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

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Abstract

We conduct a field experiment where small farmers in West Bengal received microloans designed to finance the cultivation of potatoes, a high-value and risky cash crop. The loans had durations that matched crop cycles, below-average interest rates, dynamic borrower repayment incentives and crop index insurance. In one design (TRAIL), a local trader-lender was incentivized to recommend borrowers to the lender, who then offered individual liability loans to a random subset of those recommended. In the other approach (GBL), the lender offered joint liability loans to self-formed groups of five borrowers, with mandated high frequency group meetings and savings targets. TRAIL loans induced borrowers to expand potato cultivation and farm incomes by 20-30%, whereas there were insignificant effects for GBL loans. This was because TRAIL borrowers were more productive and lower-risk. The TRAIL scheme had higher repayment and take-up rates than GBL, but significantly lower administrative costs.

Key words: Agricultural Finance, Agent Based Lending, Group Lending, Selection, Repayment

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1 Introduction

A major challenge in development policy is finding ways to finance the agricultural needs of poor farmers. Institutional finance is typically available only to those with enough assets to post as collateral. The difficulty of selecting creditworthy borrowers and enforcing repayments on unsecured loans results in the majority of the rural population in most developing countries being excluded from the formal financial sector. In turn this restricts growth in agricultural production and prevents poor farming households from diversifying into high value cash crops (Feder, 1985, Armendáriz and Morduch, 2005).

Microcredit has filled this chasm to some extent, but due to its requirements of high repayment frequency and low tolerance for risk, has not financed the productive needs of poor borrowers successfully. Recent evaluations of microcredit indicate that rather than increasing entrepreneurship or borrower incomes, its principal role has been to allow consumption smoothing and the purchase of consumer durables (Morduch, 1998, Banerjee, Duflo, Glennerster, and Kinnan, 2011, Banerjee, 2013).

This paper investigates a new mechanism (called Trader Agent Intermediated Lending, or TRAIL) for selecting farmers with low landholdings to receive unsecured individual-liability loans to finance agricultural working capital. In contrast to standard microcredit, these loans have durations which match crop cycles, and repayment amounts are index-insured against yield and price risk in the major cash crop. The interest rate is set below the average interest rates on loans from informal lenders. Local intermediaries embedded in the local community, who have extensive experience and knowledge about the creditworthiness of local farmers are appointed as *agents* and are asked to recommend borrowers to the lender. They are incentivized through commissions that depend on the loan repayments of the borrowers. Borrowers are induced to repay by conditioning their future credit access on current loan repayments.

Through a field experiment conducted in 48 villages in two districts of West Bengal, India during 2010-12, we assess the performance of the TRAIL scheme. We focus on potato-growing districts, since potatoes are the leading cash crop in West Bengal. Shree Sanchari, a Kolkata-based microfinance institution offered TRAIL loans at an annual interest rate of 18% (compared to 25% average rates charged by informal lenders), with a duration of 4 months. Successful repayment would render a borrower eligible for another TRAIL loan in a future lending cycle equal to 133% of the current loan repaid. The lender paid agents 75% of the interest received from their recommended borrowers as commission.

Since loans were offered to a randomly-selected subset of the borrowers recommended by the agent, we compare outcomes between the treated borrowers and those who were recommended but were unlucky in the lottery and did not receive the loans. This allows us to estimate the average treatment effect of the TRAIL loans, uncontaminated by endogenous selection.

We compare the impacts of the TRAIL scheme with those of a Group Based Lending (GBL) scheme, where selection and enforcement were induced through a mechanism similar to that used in traditional microcredit. Borrowers self-selected into groups that met with an official of the MFI twice every month and fulfilled savings targets, before becoming eligible to receive joint-liability loans. All other features of the loans such as interest rate, duration, index insurance and the eligibility for future credit access were the same in two schemes. We develop a theoretical model to analyze the patterns of borrower selection in both alternatives, as well as their impacts on cultivation, output and agricultural incomes. The predictions of the model are tested with data from loan records as well as detailed household surveys collected every four months from a sample of households in the study villages.

Our theoretical model is one of segmented credit markets within each village, where borrowers are classified into two categories: *connected* and *floating*. Connected borrowers are in turn partitioned into different networks: each network consists of lenders and borrowers who behave in a cooperative fashion to maximize the aggregate payoffs of network members, and share useful production and marketing information that raises farm productivity. This cooperative behavior could be the result of close social and economic relationships, or altruism within networks. Every lender belongs to some network. Floating borrowers do not belong to any network, and do not have access to network benefits. The credit relationships across networks or between lenders and floating borrowers is characterized by non-cooperative behavior, because of the lack of altruism and close social links. Partly for this reason, and partly due to higher default risks (networked borrowers are more productive than floating borrowers), floating borrowers pay higher interest rates in the informal market.

The predictions of this model are similar to related models of segmented credit markets based on non-cooperative behavior and informational or enforcement frictions (as explained in the online Appendix). A lender appointed as a TRAIL agent is motivated to recommend borrowers from his own network. This is due both to cooperation within networks, and the incentives generated by the repayment-based commissions. This reduces the likelihood of the networked borrowers defaulting. In contrast, in the GBL scheme, floating borrowers are not excluded: all borrowers whose opportunity cost of the time spent attending group meetings, and cost of meeting savings requirements are small enough, will form groups and apply for loans. Thus GBL groups may consist of connected or floating borrowers, or both. Floating borrowers in the GBL scheme do not have the network benefits. As a result the pool of GBL borrowers is likely to have lower average productivity and repayment rates than the pool of TRAIL borrowers.

Since connected borrowers are more productive, the same drop in interest rates causes TRAIL borrowers to expand production and borrowing by more, and achieve higher income increases than GBL borrowers. This effect is reinforced by the cooperation between the TRAIL borrowers and the agent, since a larger scale of borrowing generates higher agent commissions, which are internalized by borrowers. In contrast, the joint liability feature in GBL raises the effective cost of credit, and peer pressure from group members discourages borrowers from expanding the scale of borrowing and taking risk. Hence the TRAIL scheme is predicted to lead to higher borrowing, greater production of high value cash crops and higher farm incomes than the GBL scheme.[1]

The experiment was carried out in two districts in the potato-growing belt of the state of West Bengal in India. Potatoes generate substantially higher value added and farm income per acre than the major alternatives: paddy and sesame. However they also involve higher working capital requirements to pay for expensive inputs. The loans were timed to match the production and marketing cycles of potatoes, and index insurance was provided against fluctuations in potato yield and prices in the localized area. Hence our expectation is that access to cheaper credit would induce farmers to expand production of potatoes in particular.

In line with the predictions of the model, we find evidence that the TRAIL scheme induced a (quantitatively and statistically) significant increase in levels of borrowing, acreage devoted to potatoes, and farm incomes. The effects of the GBL scheme were substantially smaller, and mostly statistically insignificant. The evidence also supports the main channels suggested by the theory. TRAIL agents were significantly more likely to recommend safe in-network borrowers, i.e., persons who had borrowed from them in the past, belonged to the same caste network, and who were charged below-average interest rates on the informal market. In contrast, GBL applicants paid above-average interest rates on informal loans. Intent-to-treat estimates of the rate of return in potatoes and total farm income for TRAIL borrowers ranged from 70 to 115% and were statistically significant; in contrast the corresponding point estimates were 37-38% or lower for GBL borrowers and were statistically insignificant.

With regard to loan repayments and take-up, the TRAIL scheme exhibited superior performance as well. The average TRAIL repayment rate at the end of two years was 98%, compared to 91% in GBL. The higher loan take-up rates and larger effects on farm incomes indicate that TRAIL borrowers benefitted more from the scheme than GBL borrowers did.[2] Moreover, we found no evidence that agents extracted the benefits of TRAIL borrowers by manipulating prices or quantities. Nor is there evidence that the agent helped TRAIL borrowers by lowering their interest rates, lowering input prices or raising output prices. Finally, the lender incurred substantially lower administrative costs to implement the TRAIL scheme than GBL, because there were no group meetings, which reduced personnel costs. This resulted in considerable cost savings for the MFI.

These results indicate that the TRAIL scheme successfully harnessed local network rela-

[1] Models of segmented credit markets based on non-cooperative behavior predict similar selection patterns, because of the incentives of the TRAIL agent induced by repayment-based commissions. To the extent that TRAIL borrowers are more productive than GBL borrowers, the same drop in the cost of credit expands their scale of cultivation and farm incomes by more. This expansion is accentuated when the TRAIL borrowers and agent cooperate.

[2] However, because the GBL estimates are imprecise, some of these differences are not statistically significant.

tionships between loan agents and borrowers to create a "win-win" situation where both borrowers and agents benefitted, while generating high loan take-up, high repayment rates and lower administrative costs. In contrast, the GBL scheme attracted borrowers of lower average (and more dispersed) quality, who were less motivated to expand cultivation and to bear risk, resulting in impacts that were lower on average and more dispersed. It does not appear that this is the result of lower risk-taking by GBL borrowers due to the joint liability tax: GBL borrowers also expanded area under potato cultivation, but their output did not increase significantly. This is consistent with the hypothesis that productivity differences drive the differential effects, though we cannot rule out competing explanations based on superior effort incentives in TRAIL owing to higher powered incentives inherent in individual liability loans.

Our paper contributes to the policy debate on ways to promote financial inclusion of the rural poor in the developing world. Various countries have attempted to expand financial services in rural areas by employing local agents, but with limited success.[3] Research suggests that these programs often fail because agents can collude and extract rents from the customers (Floro and Ray, 1997). Instead, we demonstrate that it is possible to design an agent-intermediated lending scheme in a manner that limits the possibility of collusion.[4] In the TRAIL scheme, agents can only recommend households that own less than a predetermined threshold of land. All loan transactions take place between the lender and the borrower and the agent has no control over funds. Only a random subset of households recommended are selected to receive the loan, which also limits the benefit to borrowers of making side-payments to the agent in return for a recommendation. These restrictions limit the avenues through which the agent could extract surplus from the recommended borrowers. We also do not find any evidence of extraction in our experimental sample.[5]

The paper is organized as follows. Section 2 explains the experimental design and data, followed by Section 3 which presents the theoretical model. Section 4 contains the main empirical results, followed by robustness checks and sensitivity analysis in Section 5. Section 6 concludes.

[3] Agents have been employed to intermediate financial services in Thailand (Onchan, 1992), Philippines (Floro and Ray, 1997), Bangladesh (Maloney and Ahmad, 1988), Malaysia (Wells, 1978) and Indonesia (Fuentes, 1996).

[4] A large literature in contract theory discusses the role of middlemen and managers in contexts with asymmetric information. See Melumad, Mookherjee, and Reichelstein (1995), Laffont and Martimort (1998, 2000), Faure-Grimaud, Laffont, and Martimort (2003), Mookherjee and Tsumagari (2004), Celik (2009), Motta (2011). It has been shown that the problems associated with a delegation of discretionary power to an informed third party can be limited by constructing appropriate incentive schemes and constraining the extent of discretion that middlemen are allowed.

[5] The TRAIL scheme is related to a lending approach that India's central bank has been promoting recently, where "banking facilitators" are recruited from within the local communities to help with borrower selection as well as monitoring of borrowers on behalf of formal banks (Srinivasan, 2008). To the best of our knowledge no rigorous evaluation of that approach has been carried out so far; the knowledge generated in this study could inform policymakers and central bank officials involved in the design of that scheme.

2 Experimental Design and Data

We collaborated with Shree Sanchari, a microfinance institution based in Kolkata, to conduct a field experiment in two districts Hugli and West Medinipur in the state of West Bengal, India. These two districts grow some of the largest quantities of potatoes in West Bengal. The state itself produces about a third of all potatoes grown in India. In October 2010 Shree Sanchari introduced the TRAIL scheme in 24 randomly selected villages, and the GBL scheme in a separate set of 24 villages. To minimize spillovers, the experimental design ensured that each TRAIL village was at least 8 kilometers away from a GBL village. Prior to this project, Shree Sanchari had not operated in any of these villages.[6]

In both schemes, Shree Sanchari offered borrowers multiple cycles of loans of 4-month durations at an annual interest rate of 18%. The first cycle loans were capped at Rupees 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 lump sum in the potato harvest season. Upon full repayment, the borrower became eligible for a new loan which was 33 percent larger than the first, for another 4-month duration and at the same interest rate. In this way in each subsequent cycle successful borrowers became eligible for a 33 percent increase in loan size, with all other loan terms remaining unchanged. Those who repaid less than 50 percent of the repayment due were not allowed to borrow again. Those who repaid less than the full but more than 50 percent of the repayment amount were eligible to borrow 133 percent of the principal repaid. To facilitate credit access for post-harvest storage, borrowers were allowed to repay the loan in the form of potato "bonds" rather than cash, in which case the amount repaid was calculated at the prevailing price of potato bonds.[7] Both schemes had an in-built index insurance scheme – the required repayment would be revised downwards if revenue per acre for potatoes fell 25 percent below a three year average in the village (as assessed through a separate village survey). While Shree Sanchari told borrowers that these were agricultural loans, and the terms of the loans implicitly encouraged borrowers to use them for agriculture, borrowers were not required to report to Shree Sanchari the intended or actual use of the loan.[8]

[6] In another 24 villages, Shree Sanchari implemented an alternative version of the agent intermediated lending scheme called GRAIL, where the agent was recommended by the village council or *Gram Panchayat*. Borrower selection and impacts of the GRAIL scheme will be analysed in future research. Sixty-eight of the total of 72 villages were also part of a sample drawn for a previous project conducted by a subset of the current authors (see Mitra, Mookherjee, Torero, and Visaria, 2013).

[7] When potatoes are placed in cold storage, the storage facility issues receipts, also known as "bonds". These are traded by farmers and traders.

[8] However in our household surveys we did ask respondents to tell us the actual purpose of each loan they reported having taken.

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

In the TRAIL villages, officials from Shree Sanchari consulted with prominent persons in the village to draw up a list of traders/business people who had at least 50 clients in the village, and had been in business in the village for at least three years. One person from the list was randomly chosen and offered the opportunity to become an agent.[9] The agent was asked to recommend 30 village residents who owned no more than 1.5 acres of agricultural land, as potential borrowers. Our project officer and an official from Shree Sanchari conducted a lottery in the presence of village leaders to select 10 out of these 30 individuals who were then offered the loan. Loan officers visited these randomly chosen individuals in their homes to explain the loan terms and disburse the loan if they accepted the offer.

At the beginning of cycle 1, for each loan given to borrowers whom he recommended, the agent was required to deposit Rs 50 with Shree Sanchari. At the end of each loan cycle he received as commission 75% of the interest received on these loans. The deposit was refunded to the agent at the end of two years, in proportion to the loan repayment rates of his recommended borrowers. Agents were told their contract would be terminated at the end of any cycle in which 50% of their recommended borrowers failed to repay. Agents were also promised an in-kind reward of an expenses-paid holiday at a local sea-side resort if they survived in the program for two years.

2.2 The Group-based Lending (GBL) Scheme

In the GBL villages, Shree Sanchari initiated operations in February/March 2010 by inviting residents to form 5-member groups, and then organizing bi-monthly meetings for all groups in the presence of Shree Sanchari loan officers, where they made regular savings deposits at the rate of Rupees 50 per member per month. 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 Rupees 2,000 in Cycle 1, for a total of Rupees 10,000 for the entire group, with a four-month duration, payable in a single lump sum. All group members shared liability for the entire Rupees 10,000: if less than the full amount due was repaid in any cycle, all members were disqualified from future loans; if the loans were fully repaid 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 standard protocol that is used by Shree Sanchari. To cover their administrative costs Shree Sanchari retained 75% of the interest received.

[9]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. Shree Sanchari officials would go down the list in this manner until the position was filled. In practice, the first person offered the position accepted it in every village.

2.3 Data and Descriptive Statistics

Starting in December 2010, we collected household survey data from 50 households in each village at four-month intervals. This included information 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, with reference periods of four months. The household sample was chosen as follows. In each village sample we included all 10 Treatment households: households that both were recommended for loans/formed groups (in TRAIL/GBL villages, respectively) and also were randomly selected to receive loans. We also included 10 Control 1 households: chosen randomly from those that were recommended/formed groups (in TRAIL/GBL respectively) but were *not* selected to receive loans. Finally, we included 30 households that were not recommended/did not form groups. These were chosen by first, purposively selecting households to ensure that all 24 sample households from the Mitra, Mookherjee, Torero, and Visaria (2013) study were included, and next, filling any remaining additional sample slots through a random draw of non-recommended/non-selected households from the village.[10]

Table 1 provides descriptive statistics pertaining to TRAIL and GBL villages. Panel A shows there were no significant differences in village characteristics across the two treatment groups. Household characteristics are described in Panel B. These statistics are computed for the restricted sample of 24 households per village that were included in the original sample drawn for the Mitra, Mookherjee, Torero, and Visaria (2013) study.[11] For most characteristics, there are only minor differences across the two treatment groups. However GBL households were more likely to be Hindu, had slightly larger household sizes, were more likely to have received government transfers and were more likely to have purchased agricultural inputs on credit during Cycle 1. However, as the F-statistic shows, we cannot reject the joint hypothesis that these characteristics are similar on average across the two treatment groups.

Table 2 describes credit market transactions that took place during September – December 2010 in all sample households that owned less than 1.5 acres of land. Since this was the planting season for potatoes, which are the crop with the highest working capital requirements in this region, these data provide a picture of the main sources of agricultural credit, and characteristics of the loans. The sample households self-reported all borrowing,

[10]The 24 households in the Mitra, Mookherjee, Torero, and Visaria (2013) study were a stratified (by land-size) random sample of all households that had cultivated potatoes in the year 2007.

[11]We do this for the following reason. It is unlikely that our full sample of 50 households per village would be balanced across treatment groups, as both Treatment and Control 1 households were systematically selected into the sample by virtue of being recommended by the agent (TRAIL villages)/joining a group (GBL villages). In contrast, Control 2 households were selected by virtue of not being recommended, and form an unknown proportion of the population of households that the agent would not have wanted to recommend. Thus it is unclear how to re-weight these two groups to arrive at a representative sample of village households. Restricting attention to the stratified random sample drawn before the lending schemes were introduced side-steps this problem.

regardless of source or loan purpose. We present here data on all borrowing and borrowing for agricultural purposes.[12] Note first that nearly 70 percent of sample households borrowed in this 4-month period. Informal lenders (traders and moneylenders) provided two-third of all agricultural credit and thus were the single most important lender category. We also find that credit cooperatives provided about a quarter of the agricultural credit, but a closer look at the data show that it is the households with larger landholdings who borrow more from credit cooperatives. Presumably this is because they require that the borrower posts collateral: nearly three quarters of their loans were collateralized.[13]

The average interest rate on loans from informal lenders is 26%, substantially above the rate that Shree Sanchari charged on the TRAIL and GBL loans. The average duration of informal loans is 4 months, similar to TRAIL and GBL loans. Only 1% of informal loans are secured by collateral. Cooperatives and government banks charge substantially lower interest rates and have longer average durations, but are much more likely to be collateralized, again pointing to the fact that they are less likely to be available to households with low levels of assets.

Table 3 describes the mean characteristics of the major categories of crops grown by sample farmers in 2011 and 2012. Paddy is grown twice or thrice a year, and in both years, farmers planted on average 0.70 acres of land with paddy. Potatoes and sesame are both winter crops planted only once a year, and the average farmer planted each on about similar quantities of land: potatoes on 0.48 acres and sesame on 0.43 acres. A large range of vegetables such as cauliflower, cabbage, gourd, chillies and lentils are grown year-round on small patches, accounting for an acreage of 0.20 over the year. As the table shows, potato cultivation involves large investment during cultivation: the annual cultivation cost for potatoes was just about Rs 10,000 in both years. However the revenues and value added earned from potato cultivation was also considerably higher than that earned from sesame, paddy or vegetables. These figures make it clear that potatoes have high working capital needs, and are also the major source of high farm income in these villages. We also see that crop prices can vary considerably from year to year. Price fluctuations are an important source of the risk involved in agriculture. Potato prices especially can be very variable: Mitra, Mookherjee, Torero, and Visaria (2013) report that the average farmgate price of potatoes was Rs 3.84 in 2007, and Rs 2.35 in 2008, considerably lower than the Rs 4.61 and Rs 5.51 in 2011 and 2012 respectively. Our sample period was a period of relatively high potato prices.

[12] Importantly, the data also include information on trade credit from input suppliers. Since we collected detailed data on input purchases, we are able to cross-check that all inputs purchased on credit are counted as loans.

[13] In statistics not presented here, we find that informal lenders become a progressively more important source of agricultural credit as household landholding decreases from 1.5 acres to zero. Landless households received 87% of their agricultural credit from informal lenders, and only 6% from cooperatives.

3 Theoretical Model

As explained in Section 1, we use a model of segmented informal credit markets, which abstracts from standard adverse selection or moral hazard, and instead assumes cooperative behavior within borrower-lender networks, and noncooperative behavior among players from different networks. Our model is motivated by the dense social and economic agent-borrower relationships described in a field study of a sub-sample of these villages and documented in Ah-Tye, Bai, Blanco, Pheiffer, and Winata (2013). Agent and borrowers interact in credit, and insurance markets, and agents also provide borrowers with advice on production, input-sourcing and marketing matters. This cooperative behavior may be the result of repeated interaction among non-cooperative agents (a la the Folk Theorem), or may be due to altruism within networks. Similar results can be obtained using more standard (non-cooperative) formulations of credit markets, but involving adverse selection and moral hazard, as in Ghatak (2000) and Besley and Coate (1995). Details of such formulations are provided in Appendix A-1.

Our model is silent on how the payoffs earned by the network are distributed among its members. Payoff vectors where the lion's share from the benefits of cooperation accrue to a few members (e.g., lenders rather than borrowers) are also possible in the model. In practice however, the TRAIL scheme was designed to limit such "extraction" by agents: agents were responsible for recommending borrowers at the beginning of the scheme, but not for loan disbursal or collection of repayment, recommendations could not be modified after they had been made, households with more than 1.5 acres of cultivable land were ineligible to be recommended, and only a random sub-set of recommended borrowers were selected to receive loans. All of these features would limit the extent to which borrowers and agents could enter side-contracts that might siphon off the benefits accruing to borrowers. In the empirical analysis we also test for, but do not find, evidence of extraction by the agent through manipulation of credit, input or output contracts.

3.1 Informal Credit Market, pre-MFI

The village is partitioned into a number of networks, and a set of *floating* borrowers. Each network has some lenders and *connected* borrowers who are knit together into a group with close economic and social ties. Each network behaves in a cooperative fashion, in the sense that decisions are made by network members to maximize the aggregate payoff of all within-network members. Floating borrowers operate in isolation and behave non-cooperatively, to maximize their own payoffs. Members of two different networks play non-cooperatively when they participate in some transaction. Hence lenders from different networks compete in offering credit to the floaters, *a la* Bertrand in the informal market.

Network members help each other with production and business matters, whereas floaters do not receive any help. Foster and Rosenzweig (1996), Bandiera and Rasul (2006), Conley and Udry (2010) have provided evidence that farmers learn from others in the same social network. As a result connected borrowers' projects succeed with a higher probability (p_c) than the floaters' projects do (p_f). In particular, we assume that $p_f(2 - p_f) < p_c$.[14]

All lenders face a cost of capital ρ_I, and are unconstrained in terms of lending capacity. The connected and floating borrowers have production functions $f_C(l)$ and $f_F(l)$ respectively. It is assumed that the help received from the network makes connected borrowers more productive, i.e. $f_C'(l) \geq f_F'(l), \forall l$. The production functions are strictly increasing, strictly concave, twice-differentiable function of loan size l satisfying Inada conditions.

Loans are needed to purchase a variable input whose price is normalized to 1. We abstract from moral hazard in loan repayments, and assume that loans are always repaid when the borrower's project succeeds. This is true for both floating and connected borrowers.[15] Borrowers have limited liability: when the project fails, they do not repay.

Since all networks have identical costs of capital and there are no capacity constraints, there is no gain from borrowing or lending across networks.[16] Each connected borrower obtains a loan from within his own network, and the network makes a cooperative choice of the loan size of each own-network borrower. Hence a connected borrower selects a loan size $l_I^c = \text{argmax}_{l \geq 0}\{p_c f_C(l) - \rho_I l\} \equiv p_c \Pi_C(\frac{\rho_I}{p_c})$ where $\Pi_C(r)$ denotes the maximized value of $f_C(l) - rl$, and r is the *effective cost of credit (ECC)*.

Lenders from different networks compete with one another to lend to floating borrowers *a la* Bertrand. Thus floaters obtain credit at the competitive rate $\frac{\rho_I}{p_f}$ at which lenders break even on average. A floating borrower selects a loan size $l_I^f = \text{argmax}_{l \geq 0}\{p_f f_F(l) - \rho_I l\} \equiv p_f \Pi_F(\frac{\rho_I}{p_f})$. Since the effective cost of credit for floating borrowers is higher, they select smaller loan sizes: $l_I^f < l_I^c$.

3.2 Agent-Intermediated Lending: TRAIL

Now consider the introduction of the TRAIL scheme into this credit market. A single network lender is chosen randomly to be the agent for the scheme. He recommends a set of borrowers, of whom a randomly chosen subset is offered TRAIL loans at the interest rate r_T. The agent stands to receive a fixed fraction $K \in (0, 1)$ of the interest payment made by the borrower. We assume $r_T < \rho_I$.

[14] This assumption affects only the comparison between repayment rates in the TRAIL and GBL schemes. If it were not true, repayment rates would always be higher in GBL.

[15] The results extend when floating borrowers are allowed to default strategically, provided this default rate d is smaller than the TRAIL commission rate K.

[16] If p_c is always constant regardless of whether the loan is given by a own-network lender or an other-network lender, then lenders are indifferent between lending within our outside their network, and so we assume they lend within the network. If instead p_c is lower when the lender belongs to another network, then clearly the lender prefers to lend within his network.

Suppose initially there is no collusion, in the sense that the borrowers cannot/do not bribe the agent in exchange for recommending them. Whom will a network lender recommend for a TRAIL loan? If he selects an own-network borrower, this borrower will select the loan size that maximizes the network's aggregate profit: $l^c_T = \text{argmax}_{l\geq 0}\{p_c f_C(l) - (1-K)p_c r_T l\} \equiv p_c\Pi_C((1-K)r_T)$. Clearly, the ECC has decreased from $\frac{\rho_I}{p_c}$ in the pre-intervention regime to $(1-K)r_T < \rho_I$ under the TRAIL scheme, and so $l^c_T > l^c_I$. If a floating borrower is recommended and offered the loan, he will non-cooperatively select the loan size that maximizes his own payoff: $l^f_T = \text{argmax}_{l\geq 0}\{p_f f_F(l) - p_f r_T l\} \equiv p_f\Pi_F(r_T)$. The ECC is r_T, so the loan size is higher than in the informal market, but smaller than for a connected borrower in TRAIL. The network lender will earn an expected commission of $Kp_f r_T l^f_T$. The gain from recommending a floating borrower is $Kp_f r_T l^f_T$, and from recommending a borrower from another network is $Kp_c r_T l^f_T$.[17] Recommending a borrower from a different network therefore dominates recommending a floating borrower because the help that the borrower receives from his network ensures that he repays with a higher probability, which in turn implies a higher expected commission for the agent.

Now examine the agent's incentive to recommend an own-network borrower, rather than a connected borrower from another network. The former option dominates since

$$p_c[\Pi_C((1-K)r_T) - \Pi_C(\frac{\rho_I}{p_c})] \geq Kp_c r_T l^f_T + p_c[\Pi_C(r_T) - \Pi_C(\frac{\rho_I}{p_c})] \geq Kp_c r_T l^f_T$$

Here the first inequality follows from $\Pi_C((1-K)r_T) \geq Kr_T l^f_T + \Pi_C(r_T)$ (as the agent internalizes the increased profits from a lower ECC for a within-network borrower), and the second inequality follows from $r_T < \rho_I < \frac{\rho_I}{p_c}$ (the network borrower in turn internalizes the commissions earned by the agent).

Now suppose borrowers could bribe the agent in return for being recommended. Given that the agent is already cooperating fully with own-network borrowers, only the returns from recommending out-of-network borrowers is affected. If the agent has absolute bargaining power, he can extract at most all the increased profits that other-network borrowers would earn. In that case, he would earn the same benefit from selecting an other-network borrower as from an own-network borrower.[18] If the agent's bargaining power is any lower he would clearly prefer to select the own-network borrower.

With regard to floating borrowers, the most a network lender can extract is all their profit gains, thus earning a net benefit of $Kp_f r_T l^f_T + p_f[\Pi_F(r_T) - \Pi_F(\frac{\rho_I}{p_f})]$. Consider the function $Q(p) \equiv Kpr_T l^*(r_T) + p[\Pi_F(r_T) - \Pi_F(\frac{\rho_I}{p})]$ where $l^*(r_T)$ denotes the maximizer of $f_F(l) - r_T l$. Notice that by the Envelope Theorem $\frac{\partial \Pi_F}{\partial p}(\frac{\rho_I}{p}) = \frac{\rho_I}{p^2}l^*(\frac{\rho_I}{p})$. Moreover, $\Pi_F(r_T) - \Pi_F(\frac{\rho_I}{p}) \geq$

[17]By assumption, a borrower from another network will not internalize the profits earned by the agent. Hence such a borrower will select the same loan size l^f_T as a floating borrower. Note we are assuming here that a borrower from a different network will be just as productive as a borrower from the same network. If instead he is less productive, the agent's preference tilts further in favor of an own-network borrower.

[18]The agent could make a take-it-or-leave-it offer to an other-network borrower, stipulating the size of the loan as well as the bribe. Thus the agent would receive the entire benefit that accrued to this borrower and thus earn the same payoff as he would get from recommending an own-network borrower.

$[\frac{\rho_I}{p} - r_T]l^*(\frac{\rho_I}{p})$. Hence

$$\begin{aligned} Q'(p) &= Kr_T l^*(r_T) + [\Pi_F(r_T) - \Pi_F(\frac{\rho_I}{p})] - \frac{\rho_I}{p} l^*(\frac{\rho_I}{p}) \\ &\geq Kr_T l^*(r_T) + [\frac{\rho_I}{p} - r_T]l^*(\frac{\rho_I}{p}) - \frac{\rho_I}{p} l^*(\frac{\rho_I}{p}) = Kr_T l^*(r_T) - r_T l^*(\frac{\rho_I}{p}) \end{aligned}$$

which is positive as long as $K > k^* \equiv [l^*(\frac{\rho_I}{p_c})/l^*(r_T)]$. This implies collusion with a connected borrower dominates collusion with a floating borrower, as long as the commission rate is large enough. We thus obtain

Proposition 1 *If collusion is not allowed, it is optimal for the TRAIL agent to recommend an own-network borrower. Even when collusion is possible, he will still prefer to recommend an own-network borrower, as long as the commission rate K is high enough.*

3.3 Group-based Lending: GBL

To analyze the GBL scheme, we simplify by assuming that groups are of size two as in Besley and Coate (1995). The group is jointly liable to repay the two loans. We abstract from the possibility that the limited liability constraint binds for some landholding sizes. This ensures that even if only one member's project succeeds, both loans can and will be repaid. Borrowers have to attend group meetings and make regular savings to qualify for a group loan. This imposes an additional cost γ_i for a borrower of type $i \in \{c, f\}$.

If two connected borrowers from the same network form a group, both loans will be repaid with probability $p_c(2 - p_c)$, and neither loan will be repaid with the remaining probability $1 - p_c(2 - p_c)$. If two floating borrowers form a group, both loans will be repaid with probability $p_f(2-p_f)$ and neither will be repaid with the remaining probability $1-p_f(2-p_f)$. Our assumption that $p_f(2-p_f) < p_c$ implies (F, F) groups repay at a lower rate than TRAIL borrowers do, whereas (C, C) groups repay at a higher rate.[19]

Compared with individual liability loans, a joint liability loan involves a 'tax' corresponding to the additional repayment burden associated with loans of other group members, should their projects fail. A connected borrower group thus involves an ECC of $r_T + (1 - p_c)r_T = (2-p_c)r_T$ rather than r_T. Hence a (C, C) group will select a loan l_G^C to maximize $p_c[f_C(l) - (2 - p_c)r_T l]$ and attain a per member profit of $p_c\Pi_C((2 - p_c)r_T)$. *The joint liability tax in GBL therefore implies a smaller expansion of borrowing and cultivation scale for connected borrowers, compared with TRAIL.* As for floating borrowers, an (F, F) group will select a loan l_G^f to maximize $p_f f_F(l) - p_f(2 - p_f)r_T l$ and attain a per member profit of $p_f\Pi_F((2 -$

[19]This last result captures the fact that, for a given probability of success and interest rate, GBL repayment rates still dominate those of an individual liability loan because group members have the incentive to repay on behalf of those who are unsuccessful.

$p_f)r_T)$. Since $(2-p_f) > (2-p_c) > 1$, the loan size and scale of cultivation of GBL borrowers will be uniformly smaller than that of TRAIL borrowers.

We do not address the question whether this model will give rise to positive assortative matching, as this depends on the distribution of bargaining power within groups. More importantly, it does not affect comparisons between TRAIL and GBL. Consider the consequences of a mixed group (C, F). With side-payments within the group, (l_c, l_f) would be selected to maximize $p_c f_C(l_c) + p_f f_F(l_f) - [1 - (1 - p_c)(1 - p_f)]r_T(l_c + l_f)$. The ECC for the loan of the connected member of a group would be $[1 + \frac{p_f}{p_c} - p_f]r_T > r_T$, and for a floating member would be $[1 + \frac{p_c}{p_f} - p_c]r_T > r_T$. Hence the average loan size in a mixed (C, F) group would also be smaller than for a TRAIL borrower.

It is unclear whether an (F, F) group or a (C, C) group would benefit more from a GBL loan. For the (F, F) group the decrease in the ECC is from $(2 - p_f)r_T - \frac{\rho_I}{p_f}$ which is larger than the decrease $(2 - p_c)r_T - \frac{\rho_I}{p_c}$ for the (C, C) group, since $\frac{\rho_I}{p} - (2 - p)r_T$ is decreasing in p. However, the profit function is a decreasing convex function of the ECC, so profits rise at a slower rate for the (F, F) group. Therefore we cannot order the gains for the two groups without making additional assumptions.

In what follows, we shall represent GBL borrowers as including both (C, C) and (F, F) groups. This is because both kinds of groups would have an incentive to form and apply for a GBL, as long as the costs of group meetings and savings requirements are small enough that there is still a net advantage of a lower interest burden for both groups. Importantly, *there is no mechanism in GBL to screen out one kind of group in preference to the other.* To simplify the exposition we ignore (C, F) groups hereafter, while noting the qualitative conclusions would be unaltered if they were also present.

The key differences in the selection patterns and cultivation outcomes between the GBL and TRAIL schemes are the following. First, TRAIL has an in-built screening mechanism such that the agent has a preference for selecting connected borrowers from his own network. In contrast GBL borrowers are likely to include both connected and floating borrowers. Therefore, TRAIL agents will select safer, more productive borrowers (who pay lower interest rates on the informal market, and have a higher productivity). Second, the joint liability tax inherent in GBL implies that the effective cost of credit is lower for TRAIL borrowers, so they will borrow and cultivate high-value crops more. These results would obtain even in the presence of non-cooperative behavior within networks. With cooperative behavior resulting from close network ties, the agent and connected borrowers internalize mutual benefits in TRAIL, which generate further increases in borrowing and cultivation scales. These features combine to yield the prediction that TRAIL borrowers will increase borrowing, scale of cultivation of high value cash crops, and farm income by more than GBL borrowers.

The theory does not have a clear prediction for whether repayment rates will be higher in the TRAIL or GBL schemes. On the one hand TRAIL agents tend to select connected borrowers with a higher probability of project success. On the other hand, for any given type of borrower, GBL loans are repaid at higher repayment rates because group members have the incentive to repay on behalf of those who are unsuccessful. Finally, we expect lower take-up of loans in the TRAIL scheme because of the joint liability tax and the burden of attending group meetings and achieving mandated savings targets.

Table 4 summarizes these comparisons of the TRAIL and GBL selection patterns and impacts. Below these predictions will be tested in the data.

4 Empirical Analysis

This study examines two different lending schemes, or mechanisms for delivering microcredit. The schemes differ in how households were selected to become borrowers. Therefore, when estimating and comparing the effects of the loans on borrowers in the two schemes, we account for the fact that households selected in the two schemes may have very different characteristics, not all of which may be observable to us. To do this, we rely on the fact that only a randomly chosen subset of the selected households (households recommended by the agent/that formed groups in TRAIL/GBL villages) were offered the loans. Therefore any differences between households that were recommended but were not offered loans (Control 1 households) and those that were both recommended and offered loans (Treatment households) must be caused by the loans. We call this the "treatment effect". Similarly, we can estimate the "selection effect": the difference between Control 1 households and Control 2 households (those that were not recommended/did not form groups in TRAIL/GBL villages).

In our regression specification below,

$$\begin{aligned} y_i = \beta_0 + \beta_1 \text{TRAIL} + \beta_2(\text{TRAIL} \times \text{Control 1}) + \beta_3(\text{TRAIL} \times \text{Treatment}) \\ + \beta_4(\text{GBL} \times \text{Control 1}) + \beta_5(\text{GBL} \times \text{Treatment}) + \gamma\, \mathbf{X}_i + \varepsilon_i \end{aligned} \tag{1}$$

y_i denotes the outcome variable of interest, the selection effect in the TRAIL scheme is β_2 and in the GBL scheme is β_4, and the treatment effect in the TRAIL scheme is $\beta_3 - \beta_2$ and in the GBL scheme is $\beta_5 - \beta_4$.[20] $\mathbf{X}_i$ includes a set of additional controls including the land owned by the household, a year dummy to control for secular changes over time, and a dummy variable for whether the village received a separate intervention informing residents of the prevailing market prices for potatoes.[21] Standard errors are clustered at the village level to account for spatial correlation in outcomes.

[20] All treatment effects presented in the Tables below correspond to the intent-to-treat estimates as they compare the outcomes for Treatment and Control 1 households as assigned.

[21] This information intervention was undertaken for a separate project examining the effect of delivering information about potato prices to farmers and is similar to the "public information" treatment described in Mitra, Mookherjee, Torero, and Visaria (2013). Villages were assigned to the information treatment randomly and orthogonally to the credit intervention that is the focus of the present paper.

4.1 Treatment Effects on Borrowing, Cultivation and Farm Incomes

Table 5 presents estimates of treatment and selection effects of the main outcomes of interest: borrowing (Panel A), cultivation and farm income from the major cash crop (Panel B) and income from other crops (Panel C). These estimates are computed from regressions according to the specification in equation (1). The full regression results are available in the online Appendix A-2.

4.1.1 Effects on Borrowing

Row 1 in Table 5 presents effects of the TRAIL and GBL schemes on how much households borrow for agricultural purposes. The TRAIL selection effect is estimated to be Rupees 417 but is not statistically significant, suggesting that households recommended by the agent did not borrow significantly different amounts from those not recommended, absent the program (column 6). However the TRAIL treatment caused overall borrowing to increase substantially, by Rs. 7126 (column 4), which represents almost a 100 percent increase over the Rs. 7280 mean borrowing by Control 1 borrowers (column 7). Households that formed groups in the GBL villages also borrowed a similar amount on average to those who did not form groups (column 5) but the program loans caused their borrowing to increase significantly by Rs. 6464 (column 3), which is an 88 percent increase over the mean.[22]

To check if the program loans crowded out loans from other sources, Row 3 in Panel A examines if total borrowing for agricultural purposes through non-program loans decreased as a result of treatment. The treatment effects are small in magnitude and non-significant for both TRAIL and GBL borrowers. This indicates that the program loans given by Shree Sanchari were a net addition to the agricultural borrowing of the treated groups, consistent with the idea that sample households face credit constraints in agriculture.

Row 2 shows effects on the unit cost of borrowing. Note first that consistent with our theoretical prediction that GBL groups include a larger fraction of floating borrowers who pay higher interest rates in the informal market, we find that the selection effect in the GBL scheme is significantly positive: households that formed groups paid on average 4 percentage points higher annually for agricultural credit than those who did not form groups. In contrast the TRAIL selection effect is small and non-significant. Next, we find that for both TRAIL and GBL schemes, the treatment caused the average annual interest rate on agricultural loans to decrease significantly.[23] For TRAIL borrowers the cost of

[22] See Table A-2 in the online Appendix A-2 for the full set of results.

[23] We computed this interest rate using household reports of the principal of each loan, the repayment amount due, and the repayment schedule. Trade credit was also counted as a loan and recorded as such, and included in the total borrowing and used to compute the cost of borrowing. Since we asked detailed questions about input purchases in each cycle, we were able to cross-check that inputs purchased on credit were always accounted for.

credit decreased by 3 percentage points (a 12.5 percent reduction over the control 1 mean), and for GBL borrowers it decreased by 7 percentage points (a 29 percent reduction).

Row 4 shows the treatment had no spill-over effects on the cost of borrowing from non-program sources. This is consistent with the idea that being recommended/forming a group and then receiving a program loan did not change the local information about these households' inherent repayment probabilities, or substantially change these probabilities.

4.1.2 Effects on Cultivation and Farm Incomes

Since the treatment caused total borrowing for agricultural purposes to increase, one expects that it created real effects through increased agricultural activity. Since the loans were designed specifically to make it possible to finance the cultivation of the major cash crop, potatoes, we present first the estimated effects on potato cultivation.[24]

Row 5 of Table 5 shows that households recommended by the TRAIL agents were likelier (by 9.5 percentage points, which is 14 percent of the Control 1 mean of 68%) than average to cultivate potatoes. Receiving the program loans did not change this probability significantly, but it did change the acreage devoted to potatoes by potato cultivators (by 0.09 acres, 20 percent of the control 1 mean, Row 6). About half of this increase in acreage was achieved by leasing in more land (Row 7). TRAIL treatment households also spent more on inputs (Row 8) and produced higher output (treatment effect is 18% of control 1 mean, Row 9). The net effect is an 18% increase in revenue (Row 10) of 18%, and an 18% increase in value-added (Row 11). Value-added is computed by subtracting from revenues only the costs of purchased or rented inputs.[25] Importantly, self-provided inputs are not accounted for, the most important of which is typically family labor. Row 12 shows a small and statistically insignificant increase in family labor hours devoted to potato cultivation. We impute a cost of family labor at the average market wage rate for hired labor in the village (which is an upper bound to the shadow cost of family labor) to obtain an estimate of imputed net profits from potato cultivation. In Row 13, the TRAIL treatment effect is Rs 1676, which is 21% of the control 1 mean. For GBL households, the point estimates suggest that households that formed GBL groups cultivated smaller quantities of potatoes, spent less on inputs and earned lower revenue and value-added (Column 5). However, although the program loans increased these (Column 3) the treatment effects are estimated imprecisely, presumably due to the high variance in the productivity of these households. As a result the average effect is non-significant.

Panel C of Table 5 shows program effects on incomes earned from other main crops (paddy,

[24]See Panel A in Table A-3 in online Appendix A-2 for the full set of results.

[25]For all inputs purchased, we asked the respondent to report both the payment made immediately upon purchase and the amount of trade credit received. The total cost of the input is calculated as the sum of the two. For share-cropped land the household reports to us the share of the harvest that is paid to the landlord. We use this in combination with the harvest quantity and the price at which the harvest was sold to compute the monetary value of this rental payment.

sesame and vegetables). TRAIL loans caused farmers to increase acreage devoted to these crops as well, but although positive, the increases in harvest, revenue or value-added were not significantly different from zero. For GBL borrowers also there is no significant increase in value-added from any of the other crops.

Finally in Row 19 we present the treatment and selection effects on total farm income of the households, aggregating across all crops. Given the large share of potatoes in total cultivation, the positive TRAIL treatment effect on value-added from potatoes leads to a large, positive and statistically significant TRAIL treatment effect on overall farm profits, of the order of 25% over the Control 1 mean. In contrast, GBL shows a negligible and statistically insignificant treatment effect on total farm income.

4.2 Testing Theoretical Assumptions and Predictions

4.2.1 Comparing Productivity of Selected TRAIL and GBL Borrowers

Having estimated the large positive effects of the TRAIL scheme on borrowers' agricultural value-added and incomes, we now examine the mechanisms behind these effects. First, we test the prediction that households recommended by TRAIL agents were more productive than households that formed groups in GBL villages.

Assuming that revenue is a Cobb-Douglas function of the cost of production, we estimate the regression

$$\begin{aligned}\log(Revenue_{iv}) = \alpha_0 + \alpha_1\text{TRAIL} + \alpha_2(\text{GBL} \times \ \log \text{Cost}_{iv}) + \alpha_3 \ (\text{TRAIL} \times \ \log \text{Cost}_{iv}) \\ +\alpha_4(\text{GBL} \times \text{Recommended}) + \alpha_5(\text{TRAIL} \times \text{Recommended}) + \gamma \ \mathbf{X}_i + \varepsilon_{iv}\end{aligned} \tag{2}$$

for household i in village v. This is run for each separate crop, as well as after aggregating across all 4 major crop categories.[26] Cost refers to cost of cultivation. Given our finding above that program loans caused households to expand cultivation of all crops, we use assignment to treatment as an instrument for the cost of cultivation. The underlying identification assumption is that treatment status does not affect productivity. This is because productivity depends on network relationships, which are available whether or not the household receives a loan. Under this identification assumption, we obtain consistent estimates of the elasticities α_2 of revenue with respect to cost for GBL households, and α_3 for TRAIL households, which are presented in Panel A of Table 6. This enables us to estimate the rate of return on the additional cultivation costs incurred as a result of receiving program loans. Specifically, we can estimate $\text{RoR}_{\text{GBL}} = (\alpha_2 \times \frac{Revenue}{Cost}) - 1$, and $\text{RoR}_{\text{TRAIL}} = (\alpha_3 \times \frac{Revenue}{Cost}) - 1$. As seen here, the TRAIL loans had a significant and large rate of return on income from potatoes of 72% as estimated by the Cobb-Douglas production

[26]The vector of control variables includes the land owned by the household, a year dummy and a dummy variable for the information intervention, as described in Section 4.

function. In contrast, the rate of return on GBL loans was 37% and not significantly different from zero. Since potatoes are a major source of agricultural income in this region, the large impact of TRAIL loans on potato output also translates into a large effect on total farm income: we estimate a rate of return of 103 percent on TRAIL loans, and a non-significant 38 percent on GBL loans.

An alternative less parametric procedure of estimating rates of return is shown in Panel B of Table 6. We calculate directly the ratio of the treatment effect on value-added, to the treatment effect on cultivation cost in TRAIL and GBL respectively. These are reported in Panel B, with standard errors computed by bootstrapping using 600 replications. The rate of return achieved by the TRAIL treatment group in potato was 105%, and for total farm income was 115%, both statistically significant at the 1% level. The corresponding parametric estimates in Panel A are 72% and 103%. The rates of return achieved by the GBL treatment group were substantially smaller – 37-38% in Panel A and 9% and even lower in Panel B, neither of which were statistically significant.

4.2.2 Selection Patterns in TRAIL and GBL

We showed above that TRAIL borrowers were more productive than GBL borrowers. In our theoretical model this occurs because TRAIL agents recommend households that belonged to their own network, who benefit from network benefits, rather than 'floating' borrowers who do not receive any network benefits. In Table 7 we test if TRAIL agents showed a preference for recommending households that belonged to their own network. This is done by running a linear probability regression of the form

$$\text{Recommended}_{iv} = \alpha_0 + \beta(\text{Interacted with agent})_{iv} + \gamma\, \mathbf{X}_i + \varepsilon_{iv} \qquad (3)$$

on the sample to households owning less than 1.5 acres of cultivable land in TRAIL villages. On the left hand side we have an indicator variable for whether household i in village v was recommended by the TRAIL agent, and on the right hand side a set of variables indicating whether the household had bought inputs, borrowed, or worked for the agent in the 3 years prior to this study. We control for a range of other household demographics and assets, including land owned. In column 1, we see that households that had borrowed from the agent in the past, were 14 percentage points more likely to be recommended. As column 2 shows, this result remains strong even after we have controlled for the social identity of the household, and its interaction with the agent's identity. Thus, although it is true that agents were less likely to recommend households that belonged to a different caste from themselves, a prior credit relationship was an important predictor of a recommendation.

According to our theory, *within* the agent's own-clientele which is composed of own-network borrowers and floating borrowers, the agent would be more likely to recommend the former who pay lower informal interest rates. This implies that among the agent's own-clientele, those he recommended would pay a lower interest rate. Table 8 tests this prediction in

Columns 1 and 2 which correspond respectively to a OLS and Heckman-selection-corrected regression of the informal interest rate (where the correction pertains to selection of those who reported taking at least one loan).[27] We see that within the agent's own-clientele, those the agent recommended paid 7% less on the informal market, consistent with our model prediction. The recommendation dummy in TRAIL on the other hand has a positive coefficient of 2.2% which is statistically insignificant.[28] This is in stark contrast to GBL villages, where those forming groups were paying over 5% more on the informal market than those who never formed a group. GBL thus attracted borrowers who were perceived by local lenders to be higher default risks compared with the rest of the village population. When we pool the data for TRAIL and GBL selected borrowers (shown in columns 5 and 6), TRAIL selected borrowers paying 6.4% less in the informal market compared with those applying for GBL. This is consistent with our model, for the case where GBL attracts disproportionately the floating borrowers, and with the finding above that TRAIL borrowers achieved a higher rate of return compared with GBL borrowers.

4.2.3 Repayment and Take-up Patterns in TRAIL and GBL

The preceding results suggest TRAIL selected borrowers that were more productive and were lower default risks. However, borrowers in the GBL scheme benefit from the joint liability – even when their own projects fail, their group members have an incentive to repay the loan on their behalf. This positive effect on loan repayment could overwhelm the negative effect of having less productive borrowers. Therefore, it is unclear in the model which of the two schemes will generate higher repayment rates, and we must turn to the data.

Panel A of Figure 1 shows the evolution of repayment rates in TRAIL and GBL across the six loan cycles, along with the corresponding 90% confidence intervals. Repayment rates were high in both schemes: at the end of 6 cycles, the average repayment rate was 98 percent in the TRAIL scheme, and 91 percent in the GBL scheme. When we estimate the difference in repayment rates in each cycle separately, we see that the TRAIL scheme had significantly higher repayment rates in Cycles 3, 4 and 6, a lower repayment rate in Cycle 2, while in Cycle 5 the confidence intervals overlap. At the end of Cycle 6 we estimate that

[27] The first round selection equation uses as an instrument a dummy for whether the household head reported cultivation as his primary occupation. Since agricultural production loans are much larger than consumption loans, this is a good predictor of the likelihood the household reported at least one loan. The identifying assumption is that conditional on taking a loan, and all the included regressors such as landholding and caste, the occupation of the household head *per se* does not affect the interest rate.

[28] Regarding those not in his own network, the agent might not be well informed about those outside his own clientele, and may be choosing randomly. In this case there should be no difference in interest rates between the recommended and the non-recommended. If he does have information he would be inclined to recommend the safer ones. So the predicted effect on those recommended from outside his own network is zero or negative. The recommendation dummy in columns 1 and 2, captures the difference between recommended and non-recommended amongst those not in the agents own network. We cannot reject the null hypothesis that this difference is zero.

the repayment rate on TRAIL loans was 9 percentage points higher than on GBL loans.[29]

The take-up rate of loans in our two schemes can also be a useful metric of the extent to which these loans affected borrower welfare *ex ante*. Since the loans were offered to a random subset of households that were recommended/formed groups in order to receive these loans, a low take-up rate would indicate that households did not expect to receive large benefits from them. In Panel B of Figure 1 we present the continuation rate, i.e. the proportion of those eligible to borrow in the cycle in question that actually took the loan. In Panel C we present the take-up rate, which is the proportion of those eligible to borrow at the outset of Cycle 1 who took the loan in any subsequent cycle. The take-up rate is jointly determined by past take-up, default (which would disqualify the household from participating in a subsequent cycle) and current take-up. Both panels show that borrower participation was consistently higher in the TRAIL scheme in all cycles. The differences were statistically significant in all cycles starting with Cycle 3.

5 Robustness Checks and Sensitivity Analysis

In this section, we examine a number of ancillary issues which affect our assessment of the success of TRAIL in enhancing borrowers' welfare. These involve (i) possible compensatory effects on non-farm incomes; (ii) sensitivity of farm income effects to price and wage fluctuations; (iii) sensitivity of the standard errors to the choice of the cluster (iv) the possibility that borrower benefits may have been siphoned off by the TRAIL agent through higher input and output prices and higher interest rate on loans; and (v) distributive impacts.

5.1 Effect on Non-Farm Incomes

Did the increase in TRAIL borrower farm incomes come at the expense of non-farm incomes? Conversely, could the GBL loans have had positive treatment effects on non-farm incomes instead of agricultural incomes? In Table 9 we see positive but imprecisely-estimated effects of the TRAIL loans on rental income, income from sales of animal products, labor income, reported business profits, current value of business and total household income from non-agricultural sources. The treatment effects of GBL loans are smaller and also estimated imprecisely. The point estimate of the GBL treatment effect on aggregate non-farm income is negative, while that for TRAIL is positive, though both are statistically indistinguishable from zero.[30]

[29]This is obtained by regressing repayment rate in Cycle 6 on the TRAIL treatment dummy and landholding.

[30]The full set of results are presented in Table A-6 in the online Appendix A-2.

5.2 Sensitivity to Potato Price Fluctuations

The production of cash crops usually involves high risk, part of which arises from price fluctuations. Potato prices exhibit substantial volatility across years, as well as intra-year fluctuations, as explained in detail in Mitra, Mookherjee, Torero, and Visaria (2013). There is considerable volatility in the price of potatoes – the average, across all sample villages, of the median price received by farmers from potato sales was Rs 3.84 in 2007, 2.35 in 2008, 3.85 in 2011 and 5.36 in 2012. Table 10 shows how estimated treatment and selection effects for potato value-added would have been affected had the potato prices been different. In particular, we price all farmers' potato sales at an imputed price equal to the median price received by farmers in that village in a different year, but assume all input purchases took place at actual prices. Row 1 is identical to Row 11 in Table 5, and shows estimated effects on value-added given actual prices at which farmers sold. Row 2 is computed as if all farmers sold potatoes at the median farmgate price in that same village in 2011. Row 3 is computed as if they sold them at the median price in 2012, and so on. Prices were higher in 2012 than in 2011, and so we see that had 2012 prices prevailed throughout the sample, the estimated treatment effects would have been almost twice as large and highly significant. The GBL treatment effect would have been smaller than in TRAIL (Rs 500 instead of Rs 3187) and would have continued to be statistically insignificant. On the other hand, the TRAIL treatment effects would have been insigificant if the potato prices had been the lower value they took in 2007, and would have been significant and negative if they had been as low as in 2008. In contrast, the GBL treatment effect point estimate would have been positive at 2008 prices although it would still have been statistically insignificant.[31] That our estimated treatment effects are sensitive to fluctuations in potato prices should not be surprising: the scheme successfully financed agricultural production, and agricultural prices are usually subject to large fluctuations; therefore it is to be expected that these fluctuations would drive the profitability of agricultural operations from year to year. This might also help to understand why, in the absence of this scheme, TRAIL borrowers did not take advantage of the large gap between the estimated rates of return (70%) and the cost of borrowing (25% or lower) in order to borrow and cultivate even more potatoes than they already did. The rate of return that farmers anticipate at the time of planting or cultivation in any given year is probably considerably below what we calculated in the years of the experiment.

This uncertainty in the treatment effect on value-added highlights the need for any credit scheme aimed at agricultural finance to also provide insurance against aggregate risk. As stated earlier, although it was not triggered in our study period, our scheme included index insurance, so that the repayment obligation would have been reduced if the local revenue per acre had fallen by 25% or more relative to a 3-year historical average, thus limiting the losses to the borrower households. This feature may have positively affected the take-up of these loans, relative to other loans that may already be available in the formal and informal market.

[31] The full set of results are presented in Table A-7 in the online Appendix A-2.

5.3 Sensitivity to Choice of Cluster

Standard errors in all our regressions discussed so far are clustered at the village level, to account for spatial correlation in outcomes. However, it could be argued that the relevant unit at which outcomes are correlated is the specific network that the household is part of. Although we did not map actual networks in our sample villages, we can follow the theoretical model and identify in our sample two types of networks: in TRAIL villages, all recommended borrowers (Treatment and Control 1) are assumed to belong to the TRAIL agent's network, and in GBL villages all households that formed groups are assumed to belong to their specific group network. All Control 2 households are assumed to belong to singleton networks. When standard errors are clustered using these alternative cluster definitions, the results on the program effects on potato cultivation, output, value-added and profits are very similar to those presented in the Table 5.[32]

5.4 Extraction by Agent in Other Spheres of Interaction

We argued above that the TRAIL agent recommended borrowers from his own network and that network ties caused him to internalize the benefits to the borrowers. A natural question that arises then is whether he extracted these benefits from the borrowers, thus reducing the net benefit to borrowers from the scheme. This extraction could occur in the form of a bribe in return for being recommended, or a side-payment, say after the harvest season. Alternatively, this extraction could have take place indirectly through manipulation of other transactions among the lender and own-network borrowers. The TRAIL agent could have increased the quantity that the borrower must sell to him at a discounted price, or adjusted downward the price he paid for the output. Alternatively, the agent could have sold inputs at higher prices to the borrower. Finally, the agent might have charged higher interest rates on loans.

Naturally, it is difficult to collect data on bribery or side-payments between borrowers and agents. However, we do have detailed data on input purchase and output sale of sample household, collected every four months, which we can use to test if the agent extracted rents from TRAIL borrowers through these channels.[33]

In Table 11 we analyse input, output and credit transactions reported by sample households in TRAIL villages. Column 4 shows the mean incidence of such transactions for the control 1 households. In the first two rows of Panel A show that over the 6 cycles, only approximately 9% of input transactions by control 1 households were with the agent, accounting for 8% of input values purchased. The top rows of Panel B show that 21% of output transactions of control 1 households were with the agent, representing 15% of the transaction value, and

[32]These results are presented in Table A-5 in online Appendix A-2.

[33]Students in Boston University's Masters of Global Development Studies program did fieldwork and very helpful analysis addressing this question (Ah-Tye, Bai, Blanco, Pheiffer, and Winata, 2013).

the top two rows of Panel C show that only 17% of control 1 households borrowed from the agent, accounting for only 5% of the total borrowing by households. It does not appear that the agent has a monopoly or near-monopoly on these transactions in the village.[34]

Columns 1 and 2 present the treatment and selection effects. Looking first across Panels A and B, Column 2 shows that recommended households were slightly more likely to buy and sell from the agent. However, the effects are statistically non-significant for the most part, with the exceptions that recommended households paid significantly lower rents on power-tillers to the agent, and sold a significantly higher fraction of their output to the agent. Hence it does not appear to be consistently true that agents charged higher prices to recommended households as payment for recommending them. We also do not find in Column 1 that recommended households that actually were randomly selected to receive loans, transacted larger quantities with or paid higher prices to/received lower prices from the agent. The treatment effect is significant only for the rental rate on power tillers and in fact shows that Treatment households could rent power tillers more cheaply from the agent than Control 1 households. If anything, the benefits of the TRAIL loan obtained by the borrower were supplemented by cheaper inputs purchased from the agent, the very opposite of the hypothesis that the benefits were being siphoned off by the agent.

In Panel C we consider the borrowing from the agent during the 6 cycles, and the interest rate charged. Recall from Table 7 that the agent was more likely to recommend households that had borrowed from him in the 3 years prior to the program. Column 2 shows that recommended borrowers continue to be more likely to borrow from the agent, and also receive a larger share of their total borrowing from the agent. However, presumably because they now receive the program loans, treatment households become *less* likely to borrow from the agent during the 6 cycles. Interest rates charged by the agent also do not change.

Overall, we cannot find evidence that the agent extracted side-payments from the borrowers by engaging in greater volume of transactions, or charging higher prices/paying lower prices to the borrowers. It appears likely that the TRAIL treatment households retained control over the program benefits that accrued to them.

5.5 Heterogeneity in Selection and Distributive Impacts

We have thus far discussed results pertaining to average impacts of TRAIL and GBL. In (Maitra, Mitra, Mookherjee, Motta, and Visaria, 2014), we study the heterogeneity of treatment and selection effects, which are relevant to evaluating distributive impacts of the different schemes. First, compared to the households that the TRAIL agent recommended, households that formed groups in the GBL villages were more likely to be landless and belong to scheduled castes. In particular, TRAIL agents were likely to recommend farmers who owned between 0.5 and 1 acres of land, whereas it was households that owned less than 0.25 acres who were most likely to form GBL groups. Most TRAIL agents were

[34] See Tables A-8 – A-10 for the full set of results.

not from a scheduled caste (this may reflect historical caste-based occupational patterns), and they were less likely to recommend scheduled caste borrowers. This could be because they were less likely to have lent money to them in the past. Hence while the TRAIL scheme delivered superior results with respect to cultivation, output and income, the GBL scheme was more likely to expand credit access for the socio-economically weaker sections of the village population. Note again, however, that it did not generate significant positive impacts on output or income for these sections of the population.

Second, the TRAIL loans had different treatment effects on the allocation of time by male and female members of the household. Females tended to reduce labor hours in employment outside the household and correspondingly spend more time on non-agricultural self-employment, but their total hours worked on the family farm or in the aggregate did not change significantly. In contrast, male members significantly increased hours of work on the family farm, and to some extent on other self-employment, without cutting back on hours spent on employment outside the household. Hence the impacts of TRAIL on female household members are ambiguous: the switch to self-employment and the increase in family incomes presumably made them better-off, at the possible cost of a decline in their independent earnings, which could reduce their bargaining power within the household.

6 Conclusion

The problem of identifying creditworthy borrowers and enforcing payment in the absence of collateral have made agricultural finance in developing countries notoriously cost-ineffective. While microcredit has famously solved the information problems by leveraging information about borrower types and actions embedded in the local community, it has not hitherto been used as a source of agricultural finance. In this study, we have demonstrated that it is possible to build on the same key principles of microcredit, to design a lending mechanism that targets productive farmers who earn high rates of return and repay the loans with high probability.

The trader-agent intermediated lending (TRAIL) scheme involved individual liability loans at below-market-average interest rates, durations that matched crop cycles of the most important cash crop in the region, and insured against local yield and price shocks. The scheme was particularly successful in inducing selected beneficiaries to increase the cultivation and output of potatoes. This did not come at the cost of reduction in income from any other source that we measured. We explained this result in terms of the underlying selection patterns: TRAIL agents recommended households from among their own networks that they knew had high productivity and were safe credit risks. As a result, the TRAIL loans had a higher than 98% repayment rate at the end of two years. In the GBL scheme, which relied on the traditional group-based micro-finance approach we did not find comparable positive effects on farm output. We argue this is because both high and low productivity households participated in the GBL scheme. However the joint liability feature meant that the GBL scheme also attained high repayment rates, although their magnitude was slightly lower than for TRAIL. Loan take-up rates were higher in the TRAIL scheme, indicating higher *ex ante* effects on borrower welfare. We also found no evidence that TRAIL agents siphoned off the benefits of recommended or treated borrowers.

Although it is clear that TRAIL borrowers expanded output of the cash crop significantly as a result of the expanded credit access, the high prices prevailing during the years of the experiment are also responsible for the positive effects that we find on value added and income. If output prices had been considerably lower (as they were as recently as 2008) the increased output could have translated into a net loss. This finding is consistent with the well-known fact that agricultural prices fluctuate considerably from year to year, and therefore agriculture is a high-risk enterprise. This underscores the need for agricultural financing schemes to also include an insurance component. It is likely that the fact that our scheme provided insurance contributed positively to its high take-up rates.

Nevertheless, the fact that the scheme lowered borrowing costs, and induced borrowers to expand the cultivation scale of potatoes, suggest that there were positive *ex ante* welfare improvements. The absence of mandatory group meetings, savings requirements, or the burden of joint liability also likely lowered the costs of participating in the scheme.

From the lender's perspective as well, the administrative cost of the TRAIL scheme was considerably lower than the cost of the GBL scheme. The bulk of the cost savings in the TRAIL scheme came from lower outlays on loan officers' salaries and transport, since the TRAIL design did not require the lender to organise and attend bi-monthly meetings with GBL group members. On the other hand, however, the lender paid 75% of the loan interest received on TRAIL loans to the agents, whereas it retained the entire interest received on GBL loans. In some developing countries, government policy ensures that institutions that offer microcredit and agricultural financial services have access to funds at lower than the market interest rate.[35] In such environments, the lender could break even or earn profits from the TRAIL scheme. Coupled with the large effects on agricultural production and farm incomes, this approach could help to fulfill the promise of microfinance.

[35]Notably, in Bangladesh, MFIs receive loanable funds from a government-sponsored agency at roughly half the interest rate that commercial banks charge.

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Table 1: Randomization

	TRAIL		GBL		Difference
	Mean	SE	Mean	SE	TRAIL - GBL
Panel A: Village Level Differences					
Number of households	297.59	48.06	388.50	80.36	-90.91
Percent households electrified	0.60	0.06	0.59	0.05	0.01
Has primary school	0.77	0.09	0.79	0.08	-0.02
Has primary health centre	0.27	0.10	0.21	0.08	0.06
Has bank branch	0.14	0.07	0.17	0.08	-0.03
Has pucca road	0.27	0.10	0.42	0.10	-0.14
Panel B: Household Level Differences					
Male Head	0.95	0.01	0.94	0.01	0.01
Non Hindu	0.21	0.02	0.16	0.02	0.06**
Scheduled Caste (SC)	0.23	0.02	0.25	0.02	-0.02
Scheduled Tribe (ST)	0.05	0.01	0.04	0.01	0.01
Other Backward Caste (OBC)	0.06	0.01	0.06	0.01	-0.01
Household Size	5.13	0.12	5.32	0.11	-0.19
Age of Household Head	49.94	0.58	51.56	0.53	-1.61**
Household Head: Married	0.91	0.01	0.90	0.01	0.01
Household Head: Completed Primary School	0.50	0.02	0.49	0.02	0.00
Household Head: Occupation Cultivator	0.56	0.02	0.55	0.02	0.01
Household Head: Occupation Labor	0.22	0.02	0.22	0.02	-0.01
Household Head: Resident	0.99	0.01	0.99	0.01	0.00
Landholding (acres)	1.00	0.05	1.05	0.06	-0.05
Landless	.07	0.01	0.08	0.01	-0.01
Purchased inputs on credit	0.38	0.02	0.43	0.02	-0.05*
Received government benefits	0.54	0.02	0.62	0.02	-0.08***
Total Borrowing$^+$	6579.42	524.32	6417.26	489.24	162.52
Duration (Days)$^+$	124.88	1.57	122.47	1.27	2.40
Interest Rate (Per annum)$^+$	20.48	0.87	20.89	0.77	-0.40
Number of Loans$^+$	2.17	0.06	2.24	0.06	-0.06
Collateralized$^+$	0.02	0.00	0.01	0.00	0.01*
Joint Significance of Household Variables‡					27.07

Notes:
$^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. ‡: $\chi^2(16)$. Panel A uses village census data collected in 2007-2008; Panel B uses the 2007-2008 sample, but data from the 2010 Cycle 1 survey. $^+$: Restricted to loans from informal sources for agriculture.

Table 2: Credit Market Characteristics

	All Loans (1)		Agricultural Loans (2)	
Does the household Borrow?	0.69		0.59	
Total Borrowing†	6221.78	(10140.18)	4952.85	(8607.67)
Proportion of Loans by Source‡				
Informal Lenders	0.65		0.66	
Family and Friends	0.05		0.03	
Cooperatives	0.23		0.24	
Government Banks	0.05		0.05	
Interest Rate (Annualized) by Source				
Informal Lenders	26.57	(24.14)	26.36	(24.51)
Family and Friends	20.53	(15.09)	19.84	(16.32)
Cooperatives	15.41	(3.07)	15.62	(3.15)
Government Banks	11.91	(4.30)	11.83	(4.65)
Duration (Days) by Source				
Informal Lenders	123.63	(27.54)	122.52	(20.29)
Family and Friends	168.92	(103.61)	174.13	(101.31)
Cooperatives	323.53	(91.19)	320.19	(93.97)
Government Banks	299.67	(108.95)	300.35	(108.74)
Proportion of Loans Collateralized by Source				
Informal Lenders	0.01		0.01	
Family and Friends	0.02		0.07	
Cooperatives	0.73		0.77	
Government Banks	0.77		0.83	

Notes:
The sample consists of sample households in TRAIL and GBL villages with less than 1.5 acres of land. All loan characteristics are summarized for loans taken by the household in Cycle 1. Program loans are not included. When computing interest rate summary statistics we do not consider loans for which the borrower reports that the principal amount equals the repayment amount.
†: Total borrowing = 0 for households that do not borrow.
‡: Proportion of loans in terms of value of loans at the household level. Proportion computed for households that borrow. Standard Deviations in parenthesis.

Table 3: Selected Crop Characteristics

	2011 Sesame (1)	2011 Paddy (2)	2011 Potatoes (3)	2012 Sesame (4)	2012 Paddy (5)	2012 Potatoes (6)
Acreage (acres)	0.44	0.70	0.48	0.46	0.70	0.48
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Harvested quantity (Kg)	141.69	1153.46	5207.62	144.74	1187.24	5052.68
	(3.27)	(20.03)	(90.98)	(4.04)	(29.25)	(125.94)
Cost of cultivation (Rupees)	717.51	4495.50	10474.21	741.58	4939.15	10627.31
	(17.42)	(81.38)	(197.19)	(24.22)	(126.63)	(281.48)
Family labor (Hours)	26.57	41.23	58.92	29.02	44.56	61.62
	(0.39)	(0.61)	(0.86)	(0.60)	(0.93)	(1.18)
Price Received by Farmers (Rupees)	27.23	9.45	4.61	31.54	9.38	5.51
	(0.22)	(0.04)	(0.03)	(0.15)	(0.05)	(0.04)
Revenue (Rupees)	3005.74	7385.61	21208.61	3627.83	8080.20	24901.82
	(69.69)	(145.93)	(412.20)	(111.11)	(237.77)	(687.96)
Value-added (Rupees)	2286.77	2999.18	10615.09	2885.21	3149.42	14243.61
	(61.75)	(104.76)	(268.57)	(98.90)	(168.13)	(455.34)
Value-added Per Acre	5192.29	4310.88	22144.13	6320.40	4515.78	29584.66

Notes:
The sample consists of sample households in TRAIL and GBL villages with less than 1.5 acres of land. Standard Errors in parenthesis.

Table 4: Summary of Theoretical Predictions

Treatment		*Composition* C=connected F=floaters	*Observed Interest rate*	*Repayment Rate*	*Effective Cost of Credit*
TRAIL	Treatment	C	r_T	p_c	$(1-K)r_T$
	Control 1	C	$\frac{\rho_I}{p_c}$	p_c	$\frac{\rho_I}{p_c}$
	Control 2	C, F	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$	p_c, p_f	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$
GBL	Treatment	CC, FF	r_T	$p_c(2-p_c), p_f(2-p_f)$	$(2-p_c)r_T, (2-p_f)r_T$
	Control 1	CC, FF	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$	p_c, p_f	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$
	Control 2	C, F	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$	p_c, p_f	$\frac{\rho_I}{p_c}, \frac{\rho_I}{p_f}$

Table 5: Program Impacts. Treatment and Selection Effects.

		Unit	Treatment		Selection		Sample	Mean
			TRAIL	GBL	TRAIL	GBL	Size	Control 1
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Effects on Total Borrowing and Cost of Borrowing								
1	Borrowing (All Loans)	Rs	7126.23***	6464.46***	-417.02	-919.86	2758	7279.76
2	Cost of Borrowing (All Loans)	Percent (Annualized)	-0.03**	-0.07***	-0.01	0.04**	2428	0.24
3	Borrowing (Non-program Loans)	Rs	-495.74	254.72	-372.19	-930.27	2601	7279.76
4	Cost of Borrowing (Non-program Loans)	Percent (Annualized)	0.01	-0.01	-0.01	0.04***	2159	0.24
Panel B: Effects on Potato Production								
5	Cultivate		0.0545	0.0492	0.0949***	0.0614	4163	0.677
6	Acreage	Acres	0.0896***	0.0402	0.0010	-0.0421	2718	0.432
7	Leased-in acres	Acres	0.0467**	0.0222	-0.00265	0.00447	2718	0.111
8	Cost of production	Rs	1774**	1308	372.8	-1111	2718	9538
9	Output	Kg	888.0***	278	145.4	-417.9	2718	4760
10	Revenue	Rs	3429***	1637	942	-2534	2718	19137
11	Value added	Rs	1687**	271.8	555.6	-1371	2718	9498
12	Family labour hours	Hours	6.03	4.906	-0.2	4.951	2718	57.86
13	Imputed profit	Rs	1676**	457	203.2*	-1665	2718	8076
Panel C: Comparing Acreage and Value-Added in Different Crops								
	Sesame							
13	Acreage	Acres	0.0424*	0.0111	0.0192	-0.0052	2037	0.414
14	Value added	Rs	180	-158.3	-115.7	73.41	2037	2126
	Paddy							
15	Acreage	Acres	0.0324**	0.0516	-0.0402	-0.00237	3054	0.641
16	Value added	Rs	271.6	573.6	-469.9	-759.6*	3047	2506
	Vegetables							
17	Acreage	Acres	0.159**	-0.0197	-0.0161	-0.0145	402	0.196
18	Value-Added	Rs	1255	-1955	1329	-957.5	402	8325
Panel D: Effects on Household Income								
19	Total Farm Income	Rs	2621***	53.24	11466***	10066***	4163	10328

Notes: Standard errors, clustered at the village level are in parentheses. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres. Coefficient estimates not presented. All regressions include TRAIL dummy, TRAIL dummy interacted with Treatment household, TRAIL dummy interacted with Control 1 household, GBL dummy interacted with Treatment household and GBL dummy interacted with Control 1 household, land owned by the household, a Year 2 dummy and a dummy for Information Village.

Table 6: Rates of Return

	Potatoes	Total Farm Income
	(1)	(2)
Panel A: IV estimates based on Cobb-Douglas production function		
TRAIL (α_3)	0.83***	0.92***
	(0.16)	(0.16)
GBL (α_2)	0.67	0.63
	(0.47)	(0.56)
Implied RoRs at mean cost/revenue ratio		
TRAIL	0.72	1.03
GBL	0.37	0.38
Panel B: Bootstrapped estimates		
TRAIL	1.05***	1.15***
	(0.06)	(0.02)
GBL	0.09	-0.1
	(0.37)	(0.29)

Notes:
In Panel A, ROR defined as the elasticity of revenue on cost (from a regression of log revenue on log cost using assignment to treatment as the instrument) multiplied by ratio of revenue to cost. In Panel B, ROR defined as the ratio of the treatment effect on value added and the treatment effect on cost. Standard errors are bootstrapped with 600 replications. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to Treatment and Control 1 households with at most 1.5 acres of land.

Table 7: Selection: TRAIL

(Dependent Variable: Household was recommended into the scheme)

	(1)	(2)
Bought from agent	0.023	0.016
	(0.044)	(0.047)
Borrow from agent	0.139***	0.142***
	(0.037)	(0.035)
Work for agent	0.003	-0.005
	(0.049)	(0.055)
Non Hindu		0.030
		(0.143)
Non Hindu × Agent Hindu		-0.098
		(0.132)
SC		0.544***
		(0.031)
SC × Agent High Caste		-0.610***
		(0.036)
ST		-0.198*
		(0.108)
ST × Agent High Caste		0.218
		(0.166)
Constant	0.023	0.037
	(0.079)	(0.098)
Sample Size	1,031	1,031
Number of Villages	24	24

Notes:
Linear Probability Estimates. Dependent variable is household was recommended/selected into the scheme. Standard errors, clustered at the village level, are in parentheses. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres. All regressions control for age, gender, educational attainment, primary occupation of the household head, household size, dummies for whether the household purchased on credit or received government transfers and landholding.

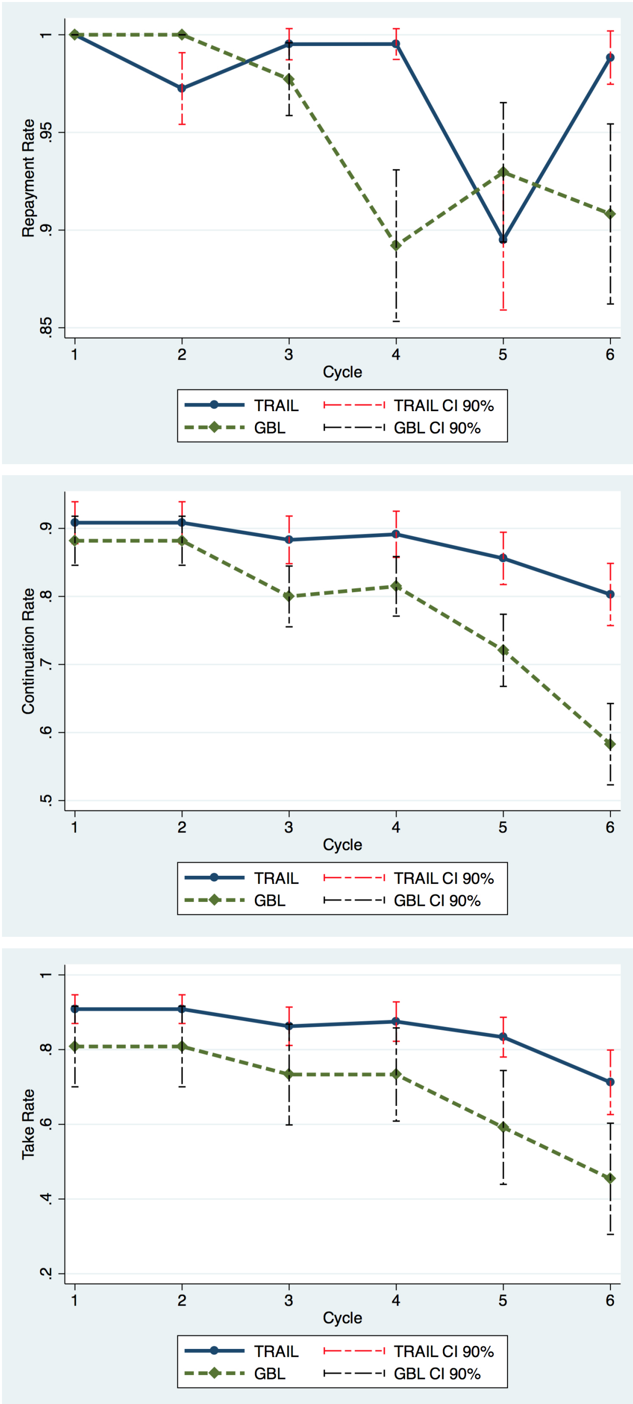
Table 8: Interest Rate Comparisons

(Dependent Variable: average interest rate paid on informal loans)

	TRAIL		GBL		TRAIL v GBL	
	OLS	Heckman	OLS	Heckman	OLS	Heckman
	(1)	(2)	(3)	(4)	(5)	(6)
Recommend	0.022	0.022	0.053*	0.052*		
	(0.016)	(0.017)	(0.027)	(0.029)		
Own-clientele	0.050	0.049*				
	(0.033)	(0.027)				
Own-clientele × Recommend	-0.071**	-0.071**				
	(0.026)	(0.035)				
TRAIL					-0.064	-0.064**
					(0.046)	(0.027)
High caste	-0.058***	-0.059***	0.134*	0.134***	0.053	0.053*
	(0.016)	(0.016)	(0.071)	(0.031)	(0.044)	(0.028)
Landholding	0.091	0.090	-0.103	-0.071	-0.047	-0.023
	(0.070)	(0.078)	(0.170)	(0.142)	(0.182)	(0.129)
Landholding Squared	-0.063	-0.062	0.065	0.050	0.053	0.042
	(0.044)	(0.052)	(0.129)	(0.093)	(0.136)	(0.086)
Constant	0.238***	0.240***	0.196***	0.151	0.271***	0.235**
	(0.013)	(0.068)	(0.027)	(0.118)	(0.046)	(0.112)
Inverse Mill's Ratio (λ)		-0.002		0.038		0.032
		(0.055)		(0.095)		(0.098)
Sample Size	438	1,032	417	1,038	412	911

Notes:
The dependent variable is the average interest rate the household pays on loans taken from traders or moneylenders, for non-emergency and non-consumption purposes, in Cycle 1. The sample in columns 1 and 2 consists of all sample households in TRAIL villages. The sample in columns 3 and 4 consists of all sample households in GBL villages. The sample in columns 5 and 6 consists of all Recommended (Treatment and Control 1) households in TRAIL and GBL villages. Columns 2, 4 and 6 report the results of the second step of a Heckman two-step regression, where the first stage selection regression estimates the likelihood that the households takes a non-emergency and non-consumption loan from a trader or moneylender in Cycle 1. Explanatory variables included in the first stage are Landholding, Landholding squared and an indicator variable for cultivator household. Standard errors are in parenthesis. In columns 1, 3 and 5, standard errors are clustered at the village level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres.

Figure 1: Loan Performance: Repayment, Continuation and Take-up Rates



Panel A: Repayment conditional on being eligible and continuation

Panel B: Takeup/Continuation conditional on eligibility

Panel C: Maximum number eligible in each village is 10

Table 9: Treatment Effect on Non-Farm Income.

		Treatment TRAIL	GBL	Selection TRAIL	GBL	Sample Size	Mean Control 1
1	Rental Income (Rupees)	153.6	784.4	-182.1	-427.9	4162	1508
2	Income from Animal Products (Rupees)	166.8	49.18	62.66	-279.1	4162	771
3	labour income (year; Rupees)	393	-5642	-12729**	-4941	4162	37465
4	Wage employment (last 2 weeks; Hours)	0.615	-4.496	-6.855*	1.749	4162	40.24
5	Self-employment (last 2 weeks; Hours)	6.884	4.294	0.215	5.914*	4162	121.8
6	Reported profits (Rupees)	2343	2918	100.9	-1917	4162	5802
7	Current value business (Rupees)	4917	6692	952.1	353.8	4162	10465
8	Total Non-Farm Income (Rupees)	3056	-1890	-12748	-7565	4162	45546

Notes:
Standard errors, clustered at the village level are in parentheses. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres. Coefficient estimates not presented. All regressions include TRAIL dummy, TRAIL dummy interacted with Treatment household, TRAIL dummy interacted with Control 1 household, GBL dummy interacted with Treatment household and GBL dummy interacted with Control 1 household, land owned by the household, a Year 2 dummy and a dummy for Information Village.

Table 10: Sensitivity of Treatment Effects for Potato Value Added to Price Changes.

Dependent Variable: Value added (Actual/Imputed)

		Treatment TRAIL	Selection GBL	Sample TRAIL	Mean GBL	Size	Control 1
1	Actual	1687**	271.8	555.6	-1371	2718	9498
2	2011 prices	1654***	55.11	318	-872.7	2718	8258
3	2012 prices	3187***	500	254.8	-1907	2718	14311
4	2007 prices	-194.7	-328.5	-45.25	-2744	2718	4423
5	2008 prices	-1913**	1653	1079	-2886**	2718	-4434
6	2011 market wage	1672**	217.3	463.5	-1483	2718	8219
7	2012 market wage	1665**	182.6	460.4	-1416	2718	8134

Notes:
Standard errors, clustered at the village level are in parentheses. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres. Coefficient estimates not presented. All regressions include TRAIL dummy, TRAIL dummy interacted with Treatment household, TRAIL dummy interacted with Control 1 household, GBL dummy interacted with Treatment household and GBL dummy interacted with Control 1 household, land owned by the household, a Year 2 dummy and a dummy for Information Village.

Table 11: Treatment and Selection Effects for Transactions with TRAIL Agent

	Treatment Effect (1)	Selection Effect (2)	Sample Size (3)	Mean Control 1 (4)
Panel A: Input Purchase				
Buy any Input from agent†	-0.00338	0.00780	12,448	0.0875
Share of agricultural input purchased from agent	-0.00359	0.0187	10,196	0.0760
Input Price (Rs/unit)				
Inorganic fertilizer	-0.322	0.170	1,672	13.78
Organic fertilizer	29.39	-4.024	370	16.12
Outside seeds	2.174	-2.863	1,654	22.36
Pesticide	-31.08	-25.32	2,691	533.5
Powertiller	-32.33***	-33.23**	1,403	195.2
Water/irrigation	148.3	-148.3	1,230	72.30
Panel B: Output Sold				
Sold output to agent†	0.00559	0.00560	2,990	0.209
Share of output sold to agent	0.0152	0.0465*	2,765	0.151
Output Price (Rs/kg)				
Potato	0.098	0.00955	1,386	4.507
Paddy	0.0289	-0.149	498	9.282
Sesame	-7.817	8.429	881	28.42
Panel C: Borrowing				
Borrowed from agent†	-0.082*	0.060*	1398	0.173
Share of total borrowing from agent	-0.036**	0.016*	1398	0.049
Interest rate (APR)	-0.003	0.007	4320	0.145

Notes:
Standard errors, clustered at the village level are in parentheses. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to sample households in the TRAIL villages. Borrowing (in Panel C) restricted to agricultural purposes. Coefficient estimates not presented. All regressions include TRAIL dummy interacted with Treatment household, TRAIL dummy interacted with Control 1 household, land owned by the household, a Year 2 dummy and a dummy for Information Village.
†: Purchased inputs from , sold output to or borrowed from agent in the last 2 years.

Online Appendix

A-1 Alternative Theoretical Models

In this appendix we explain how similar predictions would be generated with alternative models of the informal credit market based on noncooperative behavior and adverse selection or moral hazard.

The following assumptions are common to all the models:

- The informal credit market is segmented. In each segment there is one lender who is in a privileged position to deal with borrowers in that segment. Lenders in different segments engage in price competition with one another. All lenders face a common cost of capital ρ_I and have no capacity constraints.
- Borrowers are shielded by limited liability, have no collateral, and require capital to start a productive project.
- We allow for side-contracts between informal lenders and borrowers, which are unobservable to the MFI.
- All parties are risk neutral.
- The TRAIL and GBL loans charge interest rate $r_T < \rho_I$.

- *Adverse Selection Model*: This model is based on Ghatak (2000). Borrowers know the riskiness of their own and each other's projects. A safe project succeeds with probability $p_s \in (0, 1)$, whereas a risky project succeeds with a strictly lower probability, p_r. All borrowers belong to some segment. The model abstracts from repayment incentives and assumes borrowers repay whenever they have the means to do so. With certain parametric assumptions, the model generates an Akerlof-style 'lemons' equilibrium, where low-risk borrowers do not have access to any loans at all, an outcome that causes investment to be lower than the social optimum. Ghatak (2000) showed how this under-investment can be eliminated through a group-based lending scheme with joint liability. In Ghatak (2000) informal lenders are just as uninformed as the MFI about the borrowers' risk type.[36] Instead, we assume that informal lenders are informed about the risk type of certain borrowers in the market. In particular, we assume that each lender lends on a regular basis to borrowers in her segment, and has learnt their risk types through past experience. This information about borrower risk type is unavailable to lenders in other segments. This gives lenders monopoly power over safe borrowers within their segments. All segments have the same ratio θ of risky to safe types of borrowers.

[36]The theoretical literature on microcredit has usually assumed that the MFIs and the informal lenders are either equally uninformed (Navajas, Conning, and Gonzalez-Vega, 2003, McIntosh and Wydick, 2005, Casini, 2010, Guha and Chowdhury, 2012, Demont, 2012), or they share the same information (Jain, 1999, Jain and Mansuri, 2003).

As in Ghatak (2000), this model assumes all projects involve a fixed scale of cultivation and a given need for working capital, so loan sizes do not vary.[37] Hence this model is useful in illustrating selection patterns that can arise with TRAIL and GBL, rather than impacts on loan size and scales of cultivation. The moral hazard model to be developed below has the advantage of incorporating these latter aspects as well. Let the required loan size to be normalized to 1, while the outside option of the borrower is denoted by a. If the project succeeds, a borrower of type $i \in \{r, s\}$ obtains a payoff R_i and 0 otherwise.

The informal market before the MFI enters is as follows. A strategy for each lender is represented by a set of interest rates offered to own-segment borrowers distinguished by their risk types, and to borrowers in other segments: $\{r_s, r_r, r\}$, respectively denoting interest rate offered to own-segment safe borrowers, own-segment risky borrowers, and other-segment borrowers. Lenders simultaneously announce their interest rates. Following Ghatak (2000), we impose the assumptions below to ensure that an equilibrium exists in the informal market:

$$R_r - \frac{a}{p_r} \geq R_s - \frac{a}{p_s} \tag{A-1}$$

$$R_s - \frac{a}{p_s} < \frac{\rho_I}{\overline{p}} \tag{A-2}$$

$$p_s R_s > \rho_I + a \tag{A-3}$$

Equation (A-1) ensures that any interest rate that satisfies the safe borrowers' participation constraint also satisfies the risky borrowers' participation constraint, so that there is no interest rate that attracts only safe borrowers. Equation (A-2) implies that the participation constraint of safe borrowers is not satisfied when the interest rate, r, is greater or equal to $\rho_I/\overline{p}$, with $\overline{p} \equiv \theta p_r + (1-\theta)p_s$. Equation (A-3) states that the safe project is socially productive.

- *Moral Hazard Model*: in this version of the model we assume that borrowers' projects are always successful but borrowers can nonetheless default on their loans intentionally. In each segment there is at least one lender who has social and economic ties with the borrowers belonging to that segment. Harnessing this social capital, he can induce borrowers in his own segment to repay with probability p_c. However, he is unable to enforce the same repayment rate with external borrowers, who repay with probability $p_f < p_c$.[38] We assume that default risks are independent of the loan contract, for the sake of simplicity.[39]

  As in the model in the main text, we assume that there is a set of floater-borrowers that do not belong to any segment, and $p_f(2-p_f) < p_c$. We also make similar assumptions

[37]With variable loan sizes, it is well known that the simple result of market breakdown for safe types with adverse selection may no longer occur, as lenders can screen borrower types via nonlinear interest rates that vary with loan size. Safe types can get small enough loans at low interest rates that do not attract risky types. The resulting extension of the adverse selection model becomes more complicated.

[38]This can be rationalized in the following way: suppose that the benefit from defaulting is a random variable that takes three possible values $\theta \in \{\theta_L, \theta_M, \theta_H\}$ with probabilities $\{p_f, p_c - p_f, 1-p_c\}$ respectively. Also assume that the informal lender can commit to deny future loans in case of default, which entails a cost $\Delta \equiv \theta_L$ to the borrower. The lender can impose an additional penalty $s \equiv \theta_M$ on own-segment borrowers that default, but not on any other borrowers.

[39]This requires benefits of default and subsequent sanctions be large enough relative to the loan repayments involved.

concerning the production function. A borrower with a TFP denoted by g has a production function $gf(l)$ where f is a strictly increasing, strictly concave, twice differentiable function of loan size l satisfying Inada conditions. The TFP of connected borrowers (who belong to some segment) and floating borrowers (who do not belong to any segment) are denoted by g_c and g_f, where $g_c \geq g_f$ (for reasons similar to those discussed in the text: connected borrowers have access to technical and marketing information within their networks, unlike floaters). Each borrower's outside option equals a. Use $l_i(r)$ to denote the Walrasian loan demand of type $i = c, f$ borrower at interest rate r, i.e., which maximizes $g_i f(l) - rl$.

Lenders compete with one another in the credit market, and can make different contract offers to different borrowers. Besides their advantage with respect to enforcement of repayments *ex post*, a lender has a slight locational advantage over other lenders with regard to transactions with own-segment borrowers: whenever the latter are indifferent between borrowing from different lenders they end up borrowing from their own-segment lender.

The timing of the game is as follows: at stage 1, the informal lenders announce contract offers. At stage 2, each borrower accepts at most one offer. At stage 3, the borrowers learn θ and decide whether to repay or not. Conditional on default, sanctions are imposed.

Predictions

The Informal Credit Market

We present the main results for the two alternative models, and explain the underlying reasoning informally; formal proofs are available upon request.

Proposition 2 *(Adverse Selection Model) There is a unique equilibrium outcome in the informal market, in which safe types borrow from their own-segment lender at interest rate* $r_s \equiv R_s - \frac{a}{p_s}$, *while risky types borrow (from any lender) at interest rate* $r_r \equiv \frac{\rho_I}{p_r}$.

Here the informal lender uses his privileged information to identify the safe clients in his own segment, and charges them an interest rate that extracts all their surplus. Other lenders cannot compete for these safe clients because they cannot identify them. The only way to attract them would be to offer all the borrowers in the segment a common loan contract, but this would attract the risky clients as well. Hence, asymmetric information shields the informal lender from competition over safe borrowers in his segment. However, all informal lenders compete over risky borrowers, and so they all earn zero expected profits from lending to them. From equation (A-2) it follows that the equilibrium interest rate charged to risky borrowers, r_r, is higher than the equilibrium interest rate charged to safe borrowers.

Denote the payoff that a borrower of type (i) earns from his informal loans as $\overline{u}_i$. Proposition 2 implies that $\overline{u}_s = a$, whereas $\overline{u}_r = p_r R_r - \rho_I > a$. Similarly denote the profit that the informal lender makes from lending to a borrower of type i as Π_i. In equilibrium, lenders make positive profits on the loans they make to their own-segment safe borrowers: $\Pi_s = p_s R_s - \rho_I - a$, but they break even on loans to risky borrowers: $\Pi_r = 0$.

Proposition 3 *(Moral Hazard Model) There is a unique equilibrium outcome in the informal market, in which connected types borrow loan amount $l_c(\rho_I)$ from their own-segment lender at interest rate ρ_I/p_c, while floaters borrow (from any lender) loan amount $l_f(\rho_I)$ at interest rate ρ_I/p_f.*

In the moral hazard model, Bertrand competition across lenders implies they earn zero expected profit. Each borrower is charged an interest rate which takes into account their respective default risks. A borrower is offered an interest rate of $\frac{\rho_I}{p_c}$ by his own-segment lender, and an interest rate of $\frac{\rho_I}{p_f}$ by every other lender. Since the loan is repaid with probability p_c to the former, and p_f to any other lender, this implies the expected loan repayment is ρ_I per rupee borrowed by any type of borrower, irrespective whether or not the lender is from the same segment. In turn this implies all lenders compete with one another on an equal footing for all borrowers, implying that they must all earn zero expected profit. However observed interest rates vary across connected and floating borrowers (with the latter paying higher rates), and loan sizes also vary with the floaters borrowing less owing to a lower TFP. Despite the segmented nature of the market, this is actually a Walrasian equilibrium.

TRAIL Selection

Now suppose the TRAIL scheme is started in the village, with one of the segment lenders being selected to be the agent. Who will the agent select? To start with, we presume the agent cannot be bribed by borrowers to induce him to recommend them.

In the adverse selection model, the agent earns positive profit from safe borrowers in their own segment, which they would stand to lose if these borrowers switch to the TRAIL loan. They earn zero profit from all other borrowers, so on the basis of profits foregone they would prefer not to recommend own-segment safe borrowers. On the other hand, these borrowers are more likely to repay the loan which generates the commission for the agent, so this consideration pre-disposes the agent to recommend their own-segment safe borrowers. If the commission rate is large enough:

$$K \geq \frac{p_s R_s - \rho_I - a}{r_T(p_s - \overline{p})} \equiv \overline{K} \tag{A-4}$$

the latter consideration dominates. If there is sufficient adverse selection in the sense that $p_s - \bar{p} > \frac{p_s R_s - \rho_I - a}{r_T}$, the threshold $\overline{K}$ is smaller than one, so there exist commission rates less than 100% for which safe borrowers will be recommended.

The moral hazard model is different insofar as there are no profits foregone on the informal market as a result of borrowers switching to TRAIL loans. The only consideration is the commission that the agent expects to earn. Suppose that the agent's discount factor is $\delta \in (0,1)$. An own-segment borrower offered a TRAIL loan will repay with probability p_c, and so will select loan size $l_c(p_c r_T)$. Since the agent loses his commission whenever the borrower defaults, he sanctions the borrower the same way as when default occurs on an informal loan. Then the expected present value of recommending an own-segment borrower satisfies the Bellman equation $V_c = p_c[K r_T l_c(p_c r_T) + \delta V_c]$, implying $V_c = \frac{K p_c r_T l_c(p_c r_T)}{1-\delta p_c}$. A connected borrower in a different segment offered a TRAIL loan will repay with probability p_f, and so will select loan size $l_c(p_f r_T)$.

The expected present value of recommending an other-segment borrower satisfies the Bellman equation $V_c^o = p_f[Kr_T l_c(p_f r_T) + \delta V_c^o]$, implying $V_c^o = \frac{Kp_f r_T l_c(p_f r_T)}{1-\delta p_f}$. Finally, a floating borrower will repay with probability p_f, and so will select loan size $l_f(p_f r_T)$. The expected present value of recommending such a borrower satisfies the Bellman equation $V_f = p_f[Kr_T l_f(p_f r_T) + \delta V_f]$, implying $V_f = \frac{Kp_f r_T l_f(p_f r_T)}{1-\delta p_f}$. It follows that recommending a different segment borrower dominates recommending a floating borrower (since the former selects a larger loan size, generating a higher commission for the agent, while the default risk is the same). And the agent prefers to recommend an own-segment borrower rather than a connected borrower from a different segment if

$$\frac{pr_T l_c(pr_T)}{1-\delta p} \quad \text{is increasing in } p \text{ at } p = p_f \tag{A-5}$$

This requires either the loan demand function l_c to be inelastic; otherwise the discount factor δ needs to be large enough. If the loan demand has constant elasticity ϵ, (A-5) requires $\delta p_f > 1 - \frac{1}{\epsilon}$. The trade-off arises since other-segment borrowers select a larger loan size (translating into a larger commission in the absence of default), but also default more often.

In summary,

Proposition 4 *Assume borrowers cannot bribe the agent. In the adverse selection model the AIL agent recommends an own-segment safe borrower if and only if the commission rate satisfies $K \geq \overline{K}$, and a randomly chosen other-segment borrower otherwise. In the moral hazard model, the agent never recommends a floating borrower, and recommends an own-segment borrower rather than a connected borrower from a different segment if (A-5) holds.*

Now consider what happens when the TRAIL agent can be bribed. Assume that the agent has all the bargaining power in the bribe negotiations, so extracts all the surplus of borrowers from the TRAIL loan. Similar results apply when the agent gets a fixed fraction of the borrower surplus.

Proposition 5 *Suppose the agent can extract all the borrowers' surplus upfront by charging a bribe in exchange for a recommendation for the TRAIL loan. In the adverse selection model it is never optimal for the lender to recommend an own-segment safe borrower, and it is always optimal to recommend a borrower from a different segment. In the moral hazard model, it is never optimal to recommend a floating borrower, and it is optimal to recommend an own-segment borrower if the discount rate δ is large enough.*

The intuition behind Proposition 5 is the following. Given that the agent has all the bargaining power, he can extract the entire surplus that the borrower stands to earn as a result of his recommendation. In effect the agent becomes a residual claimant on the recommended borrowers' projects, besides earning the TRAIL commissions. In the adverse selection model, this reduces the effective cost of credit to $p_i(1-K)r_T$ when a type i borrower is recommended, as the TRAIL agent internalizes the commission into the cost of credit. The agent therefore prefers to recommend a risky borrower rather than a safe borrower from within his own segment, as the effective cost of credit for the former is smaller. It can be shown that it is always optimal to select a borrower from a different segment, either on the basis of screening by the bribe demand or random selection.[40]

In the moral hazard model, we obtain a different conclusion in the presence of bribery. Recommending a floating borrower is always dominated by recommending a connected borrower from a different segment, on account of a lower TFP of the former which implies a lower loan size and willingness to pay a bribe, while both default with the same probability. Hence the agent will definitely recommend a connected borrower. There is a trade-off between recommending an own-segment borrower and an other-segment borrower: the former is less likely to default but also selects a smaller loan size (owing to a higher effective cost of credit which arises from the lower default risk) which implies a smaller commission. The former consideration dominates if the discount factor is large enough.[41]

With adverse selection, we see that the presence of collusion implies that the agent will never recommend safe borrowers from his own segment, and will be inclined to exhibit a bias in favor of other-segment borrowers. Whereas in the absence of collusion, he will select own-segment safe borrowers if the commission rate is high enough. Empirically we see the latter outcome, so this could be viewed as evidence in favor of the model without any collusive side payments. The adverse selection model without collusion produces the same predictions as the model in the text: the agent selects low-risk high-productivity borrowers from his own segment.

The moral hazard model also generates the same prediction, given the assumption that the agent is patient enough, irrespective of whether or not there is collusion. If the agent is not so patient, we see that the agent could conceivably switch to recommending a connected borrower from a different segment, but not a floating borrower. High productivity connected borrowers will be selected, irrespective of the discount rate (and also irrespective of whether or not there is collusion).

[40]Details are available in the Appendix of Maitra, Mitra, Mookherjee, Motta, and Visaria (2013).

[41]Recommending an own-segment borrower generates an expected present value payoff of

$$\frac{Kp_c r_T l_c(p_c r_T) + \{\Pi_c(p_c r_T) - \Pi_c(\rho_I)\}}{1 - \delta p_c} \tag{A-6}$$

while recommending an other-segment borrower generates

$$\frac{Kp_f r_T l_c(p_f r_T) + \{\Pi_c(p_f r_T) - \Pi_c(\rho_I)\}}{1 - \delta p_f} \tag{A-7}$$

and recommending a floater generates

$$\frac{Kp_f r_T l_f(p_f r_T) + \{\Pi_f(p_f r_T) - \Pi_f(\rho_I)\}}{1 - \delta p_f} \tag{A-8}$$

Here $\Pi_i(r)$ denotes the borrower's profit function, the maximized value of $g_i f(l) - rl$. It is evident that an other-segment borrower dominates a floater, while the comparison between an own-segment and other-segment borrower is ambiguous (with the own-segment borrower being the best option if the agent is patient enough).

GBL

Neither model makes a definite prediction regarding which type of group should be more likely to apply for a GBL loan. The adverse selection model predicts positive assortative matching but it is unclear whether a risky group or a safe group stands to gain more from GBL. GBL loans are more attractive to the safe borrowers relative to the risky type, because they are exploited in the informal market implying a lower outside option. However, the safe type also expects to repay more often, compared to a risky type, which reduces the attractiveness of a TRAIL loan. The net impact of these two contrasting impacts is ambiguous.

In the moral hazard model, a group consisting of connected borrowers will be less likely to default, which will raise their value of participating in a low-interest group loan compared with a group which contains floating borrowers. On the other hand, floating borrowers have a lower effective cost of credit owing to a higher default risk, which makes the low interest loan more attractive to them compared with connected borrowers. Which effect dominates is ambiguous.

Compounding this ambiguity, the costs of attending group meetings and meeting savings requirements may also differ between the two types (safe/risky in the adverse selection model, and connected/floater in the moral hazard model) in a way that is difficult to predict *a priori*. Hence it is possible for GBL to comprise only of groups consisting of risky types/floaters, or a mixture of these with safe/connected types. Consequently the composition of GBL could involve lower productivity and higher default risk on average compared to TRAIL.

A-2 Tables

Table A-1: Impact on Farm Income

	Total Farm Income
TRAIL	100.184
	(449.420)
TRAIL × Control 1	11,466.308***
	(1,357.722)
TRAIL × Treatment	14,087.352***
	(1,756.879)
GBL × Control 1	10,065.811***
	(1,500.573)
GBL × Treatment	10,119.055***
	(1,093.911)
Landholding	7,824.408***
	(772.377)
Year 2	2,175.697***
	(299.017)
Information	1,574.616**
	(755.062)
Constant	-5,650.377***
	(673.451)
TRAIL Treatment	2621***
GBL Treatment	53.24
TRAIL Selection	11466***
GBL Selection	10066***
Sample Size	4,163
Mean Control 1	10328

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table A-2: Program Impacts. Total Borrowing and Cost of Borrowing.

	All Loans				Non-program Loans			
		Total Borrowing		Cost of Borrowing		Total Borrowing		Cost of Borrowing
	All Households	Borrowing Households	Heckman 2-step	(APR)	All Households	Borrowing Households Households	Heckman 2-step Households	(APR)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TRAIL	1,094.254	1,704.645	1,746.997***	-0.006	1,062.212	1,665.675	1,702.941***	-0.005
	(945.728)	(1,308.410)	(488.485)	(0.019)	(935.991)	(1,306.636)	(471.188)	(0.019)
TRAIL × Control 1	47.326	-417.019	-428.268	-0.006	65.011	-372.194	-381.244	-0.007
	(371.871)	(661.254)	(625.369)	(0.009)	(361.071)	(642.224)	(603.412)	(0.009)
TRAIL × Treatment	7,579.477***	6,709.212***	6,675.995***	-0.035***	-82.520	-867.933	-964.129	-0.001
	(888.288)	(890.298)	(582.656)	(0.010)	(416.302)	(616.041)	(614.693)	(0.012)
GBL × Control 1	78.576	-919.860	-809.764	0.042**	-2.199	-930.275	-831.534	0.041*
	(623.694)	(906.190)	(640.958)	(0.021)	(628.424)	(895.678)	(618.635)	(0.021)
GBL × Treatment	5,527.292***	5,544.600***	5,597.085***	-0.026**	42.640	-675.566	-660.068	0.027***
	(1,086.979)	(1,138.491)	(600.825)	(0.012)	(733.259)	(1,068.298)	(622.590)	(0.010)
Landholding	9,860.229***	10,362.743***	8,776.287***	-0.020**	9,076.121***	10,175.240***	8,723.097***	-0.030***
	(947.583)	(1,074.144)	(633.095)	(0.009)	(909.033)	(1,077.420)	(641.741)	(0.011)
Year 2	-295.288	557.355	988.271***	0.035***	-1,194.769***	-967.172***	-564.873	0.047***
	(220.161)	(335.761)	(376.855)	(0.012)	(196.727)	(278.993)	(376.023)	(0.015)
Information	841.956	1,232.649	1,334.164***	-0.008	631.290	1,038.375	1,131.793***	-0.010
	(890.136)	(1,143.823)	(359.296)	(0.013)	(835.111)	(1,158.007)	(355.956)	(0.017)
λ			-3,402.336***				-2,857.281***	
			(955.461)				(910.291)	
Constant	-228.497	919.534	3,070.452***	0.228***	697.530	1,822.373*	3,825.254***	0.230***
	(654.453)	(916.659)	(774.882)	(0.022)	(659.398)	(922.888)	(794.714)	(0.024)
TRAIL Treatment	7532.15***	7126.23***	7104.26***	-0.03**	-147.53	-495.74	-582.89	0.01
GBL Treatment	5448.72***	6464.46***	6406.85***	-0.07***	44.84	254.71	171.47	-0.01
TRAIL Selection	47.33	-417.02	-428.27	-0.01	65.01	-372.19	-381.24	-0.01
GBL Selection	78.58	-919.86	-809.76	0.04**	-2.20	-930.27	-831.53	0.04**
Sample Size	4,140	2,758	4,140	2,429	4,140	2,601	4,140	2,159
Mean Control 1	4826.45	7279.76	4826.45	0.24	4826.45	7279.76	4826.45	0.24

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$. In columns (3) and (7) we present the the second step of a Heckman two-step regression. The first stage selection regression estimates the likelihood that the households produces the relevant crop. Explanatory variables included in the first stage are land owned by the household, an indicator variable for cultivator household, a Year 2 dummy and price information treatment dummy.

Table A-3: Program Impacts. Treatment and Selection Effects.

	Cultivate	Acreage (Acres)	leased-in acres (Acres)	Output Kg	Cost of production Rs	Family labor hours Hours	Revenue Rs	Value added Rs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Potato								
TRAIL	0.055	0.001	0.004	-115.238	97.615	-0.958	-1,486.249	-1,589.679
	(0.055)	(0.058)	(0.028)	(669.726)	(1,333.226)	(7.009)	(2,750.641)	(1,551.934)
TRAIL × Control 1	0.095***	0.001	-0.003	145.390	372.820	-0.200	942.021	555.596
	(0.027)	(0.031)	(0.028)	(340.508)	(802.783)	(3.895)	(1,413.094)	(772.692)
TRAIL × Treatment	0.149***	0.091**	0.044	1,033.433***	2,146.572**	5.830	4,370.949***	2,242.245***
	(0.036)	(0.037)	(0.028)	(382.309)	(871.933)	(3.874)	(1,438.652)	(761.007)
GBL × Control 1	0.061	-0.042	0.004	-417.906	-1,111.024	4.951	-2,533.858	-1,371.324
	(0.056)	(0.054)	(0.031)	(651.373)	(1,251.406)	(7.196)	(2,799.426)	(1,646.360)
GBL × Treatment	0.111**	-0.002	0.027	-139.874	197.007	9.857	-896.902	-1,099.531
	(0.041)	(0.037)	(0.027)	(430.239)	(955.507)	(6.133)	(1,551.877)	(756.493)
Landholding	0.380***	0.495***	-0.118***	5,469.185***	9,383.561***	15.447***	25,291.922***	15,729.890***
	(0.037)	(0.049)	(0.029)	(560.767)	(1,182.893)	(4.003)	(2,506.055)	(1,464.911)
Year 2	-0.053***	-0.008	-0.016**	-430.967***	62.384	4.826***	6,514.608***	6,626.796***
	(0.009)	(0.008)	(0.007)	(105.858)	(258.183)	(1.273)	(670.838)	(613.263)
Information	0.020	0.053	0.034	596.451	926.414	5.073	1,561.330	602.351
	(0.050)	(0.053)	(0.023)	(613.697)	(1,268.748)	(6.294)	(2,615.559)	(1,440.187)
Constant	0.425***	0.178***	0.161***	2,092.029***	4,562.177***	43.865***	3,897.719*	-756.274
	(0.049)	(0.048)	(0.030)	(572.784)	(1,090.692)	(5.284)	(2,159.238)	(1,234.441)
TRAIL Treatment	0.0545	0.0896***	0.0467**	888.0***	1774**	6.030	3429***	1687**
GBL Treatment	0.0492	0.0401	0.0222	278.0	1308	4.906	1637	271.8
TRAIL Selection	0.0949***	0.000956	-0.00265	145.4	372.8	-0.200	942.0	555.6
GBL Selection	0.0614	-0.0421	0.00447	-417.9	-1111	4.951	-2534	-1371
Sample Size	4163	2718	2718	2718	2718	2718	2718	2718
Mean Control 1	0.677	0.432	0.111	4760	9538	57.86	19137	9498
Panel B: Sesame								
TRAIL	0.101	0.015	0.008	11.712	-24.437	1.593	135.763	156.846
	(0.063)	(0.037)	(0.022)	(19.248)	(66.943)	(2.441)	(378.014)	(345.314)

Continued . . .

Table A-3 (Continued): Program Impacts. Treatment and Selection Effects.

	Cultivate (1)	Acreage (Acres) (2)	leased-in acres (Acres) (3)	Output Kg (4)	Cost of production Rs (5)	Family labor hours Hours (6)	Revenue Rs (7)	Value added Rs (8)
TRAIL × Control 1	0.107***	0.019	0.001	-4.657	102.349**	0.081	-13.851	-115.552
	(0.027)	(0.028)	(0.026)	(13.536)	(45.830)	(1.801)	(311.201)	(291.653)
TRAIL × Treatment	0.128***	0.062**	0.009	1.537	121.289**	1.974	184.743	61.565
	(0.027)	(0.023)	(0.017)	(12.945)	(55.199)	(1.708)	(251.764)	(229.696)
GBL × Control 1	0.110**	-0.005	0.006	-3.592	-123.154*	5.252**	-44.667	73.646
	(0.047)	(0.043)	(0.024)	(14.780)	(63.018)	(2.355)	(336.784)	(294.467)
GBL × Treatment	0.072*	0.006	0.009	-9.488	-129.753	4.387**	-213.993	-84.676
	(0.043)	(0.037)	(0.028)	(12.353)	(78.938)	(1.985)	(244.533)	(211.506)
Landholding	0.395***	0.394***	-0.141***	117.164***	570.860***	5.763**	2,782.291***	2,208.820***
	(0.035)	(0.037)	(0.024)	(15.859)	(55.230)	(2.220)	(311.658)	(280.557)
Year 2	-0.044***	0.022**	-0.011	2.902	30.745	4.630***	1,125.419***	1,095.483***
	(0.014)	(0.011)	(0.008)	(6.106)	(39.870)	(1.091)	(152.713)	(133.379)
Information	-0.029	0.091***	0.038**	16.229	65.313	1.417	334.426	265.557
	(0.060)	(0.030)	(0.019)	(14.337)	(62.366)	(2.288)	(277.557)	(247.071)
Constant	0.250***	0.137***	0.147***	59.264***	346.167***	18.156***	606.102*	263.871
	(0.050)	(0.035)	(0.024)	(15.763)	(64.600)	(2.256)	(316.109)	(283.038)
TRAIL Treatment	0.0209	0.0424*	0.00796	6.193	18.94	1.893	198.6	177.1
GBL Treatment	-0.0377	0.0111	0.00273	-5.896	-6.598	-0.866	-169.3	-158.3
TRAIL Selection	0.107***	0.0192	0.00124	-4.657	102.3**	0.0811	-13.85	-115.6
GBL Selection	0.110**	-0.00519	0.00584	-3.592	-123.2*	5.252	-44.67	73.65
Sample Size	4163	2037	2037	2037	2037	2037	2037	2037
Mean Control 1	0.544	0.414	0.0921	132.5	683.8	27.25	2812	2126
Panel C: Paddy								
TRAIL	-0.019	0.014	0.020	-6.338	-143.502	-1.150	214.124	382.545
	(0.037)	(0.052)	(0.036)	(109.673)	(544.045)	(4.426)	(787.181)	(546.951)
TRAIL × Control 1	0.114***	-0.040	-0.035	-56.110	-219.156	1.452	-700.064	-505.665
	(0.028)	(0.033)	(0.032)	(46.281)	(257.134)	(2.559)	(518.429)	(366.657)
TRAIL × Treatment	0.093***	-0.008	0.012	-55.121	-58.746	-0.724	-239.936	-197.674
	(0.030)	(0.035)	(0.032)	(48.004)	(276.427)	(2.885)	(546.477)	(412.309)
GBL × Control 1	0.033	-0.002	-0.015	127.751**	411.864	5.864**	-350.043	-725.624*
	(0.034)	(0.037)	(0.031)	(56.408)	(374.376)	(2.692)	(611.068)	(431.453)

Continued . . .

Table A-3 (Continued): Program Impacts. Treatment and Selection Effects.

	Cultivate	Acreage (Acres)	leased-in acres (Acres)	Output Kg	Cost of production Rs	Family labor hours Hours	Revenue Rs	Value added Rs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GBL × Treatment	0.030	0.049	0.040	101.543	452.041	10.452***	202.923	-156.909
	(0.035)	(0.039)	(0.036)	(69.433)	(420.198)	(3.536)	(660.932)	(419.408)
Landholding	0.481***	0.916***	-0.136***	853.654***	5,118.839***	23.771***	7,686.338***	2,748.557***
	(0.026)	(0.058)	(0.048)	(93.595)	(548.070)	(3.682)	(852.889)	(570.041)
Year 2	-0.020*	-0.006	-0.018**	924.978***	825.094***	6.291***	1,304.679***	278.458
	(0.011)	(0.012)	(0.008)	(63.374)	(153.752)	(1.235)	(414.488)	(361.593)
Information	-0.032	-0.042	0.034	-66.922	-492.203	-5.315	76.243	576.528
	(0.037)	(0.044)	(0.025)	(96.763)	(512.177)	(3.714)	(684.021)	(461.329)
Constant	0.522***	0.197***	0.165***	-198.219	1,455.659**	25.995***	2,407.988***	1,034.253**
	(0.031)	(0.056)	(0.045)	(120.074)	(583.654)	(4.089)	(896.958)	(482.411)
TRAIL Treatment	-0.0210	0.0324**	0.0466***	0.988	160.4	-2.176	460.1**	308.0
GBL Treatment	-0.00369	0.0516	0.0543	-26.21	40.18	4.588*	553.0	568.7
TRAIL Selection	0.114***	-0.0402	-0.0351	-56.11	-219.2	1.452	-700.1	-505.7
GBL Selection	0.0334	-0.00237	-0.0147	127.8**	411.9	5.864**	-350.0	-725.6*
Sample Size	4163	3054	3054	3054	3054	3054	3054	3054
Mean Control 1	0.767	0.641	0.0852	708.0	4324	42.02	6718	2490
Panel D: Vegetables								
TRAIL	0.018	-0.014	0.020	781.525	306.603	3.894	-181.983	-678.376
	(0.049)	(0.029)	(0.024)	(519.171)	(455.798)	(14.993)	(3,326.134)	(3,050.016)
TRAIL × Control 1	-0.011	-0.016	-0.035*	-20.969	-43.546	4.025	1,182.277	1,328.894
	(0.011)	(0.022)	(0.020)	(183.535)	(307.927)	(18.392)	(1,288.349)	(1,025.976)
TRAIL × Treatment	-0.007	0.142**	0.045	302.504	1,072.094	22.135	3,626.783*	2,583.865
	(0.011)	(0.067)	(0.046)	(232.142)	(745.138)	(17.945)	(1,844.248)	(1,587.705)
GBL × Control 1	0.045**	-0.014	-0.010	-110.290	-102.531	3.206	-1,010.409	-957.482
	(0.021)	(0.032)	(0.021)	(215.276)	(611.214)	(9.885)	(2,248.128)	(1,645.141)
GBL × Treatment	0.068***	-0.034*	0.017	-35.956	-165.752	3.478	-3,080.971*	-2,912.706**
	(0.023)	(0.019)	(0.018)	(104.440)	(502.244)	(10.686)	(1,772.812)	(1,378.714)
Landholding	0.065**	0.049	-0.122***	1,001.805**	349.959	-2.970	7,774.166***	7,263.317***
	(0.026)	(0.040)	(0.025)	(430.355)	(440.349)	(12.961)	(2,354.370)	(1,980.563)
Year 2	-0.007	0.026*	-0.008	740.838*	1,001.058***	20.512	6,169.337***	5,035.842***
	(0.010)	(0.015)	(0.008)	(374.548)	(198.930)	(12.729)	(1,723.776)	(1,700.895)

Continued . . .

Table A-3 (Continued): Program Impacts. Treatment and Selection Effects.

	Cultivate	Acreage (Acres)	leased-in acres (Acres)	Output Kg	Cost of production Rs	Family labor hours Hours	Revenue Rs	Value added Rs
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Information	0.050	0.059**	-0.002	1,005.792**	1,062.282***	46.768**	7,452.088**	6,186.548**
	(0.051)	(0.025)	(0.017)	(479.856)	(332.893)	(17.833)	(3,131.713)	(2,829.793)
Constant	0.028	0.140***	0.110***	-448.654	2,173.384***	48.213***	91.940	-1,874.682
	(0.025)	(0.040)	(0.026)	(721.773)	(404.649)	(16.376)	(2,990.169)	(2,665.239)
TRAIL Treatment	0.00376	0.159**	0.0793*	323.5	1116**	18.11**	2445	1255
GBL Treatment	0.0236	-0.0197	0.0276	74.33	-63.22	0.272	-2071	-1955
TRAIL Selection	-0.0112	-0.0161	-0.0345*	-20.97	-43.55	4.025	1182	1329
GBL Selection	0.0446**	-0.0145	-0.0104	-110.3	-102.5	3.205	-1010	-957.5
Sample Size	4163	402	402	402	402	402	402	402
Mean Control 1	0.100	0.196	0.0204	1381	3564	90.22	12030	8325

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land.
Standard errors clustered at the village level in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$

Table A-4: Program Impacts. Heckman estimates

	Potato			Sesame		
	Cost of production	Revenue	Value added	Cost of production	Revenue	Value added
	(1)	(2)	(3)	(4)	(5)	(6)
	Potato			Sesame		
	(1)	(2)	(3)	(4)	(5)	(6)
	Cost of production	Revenue	Value added	Cost of production	Revenue	Value added
TRAIL	135.922	-1,411.725	-1,553.780**	-23.061	145.876	165.614
	(500.423)	(973.981)	(629.503)	(46.030)	(176.605)	(158.528)
TRAIL × Control 1	388.004	971.560	569.825	101.908*	-16.177	-117.443
	(621.431)	(1,209.502)	(782.135)	(54.341)	(208.405)	(187.092)
TRAIL × Treatment	2,104.936***	4,289.951***	2,203.227***	119.731**	175.755	54.115
	(613.238)	(1,193.556)	(771.625)	(54.244)	(208.059)	(186.776)
GBL × Control 1	-969.847	-2,259.210*	-1,239.025	-119.017*	-17.900	96.338
	(678.740)	(1,321.044)	(854.366)	(61.572)	(236.134)	(211.986)
GBL × Treatment	204.778	-881.783	-1,092.248	-130.027**	-218.662	-89.023
	(655.451)	(1,275.716)	(824.983)	(63.218)	(242.425)	(217.638)
Land	7,955.755***	22,514.242***	14,391.876***	500.000***	2,366.826***	1,863.323***
	(611.934)	(1,191.004)	(765.550)	(67.486)	(260.270)	(233.339)
Information	825.136**	1,364.303*	507.442	69.919**	361.512***	288.080**
	(370.492)	(721.088)	(463.790)	(33.538)	(129.308)	(115.936)
Year 2	283.407	6,944.590***	6,833.919***	38.944	1,175.618***	1,137.585***
	(373.948)	(727.813)	(468.106)	(33.800)	(130.317)	(116.840)
λ	-2,920.583***	-5,681.754***	-2,736.912***	-121.883	-719.302**	-598.946*
	(813.710)	(1,583.721)	(1,018.762)	(91.587)	(352.973)	(316.502)
Constant	6,616.633***	7,894.495***	1,168.980	467.974***	1,320.403***	857.887**
	(772.043)	(1,502.624)	(966.455)	(102.897)	(396.648)	(355.646)
TRAIL Treatment	1717**	3318**	1633*	17.82	191.9	171.6
GBL Treatment	1175	1377	146.8	-11.01	-200.8	-185.4
TRAIL Selection	388.0	971.6	569.8	101.9*	-16.18	-117.4
GBL Selection	-969.8	-2259*	-1239	-119.0***	-17.90	96.34
Sample Size	4,163	4,163	4,163	4,163	4,163	4,163
Mean Control 1	6457	12954	6430	371.9	1529	1156
	Paddy			Vegetables		
	Cost of production	Revenue	Value added	Cost of production	Revenue	Value added
	(7)	(8)	(9)	(10)	(11)	(12)
TRAIL	-141.786	222.203	389.124	308.939	-157.742	-656.307
	(195.251)	(363.432)	(276.877)	(405.084)	(1,447.774)	(1,229.151)
TRAIL × Control 1	-223.150	-700.581	-502.693	-45.264	1,164.444	1,312.659
	(249.130)	(463.859)	(353.426)	(528.898)	(1,890.210)	(1,604.765)
TRAIL × Treatment	-51.742	-229.043	-192.900	1,071.083**	3,616.288*	2,574.311
	(253.828)	(472.499)	(359.979)	(529.019)	(1,890.682)	(1,605.171)
GBL × Control 1	394.038	-356.353	-716.361*	-97.383	-956.970	-908.831
	(261.633)	(487.176)	(371.202)	(499.585)	(1,785.826)	(1,516.199)
GBL × Treatment	459.679*	220.473	-146.032	-171.444	-3,140.056*	-2,966.499**
	(260.680)	(485.421)	(369.870)	(465.492)	(1,663.537)	(1,412.313)
Land	5,547.607***	8,091.820***	2,779.448***	449.884	8,811.439***	8,207.665***
	(302.001)	(560.657)	(426.716)	(536.442)	(1,935.738)	(1,646.084)

Continued ...

Table A-4 (Continued): Program Impacts. Heckman estimates

	Cost of production	Revenue	Value added	Cost of production	Revenue	Value added
Information	-512.905***	64.940	583.312***	1,144.137***	8,301.785***	6,960.124***
	(146.338)	(271.827)	(206.931)	(441.079)	(1,591.981)	(1,353.816)
Year 2	808.721***	1,297.769***	285.852	990.220***	6,056.830***	4,933.414***
	(145.200)	(269.709)	(205.317)	(295.063)	(1,065.574)	(906.246)
λ	711.531*	692.495	70.869	344.704	3,578.222	3,257.660
	(394.867)	(733.784)	(558.687)	(1,372.699)	(4,954.280)	(4,213.077)
Constant	999.727***	1,951.444***	976.031**	1,480.118	-7,104.547	-8,426.458
	(321.275)	(596.774)	(454.299)	(2,794.411)	(10,085.317)	(8,576.448)
TRAIL Treatment	171.4	471.5	309.8	1116*	2452	1262
GBL Treatment	65.64	576.8	570.3	-74.06	-2183	-2058
TRAIL Selection	-223.1	-700.6	-502.7	-45.26	1164	1313
GBL Selection	394.0	-356.4	-716.4**	-97.38	-957.0	-908.8
Sample Size	4,163	4,163	4,163	4,163	4,163	4,163
Mean Control 1	3317	5153	1910	356.4	1203	832.5

Notes:
Second step of a Heckman two-step regression are presented.
The first stage selection regression estimates the likelihood that the households produces the relevant crop.
Explanatory variables included in the first stage are land owned by the household, an indicator variable for cultivator household, a Year 2 dummy and price information treatment dummy.
Standard errors, clustered at the village level are in parentheses.
$^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres.

Table A-5: Effects on Potato Cultivation. Robustness to Alternative Clustering

	Cultivate	Output	Cost of production	Family labour hours	Revenue	Value added	Agricultural Income
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
TRAIL	0.055*	-115.796	93.385	-0.989	-1,488.198	-1,587.492	-1,586.918*
	(0.028)	(380.534)	(805.738)	(3.529)	(1,634.807)	(972.165)	(947.199)
TRAIL × Control 1	0.095*	151.936	392.224	-0.235	976.978	570.811	478.369
	(0.049)	(513.788)	(1,147.261)	(4.479)	(2,173.439)	(1,188.446)	(1,168.674)
TRAIL × Treatment	0.149***	1,039.587*	2,164.464*	5.664	4,402.500*	2,255.587*	2,151.543*
	(0.040)	(566.385)	(1,260.021)	(3.988)	(2,386.021)	(1,239.065)	(1,204.041)
GBL × Control 1	0.035	-17.484	-296.812	6.770	-559.851	-218.571	-558.360
	(0.045)	(525.387)	(1,088.376)	(6.557)	(2,214.644)	(1,340.869)	(1,325.603)
GBL × Treatment	0.114**	-51.683	403.830	10.449	-530.708	-944.247	-1,300.749
	(0.047)	(476.750)	(1,006.425)	(6.892)	(2,032.389)	(1,140.104)	(1,086.478)
Landholding	0.380***	5,545.846***	9,549.262***	14.903***	25,701.365***	15,969.069***	15,660.449***
	(0.026)	(405.070)	(929.099)	(3.693)	(1,763.803)	(1,000.462)	(978.687)
Year 2	-0.054***	-424.243***	93.039	5.065***	6,637.673***	6,721.975***	6,377.538***
	(0.008)	(96.864)	(232.454)	(1.103)	(529.659)	(491.487)	(498.982)
Information	0.023	509.441	777.030	4.185	1,180.579	371.460	265.762
	(0.026)	(332.960)	(732.170)	(3.048)	(1,407.725)	(775.764)	(755.626)
Constant	0.425***	2,086.371***	4,521.095***	44.525***	3,783.681**	-828.040	-1,700.583*
	(0.029)	(399.873)	(832.060)	(3.820)	(1,677.875)	(968.571)	(943.829)
TRAIL Treatment	0.0546	887.7***	1772**	5.899	3426***	1685***	1673***
GBL Treatment	0.0782	-34.20	700.6	3.680	29.14	-725.7	-742.4
TRAIL Selection	0.0949*	151.9	392.2	-0.235	977.0	570.8	478.4
GBL Selection	0.035	-17.48	-298.81	6.770	-559.85	-218.57	-558.36
Sample Size	4,103	2,668	2,668	2,668	2,668	2,668	2,668
Mean Control 1	0.677	4760	9538	57.86	19137	9498	8076

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the group/network level. In GBL villages, for each Treatment and Control 1 household the GBL group they formed is the cluster; each Control 2 household is a singleton cluster. In TRAIL villages, all Treatment and Control 1 households belong to the same cluster, and all Control 2 households belong to singleton clusters. . $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table A-6: Effect on Non-Farm Incomes

	Income From Rent (Rs) (1)	Income From Animal Products (Rs) (2)	Labor Income Year (Rs) (3)	Wage Employment last 2 weeks (Hours) (4)	Self-employment last 2 weeks (Hours) (5)	Reported profits (Rs) (6)	Current value of business (Rs) (7)	Total non-farm income (Rs) (8)
TRAIL	108.560	5.554	635.466	1.781	0.596	-2,534.427	-1,126.579	-1,784.848
	(532.085)	(355.240)	(7,068.918)	(3.580)	(4.820)	(1,771.661)	(2,678.297)	(8,184.392)
TRAIL × Control 1	-182.095	62.660	-12,729.069**	-6.855*	0.215	100.867	952.105	-12,747.637**
	(500.805)	(202.625)	(5,437.318)	(3.583)	(2.921)	(988.988)	(3,415.009)	(5,461.814)
TRAIL × Treatment	-28.469	229.463	-12,336.034**	-6.240*	7.099	2,443.751	5,869.309*	-9,691.290
	(584.958)	(167.812)	(5,786.361)	(3.405)	(4.420)	(1,529.128)	(3,208.141)	(6,311.356)
GBL × Control 1	-427.992	-279.106	-4,948.024	1.745	5.914*	-1,917.362	354.307	-7,572.483
	(588.114)	(188.273)	(6,249.854)	(3.505)	(3.485)	(1,971.453)	(4,569.906)	(6,067.983)
GBL × Treatment	356.382	-229.930	-10,589.894**	-2.751	10.208**	1,000.666	7,045.903	-9,462.776*
	(679.482)	(196.540)	(4,472.769)	(2.465)	(4.474)	(2,358.029)	(5,808.770)	(4,864.195)
Landholding	2,687.798***	267.666	-358.910	-22.727***	39.051***	3,920.037***	9,864.171***	6,516.591
	(399.336)	(171.962)	(3,894.848)	(2.092)	(3.811)	(1,319.515)	(3,084.993)	(4,418.838)
Year 2	618.637***	-50.971	9,365.086***	2.587***	10.004***	1,545.952***	-95.606	11,478.704***
	(117.937)	(50.638)	(810.267)	(0.548)	(1.852)	(426.144)	(782.110)	(1,104.196)
Information	-112.776	-90.339	-2,107.285	-2.224	0.137	287.369	-48.114	-2,023.031
	(351.375)	(289.516)	(5,156.547)	(2.927)	(4.568)	(1,637.636)	(2,990.193)	(6,138.902)
Constant	350.758	824.185***	42,521.843***	51.408***	96.781***	5,410.073***	6,250.040***	49,106.859***
	(449.002)	(284.628)	(5,251.554)	(2.429)	(4.515)	(1,351.452)	(2,161.766)	(6,245.452)
TRAIL Treatment	153.6	166.8	393.0	0.615	6.884	2343	4917	3056
GBL Treatment	784.4	49.18	-5642	-4.496	4.294	2918	6692	-1890
TRAIL Selection	-182.1	62.66	-12729**	-6.855*	0.215	100.9	952.1	-12748**
GBL Selection	-427.9	-279.1	-4941	1.749	5.914*	-1917	353.8	-7565
Sample Size	4162	4162	4162	4162	4162	4162	4162	4162
Mean Control 1	1508	771.0	37465	40.24	121.8	5802	10465	45546

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01, ^{**} p < 0.05, ^{*} p < 0.1$.

Table A-7: Sensitivity of Potato Value Added to Price Changes

	Actual (1)	2011 prices (2)	2012 prices (3)	2007 prices (4)	2008 prices (5)	2011 market wage (6)	2012 market wage (7)
TRAIL	-1,589.679	-1,451.226	-1,302.549	-2,859.985	-1,126.481	-1,635.501	-1,593.299
	(1,551.934)	(1,375.531)	(2,206.522)	(2,770.800)	(1,748.336)	(1,503.712)	(1,512.573)
TRAIL × Control 1	555.596	318.049	254.762	-46.367	1,051.536	463.516	460.384
	(772.692)	(562.278)	(1,031.190)	(905.080)	(799.170)	(788.022)	(791.002)
TRAIL × Treatment	2,242.245***	1,972.191***	3,441.345***	-241.029	-861.474	2,135.178***	2,125.575***
	(761.007)	(640.304)	(1,114.583)	(875.179)	(783.554)	(737.285)	(738.314)
GBL × Control 1	-1,371.324	-872.689	-1,906.918	-2,787.480	-2,679.533**	-1,482.598	-1,416.493
	(1,646.360)	(1,350.561)	(2,017.476)	(1,878.110)	(1,275.888)	(1,577.395)	(1,593.019)
GBL × Treatment	-1,099.531	-817.578	-1,406.869	-2,970.609**	-1,251.511*	-1,265.260*	-1,233.923*
	(756.493)	(686.889)	(1,060.696)	(1,239.659)	(713.242)	(705.881)	(707.044)
Landholding	15,729.890***	11,595.234***	18,427.354***	4,743.184*	-6,241.849***	15,420.887***	15,388.790***
	(1,464.911)	(1,188.217)	(1,972.007)	(2,528.438)	(1,557.149)	(1,433.362)	(1,437.439)
Year 2	6,626.796***	-551.623*	-1,311.565***	-1,928.218***	-1,651.548***	6,502.891***	6,501.867***
	(613.263)	(301.417)	(435.676)	(445.890)	(505.500)	(614.109)	(613.046)
Information	602.351	866.934	1,580.497	900.642	-2,993.669*	556.710	628.278
	(1,440.187)	(1,269.801)	(2,101.128)	(2,554.799)	(1,599.434)	(1,382.008)	(1,390.102)
Constant	-756.274	3,265.392***	6,307.867***	5,391.075*	2,106.789	-1,672.060	-1,824.418
	(1,234.441)	(1,091.183)	(1,640.444)	(2,965.525)	(1,733.612)	(1,193.182)	(1,203.379)
TRAIL Treatment	1687**	1654***	3187***	-194.7	-1913**	1672**	1665**
GBL Treatment	271.8	55.11	500.0	-328.5	1653	217.3	182.6
TRAIL Selection	555.6	318.0	254.8	-45.25	1079	463.5	460.4
GBL Selection	-1371	-872.7	-1907	-2744	-2886**	-1483	-1416
Sample Size	2718	2718	2718	2718	2718	2718	2718
Mean Control 1	9498	8258	14311	4423	-4434	8219	8134

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01, ^{**}p < 0.05, ^{*}p < 0.1$.

Table A-8: Transactions with TRAIL Agent Input Market

	Ever buy from Agent	Share buy from Agent	Input Price (Rs/unit) Inorganic Fertilizer	Organic Fertilizer	Outside Seed	Pesticide	Powertiller	Water/irrigation
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Inorganic fertilizer	-0.030***	-0.011*						
	(0.007)	(0.006)						
Organic fertilizer	-0.100***	0.011						
	(0.011)	(0.017)						
Outside seed	-0.054***	-0.044***						
	(0.011)	(0.009)						
Plough/bullock	-0.156***	-0.101***						
	(0.011)	(0.010)						
Powertiller	-0.160***	-0.102***						
	(0.010)	(0.009)						
Local seed	-0.158***	-0.086***						
	(0.010)	(0.013)						
Water/irrigation	-0.160***	-0.103***						
	(0.010)	(0.009)						
Treatment	0.004	0.015						
	(0.013)	(0.013)						
Control 1	0.008	0.019						
	(0.013)	(0.013)						
Buy from agent			0.070	-10.833***	-0.644	66.470**	36.711**	147.802
			(0.323)	(3.677)	(1.343)	(28.633)	(14.958)	(131.529)
Buy from agent × Treatment			-0.152	25.365*	-0.690	-56.406	-65.564***	
			(0.428)	(15.010)	(1.574)	(48.582)	(15.024)	
Buy from agent × Control 1			0.170	-4.024	-2.863*	-25.323	-33.231**	-148.345
			(0.508)	(2.631)	(1.568)	(45.789)	(15.136)	(132.129)
Landholding	-0.040***	-0.020	0.291	-3.600	-4.804*	-20.291	0.996	12.531
	(0.013)	(0.013)	(0.226)	(7.811)	(2.719)	(18.900)	(3.606)	(11.597)
Year 2	-0.021***	0.007**	6.406***	9.052	-2.174	36.118***	19.594***	-20.841***
	(0.003)	(0.003)	(0.132)	(6.914)	(1.517)	(10.393)	(2.161)	(5.864)
Information Village	0.003	0.009	0.111	6.908	1.342	-2.178	1.220	-2.888
	(0.010)	(0.010)	(0.175)	(6.071)	(1.889)	(15.979)	(2.403)	(6.256)
Constant	0.190***	0.101***	10.081***	19.101***	26.283***	533.145***	183.253***	83.088***
	(0.015)	(0.014)	(0.171)	(4.702)	(1.270)	(17.676)	(2.401)	(3.991)
TRAIL Treatment	-0.00338	-0.00359	-0.322	29.39*	2.174	-31.08	-32.33***	148.3
TRAIL Selection	0.00780	0.0187	0.170	-4.024	-2.863*	-25.32	-33.23**	-148.3
Sample Size	12,448	10,196	1,672	370	1,654	2,691	1,403	1,230
Mean Control 1	0.0875	0.0760	13.78	16.12	22.36	533.5	195.2	72.30

Table A-9: Transactions with TRAIL Agent Output Market

	Ever sold output to agent	Share of output sold to agent	Output (price/kg)		
			Potato	Paddy	Sesame
	(1)	(2)	(3)	(4)	(5)
Paddy	-0.089***	-0.005			
	(0.019)	(0.018)			
Sesame	-0.132***	-0.019			
	(0.015)	(0.014)			
Treatment	0.011	0.062**			
	(0.027)	(0.026)			
Control 1	0.006	0.046*			
	(0.026)	(0.024)			
Landholding	-0.114***	0.005	0.282***	-0.045	0.640
	(0.027)	(0.024)	(0.086)	(0.200)	(0.567)
Year 2	-0.084***	0.016**	1.267***	-0.563***	8.195***
	(0.010)	(0.008)	(0.053)	(0.117)	(0.681)
Information Village	0.128***	0.107***	-0.287***	-0.238*	-0.892***
	(0.020)	(0.019)	(0.063)	(0.141)	(0.250)
Sell to agent			-0.286***	0.245	0.619
			(0.108)	(0.166)	(0.511)
Sell to agent × Treatment			0.195	-0.120	0.612
			(0.184)	(0.206)	(0.795)
Sell to agent × Control 1			0.096	-0.149	8.429
			(0.148)	(0.195)	(7.904)
Constant	0.297***	0.047**	3.894***	9.849***	23.110***
	(0.024)	(0.023)	(0.057)	(0.153)	(0.222)
TRAIL Treatment	0.00559	0.0152	0.0998	0.0289	-7.817
TRAIL Selection	0.00560	0.0465**	0.0955	-0.149	8.429
Sample size	2,990	2,765	1,386	498	881
Mean Control 1	0.209	0.151	4.507	9.282	28.42

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table A-10: Transactions with TRAIL Agent Credit Market

	Ever Borrow from Agent (1)	Share Borrow from Agent (2)	APR (3)
Treatment	-0.022	-0.020	
	(0.031)	(0.013)	
Control 1	0.060*	0.016*	
	(0.031)	(0.009)	
Loan from Agent			0.026
			(0.019)
Loan from Agent × Treatment			-0.004
			(0.045)
Loan from Agent × Control 1			-0.007
			(0.029)
Landholding	-0.029	-0.019	-0.002
	(0.059)	(0.019)	(0.007)
Year 2	-0.037**	0.008	-0.011**
	(0.017)	(0.009)	(0.005)
Information Village	0.101	0.018	0.024***
	(0.115)	(0.025)	(0.006)
Loansize			0.004***
			(0.001)
Duration > 120 days			0.045***
			(0.007)
Constant	0.099	0.031	0.089***
	(0.077)	(0.025)	(0.008)
TRAIL Treatment	-0.082*	-0.036**	0.003
TRAIL Selection	0.060*	0.016*	-0.007
Sample size	1,398	1,398	4,320
Mean Control 1	0.173	0.049	0.145

Notes:
The sample consists of sample households in TRAIL and GBL villages with at most 1.5 acres of land. Standard errors clustered at the village level in parentheses. $^{***}p < 0.01$,$^{**}\,p < 0.05$,$^{*}\,p < 0.1$. Borrowing restricted to agricultural purposes.