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

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Abstract

We conduct a randomized 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.

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1 Introduction

A major challenge in development policy is to find a way for formal financial institutions to provide credit to meet agricultural needs of poor farmers. Institutional finance is typically available only to those with enough land or assets to post as collateral, resulting in financial exclusion of the majority of the rural population in most developing countries. This restricts growth in agricultural production and the ability of poor farming households to escape poverty by diversifying into high value cash crops with high capital requirements (Feder, 1985, Armendáriz and Morduch, 2005). The underlying problem is the difficulty of selecting creditworthy borrowers and enforcing loan repayments among those lacking asset collateral.

This chasm has been filled to some extent by microcredit. But due to its requirements of high repayment frequency and low tolerance for risk, microcredit has not succeeded in financing productive needs of poor borrowers. Recent evaluations of microcredit indicate that instead of 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 potatoes, a 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 they recommend. 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. The loans

were index-insured against village-level fluctuations in potato yield or prices of greater than 20%.

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 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, while controlling for endogenous selection.

We compare the impacts of the TRAIL scheme with those of the 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 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 GBL and TRAIL loans. Thus, joint liability and "horizontal social capital" inherent in peer monitoring and peer pressure were the primary mechanisms for selection, monitoring and loan repayment in the GBL scheme, rather than the "vertical social capital" represented by borrower-lender relationships that was leveraged in the TRAIL scheme.

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 market 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 (i.e., maximize aggregate payoffs of network members), besides sharing useful production and marketing information that raises farm productivity. Cooperative behavior can result from close social and economic relationships and/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 on the informal market.

The predictions of this network-based model are as follows. Similar predictions are also generated by more conventional models of segmented credit markets based on adverse selection or moral hazard and absence of cooperative behavior within networks. A networked lender appointed as a TRAIL agent is motivated to recommend borrowers from his own network. This owes 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, the cheaper interest rate on GBL loans compared with that on loans

from informal sources induces *both* groups of connected borrowers and floating borrowers to form and apply for joint liability loans. Hence the composition of TRAIL borrowers are inherently biased in favor of connected borrowers compared to GBL.

Since connected borrowers are more productive, a given drop in interest rates induces TRAIL borrowers to expand production and borrowing by more than in GBL. This is reinforced by cooperative behavior of TRAIL borrowers towards the agent, as a larger scale of borrowing generates higher agent commissions. Moreover, the joint liability feature in GBL (which raises effective cost of credit) and peer pressure from group members tends to discourage expansion in the scale of borrowing and in risk-taking. Hence TRAIL is predicted to generate higher expansion of borrowing, production of high value cash crops and farm incomes than GBL.[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 main alternatives such as 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 potato, and index insurance 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 TRAIL induced a (quantitatively and statistically) significant increase in levels of borrowing, acreage devoted to potatoes, and farm incomes. The comparative effects of GBL 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 potato and total farm income ranged from 70-115% and were statistically significant; in contrast the corresponding point estimates were 37-38% in GBL and were statistically not significant.

With regard to loan repayments and take-up, TRAIL 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 borrowers benefitted more from TRAIL.[2] Moreover, we found no evidence of manipulation

[1]Segmented credit market models based on non-cooperative behavior also predict the selection patterns as the model above, because of the incentives of the TRAIL agent induced by repayment-based commissions. To the extent that more productive borrowers are selected in TRAIL, the effects of a drop in the cost of credit on expansion of scale of cultivation and farm incomes are larger. This expansion is accentuated when the TRAIL borrowers and the agent cooperate.

[2]However, due to high imprecision of GBL estimates, some of these differences are not statistically significant.

of transactions with borrowers that could have been used by the agent to extract TRAIL borrower benefits. 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 TRAIL successfully harnessed local network relationships between loan agents and borrowers to create a "win-win" situation where borrowers and agents benefitted, while generating high repayment rates, loan take-up and lowering 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 lower average (and more dispersed) impact on potato production and farm incomes.

Our paper contributes significantly to an on-going policy debate in India regarding ways to increase financial access of the rural population of the country. Specifically the TRAIL scheme employs a lending approach that India's central bank has been promoting recently: the Reserve Bank of India (RBI) has recently recommended that a network of banking correspondents (BCs) and banking facilitators (BFs) be recruited from within local communities (Srinivasan, 2008). To our knowledge this is the first paper to systematically examine and test a variant of the banking facilitator (BF) scheme proposed by RBI. While concerns have been raised that banking facilitators might abuse their discretionary power, our mechanism is designed so as to limit the possibility that the local intermediaries (whom we call *agents*) collude and extract all surplus.[3] Agents can only recommend households that own less than a pre-determined 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. These restrictions limit the avenues through which the agent could extract surplus from the recommended borrowers. We also empirically evaluate evidence of possible extraction.[4]

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 some additional results in Section 5. Section 6 concludes.

[3] A large literature in contract theory discusses the role of middlemen and managers in contexts with asymmetric information (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.

[4] 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). Floro and Ray (1997) argue that in the Philippines the major group of informal lenders colluded to engage in rent-seeking, thus defeating the purpose of the program.

2 Experimental Design and Data

The field experiment was conducted in two districts Hugli and West Medinipur in the state of West Bengal, India. The districts were chosen because they grow some of the largest quantities of potatoes in West Bengal. The state itself produces about a third of all potatoes grown in India. We collaborated with Shree Sanchari, a Kolkata based MFI. In October 2010 Shree Sanchari implemented the TRAIL scheme in 24 randomly selected villages, and GBL in another 24 villages. The two schemes were never offered in the same village and 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.[5]

Loans given through both schemes shared certain common features. The annual interest rate charged was 18%. The first round loans were capped at Rupees 2000 (equivalent to approximately $US40 at the prevailing exchange rate), and were disbursed in October-November 2010, when potatoes are planted. Repayment was due four months later following the potato harvest, in a single lump sum. 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.[6] While the terms of the loan implicitly encouraged borrowers to use the loans in agriculture, borrowers were not required to state the intended or actual use of the loan when they applied for it.[7]

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,

[5] In 24 other villages we implemented an alternative version of the agent intermediated lending scheme: there the agent was recommended by the village council or *Gram Panchayat*. We call this approach GRAIL. In this paper we compare the selection patterns and outcomes in TRAIL and GBL. Analysis of GRAIL is left for future research. 68 of these 72 villages were in a sample drawn for a previous project conducted by a subset of the authors in this project (see Mitra, Mookherjee, Torero, and Visaria, 2013).

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

[7] However in our household survey data we do ask respondents to report the actual purpose of each loan they have taken irrespective of whether the loan is from Shree Sanchari or any other formal or informal source.

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.[8] 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 would be 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.

For each recommended borrower who accepted the loan, the agent was required to deposit Rs 50 with Shree Sanchari. Subsequently, at the end of each loan cycle he received as commission 75% of the interest paid by each borrower whom he had recommended. The initial deposit was refunded to the agent at the end of two years, in proportion to loan repayment rates by the recommended borrowers. The agent's contract would be terminated at the end of any cycle in which 50% of the borrowers failed to repay. All agents who survived in the program for two years were promised a special holiday package at a local sea-side resort. In informal conversations with our research team, TRAIL agents also reported that they expected that their participation in the scheme would improve their reputation and market share within the village.

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 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 lumpsum. 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 and mandated savings 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.

[8]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

Household surveys were conducted every four months with 50 households in each village. We collected 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. Sample households belong to one of three categories. In each village sample there are 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. There are also 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, there are 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 were filled through a random draw of non-recommended/non-selected households from the village.[9]

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.[10] 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 in Cycle 1, for all sample households that owned less than 1.5 acres of land. Our surveys included questions pertaining to all borrowing, borrowing for agricultural purposes and borrowing for consumption and emergency purposes. These purposes are self-reported by the households. Households also borrow for business and other (non-specified) reasons; these are omitted from the summary statistics

[9]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.

[10]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 either being recommended by the agent or by joining a GBL group. By 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 reweight 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 designed or introduced sidesteps this problem.

presented in Table 2.[11] Households borrow from multiple sources – traders and money lenders (informal lenders), government banks, friends and family, cooperatives (under the *Swarna Jayanti Swarojgar Yojna* or SJSY scheme), other MFIs and others (unspecified lenders). We exclude borrowings from other MFIs and others from our analysis as these contribute very little to the overall household lending: approximately 1 percent of household borrowings are from other MFIs and none of this is for agricultural purposes. The majority of loans are from informal lenders, followed by cooperatives under the SJSY scheme. Only 6 percent of all agricultural loans are from government banks.

The average interest rate on loans from informal lenders is 26%, substantially above the rate on 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 collateralized. Loans from cooperatives and government banks charge lower interest rates of 15 and 12%, have longer average durations (323 and 299 days respectively), and are collateralized (73 and 77%) to a much higher degree. Hence access to low cost and longer duration institutional finance requires collateral, which poor households mostly lack, resulting in the majority of them borrowing from informal sources.

Table 3 describes production details of major crops. Paddy is grown twice or thrice a year, accounting for an average annual acreage of 0.69. Potato is a winter crop planted only once a year, with sesame being the only other major competitor in the same season: both account for similar annual acreages: 0.48 and 0.43 respectively. A large range of vegetables such as cauliflower, cabbage, gourd, chillies and lentils are grown year round on small patches, accounting for annual acreage of 0.20. Potato involves the highest annual cultivation cost of Rs 10335 (followed by paddy at Rs 4061), the highest average revenue of Rs 17708 (followed by Rs 8976 aggregating across all vegetables, and Rs 2599 for paddy), and the highest value added of Rs 7245 (followed by Rs 5586 for vegetables and Rs 2843 for paddy). The pre-eminent role of potato as a source of high farm income is evident from these figures, as is the high working capital needs of this crop.

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 assumes cooperative behavior within borrower-lender networks. The motivation for the latter feature is drawn from description of dense social and economic agent-borrower relationships in a field study of a sample of these villages by our graduate students (Ah-Tye, Bai, Blanco, Pheiffer, and Winata, 2013) involving credit, insurance and advice on production, input sourcing and marketing matters provided by the agent. Foster and Rosenzweig (1996), Bandiera and Rasul (2006), Conley and Udry (2010) have provided evidence of ways in which farmers

[11] Approximately 1 percent of our sample households borrow for business purposes; a similar number borrow for other reasons.

learn from others in the same social network. Similar results are obtained using more standard formulations of credit markets without any such network effects, but involving adverse selection and moral hazard, as in Ghatak (2000) and Besley and Coate (1995).

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: they maximize the aggregate payoff of all within-network members. Floating borrowers operate in isolation and behave non-cooperatively, to maximize their own payoffs. Network lenders 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. 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 $p_f(2 - p_f) < p_c$.[12]

All lenders face a cost of capital ρ_I, and are unconstrained in terms of lending capacity. Conditional on the project succeeding, 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 help received from the network makes connected borrowers more productive, so g is higher for connected borrowers.

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.[13] When projects do not succeed, the borrower cannot repay owing to limited liability.

Since all networks have identical costs of capital and there are no capacity constraints, there is no gain from borrowing or lending across networks.[14] 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 $l_I^c = \text{argmax}_{l \geq 0}\{p_c g f(l) - \rho_I l\} \equiv p_c \Pi(\frac{\rho_I}{p_c})$ where $\Pi(r)$ denotes the maximized value of $gf(l) - rl$, and r is the *effective cost of credit (ECC)*.

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

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

[14]This is true even if the likelihood of project success and loan repayment probability is the same for a connected borrower irrespective of whether the loan is from a lender in the same or a different network. Obviously, if project success and loan repayment likelihoods are lower across networks then lending within networks is more valuable and profitable.

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 $l_I^f = \text{argmax}_{l\geq 0}\{p_f g f(l) - \rho_I l\} \equiv p_f \Pi(\frac{\rho_I}{p_f})$. 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 $r_T < \rho_I$.

Suppose initially there is no collusion, in the sense that the agent does not charge borrower bribes 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: $l_T^c = \text{argmax}_{l\geq 0}\{p_c g(a) f(l) - (1-K) p_c r_T l\} \equiv p_c \Pi((1-K) r_T; a)$. 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 $l_T^c > l_I^c$. If a floating borrower is recommended and offered the loan, he will non-cooperatively select the loan size that maximizes his own payoff: $l_T^f = \text{argmax}_{l\geq 0}\{p_f g f(l) - p_f r_T l\} \equiv p_f \Pi(r_T)$. 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 $K p_f r_T l_T^f$. The gain from recommending a floating borrower is $K p_f r_T l_T^f$, and from recommending a borrower from another network is $K p_c r_T l_T^f$.[15] 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

$$p_c[\Pi((1-K)r_T) - \Pi(\frac{\rho_I}{p_c})] \geq K p_c r_T l_T^f + p_c[\Pi(r_T) - \Pi(\frac{\rho_I}{p_c})] \geq K p_c r_T l_T^f$$

Here the first inequality follows from $\Pi((1-K)r_T) \geq K r_T l_T^f + \Pi(r_T)$ (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).

[15] 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_T^f 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.

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.[16] And 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 $Kp_f r_T l_T^f + p_f[\Pi(r_T) - \Pi(\frac{\rho_I}{p_f})]$. Consider the function $Q(p) \equiv Kpr_T l^*(r_T) + p[\Pi(r_T) - \Pi(\frac{\rho_I}{p})]$ where $l^*(r)$ denotes the maximizer of $gf(l) - rl$. Notice that by the Envelope Theorem $\frac{\partial \Pi}{\partial p}(\frac{\rho_I}{p}; a) = \frac{\rho_I}{p^2} l^*(\frac{\rho_I}{p})$ Moreover, $\Pi(r_T; a) - \Pi(\frac{\rho_I}{p}; a) \geq [\frac{\rho_I}{p} - r_T] l^*(\frac{\rho_I}{p})$ Hence

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

which is positive as long as $K > k^* \equiv [l^*(\frac{\rho_I}{p_c})/l^*(r_T)]$. In other words, 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

[16] 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.

$1 - p_c(2 - p_c)$. 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.

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 $p_c[gf(l) - (2 - p_c)r_T l]$ and attain a per member profit of $p_c\Pi((2 - p_c)r_T)$. *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 $p_f gf(l) - p_f(2 - p_f)r_T l$ and attain a per member profit of $p_f\Pi((2 - p_f)r_T)$. 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 the answer depends on assumptions about the allocation 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 $p_c g(a)f(l_c)+p_f g(a)f(l_f)-[1-(1-p_c)(1-p_f)]r_T(l_c+l_f)$. 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 be a mix of connected and floating borrowers. So TRAIL selection patterns will be biased in favor of safer, more productive borrowers

(who pay lower interest rates on the informal market, and have a higher TFP). 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 experience larger increases in borrowing, scale of cultivation of high value cash crops, and increases in farm income.

The comparison of repayment rates between TRAIL and GBL is theoretically ambiguous. On the one hand TRAIL tends 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 are incentivized to repay on behalf of those who are unsuccessful. Finally, we expect higher takeup of loans in TRAIL, owing to its avoidance of the joint liability tax, or 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.

4 Empirical Analysis

We now test the predictions of our model. Our experimental design allows us to estimate separately the *selection effect* and the *treatment effect* of the two lending schemes. The selection effect represents differences between recommended or self-selected households (in the TRAIL and GBL schemes respectively) and the non-recommended or non-selected. We estimate this by the difference between estimated mean outcomes for households that were recommended/self-selected but were unlucky in the lottery and did not receive the TRAIL or GBL loans (Control 1 households), and the mean for households that were not recommended or did not self-select (Control 2 households). The treatment effect is estimated as the difference between the mean outcome for households that were recommended and chosen to receive the loan (Treatment households), and those who were recommended but were not chosen to receive the loan (Control 1 households). Our regression specifications take the following form:

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

Here y_i denotes the outcome variable of interest and $\mathbf{X}_i$ includes a set of additional controls including the land owned by the household.[17] The selection effect in the TRAIL scheme

[17] We also include a year dummy to control for changes over time, and a dummy for whether the village received the price information intervention. This information intervention is part of a separate project

corresponds to β_2, and in the GBL scheme corresponds to β_4. In the TRAIL scheme this treatment effect is $\beta_3 - \beta_2$ and in the GBL scheme the treatment effect is $\beta_5 - \beta_4$. [18]

4.1 Treatment Effects on Borrowing, Cultivation and Farm Incomes

We start by presenting estimates of treatment effects of the main outcomes of interest: borrowing, cultivation and farmer incomes. Later we will present evidence pertaining to the predictions of our model, which will thereby help identify channels of impact.

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. As can be seen from column 6, TRAIL agents recommended borrowers who borrowed on average Rupees 417 less than non-recommended borrowers (this is the TRAIL selection effect). However the TRAIL treatment caused overall borrowing to increase substantially, by Rs. 7126 (see column 4), which represents almost a 100 percent increase over the mean borrowing by Control 1 borrowers (Rs. 7280). The treatment effect on aggregate borrowing in the GBL scheme, presented in column 5, is lower (Rs. 6464), which represents a 88 percent increase over the mean. This effect is also statistically significant.

To check if our program loans (disbursed by Shree Sanchari) crowded out loans from other sources, Row 3 in Panel A presents estimated treatment and selection effects on borrowing for agricultural purposes through non-program loans (i.e., excluding the loans that Shree Sanchari disbursed). There are no significant treatment effects here. Hence the loans disbursed by Shree Sanchari constituted a net addition to borrowing of the treated groups.

Row 2 shows treatment effects on the unit cost of borrowing. For both TRAIL and GBL there was a significant reduction, by 3% and 7% respectively. We therefore see a larger reduction in the case of GBL. This is accounted for partly by a positive GBL selection effect of approximately 4%. Consistent with our theoretical prediction that GBL included a larger fraction of floating borrowers who pay higher interest rates on the informal market. GBL attracted groups (Control 1 households) paying higher interest rates by about 4% compared with borrowers (Control 2 households) in GBL villages who did not apply for the Shree Sanchari loans. GBL loan recipients incurred a cost of borrowing which was 3% below

examining the effect of delivering information about potato prices to farmers. This 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.

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

that of GBL Control 2 borrowers. In TRAIL on the other hand, there was no significant selection effect. We shall investigate these selection effects in more detail further below, to check whether they conform to our theoretical predictions.

Row 4 shows no spill-over effects for the TRAIL treatment borrowers on the cost of borrowing from non-program sources. In the presence of adverse selection on the informal credit market, receiving a TRAIL loan could have affected the reputation of the borrower and thereby resulted in a change in the cost of loans from informal lenders. Alternatively in the presence of moral hazard and loan repayment enforcement problems, informal lenders could have charged more owing to an increase in anticipated default risk resulting from increased overall scale of borrowing and corresponding repayment burdens. This provides evidence against any such effects. There is also no significant TRAIL selection effect on cost of borrowing from the informal market. With respect to GBL, there is no treatment effect while the selection effect is positive and significant (by approximately 4%), consistent with our interpretation of these selection effects.

4.1.2 Effects on Cultivation and Farm Incomes

Since the treatment caused total borrowing for productive purposes to increase, one expects to find real effects of this borrowing through increased productive activity. As previously discussed, the loans were designed specifically so they could be used for agriculture, and potatoes in particular. We therefore start with estimated effects on potato cultivation. See Panel B of Table 5.

Row 5 shows TRAIL agents recommended households that were likelier (by 9.5%, compared with a Control 1 mean of 68%) than average to be cultivating potatoes. The corresponding treatment effect is positive but statistically insignificant. With regard to acreage devoted to potatoes, we see a large (0.10 acre, compared with a Control 1 mean of 0.29 acres) and statistically significant treatment effect. Hence we see a significant effect on the intensive margin. This and the subsequent rows in Panel B are only estimated on the sample of farmers that reported cultivating potatoes.[19] The TRAIL treatment caused these households to lease in more land, spend more on inputs and generate a larger potato harvest. Total output of potatoes increased by 888 kg. as a result of the TRAIL loans, a 20 percent increase over Control 1 households. As a result, revenue (actual from sale or imputed using the median village price if the household did not sell potatoes) of the output increased by 18%, and value-added increased by a very similar magnitude (17%).[20] Value added

[19]We also computed the corresponding Heckman two stage estimates which accounts for selection into cultivation and the results are very similar. These results are available on request.

[20]Value-added is computed by subtracting from the revenue the reported cost of inputs. 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. Rent on owned-land and wages for family labor are not imputed,

does not include any cost for self-provided inputs, the most important of which is typically family labor. Row 10 shows a small and statistically insignificant increase in family labor hours devoted to potato cultivation. Imputing a cost of family labor at the average market wage rate for hired labor in the village (which represents an upper bound to the shadow cost of family labor) to obtain an estimate of net income from potato turns out to still yield a large and significant TRAIL treatment effect.[21]

In contrast, for GBL households the estimated treatment effects are much smaller and are statistically not significant. This is despite a larger treatment effect on the cost of credit in GBL. Such an outcome could be explained by our theory owing to TRAIL composition being more biased in favor of connected borrowers who are more productive, and/or individual loans which do not carry a 'joint liability tax' burden. We shall seek further evidence concerning these explanations below.

Panel C of Table 5 shows effects on incomes earned from other main crops (paddy, sesame and vegetables). In contrast to the large and statistically significant TRAIL treatment effects on potatoes, the treatment effect on the other major crops are small and statistically not significant. 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 16 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

An important assumption of our model is that connected borrowers are more productive than floating borrowers. Since the model predicts that TRAIL composition is more biased in favor of connected borrowers, it also predicts that the average TFP of those selected in TRAIL is higher than those selected in GBL.

To test this prediction, we need to estimate TFP of selected TRAIL and GBL borrowers. Assuming that revenue is a Cobb-Douglas function of the cost of production, we can

due to the well-documented problem that it is difficult to compute the shadow wage of family inputs.

[21] This result is not shown in the Table, and is available on request.

estimate the regression

$$\log(Revenue_{iv}) = \alpha_0 + \alpha_1 TRAIL + \alpha_2 \ \log(Cost_{iv}) + \alpha_3 \ \log(Land_{iv}) + \epsilon_{iv} \qquad (2)$$

for household i in village v. This can be run for each separate crop, or aggregating across all cultivated crops. *Cost* refers to cost of cultivation and *Land* refers to land owned. We can use assignment to treatment as an instrument for the cost of cultivation. The underlying identification assumption is that treatment status (i.e., whether the household actually receives a loan) does not affect TFP. Under this conservative identification assumption, we can obtain consistent estimates of the elasticity α_2 of revenue with respect to cost. This enables us to estimate the rate of return achieved by TRAIL and GBL farmers with respect to the additional cultivation costs incurred as a result of receiving program loans. Specifically, we can estimate ROR = $(\alpha_1 \times \frac{Revenue}{Cost}) - 1$. Results are shown in the bottom panel of Table 6.

An alternative less parametric procedure of estimating rates of return is shown in the top panel 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 Specification 1, 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 Specification 2 are 72% and 103%. The rates of return achieved by the GBL treatment group were substantially smaller – 37-38% in Specification 2 and 9% and even lower in Specification 1, none of which were statistically significant.

4.2.2 Selection Patterns in TRAIL and GBL

We now test the theoretical predictions concerning differences between recommended or selected and non-recommended or non-selected households in TRAIL and GBL respectively.

The first prediction was that TRAIL agents would be more inclined to recommend those households that had borrowed from them previously (i.e., their own clientele), and amongst their own clientele those from their own network, rather than 'floating' borrowers. Table 7 tests this, by running a linear probability regression for the event that a household was recommended in TRAIL, or formed a group in GBL. Regressors include dummies for previous purchase, borrowing or employment from the agent, for caste of the borrower interacted with caste of the agent, besides a range of other household demographics and assets. We see past borrowing is a significant positive predictor of TRAIL recommendation (borrowing from the agent in the past results in a 14 percentage point increase in the likelihood of being recommended), while some caste differences are significant negative predictors. This is exactly what our model predicted. In GBL on the other hand we do not see any of the regressors playing a significant role, except a higher likelihood for landless households to form GBL groups. The selection patterns with landholding are clearly different in TRAIL,

where we see an inverted-U pattern, with those owning between half and one acre more likely to be recommended than others.

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).[22] 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.[23] 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 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. Then TRAIL should achieve higher repayment rates than GBL. However the joint liability feature of GBL exercises an effect in the opposite direction, controlling for borrower types. As the model showed, repayment rates in GBL are $p_i(2-p_i)$ for type i borrowers, rather than p_i in TRAIL. Hence which program should achieve higher repayment rates is theoretically ambiguous.

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. TRAIL achieved

[22]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.

[23]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.

a significantly higher repayment rate in cycles 3, 4 and 6, a lower repayment rate in cycle 2, while in cycle 5 the confidence intervals overlap. Hence the repayment rates of the two programs are not clearly ordered. From the standpoint of fiscal sustainability of the MFI, repayment rates are of interest in their own right. It is also the standard metric that is used by microfinance institutions to define the success of their scheme. So it is important to note that repayment rates are high in both schemes. The average repayment rate at the end of six cycles was 98 percent on TRAIL loans and 91 percent for GBL loans. At the end of Cycle 6 the repayment rate on TRAIL loans was 8.6 percentage points higher than on GBL loans.

Another issue which helps evaluate the extent to which these loans affected borrower welfares, is the rate at which loans offered to selected borrowers were actually taken up. Panels B and C in Figure 1 track continuation and take-up rates of the two programs across successive cycles. The continuation rate in Panel B is the proportion of those eligible to borrow in the cycle in question that actually took the loan. The take up rate in Panel C is the proportion of those eligible to borrow at the outset of Cycle 1 who took the loan in any subsequent cycle (the joint outcome of past take up, defaults and current take-up). Both panels show TRAIL achieved higher continuation and takeup rates in all cycles, and these differences were statistically significant from cycle 3 onwards.

5 Additional Issues

The preceding section has shown that TRAIL had significant treatment effects on potato production and farm incomes, unlike GBL. This could be explained partly by differential selection patterns: TRAIL agents were more inclined to recommend safe borrowers from their own network, while GBL tended to attract less safe borrowers. TRAIL borrowers exhibited high rates of return, ranging from 70–110% which were precisely estimated whereas GBL borrowers' rate of return had a point estimate of less than 40% and were statistically indistinguishable from zero.

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 possible treatment effects on non-farm incomes, sensitivity of farm income effects to price and wage fluctuations, and the possibility that some of the borrower benefits may have been siphoned off by the TRAIL agent.

5.1 Effect on Non-Farm Incomes

Did the increase in TRAIL borrower farm incomes come at the expense of non-farm incomes? Conversely, might GBL have exerted larger effects than TRAIL on non-farm incomes? TRAIL and GBL treatment and selection effects on different components of

non-farm incomes and the total are presented in Table 9. There are positive but imprecisely estimated effects of the TRAIL loans on rental income, income from sales of animal products, labor income, reported profits, current value of business and total household income from non-agricultural sources. For GBL loans these effects are even smaller and also imprecisely estimated. 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.

5.2 Sensitivity to price fluctuations

The production of cash crops usually involve 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). Potato prices in these districts were higher on average in 2011 and 2012, compared with 2007 or 2008. Table 10 shows how estimated treatment and selection effects for potato value added would have been affected had the potato prices been different. Prices were higher in 2012 than in 2011, so the results presented in Row 3 show that had 2012 prices also prevailed in 2011, the estimated treatment effects would have been almost twice as large. 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, while the TRAIL treatment effect would have been significant at the 1% level.

On the other hand, the TRAIL treatment effects turn negative had prices been at their 2007 or 2008 levels, and would have been negative and statistically significant at 2008 prices. In contrast, the GBL treatment effect point estimate would have been positive at 2008 prices though it would have continued to have been statistically insignificant. These results suggest that our preceding results are sensitive to potato price fluctuations: TRAIL's performance would have been disappointing had our experiment been conducted in 2007 or 2008 and borrowers had reacted in the same way, which is plausible as most of their actions pertaining to planting, cultivation and harvest are taken before sale prices are realized.

The sensitivity analysis provides a partial answer to the question: why did TRAIL borrowers not borrow more and cultivate more potatoes, if they could borrow at 25% or below and earn rates of return 70% and higher? 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 also highlights the need for any credit scheme aimed at agricultural finance to also include an insurance feature. 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 yield had fallen by 20% or more. This could have limited the losses to the borrower households, and may have positively affected the take-up of these loans.

5.3 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. If the TRAIL agent purchases the crop output from the farmer, it could happen by increasing mandated sales through the agent at a discounted price, or by adjusting downward the price paid by the agent to the farmer. Or the agent might charge higher prices for inputs sold to the borrower.

It is of course difficult to get data on bribery or side-payments between borrowers and agents. However, we do have detailed data on input purchase and output sale collected every four months, which we can use to test if the agent increases rents extracted from TRAIL borrowers through these channels.[24]

Table 11 shows results of analysing input and output transactions reported by sample households in TRAIL villages. The first two rows of Panel A shows approximately 9% of input transactions were with the agent, accounting for 8% of input values purchased. The top rows of Panel B shows 21% of output transactions were with the agent, representing 15% of the transaction value. It is by no means the case that the agent has a monopoly or near-monopoly on these transactions.

The remaining rows in the Table 11 show per unit prices for transactions in different inputs and outputs. Columns 3 and 4 show treatment and selection effects for the likelihood of such transactions, and transaction prices. With regard to the selection effect on input transactions, Column 4 shows recommended agents were slightly more likely to buy and sell from the agent, and only the difference in share of output value sold to the agent is statistically significant. The point estimate of the selection effect on unit prices of inputs purchased is negative for all inputs except inorganic fertilizer (for which the difference is statistically insignificant). For only one input – power tiller – is this difference significant and in this case the sign is negative. Hence input transactions with the agent involved borrowers buying at a discount relative to other sellers, contrary to the hypothesis that agents extracted higher margins from households they recommended. The same is true of the treatment effect on input prices: it is significant only for power tiller transactions, and the sign is negative. In other words, those recommended borrowers that actually got TRAIL loans paid *lower* power tiller rental rates compared to Control 1 households who were also recommended but did not get the loan. If anything, the benefits of the TRAIL loan obtained by the borrower were supplemented by cheaper inputs purchased from the

[24]We are grateful to fieldwork and data analysis conducted on this issue by Boston University students in the Masters in Global Development Studies program, summarized in Ah-Tye, Bai, Blanco, Pheiffer, and Winata (2013).

agent, the very opposite of the hypothesis that the benefits were being siphoned off by the agent.

On the output side, the price differences between recommended and non-recommended households are small and statistically insignificant, with respect to both treatment and selection effects. We therefore have no evidence that the agent manipulated other transactions to earn more rents from borrowers he recommended, or those that received TRAIL loans.

6 Conclusion

To summarize, our experiment shows the success of trader-agent intermediated individual liability loans with below-market-average interest rates, durations that matched crop cycles of potato the most important cash crop in the region, and insured against local yield and price drops exceeding 20%. They were particularly successful in inducing selected beneficiaries to increase cultivation of potato and raise their farm incomes by 20-30%. We explained this by TRAIL agents recommending households from among their own networks that they knew were productive farmers and safe credit risks. TRAIL agents benefited by earning commissions based on loan repayments, which incentivized them appropriately. TRAIL attained very high repayment rates as a result, above 98% at the end of two years. GBL which differed from TRAIL in relying on a traditional group-based microfinance approach did not achieve comparable success with respect to outputs or farm incomes. We explained this by differences in selection of borrower types between TRAIL and GBL, with the latter attracting households that were less productive and with higher default risks. GBL also attained high repayment rates which exceeded 90% at the end of two years, slightly lower than for TRAIL. Loan take-up rates were higher in TRAIL. As we found no evidence of TRAIL agents siphoning off benefits from borrowers they recommend, or those successful in getting TRAIL loans, the scheme appears to have been successful in raising borrower welfares.

An added qualification is that the results are sensitive to prices prevailing during the years of the experiment: it is possible that the *ex ante* benefits to borrowers are overstated by our *ex post* return calculations, as potato prices in 2011 and 2012 were high relative to other years. Nevertheless, the fact that the scheme lowered borrowing costs, and induced borrowers to expand cultivation scale of potato, indicate that there were positive *ex ante* welfare improvements. The fact that TRAIL eliminated mandatory group meetings, savings requirements and the burden of the joint liability tax should confer it an added advantage over the group-based approach.

Lending institutions typically evaluate loan programs by repayment rates and clientele size (i.e., loan take-up rates), besides administrative costs. We have shown that TRAIL achieved higher repayment rates and loan take-up rates than GBL, though the differences

on these dimensions were small. With regard to administrative costs as well, TRAIL was more economical than GBL. The bulk of the cost savings of TRAIL came from reducing loan officers' salaries and transport expenses, since there were no group meetings in the TRAIL design. These costs amounted to Rupees 1125 per month (at 2012 prices) per GBL village. In contrast, loan officers visited TRAIL villages only once in four months, resulting in personnel and travel cost of only Rupees 31.25 per month per village. In addition, the MFI also paid for the services of an office assistant for the GBL villages, and incurred expenses on phone calls and additional visits to the village to negotiate with the GBL groups, bringing its per-month cost of operating the GBL scheme in a village to Rupees 1463, whereas the cost of running the TRAIL scheme was only Rupees 68 per village: a difference of almost Rupees 1400 per village.

Nevertheless, at the 12 percent per annum rate at which our collaborating MFI Shree Sanchari would have obtained these loanable funds from formal financial institutions in India, it would not have broken even on TRAIL.[25] However a recent policy reform passed in the Indian Parliament lowers costs of credit to banks that is earmarked for lending to poor farmers on a priority basis at a concessional rate of 4.5% per annum. At such a cost of capital, TRAIL could turn out to be financially sustainable for banks lending to poor farmers, though this may require reducing the agents commission rate to some degree. Further experiments are necessary to assess the financial sustainability of TRAIL, before it can be scaled up for widespread adoption.

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[25]They could expect to earn at best Rupees 75 in Cycle 1 and Rupees 312 in Cycle 6. In cycle 1, if all loans were repaid in full, the total loan interest generated from 10 loans would be Rupees 1200. Shree Sanchari would retain 25 percent of this after paying agent commissions. Since a cycle lasts 4 months this works out to a revenue of Rupees 75 per month per village, or Rs. 22.5 per loan. This would not cover the administrative cost of Rs 68 per TRAIL loan.

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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)		Consumption Loans (3)	
Does the household Borrow?	0.69		0.59		0.19	
Total Borrowing†	6221.78	(10140.18)	4952.85	(8607.67)	738.58	(3111.56)
Proportion of Loans by Source‡						
Informal Lenders	0.65		0.66		0.77	
Family and Friends	0.05		0.03		0.12	
Cooperative/SJSY	0.23		0.24		0.08	
Government Banks	0.05		0.05		0.02	
Interest Rate (Annualized) by Source						
Informal Lenders	26.57	(24.14)	26.36	(24.51)	34.37	(11.50)
Family and Friends	20.53	(15.09)	19.84	(16.32)	20.35	(12.76)
Cooperative/SJSY	15.41	(3.07)	15.62	(3.15)	13.56	(1.75)
Government Banks	11.91	(4.30)	11.83	(4.65)	12.31	(2.57)
Duration (Days) by Source						
Informal Lenders	123.63	(27.54)	122.52	(20.29)	128.55	(51.50)
Family and Friends	168.92	(103.61)	174.13	(101.31)	151.94	(95.38)
Cooperative/SJSY	323.53	(91.19)	320.19	(93.97)	342.03	(72.55)
Government Banks	299.67	(108.95)	300.35	(108.74)	273.13	(126.80)
Proportion of Loans Collateralized by Source						
Informal Lenders	0.01		0.01		0.0.05	
Family and Friends	0.02		0.07		0.00	
Cooperative/SJSY	0.73		0.77		0..38	
Government Banks	0.77		0.83		0.63	

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

	Potato (1)		Sesame (2)		Paddy (3)		Vegetables (4)	
Acreage (acres)	0.48	(0.01)	0.43	(0.01)	0.69	(0.01)	0.20	(0.01)
Total input cost (Rupees)	9228.61	(232.75)	650.99	(21.84)	3804.95	(89.42)	2898.38	(177.48)
Total cultivation cost (Rupees)	10335.98	(276.22)	695.41	(24.94)	4061.05	(101.64)	3285.02	(214.99)
Family labor (Hours)	56.46	(1.25)	24.32	(0.51)	37.97	(0.79)	82.30	(4.62)
Revenue (Rupees)	17782.58	(454.95)	2433.85	(82.64)	6696.50	(168.86)	8976.33	(630.04)
Value-added (Rupees)	7245.25	(270.25)	1736.61	(72.09)	2843.13	(125.93)	5586.79	(506.55)

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
Panel A: Effects on Total Borrowing and Cost of Borrowing								
1	Loan Size (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	Loan Size (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	Output	Kg	888.0***	278	145.4	-417.9	2718	4760
9	Cost of production	Rs	1774**	1308	372.8	-1111	2718	9538
10	Family labour hours	Hours	6.03	4.906	-0.2	4.951	2718	57.86
11	Revenue	Rs	3429***	1637	942	-2534	2718	19137
12	Value added	Rs	1687**	271.8	555.6	-1371	2718	9498
Panel C: Comparing Value-Added in Different Crops								
13	Sesame	Rs	180	-158.3	-115.7	73.41	2037	2126
14	Paddy	Rs	271.6	573.6	-469.9	-759.6*	3047	2506
15	Vegetables	Rs	1255	-1955	1329	-957.5	402	8325
Panel D: Effects on Household Income								
16	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

	Potato	Sesame	Paddy	Vegetables	Total Farm income
	(1)	(2)	(3)	(4)	(5)
Specification 1					
TRAIL	1.05***	4.01*	-0.21	1.29	1.15***
	(0.06)	(2.29)	(3.67)	(1.27)	(0.02)
GBL	0.09	-8.16	-0.70	3.06	-0.10
	(0.37)	(13.05)	(1.72)	(3.79)	(0.29)
Specification 2					
TRAIL	0.72**	-18.77	0.88	-4.18	1.03***
	(0.33)	(308.02)	(2.27)	(5.52)	(0.35)
GBL	0.37	25.43	-2.68	1.56	0.38
	(0.97)	(82.03)	(8.06)	(11.67)	(1.23)

Notes:
In Specification 1, 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. In Specification 2, 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. $^{***}: p < 0.01$,$^{**}: p < 0.05$,$^{*}: p < 0.1$. Sample restricted to households with at most 1.5 acres.

Table 7: Selection: TRAIL versus GBL

(Dependent Variable: Household was recommended/selected into the scheme)

	(1) TRAIL	(2) GBL	(3) TRAIL	(4) GBL
Bought from agent	0.016		0.012	
	(0.047)		(0.048)	
Borrowed from agent	0.142***		0.135***	
	(0.035)		(0.035)	
Worked for agent	-0.005		0.000	
	(0.055)		(0.054)	
Non Hindu	0.030	-0.059	0.030	-0.056
	(0.143)	(0.108)	(0.140)	(0.108)
Non Hindu × Agent Hindu	-0.098		-0.097	
	(0.132)		(0.130)	
SC	0.544***	-0.028	0.534***	-0.018
	(0.031)	(0.067)	(0.035)	(0.066)
SC × Agent High Caste	-0.610***		-0.589***	
	(0.036)		(0.037)	
ST	-0.198*	0.024	-0.177	0.017
	(0.108)	(0.152)	(0.104)	(0.147)
ST × Agent High Caste	0.218		0.194	
	(0.166)		(0.157)	
OBC	-0.005	0.110	-0.007	0.110
	(0.077)	(0.108)	(0.078)	(0.107)
Landholding	0.208*	-0.177		
	(0.123)	(0.165)		
Landholding Squared	-0.236**	0.014		
	(0.086)	(0.093)		
Landless			-0.010	0.112*
			(0.052)	(0.063)
Constant	0.037	0.392***	0.051	0.316**
	(0.098)	(0.130)	(0.099)	(0.120)
Sample Size	1,031	1,037	1,031	1,037
Number of Villages	24	24	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 and dummies for whether the household purchased on credit or received government transfers.

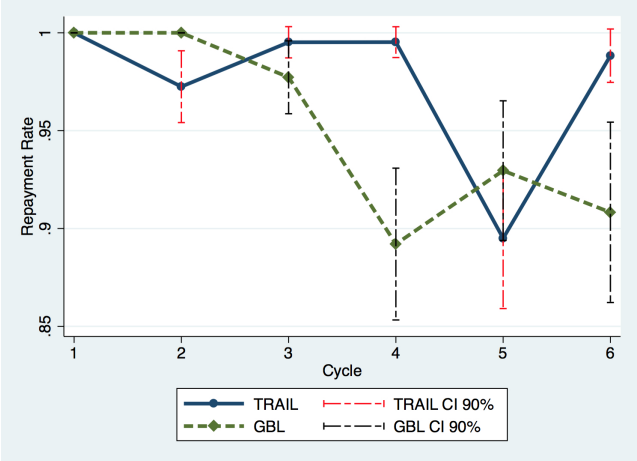
Table 8: Interest Rate Comparisons

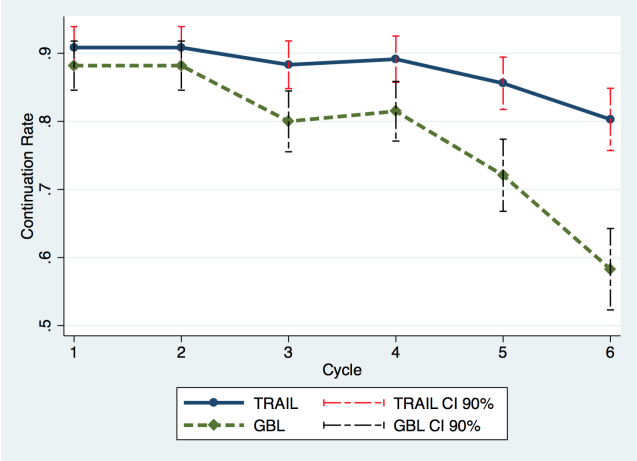
(Dependent Variable: average interest rate paid on informal loans)

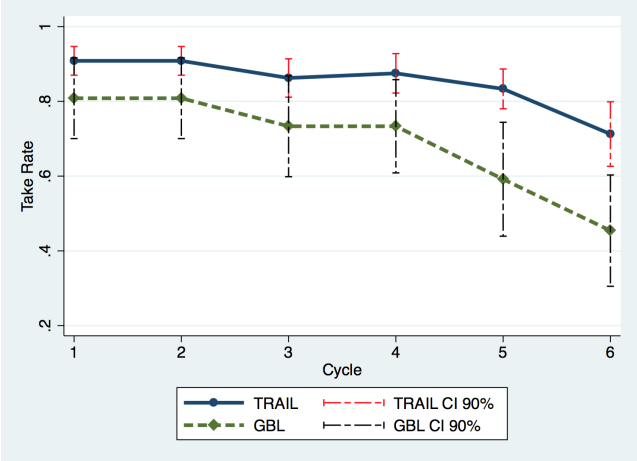
	TRAIL		GBL		TRAIL v GBL	
	OLS	Heckman	OLS	Heckman	OLS	Heckman
	(1)	(2)	(3)	(4)	(5)	(6)
Recommend	0.022	0.022	0.053*	0.052*		
	(0.016)	(0.017)	(0.027)	(0.029)		
Own-clientele	0.050	0.049*				
	(0.033)	(0.027)				
Own-clientele × Recommend	-0.071**	-0.071**				
	(0.026)	(0.035)				
TRAIL					-0.064	-0.064**
					(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		Selection		Sample	Mean
		TRAIL	GBL	TRAIL	GBL	Size	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	Selection	Sample	Mean		
		TRAIL	GBL	TRAIL	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

	Sample Size (1)	Mean Control 1 (2)	Treatment Effect (3)	Selection Effect (4)
Panel A: Input Purchase				
Ever Buy any Input from agent	12,448	0.0875	-0.00338	0.00780
Share of agricultural input purchased from agent	10,196	0.0760	-0.00359	0.0187
		Input Price (Rs/unit)		
Inorganic fertilizer	1,672	13.78	-0.322	0.170
Organic fertilizer	370	16.12	29.39	-4.024
Outside seeds	1,654	22.36	2.174	-2.863
Pesticide	2,691	533.5	-31.08	-25.32
Powertiller	1,403	195.2	-32.33***	-33.23**
Water/irrigation	1,230	72.30	148.3	-148.3
Panel B: Output Sold				
Ever sold output to agent	2,990	0.209	0.00559	0.00560
Share of output sold to agent	2,765	0.151	0.0152	0.0465*
		Output Price (Rs/kg)		
Potato	1,386	4.507	-0.0516	0.0436
Paddy	498	9.282	-0.0215	-0.207
Sesame	881	28.42	-1.003	1.331

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. 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.