the agent in TRAIL villages and the MFI in GBL villages) received 75 percent of interest payments as commission, and the repayment rates were similar. The capital costs of the loans were also the same. It follows that TRAIL loans generated a higher financial return for the lender.[35]

4.3 Testing Theoretical Predictions

Now we turn to tests of our theoretical predictions about the patterns of borrower selection in the two schemes, and about how treatment effects varied with borrower ability in the TRAIL scheme. For this we first need to obtain ability estimates for each household.

4.3.1 Ability Estimates

We start by examining the correlates of cultivation and output at the household level. Columns 1, 2, 4 and 5 in Table 8 show random effects and OLS regressions of acreage devoted to potatoes and potato output on observable characteristics, based on equation (17) in Section 3.5.1. As one

[35] All the loan capital was raised through a research grant, and so the financial sustainability of the two schemes was not a primary concern for us. However our results suggest that a lender implementing the TRAIL scheme would break even if it could access the loan capital at the Indian priority sector lending rates for the rural poor.

might expect, larger, more landed households, those whose heads were Hindu, who did not belong to the lower castes/tribes, and whose primary occupation was cultivation all devoted more land to potato cultivation and produced greater potato output. However, in addition to these observable characteristics, unobservable factors such as skill and technical know-how might also contribute to farmer ability and therefore determine cultivation and output. Therefore it is preferable to estimate ability as a function of household-specific factors, incorporating both observable and unobservable characteristics, following equations (19) and (20). Accordingly we use the following specification:

$$y_{hvt} = \alpha_h + T_t + \text{Information}_v + \epsilon_{hvt} \tag{32}$$

where y_{hvt} is either acreage devoted to potatoes or quantity of potatoes produced and α_h is the household fixed effect representing the household's ability as described above. We include as controls only year dummies and a dummy variable for villages receiving the orthogonal information treatment. Recall that we cannot estimate ability for GBL Treatment households because joint liability loans created differential incentives for households depending on the ability of their group members. Therefore these regressions are run on all sample households in TRAIL villages and only on Control 1 and Control 2 households in GBL villages. The results are reported in Columns 3 and 6 in Table 8.

Recall from Section 3.5.1 that while predicted household fixed effects $\hat{\alpha}_h$ from this regression correspond to the ability ζ_h for control households, they correspond instead to $\pi_h \equiv \delta\zeta_h + K$ for treated households in TRAIL villages. We, therefore, follow equations (24)–(26) and recover the ability estimates $\hat{\zeta}_h$ for TRAIL treated households using the procedure described in Section 3.5.1.

The kernel density estimates of the estimated ability indices are shown in Figure 1. The left panel uses estimates based on the log of potato output; the right panel uses estimates based on the log of potato acreage. In both panels, the distribution of ability for TRAIL borrowers is bimodal and spans a wide range of abilities. As would be expected, the generated distributions for Treatment and Control 1 households in the TRAIL villages are similar, because the Treatment households were drawn randomly from the set of borrowers recommended by the TRAIL agent. Accordingly, we can refer to Treatment and Control 1 households together as Selected households. Compared with Control 2 households, a smaller proportion of TRAIL Selected households is concentrated around the lower mode and a larger proportion is concentrated around the higher mode. This is consistent with our prediction that the TRAIL agent screened out low ability farmers.

Although our model has no clear predictions about how GBL group formation varied with household ability, for the sake of completeness we present in the right panel of Figure 1 the distribution of ability for Control 1 (or Selected) and Control 2 households in GBL villages. These distributions suggest that both high and low ability households joined GBL groups.[36]

We now use these estimates of ability to test Predictions 1–5.

[36] We did not find much evidence for positive assortative matching in GBL groups. The Spearman rank correlation between the ability of any particular member and the median ability of the other members of their group is 0.48 (using either ability estimates). About 62% of the groups included both members with above-median ability and members with below-median ability.

4.3.2 Test of Prediction 1

Prediction 1 states that among borrowers in his own segment, those that the TRAIL agent recommended were more able than those whom he did not recommend. Borrowers can be classified into four groups: recommended from own segment (RS), not recommended from own segment (NS), recommended from out-of-segment (RO), and not recommended from out-of-segment (NO). To distinguish between the abilities of the four groups, we run the following regression on sample households in TRAIL villages that owned at most 1.5 acres of land:

$$\hat{\zeta}_{hv} = \delta_0 + \delta_1 \text{Recommended}_{hv} + \delta_2 \text{Own Segment}_{hv} + \delta_3 (\text{Recommended}_{hv} \times \text{Own Segment}_{hv}) + X_v + u_{hv} \quad (33)$$

where $\hat{\zeta}_{hv}$ denotes the estimated ability of household h in village v, and X_v denotes a village dummy. The variable Recommended$_{hv}$ indicates whether the household was recommended by the agent for a TRAIL loan. We define the agent's segment as made up of households that borrow from him; so the variable Own Segment$_{hv}$ indicates whether household h in village v had borrowed from the agent in the three years before the project began. By including village dummies, we ensure that the coefficients reflect within-village comparisons of ability, which is appropriate because the agent was restricted to recommending borrowers from within a single village. The results are reported in Table 9. In column 1 we use as the dependent variable the estimates of ability derived from the household fixed effects regression on potato output. In column 2 we use instead the household fixed estimates from the potato acreage regression.

In the panel titled "Total Effects" it is clear that among the four groups described above, those whom the agent recommended from his own segment (group RS) had the highest ability. The difference between the ability of the RS and the NS groups is also positive, although statistically insignificant. This provides weak evidence in favor of Prediction 1.

As explained in Section 3.2, it is difficult to compare the ability of own-segment borrowers and out-of-segment recommended borrowers. This is because the agent draws randomly from outside his segment, and the number of borrowers he recommends from this group may be too small for the law of large numbers to hold. As it turns out the difference between groups RS and RO is positive and statistically significant at the 1% level. On the other hand, the point estimate of ability of group RO is lower than that of group NS, although the difference is not statistically significant. These results are consistent with the model, where borrowers recommended by the agent from outside his own segment turned out to be less able than the agent expected.

4.3.3 Test of Prediction 2

Next we test the prediction that more able borrowers paid lower interest rates on informal loans. Since we were unable to conduct a baseline survey before the study began, we restrict this analysis to Cycle 1 loans, which were likely to have been negotiated before our intervention began. To further guard against the concern that the intervention might have affected households' borrowing behavior, we restrict attention to Control 1 and Control 2 households only, since none of these households received the program loans. Under the assumption of no general equilibrium effects, this effectively allows us to estimate the relationship between borrower ability and the informal interest rates that they paid. In what follows, we focus on the sample of 661 Control 1 and Control

2 households with no more than 1.5 acres of land who reported at least one informal agricultural loan with a non-zero interest rate in Cycle 1.

In Figure 2 we present non-parametric regressions of the informal interest rates on the ability estimates. In both panels, we see a clear negative relationship, in line with the prediction that higher-ability borrowers had access to cheaper loans in the informal market. For a formal test of this relationship, Table 10 reports the results of the regression

$$r_{hv} = \sum_{i=1}^{4} \mu_i \hat{\mathrm{Q}}_{hi} + \epsilon_{hv} \quad (34)$$

where r_{hv} is the informal interest rate as described above, and $\hat{\mathrm{Q}}_{hi}$ indicates the quartile of the ability distribution to which the household belongs.

Columns 1 and 2 use ability estimates from the potato output regression, while columns 3 and 4 use estimates from the potato acreage regression. Columns 2 and 4 include village fixed effects. As can be seen in the top panel, in all four specifications, the estimated $\hat{\mu_i}$ decrease in ability, indicating a negative monotonic relationship. Standard errors are averages from 2000 bootstrap iterations of this regression. The F-statistic shows that the null hypothesis that $\mu_1 = \mu_2 = \mu_3 = \mu_4$ is rejected in all four columns at the 99 percent confidence level.

In the second panel, we present pair-wise comparisons of each $\hat{\mu_i}$. When multiple hypotheses are tested, some may be incorrectly rejected by pure chance. To guard against this concern, we apply the Bonferroni correction and adjust the confidence interval. In our case this effectively implies that only test statistics with a p-value lower than 0.01 are reported as significant. Although this is a conservative test, in columns 1 and 3 we find that the difference between $\hat{\mu}_1$ and $\hat{\mu}_4$ is significant, indicating that households at the lowest quartile of ability paid interest rates that were 12.7 to 13.9 percentage points higher than those at the highest quartile.

4.3.4 Test of Prediction 3

When estimating farmer ability in Table 8 we also estimated the parameter δ, which was defined in equation (12). Prediction 3 states that $\delta < 1$, or that borrowing and cultivation scale vary less with ability for treated than control borrowers. Equivalently, risk varies much less with ability than productivity does. Consistent with this, the point estimates of δ are 0.951 and 0.965 in columns 3 and 6 respectively. However the estimates are not precise enough to infer whether they are significantly below 1.

4.3.5 Test of Prediction 4

A point estimate of δ close to 1 suggests default risk varies relatively little with ability, so that case (b) rather than (c) of Lemma 2 applies. Accordingly, the theory predicts that TRAIL treatment effects increase in ability.

Table 11 presents heterogenous TRAIL treatment effects for different quartiles of borrower ability.

In columns 1, 2 and 3 we regress agricultural borrowing, farm revenue and farm value-added on the treatment dummy interacted with quartile dummies for ability estimates based on the volume of potato output. In columns 4, 5 and 6 the ability estimate is based on the acreage devoted to potatoes. Only sample households from TRAIL villages are included in the estimation sample. Thus, the regression specification takes the form:

$$y_{hvt} = \sum_{i=1}^{4} \xi_{1i}\ \hat{\mathrm{Q}}_{hi} + \sum_{i=1}^{4} \xi_{2i}\ (\text{Control } 1_{hv} \times \hat{\mathrm{Q}}_{hi}) + \sum_{i=1}^{4} \xi_{3i}\ (\text{Treatment}_{hv} \times \hat{\mathrm{Q}}_{hi}) + \gamma \mathbf{X'}_{hvt} + \varepsilon_{hvt} \quad (35)$$

Treatment effects on each quartile of ability are estimated as the difference $\hat{\xi}_{3i} - \hat{\xi}_{2i}$. Columns 1 and 4 confirm that treatment effects on borrowing increase in ability: while a TRAIL Treatment household in the first quartile of estimated ability borrowed ₹656 more than a TRAIL Control 1 household in the same quartile, a household in the second quartile borrowed ₹2832 more, in the third quartile borrowed ₹6327 more, and in the fourth quartile borrowed ₹9474 more. Once again, standard errors are averages of cluster bootstrap estimates with 2000 iterations. As indicated by the relevant F-statistic, the hypothesis that these four treatment effects are equal is rejected with 99 percent confidence.

In the lower panel, we estimate differences between each pair-wise combination. Using Bonferroni-corrected confidence intervals, we are able to reject the null hypothesis of no difference for four out of six pair-wise comparisons.

Prediction 4 states that if treatment effects on borrowing increase in ability, then treatment effects on output should increase in ability as well. Accordingly, we also find evidence that treatment effects increase in ability when we examine farm revenue (Columns 2 and 5) and farm value-added (Columns 3 and 6).

Figure 3, plots non-parametric regressions of farm value-added against the estimated ability index, separately for Treatment and for Control 1 households. In each panel, it is apparent that the difference between the farm value-added for the two groups of households becomes larger as the ability level increases, which is consistent with the regression results discussed above.[37]

4.3.6 Test of Prediction 5

Figure 4 plots the cumulative distribution function of estimated ability for households recommended by the TRAIL agent, and compares this with the corresponding distribution of GBL Control 1 borrowers. Again, GBL Treatment borrowers are not included in this figure because the ability index is not estimated for GBL treated households.

In Figure 4 we see that the distribution of TRAIL selected households first order stochastically dominates the distribution of GBL selected households. At each ability level in the support of the

[37]Similar figures obtain when we plot non-parametric regressions of borrowing and farm revenue against estimated ability (figures available upon request).

distribution, a larger proportion of the GBL selected households have ability lower than this level than TRAIL selected households do. The Kolmogorov-Smirnov test rejects the null hypothesis that the distributions are equal with 99 percent confidence.

Given this finding, and the finding in Table 11 that TRAIL treatment effects increase in ability, Prediction 5 states that the Selection Effect is positive and that the average treatment effect of the TRAIL loans is larger than that of the GBL loans. We have already shown evidence that both of the conditions for this prediction are met. We also saw in Table 6 that the average TRAIL treatment effect on farm value-added is significantly larger than the average GBL treatment effect.

Finally, we can use equation (29) to estimate the Selection Effect, as shown in Table 12. Our decomposition indicates that the Selection Effect is indeed positive, and accounts for 30–41% of the overall difference in average TRAIL treatment effects on farm value-added, depending on which ability estimate we use.[38]

4.4 Ancillary Issues

4.4.1 Impact of TRAIL on Transactions with Agents

A frequent concern about intermediary-based schemes is that they may promote corruption and distort the allocation of benefits between the intermediary and intended beneficiaries. For instance, the TRAIL agent may have extracted undue benefits from the borrowers, either by requiring bribes before he recommended them, demanding side-payments, or by manipulating other transactions with them, such as by charging higher input prices or paying lower output prices. Although it is naturally difficult to collect data on bribes or side-payments, we do have detailed data about sample households' input purchases from, output sales to, and borrowing from the TRAIL agent.

In Table 13 we analyse input, output and credit transactions between sample households in TRAIL villages and the TRAIL agent. In each panel, the third row shows the mean incidence of such transactions for the Control 1 households. Note first that there is no evidence that recommended households interacted exclusively with the TRAIL agent in these markets. As can be seen in Panel A, over the 3 years, Control 1 households conducted only about 8% of their input transactions with the agent, accounting for less than 6% of the value of inputs purchased. Panel B shows that they conducted 19% of output transactions with the agent, representing 15% of the value of transactions, and Panel C shows that 16% of Control 1 households borrowed from the agent, accounting for 5% of their total borrowing.

It is difficult to detect corrupt behavior by comparing the agent's transactions with Control 1 and with Control 2 households, since these groups of households are likely to be different even in the absence of any corruption. Differences between Treatment and Control 1 households are

[38]In unreported results we also construct an alternative ability measure using a household random effects regression of output/acreage on household observable characteristics. When we use this ability index in the decomposition exercise, we find that the Selection Effect explains less than 15% of the overall difference in average TRAIL treatment effects on farm value-added. That the selection effect computed using our preferred total ability estimates is more than twice as large suggests that unobserved characteristics constitute an important component of ability.

more revealing because the former were drawn randomly from those recommended by the TRAIL agent. If the TRAIL agent manipulated transactions with treated borrowers, we should expect to see significant differences between Treatment and Control 1 borrowers. In column 1 we run a regression of whether the household engaged in the relevant transaction with the TRAIL agent at all. In column 2 we regress the TRAIL agent's share in the total volume of (input or output) transactions the household carried out in that year. In columns 3–8 we run a regression of the form

$$\begin{aligned} y_{phvt} &= \lambda_0 + \lambda_1 \text{Interacted with agent}_{phv} + \lambda_2(\text{Interacted with agent}_{phv} \times \text{Treatment}_{hv}) \\ &+ \lambda_3(\text{Interacted with agent}_{phv} \times \text{Control } 1_{hv}) + \gamma X_{hvt} + \epsilon_{phvt} \end{aligned} \tag{36}$$

where Interacted with agent indicates whether the household h in village v purchased the input p from or sold the crop p to the TRAIL agent of that village in the year t. The difference $\lambda_2 - \lambda_3$ captures whether Treatment households interacted with the TRAIL agent on different terms than Control 1 households did.

In Panel A, the two significant effects are a slight increase in the price at which farmers purchased seeds, and a reduction in the rate at which they rented power tillers from TRAIL agents. The two effects go in opposite directions. The Hochberg (1988) p-value of 0.773 indicates that overall, borrowers assigned to receive a TRAIL loan continued to pay the same input prices to TRAIL agents, as households who were recommended, but not offered a loan.

In Panel B we find no significant effects on the quantities of output that borrowers sold to TRAIL agents, or the prices at which they sold them. Column 1 in Panel C shows that instead of borrowing more at higher interest rates, treatment borrowers were less likely to borrow from the agent during the three years of the experiment. The average interest rate charged by the agent also did not change.

Thus, our evidence does not indicate that the agent extracted side-payments from treated borrowers by engaging in a larger volume of transactions, charging higher prices for inputs sold or paying lower prices for outputs purchased from the borrowers, using Control 1 households as the benchmark. It appears likely that the TRAIL treatment households retained control over the program benefits that accrued to them. These results also cast doubt on the hypothesis that the agent gave more concessions or useful advice about output sales or input purchases to TRAIL borrowers, than he gave to others whom he recommended but who did not receive TRAIL loans.

4.4.2 Year-Specific Effects

The TRAIL and GBL treatment effects on agricultural output estimated in Table 5 were averages across the three years of the intervention. It is informative to examine how these effects varied across years.

As the left panel of Figure 5 shows, the TRAIL treatment effects on potato acreage are statistically significant in each of the three years. They are also similar over the three years of the experiment. The point estimate for the corresponding effect in GBL increased monotonically over the years, although it was not statistically significant for the first two years and was borderline significant only in the third year. However, statistically there is no evidence to suggest that the GBL treatment effects on potato acreage increased over the three years of the experiment. The differences in the GBL treatment effects were 0.023 acres in Year 2 versus Year 1 (p-value = 0.381), 0.006 acres in Year 3 versus Year 2 (p-value = 0.796) and 0.029 acres in Year 3 versus Year 1 (p-value = 0.331).

The right panel of Figure 5 shows that for TRAIL borrowers, the estimate of rates of return on cultivation (aggregated over the 4 major crop categories) increased from year 1 to year 2 and then remained roughly similar in year 3. However none of the pair-wise differences across years (year 1 versus year 2, year 2 versus year 3 or year 1 versus year 3) were statistically significant. For GBL borrowers, the point estimates indicate an increase in the rate of return from a negative value in year 1 to a positive value in year 2 and then a decline to a negative value in year 3 again. However once again, none of these changes are significantly different from zero.[39]

5 Conclusion

The trader-agent intermediated lending (TRAIL) scheme delegates the selection of borrowers for individual liability loans to local lenders or traders who are experienced at doing business with farmers in the local community. We compared the outcomes of this scheme with the outcomes of an alternative treatment (GBL), in which borrowers self-selected into joint liability groups.

Loan recipients in the TRAIL scheme were particularly successful at increasing potato cultivation and output. Their farm incomes increased significantly, without any off-setting decline in income from other sources. The outcomes of borrowers in GBL did not change appreciably. This was despite the fact that both the TRAIL and GBL loans were provided at below-market-average interest rates, had repayment durations that matched local crop cycles and included insurance against local yield and price shocks. This makes it unlikely that these loan features were primarily responsible for the success of the TRAIL scheme. Instead, we argue that the TRAIL scheme induced agents to select higher ability borrowers than the borrowers who self-selected into the GBL scheme.

In line with our theoretical predictions, we find that TRAIL selected more productive borrowers and treatment effects of the TRAIL loans were larger for more able households. We find also that selection differences can explain between 30 and 40 percent of the estimated difference in average treatment effects of the two schemes on farm value-added. The remainder of the difference may be caused by differences in borrower incentives: GBL loans could have had a smaller impact on borrowing, cultivation and farm incomes because the joint liability tax raised the effective interest rate. Other factors, such as differential scope for learning or social capital, may also have played a role. These need to be investigated further in future research.

Loan take-up rates were higher in the TRAIL scheme, suggesting that the scheme had larger *ex ante* effects on the average welfare of the borrowers who were offered these loans. TRAIL loans

[39] The statistical significance of all comparisons of rates of return is inferred from 90% confidence intervals of the differences of 2000 cluster-bootstrapped estimates, constructed using Hall's percentile method.

were repaid at the same high rate as GBL loans. At the same time, the costs of administering the TRAIL scheme were lower. We found no evidence that TRAIL agents siphoned off the benefits that accrued to borrowers.

A few qualifications are in order. Only ten loans were offered in each village in either scheme in our study; the results of this experiment therefore cannot be used to predict the consequences of a larger scale intervention. Also, our analysis is restricted to impacts on production and incomes; we have not examined impacts on consumption smoothing, liquidity management, investment or social empowerment. Neither do we compare the distributive impacts of TRAIL and GBL. At this stage, therefore, we do not claim that TRAIL is a superior policy alternative to traditional microcredit schemes. Instead, we limit the objective of this paper to an examination of whether borrower heterogeneity and selection can account for the differential performance of the two different schemes.

Future research is needed to examine a number of issues related to our study. These include the external validity of these results in other regions and contexts, the trade-off between number and quality of borrowers when TRAIL is scaled up to more borrowers per village, financial sustainability, distributive impacts on farm incomes, impacts on the empowerment of women and other disadvantaged social groups, impacts on household consumption and liquidity management. Such evaluations are necessary before any policy suggestions can be made.

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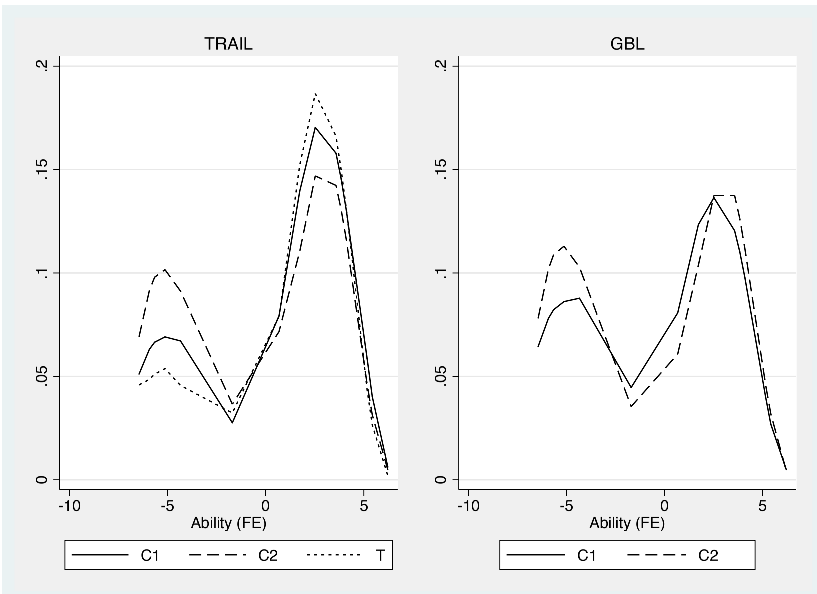
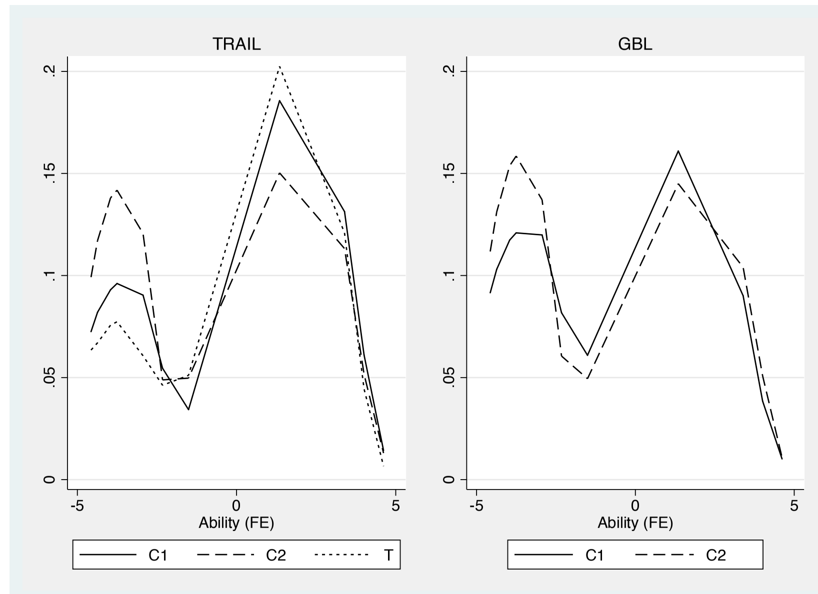
Figure 1: Density Functions of Estimated Ability for Treatment, Control 1 and Control 2 households

First stage: Log(Quantity of potatoes produced)



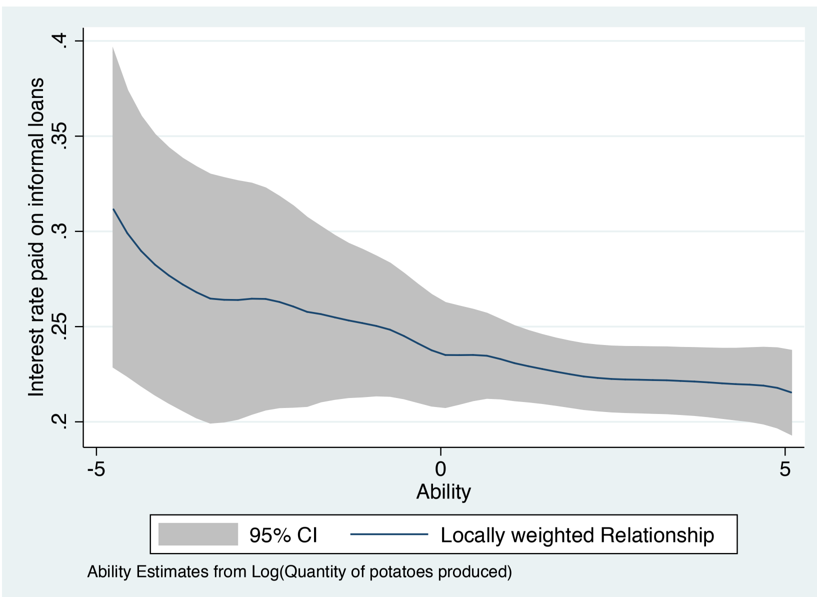
First stage: Log(Acreage under potato cultivation)



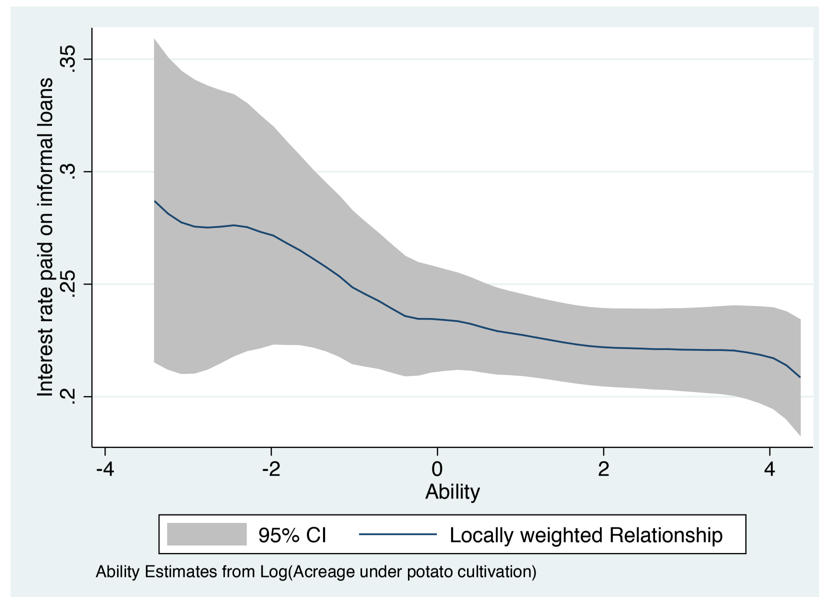
Notes:
Ability estimates for each household in TRAIL villages and Control 1 and Control 2 households in GBL villages are constructed from the household fixed effects from regressions shown in Table 8 columns 3 and 6. The ability index is not estimated for GBL treated households because their effective cost of borrowing depends on the pattern of assortative matching within groups, so that the formula for estimating ability does not have a closed-form solution. See the discussion on page 17 of the text.

Figure 2: Non-parametric Regressions of Informal Interest Rate on Ability Estimates for Control 1 and Control 2 households

First stage: Log(Quantity of potatoes produced)



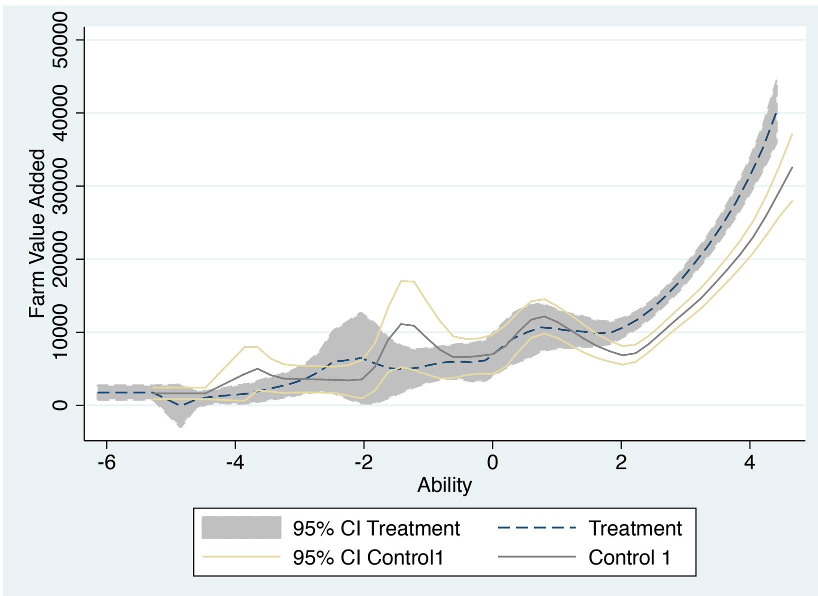
First stage: Log(Acreage under potato cultivation)



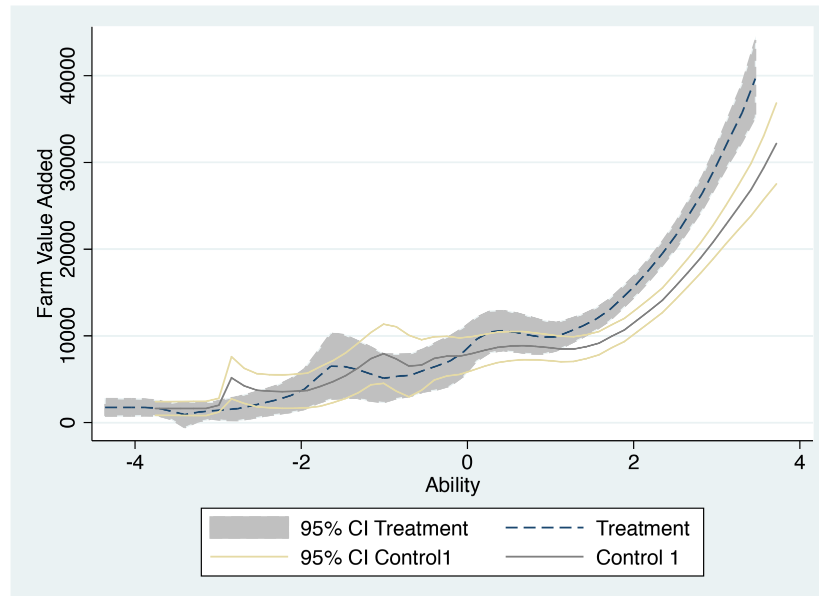
Notes:
Ability estimates for each household in TRAIL villages and Control 1 and Control 2 households in GBL villages are constructed from the household fixed effects from regressions shown in Table 8 columns 3 and 6. The ability index is not estimated for GBL treated households because their effective cost of borrowing depends on the pattern of assortative matching within groups, so that the formula for estimating ability does not have a closed-form solution. See the discussion on page 17 of the text. The dependent variable is the average annualized interest rate paid on informal production loans from traders, moneylenders and family and friends, as reported in Cycle 1. The estimating sample includes all Control 1 and Control 2 households in TRAIL and GBL villages with at most 1.5 acres who had borrowed from traders, moneylenders and family and friends in Cycle 1. Loans where the principal amount is reported equal to the repayment amount are not included.

Figure 3: Non-parametric Regressions of Farm Value Added on Ability Estimates for TRAIL households

First stage: Log(Quantity of potatoes produced)



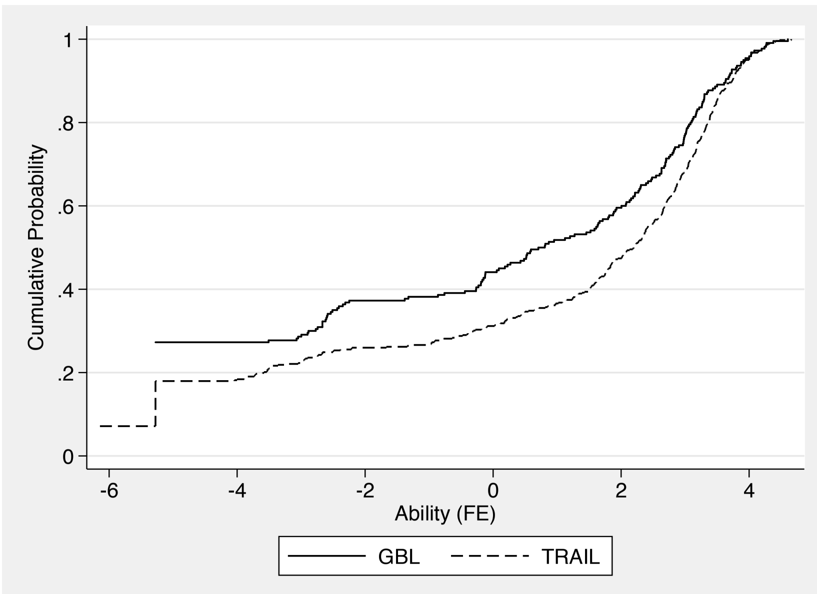
First stage: Log(Acreage under potato cultivation)



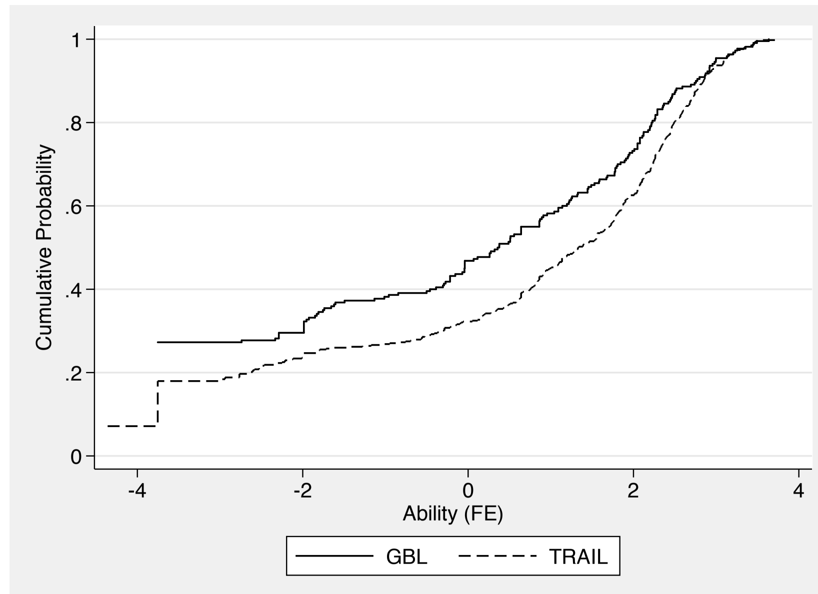
Notes:
The figure presents locally-weighted polynomial regressions of farm value added on the ability estimates. The estimation sample includes Treatment and Control 1 households in TRAIL villages with at most 1.5 acres of land. Ability estimates are constructed from the household fixed effects from regressions shown in Table 8 columns 3 and 6. The ability index is not estimated for GBL treated households because their effective cost of borrowing depends on the pattern of assortative matching within groups, so that the formula for estimating ability does not have a closed-form solution. See the discussion on page 17 of the text. The dependent variable is the total farm value added from all crops.

Figure 4: Cumulative Distribution Functions of Estimated Ability for Selected Households in TRAIL and GBL villages

First stage: Log(Quantity of potatoes produced)



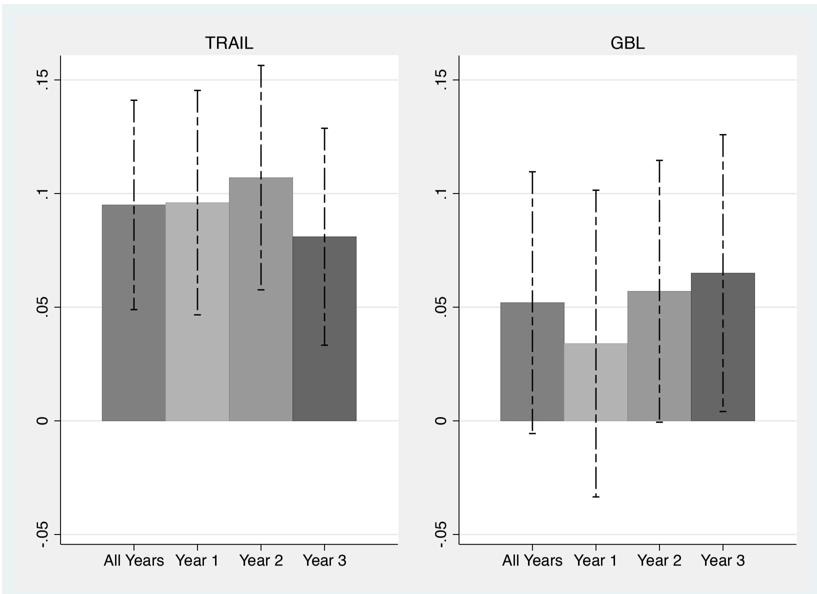
First stage: Log(Acreage under potato cultivation)



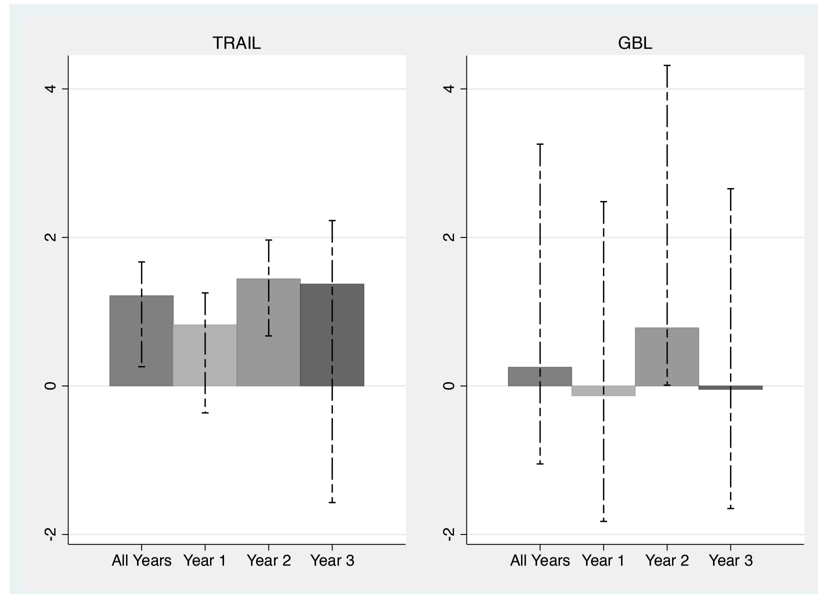
Notes:
Ability estimates for each household in TRAIL villages and Control 1 and Control 2 households in GBL villages are constructed from the household fixed effects from regressions shown in Table 8 columns 3 and 6. The ability index is not estimated for GBL treated households because their effective cost of borrowing depends on the pattern of assortative matching within groups, so that the formula for estimating ability does not have a closed-form solution. See the discussion on page 17 of the text.

Figure 5: Year-Specific Effects on Potato Acreage and Aggregate Rates of Return

Potato Acreage



Rate of Return



Notes:
The values represent the estimated treatment effects from regressions following equation (30) in the text. In the left panel, the vertical axis measures the treatment effect on acres devoted to potato cultivation. In the right panel the vertical axis measures the rate of return on value-added aggregated across all four crop categories, computed as the ratio of the treatment effect on value-added to the treatment effect on the cost of cultivation. The dashed lines show the 90% confidence intervals. In the right panel, standard errors are cluster bootstrapped with 2000 replications, and the confidence intervals are constructed according to Hall's percentile method.

Appendix A: Proofs

Proof of Lemma 2:

(i) Suppose l_i^T is nondecreasing in i. Take any pair of types satisfying $i > j$. Then $l_i^T \geq l_j^T$. Applying condition RC we obtain $\frac{f'(\bar{l}_i+l)}{f'(\bar{l}_j+l)}$ is increasing in l. Combining this with (1) which implies $\frac{f'(\bar{l}_i)}{f'(\bar{l}_j)} = \frac{\bar{\theta}_j}{\bar{\theta}_i}$, we therefore obtain $\bar{\theta}_i f'(\bar{l}_i + l) > \bar{\theta}_j f'(\bar{l}_j + l)$ for any $l > 0$.

Hence the output treatment effect for type i is

$$\begin{aligned}
\bar{\theta}_i[f(\bar{l}_i + l_i^T) - f(\bar{l}_i)] &\geq \bar{\theta}_i[f(\bar{l}_i + l_j^T) - f(\bar{l}_i)] \\
&= \bar{\theta}_i \int_0^{l_j^T} f'(\bar{l}_i + l)dl \\
&> \bar{\theta}_j \int_0^{l_j^T} f'(\bar{l}_j + l)dl \\
&= \bar{\theta}_j[f(\bar{l}_j + l_j^T) - f(\bar{l}_j)]
\end{aligned}$$

the output treatment effect for j.

(b) If the probability of crop success p_i is independent of i, equal to p, equations (1, 2) imply $\frac{f'(\bar{l}_i+l_i^T)}{f'(\bar{l}_i)}$ is independent of i. This implies $\log f'(\bar{l}_i + l_i^T) - \log f'(\bar{l}_i)$ is a constant. Differentiating this expression and setting equal to zero, we obtain

$$1 + \frac{l_i^{T'}}{\bar{l}_i'} = [-\frac{f''(\bar{l}_i)}{f'(\bar{l}_i)}][-\frac{f''(\bar{l}_i + l_i^T)}{f'(\bar{l}_i + l_i^T)}]^{-1} > 1 \tag{37}$$

owing to RC. Hence the loan treatment effect is rising in i. Applying part (a) we infer the output treatment effect is rising in i.

Finally consider the income treatment effect for i:

$$\begin{aligned}
\bar{\theta}_i[f(\bar{l}_i + l_i^T) - f(\bar{l}_i)] - p_i r_T l_i^T &= [\bar{\theta}_i f(\bar{l}_i + l_i^T) - p_i r_T l_i^T] - \bar{\theta}_i f(\bar{l}_i) \\
&\geq [\bar{\theta}_i f(\bar{l}_i + l_j^T) - p_i r_T l_j^T] - \bar{\theta}_i f(\bar{l}_i) \\
&= \bar{\theta}_i[f(\bar{l}_i + l_j^T) - f(\bar{l}_i)] - p_i r_T l_j^T \\
&= \bar{\theta}_i \int_0^{l_j^T} f'(\bar{l}_i + l)dl - p_i r_T l_j^T \\
&> \bar{\theta}_j \int_0^{l_j^T} f'(\bar{l}_j + l)dl - p_i r_T l_j^T
\end{aligned}$$

where the first inequality uses the property that type i chooses TRAIL loan size to maximize his post-intervention income, and has the option of choosing the loan size selected by type j. The

Table 1: Balance of Characteristics across Treatment Categories

Panel A: Village Characteristics

	All	TRAIL	GBL	Difference
	(1)	(2)	(3)	(4=2–3)
Number of households	392.60	327.63	457.58	-129.96
	(51.66)	(52.28)	(88.35)	
Percent households electrified	0.60	0.60	0.59	0.01
	(0.04)	(0.06)	(0.05)	
Has primary school	0.75	0.71	0.79	-0.08
	(0.06)	(0.09)	(0.08)	
Has primary health centre	0.23	0.25	0.21	0.04
	(0.06)	(0.09)	(0.08)	
Has bank branch	0.08	0.00	0.17	-0.17***
	(0.04)	(0.00)	(0.08)	
Has pucca road	0.33	0.25	0.42	0.17
	(0.07)	(0.09)	(0.10)	

Panel B: Household Characteristics

	All		TRAIL			GBL	
		Treatment	Control 1	Difference	Treatment	Control 1	Difference
	(1)	(2)	(3)	(4=2–3)	(5)	(6)	(7=5–6)
Non Hindu	0.182	0.163	0.171	-0.008	0.131	0.118	0.013
	(0.008)	(0.025)	(0.025)		(0.022)	(0.022)	
Low caste	0.404	0.374	0.385	-0.010	0.520	0.459	0.061
	(0.011)	(0.032)	(0.032)		(0.033)	(0.034)	
High caste	0.414	0.463	0.444	0.018	0.349	0.423	-0.073
	(0.011)	(0.033)	(0.033)		(0.032)	(0.033)	
Landholding	0.464	0.448	0.454	-0.006	0.354	0.395	-0.040
	(0.009)	(0.027)	(0.025)		(0.025)	(0.026)	
Male headed household	0.941	0.987	0.991	-0.005	0.930	0.895	0.035
	(0.005)	(0.008)	(0.006)		(0.017)	(0.021)	
Head Education: Primary Schooling	0.420	0.520	0.487	0.033	0.432	0.427	0.005
	(0.011)	(0.033)	(0.033)		(0.033)	(0.033)	
Joint Significance ($\chi^2(5)$)			1.04			5.41	

Notes:
Panel A uses village census data collected in 2007 by Mitra, Mookherjee, Torero, and Visaria (2017). Panel B uses household survey data from the current study and restricts the sample to households with at most 1.5 acres of land. Column 1 includes Treatment, Control 1 and Control 2 households. Columns 2 and 5 include only Treatment households. Columns 3 and 6 include only Control 1 households. Standard errors are in parentheses. ‡: $\chi^2(5)$. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table 2: Selected Crop Characteristics

	Sesame (1)	Paddy (2)	Potatoes (3)
Cultivate the crop (%)	0.46	0.67	0.62
	(0.006)	(0.006)	(0.006)
Acreage (acres)	0.21	0.47	0.31
	(0.004)	(0.007)	(0.005)
Harvested quantity (kg)	145.5	1191.26	5387.76
	(2.70)	(17.05)	(79.74)
Cost of production (₹)	335.05	2985.55	7556.46
	(8.15)	(53.52)	(142.30)
Price (₹/kg)	30.7	10.3	4.7
	(0.169)	(0.097)	(0.027)
Revenue (₹)	1636.38	5561.95	13600.5
	(38.37)	(102.77)	(256.34)
Value added (₹)	1300.47	2636.47	5986.28
	(33.73)	(69.93)	(151.43)
Value added per acre (₹/acre)	6530.38	6596.34	18139.33
	(82.31)	(109.82)	(296.79)

Notes:
Statistics are annual averages over the 3-year study period, reported for all sample households in TRAIL and GBL villages with at most 1.5 acres of land. To arrive at representative estimates for the study area, Treatment and Control 1 households are assigned a weight of $\frac{30}{N}$ and Control 2 households are assigned a weight of $\frac{N-30}{N}$, were N is the total number of households in the village. Standard errors are in parentheses.

Table 3: Credit Market Characteristics Before Experiment

	All Loans (1)		Agricultural Loans (2)	
Household had borrowed	0.67		0.59	
Total Borrowing†	6352	(10421)	5054	(8776)
Proportion of Loans by Source‡				
Traders/Money Lenders	0.63		0.66	
Family and Friends	0.05		0.02	
Cooperatives	0.24		0.25	
Government Banks	0.05		0.05	
MFI and Other Sources	0.03		0.02	
Annualized Interest Rate by Source (percent)				
Traders/Money Lenders	24.93	(20.36)	25.19	(21.47)
Family and Friends	21.28	(14.12)	22.66	(16.50)
Cooperatives	15.51	(3.83)	15.70	(2.97)
Government Banks	11.33	(4.63)	11.87	(4.57)
MFI and Other Sources	37.26	(21.64)	34.38	(25.79)
Duration by Source (days)				
Traders/Money Lenders	125.08	(34.05)	122.80	(22.43)
Family and Friends	164.08	(97.40)	183.70	(104.25)
Cooperatives	323.34	(90.97)	327.25	(87.74)
Government Banks	271.86	(121.04)	324.67	(91.49)
MFI and Other Sources	238.03	(144.12)	272.80	(128.48)
Proportion of Loans Collateralized by Source				
Traders/Money Lenders	0.02		0.01	
Family and Friends	0.04		0.07	
Cooperatives	0.79		0.78	
Government Banks	0.81		0.83	
MFI and Other Sources	0.01		0.01	

Notes:
Statistics are reported for all sample households in TRAIL and GBL villages with at most 1.5 acres of land. All characteristics are for loans taken by the households in Cycle 1. Program loans are not included. For the interest rate summary statistics loans where the principal amount is reported equal to the repayment amount are not included. To arrive at representative estimates for the study area, Treatment and Control 1 households are assigned a weight of $\frac{30}{N}$ and Control 2 households are assigned a weight of $\frac{N-30}{N}$, were N is the total number of households in their village. †: Total borrowing = 0 for households that do not borrow. ‡: Proportion of loans in terms of value of loans at the household level. All proportions are computed only over households that borrowed. Standard deviations are in parentheses.

Table 4: Program Impacts: Treatment Effects on Total Borrowing

	All Agricultural Loans (₹) (1)	Non Program Agricultural Loans† (₹) (2)	Index of dependent variables[II] (3)
TRAIL	7568***	-364.6	0.36***
	(808.1)	(646.7)	(0.073)
Hochberg p-value			0.000
Mean TRAIL Control 1	5590	5590	
% Effect TRAIL	135.38	-6.52	
GBL	5465***	-157.8	0.266*
	(903.8)	(658.9)	(0.077)
Hochberg p-value			0.003
Mean GBL Control 1	4077	4077	
% Effect GBL	134.04	-3.87	
Sample size	6,204	6,204	

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. Regressions also control for the gender and educational attainment, caste and religion of the household head, household's landholding, a set of year dummies and an information village dummy. % Effect: Treatment effect as a percentage of the mean of the relevant Control 1 group. [II]: In column 3 the dependent variable is an index of z-scores of the outcome variables in the panel; the p-values for treatment effects in this column are computed according to Hochberg (1988)'s step-up method to control for the family-weighted error rate across all index outcomes. †: Non-Program loans refer to loans from sources other than the TRAIL/GBL schemes. The complete regression results are in Table A-5. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table 5: Program Impacts: Treatment Effects in Agriculture

Panel A: Potatoes

	Cultivate (%) (1)	Land planted (Acres) (2)	Harvested quantity (Kg) (3)	Cost of Production (₹) (4)	Revenue (₹) (5)	Value Added (₹) (6)	Imputed Profit‡ (₹) (7)	Index of dependent variables[II] (8)
TRAIL Treatment	0.047	0.095***	975.371	1909.738***	4011.624***	2109.242***	1939.494***	0.198***
	(0.032)	(0.028)	(301.124)	(718.799)	(1186.538)	(621.037)	(591.339)	(0.057)
Hochberg p-value								0.003
Mean TRAIL Control 1	0.715	0.333	3646.124	8474.628	14285.467	5739.479	4740.893	
% Effect TRAIL	6.56	28.46	26.75	22.53	28.08	36.75	40.91	
GBL Treatment	0.053	0.052	514.435	1601.298*	2343.964	714.137	553.708	0.111
	(0.044)	(0.035)	(395.082)	(877.219)	(1729.723)	(918.671)	(866.430)	(0.081)
Hochberg p-value								0.861
Mean GBL Control 1	0.620	0.251	2761.127	5992.080	11014.286	4997.446	4018.796	
% Effect GBL	8.59	20.79	18.63	26.72	21.28	14.29	13.78	
Sample Size	6210	6210	6210	6210	6210	6210	6210	

Continued ...

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. Regressions also control for the gender and educational attainment, caste and religion of the household head, household's landholding, a set of year dummies and an information village dummy. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. [II]: In column 8 the dependent variable is an index of z-scores of the outcome variables in the panel; the p-values for treatment effects in this column are computed according to Hochberg (1988)'s step-up method to control for the family-weighted error rate across all index outcomes. The complete regression results are in Table A-6. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table 5 (*Continued*): Program Impacts: Treatment Effects in Agriculture

Panel B: Other Major Crops

		Sesame			Paddy			Vegetables	
	Land planted (Acres) (1)	Value Added (₹) (2)	Index of dependent variables^{II} (3)	Land planted (Acres) (4)	Value Added (₹) (5)	Index of dependent variables^{II} (6)	Land planted (Acres) (7)	Value Added (₹) (8)	Index of dependent variables^{II} (9)
TRAIL Treatment	0.044*	278.223*	0.096	0.036*	267.790	0.045	0.011	51.952	0.044
	(0.023)	(142.192)	(0.058)	(0.020)	(241.457)	(0.030)	(0.007)	(321.736)	(0.080)
Hochberg p-value			0.302			0.269			0.580
Mean TRAIL Control 1	0.266	1519.558		0.470	2556.755		0.015	889.229	
% Effect TRAIL	16.39	18.31		7.66	10.47		72.13	5.84	
GBL Treatment	0.003	-204.084	-0.041	0.011	213.527	-0.004	0.000	-323.404	-0.031
	(0.031)	(229.475)	(0.084)	(0.029)	(271.907)	(0.053)	(0.009)	(676.455)	(0.150)
Hochberg p-value			>0.999			0.943			>0.999
Mean GBL Control 1	0.193	1252.850		0.456	2336.837		0.022	1142.350	
% Effect GBL	1.46	-16.29		2.39	9.14		0.80	-28.31	
Sample Size	6210	6210		6210	6210		6210	6210	

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. Regressions also control for the gender and educational attainment, caste and religion of the household head, household's landholding, a set of year dummies and an information village dummy. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. ^{II}: In columns 3, 6 & 9, the dependent variables are indices of z-scores of the outcome variables related to that crop; the p-values for treatment effects in these columns are computed according to Hochberg (1988)'s step-up method to control for the family-weighted error rate across all index outcomes. The complete regression results corresponding to columns 1–2 are in Table A-7, to columns 4–5 are in Table A-8, and to columns 7–8 are in Table A-9. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

last inequality again uses RC in the way described in the proof of (a) above. The expression in the last line above equals the income treatment effect for type j, less $(p_i - p_j)r^T l_j^T$. This last 'correction' term equals zero (approximately) when p_i does not vary (varies very little) with i.

(c) If productivity does not vary with i, the pre-intervention loan size and output are rising in i, but after the intervention do not vary with i. Hence the loan and output treatment effects are falling in i. QED

Table 6: Program Impacts: Effects on Farm Value Added and Rates of Return

	Farm Value Added (₹) (1)	Non-Agricultural Income (₹) (2)	Index of dependent variables[II] (3)	Rate of Return[‡] Potato Cultivation (4)	Farm Value Added (5)
TRAIL Treatment	2239.22***	-608.000	0.095**	1.10[†]	1.01[†]
	(717.75)	(4153.557)	(0.043)	(0.02)	(0.02)
Hochberg p-value			0.113		
Mean TRAIL Control 1	10142.06	40115.81			
% Effect TRAIL	22.1	-1.52			
GBL Treatment	-105.2	-6092.631	-0.032	0.45	-0.07
	(1037.82))	(4959.88)	(0.046)	(1.10)	(0.58)
Hochberg p-value			>0.999		
Mean GBL Control 1	9387.6	45645.10			
% Effect GBL	-1.1	-13.35			
TRAIL vs GBL p-value	0.064	0.393			
TRAIL vs GBL (90% CI)				[-1.410, 1.418]	[-3.40, 2.56]
Sample Size	6,204	6,210			

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. Regressions also control for the gender and educational attainment, caste and religion of the household head, household's landholding, a set of year dummies and an information village dummy. The full set of results corresponding to columns 1 and 2 are in Table A-10. [‡]: The rate of return is the ratio of the treatment effect on value-added to the treatment effect on cost. [II]: In column 3 the dependent variable is an index of z-scores of the outcome variables in the panel following Kling, Liebman, and Katz (2007); p-values for this regression are reported using Hochberg (1988)'s step-up method to control the FWER across all index outcomes. In columns 1 and 2, the standard errors in parentheses are clustered at the hamlet level. In columns 4 and 5, the numbers in parentheses are the averages of cluster bootstrapped standard errors with 2000 replications. [†] indicates that the 90 percent confidence interval of bootstrapped estimates constructed according to Hall's percentile method does not include zero. The numbers in square brackets denote the 90 percent confidence interval of the TRAIL–GBL difference in rate of return, computed using Hall's percentile method with 2000 replications. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table 7: Loan Performance

	Repayment (1)	Take up (2)	Continuation (3)
Panel A: Sample Means			
TRAIL	0.954	0.856	0.805
	(0.006)	(0.008)	(0.009)
GBL	0.950	0.746	0.691
	(0.007)	(0.011)	(0.011)
Difference	0.004	0.110***	0.114***
	(0.009)	(0.014)	(0.014)
Panel B: Regression Results			
TRAIL	0.009	0.117*	0.116*
	(0.009)	(0.067)	(0.067)
Constant	1.002***	0.838***	0.827***
	(0.0006)	(0.053)	(0.053)
Mean GBL	0.950	0.747	0.694
Sample Size	2,406	3,226	3,512

Notes:
The sample consists of household-cycle level observations of Treatment households in TRAIL and GBL villages. The dependent variable in column 1 takes value 1 if a borrowing household fully repaid the amount due on a loan taken in the cycle within 30 days of the due date, and that in columns 2 and 3 takes value 1 if the household took the program loan. In column 1 the sample consists of households that had taken a program loan in that cycle, in column 2 it consists of households that were eligible to take the program loan in that cycle, and in column 3 it consists of all households that were eligible to receive program loans in Cycle 1. In Panel B, treatment effects are computed from regressions that follow equation (31) in the text. Standard errors in parentheses are clustered at the hamlet level. †: Difference between mean in TRAIL and mean in GBL. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table 8: Estimating Ability. First Stage Regressions

Dependent variable:	Log(Quantity of potatoes produced)			Log(Acreage under potato cultivation)		
	Random Effects	OLS	Fixed Effects	Random Effects	OLS	Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)
Landholding	2.003***	2.365***		1.588***	1.835***	
	(0.251)	(0.235)		(0.182)	(0.169)	
Non Hindu household	-1.818***	-0.443		-1.268***	-0.294	
	(0.326)	(0.360)		(0.238)	(0.257)	
Low caste household	-0.510**	-0.422**		-0.342**	-0.323**	
	(0.227)	(0.213)		(0.166)	(0.154)	
Male headed household	0.175	0.192		0.122	0.143	
	(0.367)	(0.347)		(0.260)	(0.245)	
Education of head: at least primary	-0.055	0.002		-0.022	0.010	
	(0.159)	(0.144)		(0.115)	(0.103)	
Occupation of head: cultivation	2.699***	2.443***		1.932***	1.749***	
	(0.203)	(0.175)		(0.147)	(0.126)	
Household size	0.175***	0.195***		0.124***	0.141***	
	(0.040)	(0.039)		(0.029)	(0.028)	
Year 2	-0.456***	-0.456***	-0.453***	-0.289***	-0.289***	-0.283***
	(0.073)	(0.073)	(0.065)	(0.052)	(0.052)	(0.046)
Year 3	-0.374***	-0.374***	-0.381***	-0.248***	-0.248***	-0.250***
	(0.076)	(0.076)	(0.070)	(0.053)	(0.054)	(0.049)
Constant	2.898***	3.637***	5.554***	-4.967***	-4.348***	-2.976***
	(0.417)	(0.783)	(0.040)	(0.297)	(0.575)	(0.028)
R^2	0.2730	0.3718	0.0025	0.2848	0.3888	0.0019
Sample size	4,833	4,833	6,204	4,833	4,833	6,204
Number of households	1,613		2,068	1,613		2,068
δ			0.951			0.965
			[0.873, 1.034]			[0.891, 1.045]
K			0.567			0.454
			[0.115, 1.035]			[0.118, 0.794]

Notes:
Standard errors in parentheses are clustered at the hamlet level. In columns 2, 3, 5 and 6 the estimating sample include Control 1 and Control 2 households in TRAIL and GBL villages with at most 1.5 acres of land. In columns 3 and 6, the estimating sample includes all sample households in TRAIL and GBL villages with at most 1.5 acres of land. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$. The numbers in square brackets denote the 90 percent confidence interval computed using Hall's percentile method with 2000 replications. † indicates that the 90 percent confidence interval of bootstrapped estimates does not include zero.

Table 9: Ability Differences and Patterns of Selection into the TRAIL scheme

Ability estimates from:	**Log(Quantity of potatoes produced)** (1)	**Log(Acreage under potato cultivation)** (2)
Recommended (δ_1)	0.390	0.278
	(0.286)	(0.205)
Own Segment (δ_2)	0.947**	0.715**
	(0.463)	(0.340)
Recommended × Own Segment (δ_3)	0.174	0.071
	(0.547)	(0.394)
Constant	0.213	0.183
	(0.656)	(0.477)
Total Effects		
Recommended:		
Own Segment (RS: $\delta_0 + \delta_1 + \delta_2 + \delta_3$)	1.723**	1.247**
	(0.704)	(0.513)
Other Segment (RO: $\delta_0 + \delta_1$)	0.602	0.461
	(0.655)	(0.478)
Not Recommended:		
Own Segment (NS: $\delta_0 + \delta_2$)	1.159	0.898
	(0.784)	(0.572)
Other Segment (NO: δ_0)	0.213	0.183
	(0.656)	(0.477)
Difference Estimates		
Own Segment: Recommended v. Not Recommended ($\delta_1 + \delta_3$)	0.564	0.349
	(0.488)	(0.353)
Recommended: Own v. Other Segment ($\delta_2 + \delta_3$)	1.121***	0.786***
	(0.322)	(0.236)
Sample Size	1,032	1,032

Notes:
Coefficients are reported from regressions that follow equation (33) in the text. The dependent variable is ability estimates constructed from household fixed effects, as reported in columns 3 and 6 of Table 8. The regressions also control for village fixed effects. The estimating sample includes all sample households in TRAIL villages with at most 1.5 acres of land. Standard errors in parentheses are clustered at the hamlet level. $^{***}p < 0.01,^{**}p < 0.05,^{*}p < 0.1$.

Table 10: Relationship between ability and interest rate paid on informal loans

Ability estimates from:	**Log(Quantity of potatoes produced)** (1)	(2)	**Log(Acreage under potato cultivation)** (3)	(4)
$\hat{Q}_1$	$0.348^{‡}$	$0.328^{‡}$	$0.348^{‡}$	$0.328^{‡}$
	(0.085)	(0.093)	(0.085)	(0.093)
$\hat{Q}_2$	$0.246^{‡}$	$0.234^{‡}$	$0.250^{‡}$	$0.239^{‡}$
	(0.020)	(0.026)	(0.020)	(0.026)
$\hat{Q}_3$	$0.237^{‡}$	$0.222^{‡}$	$0.218^{‡}$	$0.209^{‡}$
	(0.021)	(0.023)	(0.019)	(0.023)
$\hat{Q}_4$	$0.210^{‡}$	$0.211^{‡}$	$0.221^{‡}$	$0.218^{‡}$
	(0.010)	(0.022)	(0.011)	(0.022)
Joint Test$^{\#}$:$\hat{Q}_1 = \hat{Q}_2 = \hat{Q}_3 = \hat{Q}_4$	2321.2***	1971.1***	2389.9***	1994.1***
Village Fixed Effects	No	Yes	No	Yes
Sample Size	661	661	661	661
Difference Estimates				
$\hat{Q}_1 - \hat{Q}_2$	0.103	0.094	0.099	0.090
	(0.089)	(0.088)	(0.087)	(0.086)
$\hat{Q}_1 - \hat{Q}_3$	0.111	0.105	0.130	0.119
	(0.086)	(0.084)	(0.087)	(0.086)
$\hat{Q}_1 - \hat{Q}_4$	$0.139^{‡}$	0.117	$(0.127^{‡}$	0.111
	(0.084)	(0.086)	(0.085)	(0.086)
$\hat{Q}_2 - \hat{Q}_3$	0.009	0.011	0.031	0.029
	(0.036)	(0.028)	(0.033)	(0.028)
$\hat{Q}_2 - \hat{Q}_4$	0.036	0.023	0.029	0.021
	(0.028)	(.025)	(0.029)	(0.026)
$\hat{Q}_3 - \hat{Q}_4$	0.027	0.012	-0.003	-0.008
	(0.027)	(0.024)	(0.026)	(0.022)
Average interest rate paid by Control 1 households				
Both schemes:		0.242		
TRAIL		0.226		
GBL		0.260		

Notes:
The dependent variable is the average annualized interest rate paid on informal production loans from traders, moneylenders and family and friends, as reported in Cycle 1. The estimating sample includes all Control 1 and Control 2 households in TRAIL and GBL villages with at most 1.5 acres who had borrowed from traders, moneylenders and family and friends in Cycle 1. See discussion on page 27. Loans where the principal amount is reported equal to the repayment amount are not included. Standard errors in parentheses are clustered at the hamlet level, and are averages of cluster bootstrap standard errors from 2000 replications. $^{\#}$: $F(3, 7996)$. ‡: 99 percent Hall's percentile method confidence interval incorporating Bonferroni's correction for multiple hypothesis testing does not include zero. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 11: Heterogeneous Treatment Effects by Ability in the TRAIL Scheme

Ability estimates from:	**Log(Quantity of potatoes produced)**			**Log(Acreage under potato cultivation)**		
	Total Borrowing (1)	Farm Revenue (2)	Farm Value Added (3)	Total Borrowing (4)	Farm Revenue (5)	Farm Value Added (6)
Treatment Effects by Quartile						
$\hat{Q}_1$	$656^{\ddagger}$	971	629	$668^{\ddagger}$	1030	656
	(610.69)	(2119.77)	(1336.56)	(612.53)	(2126.99)	(1342.8)
$\hat{Q}_2$	$2832^{\ddagger}$	-2384	-706	$3222^{\ddagger}$	-763	-1354
	(1562.77)	(3101.69)	(1923.92)	(1576.05)	(2705.65)	(1560.6)
$\hat{Q}_3$	$6327^{\ddagger}$	$8123^{\ddagger}$	$3521^{\ddagger}$	$5657^{\ddagger}$	$5628^{\ddagger}$	$1897^{\ddagger}$
	(1266.39)	(2029.75)	(1415.15)	(1364.59)	(2451.27)	(1806.8)
$\hat{Q}_4$	$9474^{\ddagger}$	$14022^{\ddagger}$	$7734^{\ddagger}$	$8614^{\ddagger}$	$11404^{\ddagger}$	$6531^{\ddagger}$
	(2728.61)	(4675.39)	(2905.06)	(2653.91)	(4798.55)	(2914.0)
Joint Test$^{\#}$:$\hat{Q}_1 = \hat{Q}_2 = \hat{Q}_3 = \hat{Q}_4$	16081.6***	18299.2***	16780.7***	13342.2***	9497.1***	8493.0***
Differences in Treatment Effects by Quartile						
$\hat{Q}_2 - \hat{Q}_1$	2176	-3355	-3355	2554	-1793	-2014
	(1710.89)	(3982.57)	(2475.47)	(1730.28)	(3697.93)	(2208.25)
$\hat{Q}_3 - \hat{Q}_1$	$5672^{\ddagger}$	$7152^{\ddagger}$	2892	$4989^{\ddagger}$	4598	1237
	(1421.79)	(2933.36)	(1970.82)	(1489.25)	(3257.88)	(2285.5)
$\hat{Q}_4 - \hat{Q}_1$	$8819^{\ddagger}$	$13051^{\ddagger}$	$7104^{\ddagger}$	$7946^{\ddagger}$	10374	5871
	(2853.91)	(5140.47)	(3153.57)	(2789.50)	(5272.96)	(3174.5)
$\hat{Q}_3 - \hat{Q}_2$	$3495^{\ddagger}$	$10507^{\ddagger}$	$6227^{\ddagger}$	2435	$6391^{\ddagger}$	3251
	(1913.40)	(3612.24)	(2395.09)	(1957.65)	(3649.24)	(2466.0)
$\hat{Q}_4 - \hat{Q}_2$	$6642^{\ddagger}$	$16407^{\ddagger}$	$10440^{\ddagger}$	$5392^{\ddagger}$	$12167^{\ddagger}$	$7884^{\ddagger}$
	(3217.19)	(5710.95)	(3704.77)	(3174.47)	(5533.51)	(3405.22)
$\hat{Q}_4 - \hat{Q}_3$	3147	5900	4212	2957	5775	4634
	(2697.75)	(4997.28)	(3284.39)	(2726.12)	(5403.31)	(3542.17)
Sample size	3,093	3,093	3,093	3,093	3,093	3,093

Notes:
Treatment effects and differences in treatment effects are presented. Treatment effects are computed from equation (35). Estimating sample includes all sample households in TRAIL villages with at most 1.5 acres of land. Regressions control for year dummies and information village dummy. Standard errors are clustered at the hamlet level, and are averages of cluster bootstrap standard errors from 2000 replications. $^{\#}$: $F(3, 7996)$. ‡: the 99 percent Hall's percentile method confidence interval of cluster bootstrap estimates incorporating Bonferroni's correction for multiple hypothesis testing does not include zero. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table 12: Decomposition of Average Effect on Farm Value Added by Ability

	TRAIL (1)	GBL (2)	Difference (TRAIL - GBL) (3 = 1-2)	Treatment Effect (4)	Difference $\times$ Treatment Effect (5 = 3 $\times$ 4)
Ability estimates from: log(quantity of potatoes produced)					
$\hat{Q}_1$	0.18	0.27	-0.09	629.4	-58.58
$\hat{Q}_2$	0.24	0.28	-0.04	-2706	112.46
$\hat{Q}_3$	0.30	0.25	0.05	3521	163.86
$\hat{Q}_4$	0.28	0.20	0.09	7734	681.33
% of Average Treatment Effect Difference due to Selection Difference					40.76
Ability estimates from: log(acreage under potato cultivation)					
$\hat{Q}_1$	0.18	0.27	-0.09	659.9	-59.39
$\hat{Q}_2$	0.25	0.29	-0.04	-1354	54.16
$\hat{Q}_3$	0.28	0.24	0.04	1897	75.88
$\hat{Q}_4$	0.29	0.20	0.09	6531	587.79
% of Average Treatment Effect Difference due to Selection Difference					29.85

Notes:
Columns 1 and 2 present the fraction of selected borrowers in TRAIL and GBL respectively who belonged to each estimated ability quartile, and column 3 presents the difference between the two. Column 4 presents the TRAIL treatment effects on farm value-added from Table 11. The last row in each panel shows the percentage of the average treatment effect difference between the TRAIL and GBL schemes that can be explained by the Selection Effect, as per equation (29) in the text.

Table 13: Treatment Effects for Transactions with TRAIL agent

Panel A: Input Purchase†

	Purchased from agent	Agent's share in purchases	Input Price (Rs/unit)					Index of
			Fertilizer	Outside Seed	Pesticide	Power tiller	Water	input prices[II]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TRAIL Treatment	0.002	0.000	0.136	2.099*	-32.41	-29.11***	109.80	0.023
	(0.014)	(0.011)	(0.929)	(1.131)	(48.30)	(4.854)	(109.80)	(0.026)
Hochberg p-value								0.773
Mean Control 1	0.0813	0.0620	15.77	24.82	536.8	211.2	72.30	
Sample Size	17,928	17,784	2,908	2,394	3,830	1,983	1,822	

Panel B: Output Sales†

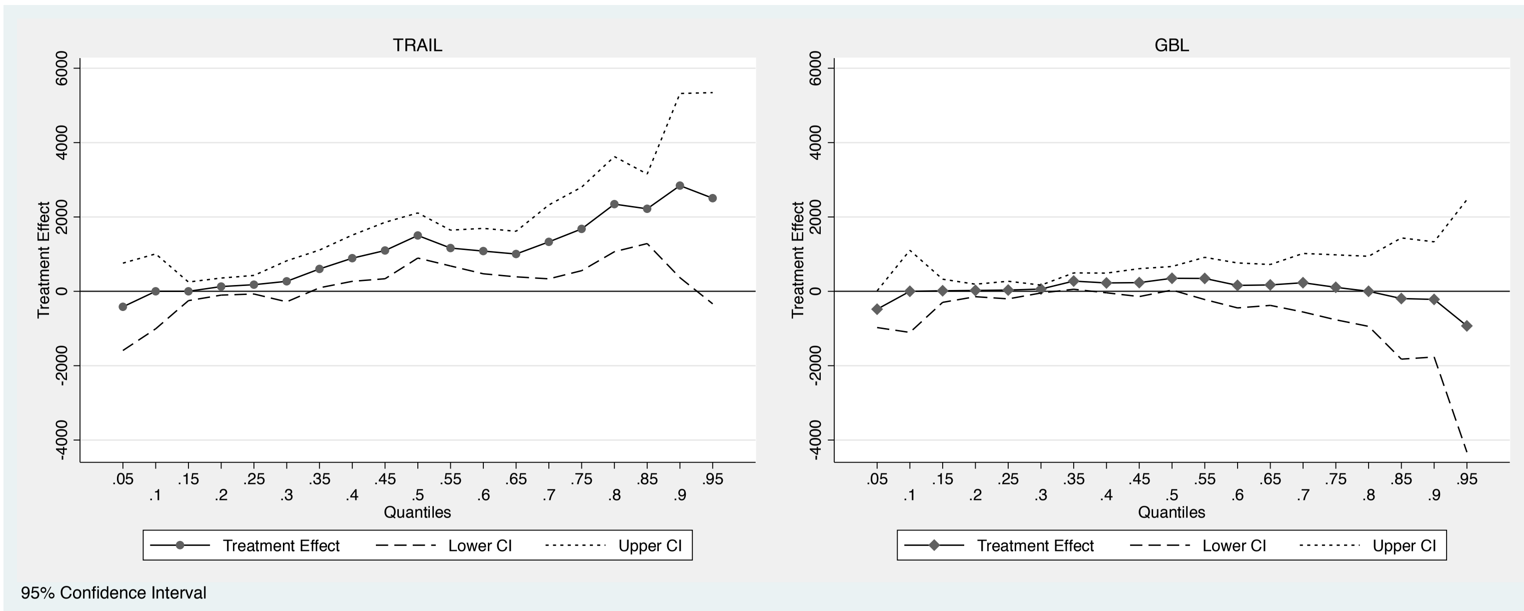
	Sold to agent	Agent's share in sales	Output Price (Rs/kg)			Index of
			Potatoes	Paddy	Sesame	output prices[II]
	(1)	(2)	(3)	(4)	(5)	(6)
TRAIL Treatment	0.020	0.027	-0.024	0.401	0.010	0.001
	(0.029)	(0.028)	(0.141)	(0.285)	(0.516)	(0.005)
Hochberg p-value						0.846
Mean Control 1	0.192	0.152	4.566	10.13	30.59	
Sample Size	4,303	4,098	2,026	791	1,280	

Panel C: Borrowing†

	Borrowed from Agent	Agent's share in borrowing	APR
	(1)	(2)	(3)
TRAIL Treatment	-0.076**	-0.036***	0.011
	(0.038)	(0.012)	0.043
Mean Control 1	0.161	0.0489	0.139
Sample Size	1,960	1,960	5,468

Notes:
The regressions are run on household-year level data for sample households with at most 1.5 acres of land in TRAIL villages. In Panel C only borrowing for agricultural purposes is considered. †: Purchased inputs from, sold output to or borrowed from agent during the survey period. II: In column 8 in Panel A and Column 6 in Panel B the dependent variables are indices of z-scores of input prices and output price respectively, following KlingLiebmanKatz2007; p-values for this regression are reported using Hochberg (1988)'s step-up method to control the FWER across the two indices. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Figure A-1: Quantile Treatment Effects: Farm Value Added



Notes:
The values represent the estimated treatment effects from a quantile regression specification of equation (30) in the text. The vertical axis measures the treatment effect on farm value added. The standard errors are cluster bootstrapped with 2000 replications, and the confidence intervals are constructed according to Hall's percentile method.

Table A-1: Robustness of Results 1. Program Impacts: Treatment Effects on Agricultural and Total Borrowing

	Alternative Clustering		Restricting to Recommended Households		Total Borrowing	
	All	Non-Program†	All	Non Program†	All	Non-Program†
	(1)	(2)	(3)	(4)	(5)	(6)
TRAIL Treatment	7567***	-365.5	7542***	-357.1	11004***	-285.9
	(1100)	(581.4)	(800.7)	(645.9)	(1177)	(1109)
TRAIL Control 1 Mean	5590	5590	5590	5590	7523	7523
% Effect TRAIL	135.37	-6.54	134.92	-6.39	146.27	-3.80
GBL Treatment	5464***	-158.5	5499***	-134.6	7980***	-952
	(1022)	(716.7)	(900.7)	(659.6)	(1143)	(895.4)
GBL Control 1 Mean	4077	4077	4077	4077	6005	6005
% Effect GBL	134.02	-3.89	134.88	-3.30	132.89	-15.85
Difference Treatment	2103	-207	2043	-222.5	3024*	666.1
	(1501.66)	(929.75)	(1207.36)	(926.81)	(1632.56)	(1418.80)
Sample size	6,210	6,210	2,733	2,733	6,204	6,204

Notes:
Treatment effects presented. †: Non-Program loans are loans from sources other than the TRAIL or GBL schemes. Columns 1, 2, 5 and 6 use data from all sample households with at most 1.5 acres of land in TRAIL and GBL villages. Columns 3 and 4 use data from Treatment and Control 1 households in the sample with at most 1.5 acres of land in TRAIL and GBL villages. Columns 1–4 are restricted to loans for agricultural purposes from moneylenders, traders and family and friends. Columns 5 and 6 include all loans irrespective of stated purpose. In columns 3–6 standard errors in parentheses are clustered at the para (hamlet) level while those in columns 1 and 2 are clustered at the village level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-2: Robustness of Results 2. Program Impacts: Treatment Effects in Agriculture. Alternative Clustering

	Cultivate (%) (1)	Acreage (Acres) (2)	Harvested quantity (Kg) (3)	Cost of Production (₹) (4)	Revenue (₹) (5)	Value Added (₹) (6)	Imputed Profit‡ (₹) (7)
				Potatoes			
TRAIL Treatment	0.047*	0.095***	975.041***	1908.985***	4010.208***	2108.584***	1938.840***
	(0.025)	(0.024)	(249.701)	(632.620)	(1060.698)	(546.374)	(534.952)
Mean TRAIL	0.715	0.333	3646.124	8474.628	14285.467	5739.479	4740.893
% Effect TRAIL	6.564	28.452	26.742	22.526	28.072	36.738	40.896
GBL Treatment	0.053	0.052*	514.011	1600.336**	2342.149	713.290	552.870
	(0.048)	(0.030)	(331.594)	(735.408)	(1479.915)	(833.048)	(775.843)
Mean GBL	0.620	0.251	2761.127	5992.080	11014.286	4997.446	4018.796
% Effect GBL	8.586	20.779	18.616	26.708	21.265	14.273	13.757
Sample Size	6216	6216	6216	6216	6216	6216	6216
				Sesame			
TRAIL Treatment	0.035	0.044**	9.640	25.846	304.917*	278.171**	179.145
	(0.025)	(0.021)	(5.850)	(44.772)	(159.456)	(133.339)	(112.534)
Mean TRAIL	0.581	0.266	81.624	436.910	1957.498	1519.558	1080.800
% Effect TRAIL	6.024	16.383	11.810	5.916	15.577	18.306	16.575
GBL Treatment	-0.024	0.003	-5.452	16.776	-188.692	-204.157	-129.467
	(0.043)	(0.030)	(8.156)	(32.762)	(218.261)	(203.706)	(197.176)
Mean GBL	0.484	0.193	60.848	258.878	1513.138	1252.850	866.288
% Effect GBL	-4.959	1.453	-8.960	6.480	-12.470	-16.295	-14.945
Sample Size	6,216	6,216	6,216	6,216	6,216	6,216	6,216
				Paddy			
TRAIL Treatment	-0.005	0.036**	22.214	212.371	471.201**	267.780	135.235
	(0.025)	(0.014)	(21.934)	(142.091)	(177.856)	(189.045)	(142.456)
Mean TRAIL	0.744	0.470	569.726	2889.838	5398.490	2556.755	93.133
% Effect TRAIL	-0.703	7.667	3.899	7.349	8.728	10.473	145.207
GBL Treatment	0.000	0.011	-36.517	-74.850	114.611	213.507	-120.627
	(0.029)	(0.022)	(57.881)	(281.160)	(437.564)	(277.301)	(194.767)
Mean GBL	0.689	0.456	672.894	3225.745	5513.227	2336.837	183.163
% Effect GBL	-0.069	2.403	-5.427	-2.320	2.079	9.137	-65.858
Sample Size	6216	6216	6216	6216	6216	6216	6216
				Vegetables			
TRAIL Treatment	0.000	0.011	27.623	81.354	137.182	51.969	-10.670
	(0.019)	(0.006)	(25.466)	(79.376)	(222.004)	(162.359)	(131.075)
Mean TRAIL	0.080	0.015	142.823	307.071	1207.642	889.229	664.507
% Effect TRAIL	0.329	72.131	19.340	26.494	11.359	5.844	-1.606
GBL Treatment	0.010	0.000	1.118	21.933	-308.116	-323.393	-396.598
	(0.019)	(0.006)	(39.512)	(134.271)	(524.917)	(393.604)	(351.505)
Mean GBL	0.112	0.022	135.893	404.919	1564.029	1142.350	853.062
% Effect GBL	9.079	0.794	0.823	5.417	-19.700	-28.309	-46.491
Sample Size	6216	6216	6216	6216	6216	6216	6216

Notes:
Treatment effects presented. Sample includes all sample households with at most 1.5 acres of land in TRAIL and GBL villages. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Standard errors in parentheses are clustered at the village level. $^{***}: p < 0.01,^{**}: p < 0.05,^{*}: p < 0.1$.

Table A-3: Robustness of Results 3. Program Impacts: Treatment Effects in Agriculture. Recommended/Formed Group.

	Cultivate (%) (1)	Acreage (Acres) (2)	Harvested quantity (Kg) (3)	Cost of Production (₹) (4)	Revenue (₹) (5)	Value Added (₹) (6)	Imputed Profit‡ (₹) (7)
				Potatoes			
TRAIL Treatment	0.048	0.094***	973.523***	1908.809***	4014.051***	2113.447***	1942.967***
	(0.031)	(0.028)	(302.107)	(721.690)	(1185.867)	(619.217)	(589.612)
Mean TRAIL	0.715	0.333	3646.124	8474.628	14285.467	5739.479	4740.893
% Effect TRAIL	6.650	28.360	26.700	22.524	28.099	36.823	40.983
GBL Treatment	0.052	0.053	515.496	1593.643*	2344.036	720.522	559.976
	(0.044)	(0.035)	(393.250)	(878.323)	(1724.660)	(908.683)	(855.015)
Mean GBL	0.620	0.251	2761.127	5992.080	11014.286	4997.446	4018.796
% Effect GBL	8.334	21.040	18.670	26.596	21.282	14.418	13.934
Sample Size	2,733	2,733	2,733	2,733	2,733	2,733	2,733
				Sesame			
TRAIL Treatment	0.036	0.044**	9.743	25.535	309.539*	283.120**	183.070
	(0.033)	(0.023)	(6.821)	(44.606)	(172.207)	(143.565)	(125.542)
Mean TRAIL	0.581	0.266	81.624	436.910	1957.498	1519.558	1080.800
% Effect TRAIL	6.264	16.461	11.936	5.844	15.813	18.632	16.938
GBL Treatment	-0.025	0.004	-5.741	17.993	-190.955	-207.767	-133.134
	(0.043)	(0.031)	(9.638)	(38.547)	(252.920)	(226.176)	(200.260)
Mean GBL	0.484	0.193	60.848	258.878	1513.138	1252.850	866.288
% Effect GBL	-5.141	2.017	-9.436	6.950	-12.620	-16.584	-15.368
Sample Size	2,733	2,733	2,733	2,733	2,733	2,733	2,733
				Paddy			
TRAIL Treatment	-0.004	0.035*	22.047	208.594	471.752*	272.167	134.595
	(0.032)	(0.021)	(31.055)	(179.907)	(281.557)	(241.453)	(131.514)
Mean TRAIL	0.744	0.470	569.726	2889.838	5398.490	2556.755	93.133
% Effect TRAIL	-0.538	7.447	3.870	7.218	8.739	10.645	144.519
GBL Treatment	-0.002	0.010	-37.354	-86.749	92.495	200.575	-116.557
	(0.039)	(0.028)	(67.640)	(352.057)	(442.096)	(270.836)	(228.690)
Mean GBL	0.689	0.456	672.894	3225.745	5513.227	2336.837	183.163
% Effect GBL	-0.290	2.193	-5.551	-2.689	1.678	8.583	-63.636
Sample Size	2,733	2,733	2,733	2,733	2,733	2,733	2,733
				Vegetables			
TRAIL Treatment	0.000	0.010	25.763	78.973	126.624	43.898	-16.404
	(0.021)	(0.007)	(45.535)	(105.759)	(419.095)	(322.147)	(237.174)
Mean TRAIL	0.080	0.015	142.823	307.071	1207.642	889.229	664.507
% Effect TRAIL	-0.051	70.509	18.038	25.718	10.485	4.937	-2.469
GBL Treatment	0.011	0.000	1.154	27.972	-287.323	-308.686	-383.217
	(0.036)	(0.009)	(61.136)	(179.261)	(856.439)	(670.745)	(576.998)
Mean GBL	0.112	0.022	135.893	404.919	1564.029	1142.350	853.062
% Effect GBL	10.182	2.208	0.849	6.908	-18.371	-27.022	-44.922
Sample Size	2,733	2,733	2,733	2,733	2,733	2,733	2,733

Notes:
Treatment effects presented. Sample includes all recommended/self selected (Treatment and Control 1) households with at most 1.5 acres of land in TRAIL and GBL villages. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Standard errors in parentheses are clustered at the para (hamlet) level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-4: Effects of Treatment on Treated: Potatoes.

	Cultivate (%) (1)	Land Planted (Acres) (2)	Harvested Quantity (Kg) (3)	Cost of Production (₹) (4)	Revenue (₹) (5)	Value Added Profit (₹) (6)	Imputed Value Added (₹) (7)	Farm Income (₹) (8)	Non-Agricultural (₹) (9)
TRAIL Treatment	0.052	0.103***	1061.189***	2079.845***	4375.197***	2304.347***	2118.617***	2958.415***	-743.708
SE	(0.034)	(0.030)	(327.758)	(782.565)	(1285.807)	(672.217)	(639.760)	(808.777)	(4408.361)
Mean TRAIL Control 1	0.715	0.333	3646.124	8474.628	14285.467	5739.479	4740.893	8324.306	40115.808
% Effect TRAIL	7.24	30.91	29.10	24.54	30.63	40.15	44.69	35.539	-1.854
GBL Treatment	0.063	0.065	632.252	1953.564*	2874.560	884.420	687.635	498.116	-8019.467
SE	(0.054)	(0.042)	(480.127)	(1071.692)	(2107.997)	(1110.926)	(1045.470)	(1286.937)	(6078.544)
Mean GBL Control 1	0.620	0.251	2761.127	5992.080	11014.286	4997.446	4018.796	7741.833	45645.104
% Effect GBL	10.21	25.80	22.90	32.60	26.10	17.70	17.11	6.434	-17.569
Sample Size	2,733	2,733	2,733	2,733	2,733	2,733	2,733	2,733	2,733

Notes:
IV regression results presented. Assignment to treatment used an an instrument for loan take-up. Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for Treatment and Control 1 households in TRAIL and GBL villages with at most 1.5 acres of land. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for gender and educational attainment of household head, household caste and religion and landholding, a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-5: Program Impacts: Treatment Effects on Agricultural and Total Borrowing

	Agricultural Borrowing		Total Borrowing	
	All Loans	Non Program Loans†	All Loans	Non Program Loans†
	(₹)	(₹)	(₹)	(₹)
	(1)	(2)	(3)	(4)
TRAIL	1,308.805**	1,258.715**	1,492.442**	1,459.568**
	(565.824)	(568.119)	(664.561)	(664.593)
TRAIL × Control 1	-214.127	-162.695	52.922	113.626
	(615.330)	(612.441)	(788.683)	(785.879)
TRAIL × Treatment	7,353.752***	-527.303	11,056.515***	-172.249
	(680.644)	(515.345)	(1,016.810)	(946.401)
GBL × Control 1	331.349	254.498	945.201	909.592
	(638.042)	(637.770)	(901.132)	(896.252)
GBL × Treatmnt	5,796.257***	96.717	8,925.093***	-42.396
	(861.049)	(568.206)	(1,001.017)	(666.740)
Landholding	9,017.990***	8,275.706***	9,676.143***	9,571.987***
	(667.613)	(656.141)	(828.726)	(818.065)
Non Hindu household	-3,283.840***	-2,772.558***	-2,749.312***	-2,544.745***
	(634.804)	(583.799)	(847.094)	(822.146)
Low caste household	-1,659.136***	-1,658.744***	-1,589.903**	-1,865.289***
	(546.353)	(485.272)	(621.189)	(583.036)
Male headed household	1,878.520***	1,349.010***	2,021.274***	1,234.385*
	(521.125)	(505.910)	(663.474)	(706.150)
Household head: Completed Primary Schooling	-121.188	66.508	659.681	775.445*
	(384.137)	(350.439)	(464.343)	(438.716)
Constant	-503.869	795.939	569.723	2,177.733**
	(716.075)	(651.976)	(919.400)	(919.036)
Treatment Effect				
TRAIL	7568***	-364.6	11004***	-285.9
	(808.1)	(646.7)	(1177)	(1109)
TRAIL Control 1 Mean	5590	5590	7523	7523
% Effect TRAIL	135.38	-6.52	146.27	-3.80
GBL	5465***	-157.8	7980***	-952
	(903.8)	(658.9)	(1143)	(895.4)
GBL Control 1 Mean	4077	4077	6005	6005
% Effect GBL	134.04	-3.87	132.89	-15.85
Treatment Differences: TRAIL – GBL	2103*	-206.8	3024*	666.1
	(1211.07)	923.86	(1632.56)	(1418.80)
Recommendation/Group Formation Effect				
TRAIL	-214.1	-162.7	52.92	113.6
	(615.3)	(612.4)	(788.7)	(785.9)
GBL	331.3	254.5	945.2	909.6
	(638)	(637.8)	(901.1)	(896.3)
Sample size	6,204	6,204	6,204	6,204

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. Regressions also control for a set of year dummies and an information village dummy. % Effect: Treatment effect as a percentage of the mean of the relevant Control 1 group. †: Non-Program loans refer to loans from sources other than the TRAIL/GBL schemes. In columns 1 and 2 the dependent variable is borrowing for agricultural purposes. In columns 3 and 4, the dependent variable includes borrowing for both agricultural and non-agricultural purposes. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-6: Program Impacts: Treatment Effects on Potato Cultivation

	Cultivate (%) (1)	Land planted (Acres) (2)	Harvested quantity (Kg) (3)	Cost of production (₹) (4)	Revenue (₹) (5)	Value added (₹) (6)	Imputed profit‡ (₹) (7)
TRAIL	0.057*	0.032	292.763	781.354	526.844	-263.985	-290.129
	(0.030)	(0.027)	(304.252)	(684.127)	(1,222.338)	(617.008)	(580.964)
TRAIL × Control 1	0.069*	0.01	137.647	446.827	433.107	-19.9	-99.093
	(0.035)	(0.026)	(293.854)	(705.030)	(1,186.249)	(600.392)	(565.336)
TRAIL × Treatment	0.116***	0.104***	1,113.018***	2,356.565***	4,444.731***	2,089.342***	1,840.401***
	(0.031)	(0.024)	(264.634)	(615.135)	(1,037.906)	(524.430)	(491.336)
GBL × Control 1	0.06	-0.002	-39.003	-360.801	-641.264	-260.993	-406.701
	(0.037)	(0.033)	(381.224)	(804.040)	(1,685.321)	(945.242)	(897.473)
GBL × Treatment	0.114***	0.050*	475.432	1,240.496*	1,702.70	453.143	147.007
	(0.035)	(0.027)	(299.069)	(703.861)	(1,249.871)	(616.922)	(569.248)
Landholding	0.364***	0.471***	5,172.909***	10,555.661***	21,918.658***	11,262.024***	10,370.559***
	(0.028)	(0.031)	(351.564)	(795.920)	(1,424.911)	(718.648)	(682.919)
Non Hindu household	-0.246***	-0.126***	-1,456.438***	-3,666.870***	-6,134.404***	-2,471.695***	-1,937.662***
	(0.041)	(0.032)	(353.577)	(791.591)	(1,424.167)	(705.968)	(649.551)
Low caste household	-0.091***	-0.067***	-785.399***	-2,350.417***	-3,662.629***	-1,299.159**	-1,201.942**
	(0.027)	(0.024)	(275.179)	(619.846)	(1,080.364)	(516.179)	(480.608)
Male headed household	0.173***	0.089***	994.458***	2,193.331***	3,533.360***	1,319.783**	925.504*
	(0.039)	(0.025)	(280.924)	(604.000)	(1,176.181)	(594.393)	(545.037)
Household head: Completed Primary Schooling	-0.032*	0.001	26.736	318.901	134.955	-198.726	-5.649
	(0.018)	(0.017)	(190.199)	(433.805)	(751.643)	(371.166)	(346.968)
Constant	0.372***	0.018	327.659	332.504	-421.257	-811.724	-926.514
	(0.048)	(0.033)	(377.208)	(816.221)	(1,567.057)	(826.290)	(781.899)
Treatment Effects							
TRAIL Treatment	0.047	0.095***	975.371	1909.738***	4011.624***	2109.242***	1939.494***
	(0.032)	(0.028)	(301.124)	(718.799)	(1186.538)	(621.037)	(591.339)
Mean TRAIL Control 1	0.715	0.333	3646.124	8474.628	14285.467	5739.479	4740.893
% Effect TRAIL	6.56	28.46	26.75	22.53	28.08	36.75	40.91
GBL Treatment	0.053	0.052	514.435	1601.298*	2343.964	714.137	553.708
	(0.044)	(0.035)	(395.082)	(877.219)	(1729.723)	(918.671)	(866.430)
Mean GBL Control 1	0.620	0.251	2761.127	5992.080	11014.286	4997.446	4018.796
% Effect GBL	8.59	20.79	18.63	26.72	21.28	14.29	13.78
Treatment Differences: TRAIL – GBL	-0.006	0.042	460.94	308.44	1667.66	1395.11	1385.79
	(0.054)	(0.044)	(495.84)	(1132.09)	(2094.95)	(1108.50)	(1048.44)
Recommendation/Group Formation Effects							
TRAIL Recommendation	0.069	0.010	137.647	446.827	433.107	-19.900	-99.093
	(0.035)	(0.026)	(293.854)	(705.030)	(1186.249)	(600.392)	(565.336)
GBL Group Formation	0.060	-0.002	-39.003	-360.801	-641.264	-260.993	-406.701
	(0.037)	(0.033)	(381.224)	(804.040)	(1685.321)	(945.242)	(897.473)
Sample Size	6210	6210	6210	6210	6210	6210	6210

Notes: Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-7: Program Impacts: Treatment Effects on Sesame Cultivation

	Cultivate (%) (1)	Land planted (Acres) (2)	Harvested quantity (Kg) (3)	Cost of production (₹) (4)	Revenue (₹) (5)	Value added (₹) (6)	Imputed profit‡ (₹) (7)
TRAIL	0.076**	0.042*	13.575*	34.763	216.493	180.985	103.803
	(0.035)	(0.021)	(7.615)	(38.950)	(175.758)	(148.649)	(127.428)
TRAIL × Control 1	0.087**	0.036*	6.924	82.209**	220.684	138.585	86.299
	(0.035)	(0.022)	(7.105)	(36.323)	(171.621)	(152.051)	(135.914)
TRAIL × Treatment	0.122***	0.079***	16.567**	108.064**	525.663***	416.808**	265.513*
	(0.035)	(0.020)	(7.703)	(42.835)	(199.094)	(175.922)	(160.609)
GBL × Control 1	0.087**	0.03	7.1	-29.721	177.119	205.714	109.877
	(0.038)	(0.029)	(9.517)	(35.876)	(249.834)	(226.649)	(202.945)
GBL × Treatment	0.063*	0.033	1.652	-12.931	-11.49	1.631	-19.497
	(0.034)	(0.023)	(7.225)	(37.340)	(169.964)	(144.475)	(124.771)
Landholding	0.369***	0.361***	101.112***	456.443***	2,619.484***	2,160.211***	1,824.131***
	(0.025)	(0.024)	(8.423)	(39.195)	(202.611)	(179.670)	(166.549)
Non Hindu household	-0.219***	-0.110***	-43.415***	-190.726***	-981.758***	-790.540***	-586.309***
	(0.040)	(0.024)	(8.564)	(37.854)	(225.407)	(197.268)	(174.952)
Low caste household	-0.046	-0.035*	-24.264***	-87.270**	-570.446***	-483.747***	-471.244***
	(0.032)	(0.019)	(6.397)	(34.847)	(148.469)	(123.300)	(104.570)
Male headed household	0.159***	0.058***	20.140***	60.999**	417.114***	357.395***	160.861
	(0.030)	(0.017)	(5.775)	(29.267)	(146.048)	(124.006)	(104.290)
Household head: Completed Primary Schooling	-0.028	-0.006	-0.845	55.517**	-31.173	-87.309	-17.108
	(0.019)	(0.012)	(4.247)	(23.008)	(102.636)	(89.738)	(79.863)
Constant	0.206***	-0.019	11.853	105.689**	-182.827	-287.901	-235.148
	(0.042)	(0.026)	(8.489)	(46.796)	(214.331)	(181.757)	(157.018)
Treatment Effects							
TRAIL Treatment	0.035	0.044**	9.643	25.855	304.979*	278.223**	179.214
	(0.033)	(0.023)	(6.738)	(44.185)	(170.527)	(142.192)	(124.683)
Mean TRAIL Control 1	0.581	0.266	81.624	436.910	1957.498	1519.558	1080.800
% Effect TRAIL	6.02	16.39	11.81	5.92	15.58	18.31	16.58
GBL Treatment	-0.024	0.003	-5.449	16.790	-188.605	-204.084	-129.374
	(0.044)	(0.031)	(9.768)	(39.016)	(256.021)	(229.475)	(203.585)
Treatment Differences: TRAIL – GBL	0.059	0.041	15.09	9.07	493.58	482.31*	308.59
	(0.055)	(0.038)	(11.90)	(58.90)	(308.09)	(270.53)	(239.30)
Mean GBL Control 1	0.484	0.193	60.848	258.878	1513.138	1252.850	866.288
% Effect GBL	-4.97	1.46	-8.95	6.49	-12.46	-16.29	-14.93
Recommendation/Group Formation Effects							
TRAIL Recommendation	0.087**	0.036*	6.924	82.209**	220.684	138.585	86.299
	(0.035)	(0.022)	(7.105)	(36.323)	(171.621)	(152.051)	(135.914)
GBL Group Formation	0.087**	0.030	7.100	-29.721	177.119	205.714	109.877
	(0.038)	(0.029)	(9.517)	(35.876)	(249.834)	(226.649)	(202.945)
Sample Size	6210	6210	6210	6210	6210	6210	6210

Notes: Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01$, $^{**}: p < 0.05$, $^{*}: p < 0.1$.

Table A-8: Program Impacts: Treatment Effects on Paddy Cultivation

	Cultivate (%) (1)	Land planted (Acres) (2)	Harvested quantity (Kg) (3)	Cost of production (₹) (4)	Revenue (₹) (5)	Value added (₹) (6)	Imputed profit‡ (₹) (7)
TRAIL	-0.034	-0.016	-47.293	-275.251	-390.783	-82.75	-27.327
	(0.025)	(0.026)	(47.688)	(233.848)	(408.812)	(268.409)	(151.034)
TRAIL × Control 1	0.091***	0.015	26.824	87.853	112.528	5.425	-54.62
	(0.029)	(0.022)	(35.814)	(183.485)	(316.830)	(223.642)	(118.265)
TRAIL × Treatment	0.086***	0.051**	49.034	300.108	583.611*	273.215	80.825
	(0.030)	(0.021)	(31.896)	(184.719)	(303.178)	(234.779)	(117.951)
GBL × Control 1	0.04	0.04	153.415**	504.43	485.573	3.818	76.057
	(0.029)	(0.030)	(75.249)	(378.657)	(512.717)	(267.850)	(219.305)
GBL × Treatment	0.039	0.051*	116.894**	429.441	600.05	217.345	-44.305
	(0.031)	(0.029)	(57.721)	(307.952)	(432.811)	(231.699)	(166.892)
Landholding	0.461***	0.894***	1,095.056***	4,936.404***	9,176.493***	4,355.661***	965.438***
	(0.025)	(0.035)	(58.297)	(306.641)	(502.942)	(310.850)	(162.100)
Non Hindu household	-0.093***	0.034	74.091	529.416	653.812	246.985	287.07
	(0.030)	(0.036)	(78.212)	(416.421)	(578.789)	(311.277)	(193.235)
Low caste household	-0.068***	0.013	2.892	-233.103	-29.732	244.56	102.271
	(0.023)	(0.021)	(39.289)	(199.890)	(294.968)	(188.775)	(114.158)
Male headed household	0.203***	0.126***	217.535***	1,007.446***	1,883.556***	857.514***	-65.749
	(0.037)	(0.026)	(39.833)	(186.046)	(335.587)	(197.871)	(77.607)
Household head: Completed Primary Schooling	-0.042**	-0.033*	-78.276**	-59.974	-389.578	-317.842*	166.684**
	(0.017)	(0.019)	(31.112)	(161.223)	(288.158)	(175.847)	(80.034)
Constant	0.420***	0.009	-462.507***	104.135	-666.993	-710.122**	-545.365***
	(0.046)	(0.033)	(62.141)	(278.700)	(499.964)	(319.610)	(175.018)
Treatment Effects							
TRAIL Treatment	-0.005	0.036*	22.210	212.254	471.083*	267.790	135.445
	(0.032)	(0.020)	(30.817)	(178.716)	(280.807)	(241.457)	(131.079)
Mean TRAIL Control 1	0.744	0.470	569.726	2889.838	5398.490	2556.755	93.133
% Effect TRAIL	-0.71	7.66	3.90	7.35	8.73	10.47	145.43
GBL Treatment	-0.001	0.011	-36.521	-74.989	114.480	213.527	-120.362
	(0.039)	(0.029)	(68.446)	(354.916)	(447.467)	(271.907)	(227.270)
Mean GBL Control 1	0.689	0.456	672.894	3225.745	5513.227	2336.837	183.163
% Effect GBL	-0.07	2.39	-5.43	-2.33	2.08	9.14	-65.71
Treatment Differences: TRAIL – GBL	-0.005	0.025	58.73	287.24	356.60	54.26	255.81
	(0.050)	(0.035)	(74.93)	(397.04)	(527.43)	(364.00)	(263.26)
Recommendation/Group Formation Effects							
TRAIL Recommendation	0.091***	0.015	26.824	87.853	112.528	5.425	-54.620
	(0.029)	(0.022)	(35.814)	(183.485)	(316.830)	(223.642)	(118.265)
GBL Group Formation	0.040	0.040	153.415**	504.430	485.573	3.818	76.057
	(0.029)	(0.030)	(75.249)	(378.657)	(512.717)	(267.850)	(219.305)
Sample Size	6210	6210	6210	6210	6210	6210	6210

Notes: Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-9: Program Impacts: Treatment Effects on Vegetable Cultivation

	Cultivate (%) (1)	Land planted (Acres) (2)	Harvested quantity (Kg) (3)	Cost of production (₹) (4)	Revenue (₹) (5)	Value added (₹) (6)	Imputed profit‡ (₹) (7)
TRAIL	0.013	0.003	92.447	87.622	257.174	155.847	174.656
	(0.023)	(0.005)	(58.992)	(103.217)	(432.459)	(332.506)	(268.585)
TRAIL × Control 1	-0.014	-0.004	-38.028	-71.467	-26.997	52.419	35.741
	(0.016)	(0.003)	(34.800)	(71.290)	(236.179)	(174.366)	(144.961)
TRAIL × Treatment	-0.013	0.007	-10.403	9.881	110.163	104.37	25.055
	(0.018)	(0.007)	(54.886)	(108.466)	(407.183)	(310.625)	(243.261)
GBL × Control 1	0.043	0.009	75.01	173.209	819.137	631.206	537.885
	(0.032)	(0.008)	(56.237)	(167.108)	(819.597)	(642.212)	(562.809)
GBL × Treatment	0.054**	0.009**	76.132**	195.138**	511.006*	307.802	141.274
	(0.021)	(0.004)	(31.890)	(87.212)	(278.071)	(210.586)	(164.347)
Landholding	0.046***	0.015***	160.812**	194.991**	1,220.125***	1,007.720***	834.731***
	(0.016)	(0.005)	(62.363)	(80.159)	(381.881)	(305.442)	(267.465)
Non Hindu household	-0.088***	-0.019***	-212.183***	-378.125***	-1,870.716***	-1,468.966***	-1,169.962***
	(0.025)	(0.006)	(61.072)	(115.947)	(480.626)	(371.842)	(303.036)
Low caste household	-0.067***	-0.014***	-171.913***	-354.617***	-1,648.337***	-1,273.133***	-1,059.710***
	(0.024)	(0.005)	(51.936)	(102.421)	(453.177)	(352.217)	(287.474)
Male headed household	0.065***	0.012***	75.320***	265.743***	641.904***	367.626**	207.3
	(0.013)	(0.003)	(26.894)	(52.538)	(217.433)	(169.123)	(133.128)
Household head: Completed Primary Schooling	-0.021**	-0.005	-60.686**	-101.688**	-511.050***	-402.102***	-280.270**
	(0.010)	(0.003)	(28.471)	(47.914)	(189.477)	(149.930)	(134.469)
Constant	0.036*	0.003	-15.724	55.99	139.705	90.951	43.941
	(0.020)	(0.005)	(46.817)	(83.638)	(324.532)	(251.147)	(206.444)
Treatment Effects							
TRAIL Treatment	0.000	0.011	27.625	81.348	137.159	51.952	-10.686
	(0.021)	(0.007)	(45.780)	(106.058)	(418.599)	(321.736)	(236.536)
Mean TRAIL Control 1	0.080	0.015	142.823	307.071	1207.642	889.229	664.507
% Effect TRAIL	0.33	72.13	19.34	26.49	11.36	5.84	-1.61
GBL Treatment	0.010	0.000	1.122	21.929	-308.131	-323.404	-396.611
	(0.036)	(0.009)	(61.427)	(180.672)	(862.988)	(676.455)	(582.580)
Mean GBL Control 1	0.112	0.022	135.893	404.919	1564.029	1142.350	853.062
% Effect GBL	9.08	0.80	0.83	5.42	-19.70	-28.31	-46.49
Treatment Differences: TRAIL – GBL	-0.010	0.010	26.50	59.42	445.29	375.36	385.93
	(0.042)	(0.011)	(76.25)	(209.48)	(961.29)	(750.97)	(630.85)
Recommendation/Group Formation Effects							
TRAIL Recommendation	-0.014	-0.004	-38.028	-71.467	-26.997	52.419	35.741
	(0.016)	(0.003)	(34.800)	(71.290)	(236.179)	(174.366)	(144.961)
GBL Group Formation	0.043	0.009	75.010	173.209	819.137	631.206	537.885
	(0.032)	(0.008)	(56.237)	(167.108)	(819.597)	(642.212)	(562.809)
Sample Size	6210	6210	6210	6210	6210	6210	6210

Notes: Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. ‡: Imputed profit = Value Added – shadow cost of labour. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Table A-10: Program Impacts: Treatment Effects on Aggregate Farm Value-Added and Non Agricultural Incomes

	Farm value added ₹ (1)	Non-Agricultural Income ₹ (2)
TRAIL	-202.309	1,167.37
	(732.455)	(4,619.439)
TRAIL × Control 1	251.979	-11,159.343***
	(759.580)	(3,686.649)
TRAIL × Treatment	2,491.269***	-11,767.343***
	(701.316)	(4,211.561)
GBL × Control 1	698.882	-4,744.83
	(1,076.983)	(5,088.544)
GBL × Treatment	593.686	-10,837.461**
	(715.426)	(4,600.405)
Landholding	17,984.694***	3,415.37
	(912.779)	(5,374.352)
Non Hindu household	-4,131.823***	5,675.42
	(884.600)	(4,559.521)
Low caste household	-2,593.192***	1,324.12
	(561.517)	(3,610.341)
Male headed household	2,734.915***	-4,912.29
	(819.115)	(10,315.913)
Household head completed primary schooling	-1,050.253**	-260.836
	(491.638)	(3,031.750)
Constant	-1,739.989*	45,738.771***
	(1,038.455)	(8,109.731)
Treatment Effects		
TRAIL Treatment	2239.29***	-608.00
	(717.75)	(4153.56)
Mean TRAIL Control 1	10142.06	40115.81
% Effect TRAIL	22.1	-1.5
GBL Treatment	-105.20	-6092.63
	(1037.82)	(4959.88)
Mean GBL	9387.58	45645.10
% Effect GBL	-1.1	-13.3
Treatment differences: TRAIL – GBL	2344.49*	5484.63
	(1264.26)	(6413.48)
Recommendation/Group Formation Effects		
TRAIL Recommendation	251.98	-11159.34***
	(759.58)	(3686.65)
GBL Group Formation	698.88	-4744.83
	(1076.98)	(5088.54)
Sample Size	6,204	6,210

Notes:
Treatment effects are computed from regressions that follow equation (30) in the text and are run on household-year level data for all sample households with at most 1.5 acres of land. % Effect: Treatment effect as a percentage of the Mean of Control 1 group. Regressions also control for a set of year dummies and an information village dummy. Standard errors in parentheses are clustered at the hamlet level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.