Agent Intermediated Lending: A New Approach to Microfinance*

Pushkar Maitra[†], Sandip Mitra[‡], Dilip Mookherjee[§]
Alberto Motta[¶], Sujata Visaria[‖]

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Abstract

We study trader agent intermediated lending (TRAIL), a new version of microfinance where local intermediaries (lenders) are appointed as agents to recommend borrowers for individual liability loans designed to allow the financing of agricultural operations. The scheme involves no peer monitoring, group meetings or savings requirements. In a randomized evaluation conducted in West Bengal, India, TRAIL loans have higher take-up rates and higher repayment rates than traditional group-based joint liability loans. This can be explained by a model of segmented informal credit markets with adverse selection, in which repayment-based commissions deter collusion and motivate agents to recommend low-risk borrowers.

Key Words: Microfinance, Agent Based Lending, Group Lending, Selection, Takeup, Repayment

JEL Classification Codes: D82, O16

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[†]Pushkar Maitra, Department of Economics, Monash University, Clayton Campus, VIC 3800, Australia. Pushkar.Maitra@monash.edu.

[‡]Sandip Mitra, Sampling and Official Statistics Unit, Indian Statistical Institute, 203 B.T. Road, Kolkata 700108, India. Sandip@isical.ac.in.

[§]Dilip Mookherjee, Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215, USA. dilipm@bu.edu.

[¶]Alberto Motta, School of Economics, University of New South Wales, NSW 2052, Australia. motta@unsw.edu.au.

[‖]Sujata Visaria, Department of Economics, Academic Building, Room 2340, Hong Kong University of Science and Technology, Clear Water Bay, Hong Kong. svisaria@ust.hk.

1 Introduction

There is a widespread belief that microfinance is the panacea for the problem of low credit availability for the poor. However, although microfinance is now widely available, recent experience has highlighted a number of problems with the traditional approach to microfinance. Rigid, high-frequency repayment schedules and a low tolerance for risk-taking restrict borrowers' project choice and prevent significant effects on asset ownership and consumption (Karlan and Mullainathan, 2010; Banerjee, Duflo, Glennerster, and Kinnan, 2011; Karlan and Zinman, 2011; Desai, Johnson, and Tarozzi, 2011). In turn, this may limit loan take-up and anti-poverty impacts. Group liability and strict repayment rules can also lead to contagious defaults, undermining the viability of MFIs, as witnessed in the recent microfinance crisis in India (Banerjee and Duflo, 2011; Gine, Krishnaswamy, and Ponce, 2011). As a result researchers, policy makers and even microfinance institutions (MFIs) themselves are searching for alternatives to the traditional model of microfinance, which would generate greater benefit for borrowers and financial stability for MFIs.

In our field visits in West Bengal, traditional microfinance clients mentioned a variety of reasons that prevented them from realizing higher benefits: restrictions imposed by loan officers on project choice; free-riding within groups; contagious defaults; and harmful effects on social capital. Also, high-frequency repayment schedules implied that microfinance was not available for agricultural investment. They also mentioned the high cost of attending weekly meetings and achieving the savings targets mandated by MFIs. These considerations motivated us to design a new approach to microfinance. A primary objective was to enable borrowers to finance agricultural working capital needs, so they could earn higher average returns than microfinance clients typically do. In our variant, loan durations match agricultural production cycles, with repayment due at the end of the agricultural season. There is no monitoring by MFI officials, and no requirement to attend any group meetings or achieve any savings target. There is no collateral requirement and so even landless households can borrow. Borrowers are liable only for their own loans: this prevents the free-riding and contagious defaults that are possible in group liability loans, and also avoids deleterious effects on social cohesion.

Although it is different from traditional microfinance in these respects, our approach preserves what is arguably the key feature of microfinance, viz. the use of local information and social capital to identify creditworthy borrowers. In each village, the MFI appoints as its agent an informed third-party individual from the local community. The agent is a trader, informal lender, or a person suggested by the local government, with considerable prior economic and social interaction with village residents. The agent recommends borrowers for individual liability loans. The scheme has a number of features designed to limit collusion or monopolistic behavior by the agent. The agent cannot recommend individuals who own more than 1.5 acres of cultivable land. Loans are advanced directly by the MFI to recommended individuals, instead of through the agent. Only a randomly chosen subset of the households recommended by the agent are offered the loan. The agent is incentivized to recommend safe borrowers through a commission that depends on the repayment rate of his recommended borrowers.

Other features include dynamic incentives for borrowers to repay – future loans sizes depend on repayment of the current loan; and index insurance – repayment due is adjusted downward if there are village-level adverse shocks to crop revenues. TRAIL loans also generate lower transactions costs for borrowers than traditional micro-loans: loans are delivered to borrowers in their own homes, and borrowers do not have to attend regular meetings or open bank accounts.[1] Both the transactions costs for borrowers and the administrative costs for the lender are substantially lower as a result.

We call this design the *Agent Intermediated Lending* or AIL approach. Our larger project examines two different ways of implementing the AIL approach: in Trader Agent Intermediated Lending (TRAIL), the agents are traders, shopkeepers or informal lenders. In Gram Panchayat Agent Intermediated Lending (GRAIL), the local government *(Gram Panchayat)* recommends individuals for the position of agent. In this paper we limit attention to the TRAIL scheme, and use theoretical analysis as well as empirical evidence from a field experiment to compare it with the traditional group-based lending (GBL) scheme.

Our theoretical model is one of borrower adverse selection. It extends the well-known Ghatak (2000) model of micro-credit in two ways. First, not only do borrowers vary in the (unobservable) riskiness of their projects, they also vary in their (observable) landholdings. This allows us to assess the relative effectiveness of TRAIL and GBL in selecting borrowers along two dimensions: risk type and wealth. Second, informal lenders incur higher costs

[1] These costs can be substantial. For example Park and Ren (2000) argue that in microfinance programs in rural China, the opportunity cost of time spent traveling to, waiting for and attending center meetings effectively added 15-20 percent to the interest rate.

of lending compared to the MFI while being better informed about the risk types of the borrowers owing to their past experience in lending to them. The informal market is segmented: each lender has exclusive information about the risk type of borrowers in her own segment. It is assumed that this information was gathered through past interactions. In the absence of the MFI, lenders across different segments compete for all high-risk borrowers in the market, but exercise monopoly power over low-risk borrowers in their own segment.

In the TRAIL scheme, one of these lenders is employed as the agent, and recommends borrowers to the MFI. This creates a potential conflict of interest: if the agent recommends her own clients, she stands to lose their business. The cost this imposes is particularly high in the case of low-risk borrowers owing to the larger profits the agent earns from lending to them. Thus, the agent has an incentive to recommend risky borrowers instead. A successfully designed TRAIL scheme would need to deter such behavior by constructing a suitable incentive scheme. A second concern is the threat of collusion: the agent might "collude" with borrowers, i.e., recommend individuals in return for side-payments, thereby siphoning off their potential loan benefits. The model shows that TRAIL is *effective*, i.e., agents are motivated to recommend safe borrowers from their own clientele, if and only if the commission rate is set high enough and there is no collusion. In contrast, the selection of types that form groups to borrow in a GBL scheme turns out to be ambiguous: GBL may attract disproportionately low-risk or high-risk individuals.[2] If the TRAIL scheme is effective, it will therefore generate (weakly) higher repayment rates: this ranking will be strict if GBL is biased in favor of selection of risky types.[3]

In our field experiment, a microfinance institution implemented the TRAIL and GBL schemes in 24 villages each, in two potato-growing districts of West Bengal. Consistent with the theoretical predictions, the results of the experiment are as follows: (a) The TRAIL scheme was effective: TRAIL agents were more likely to recommend borrowers whom they

[2]In our framework, Ghatak's arguments for positive assortative matching continue to apply. However, as in most practical instances of group-based lending, a single joint liability loan is offered, rather than a menu of different loans varying in the degree of joint liability. With a single joint liability loan it is unclear whether a safe or a risky group stands to gain more from participating in the GBL scheme. On the one hand, the safe group expects to make a higher repayment than the risky group does. On the other hand, safe borrowers are more likely to be exploited in the informal market, which makes GBL a more attractive option for them *vis-a-vis* the risky borrowers. In addition, the costs of attending group meetings and meeting savings requirements may also differ between the two groups in a way that is difficult to predict. All considered, it is possible that any given low-interest GBL loan disproportionately attracts high-risk groups.

[3]Although our model shows this result in the context of adverse selection alone, this result is reinforced if we incorporate moral hazard in repayment into the model. This is because joint liability could lead to contagious defaults, a phenomenon which does not occur with individual liability loans as in TRAIL.

had lent money to in the past, and among such borrowers they were more likely to recommend those who paid low interest rates in the informal market; (*b*) Borrowers forming groups in the GBL scheme were riskier on average: those willing to form groups paid above-average interest rates in the informal market; (*c*) After four loan cycles, repayment rates for TRAIL loans were significantly higher than for GBL loans. The observed differences in repayment rates could be explained by differential risk selection across the two schemes.

To compare borrower welfare in the two schemes we must consider a number of additional factors. First, consider the relative costs and benefits to borrowers in the two schemes. The TRAIL scheme generates higher benefits and lower costs for borrowers in some respects: they do not bear the burden of covering for the loan defaults of group members, and they do not incur the costs of attending group meetings or achieving savings targets. However, the GBL scheme provides a benefit in that when a borrower's project fails he can expect with some positive probability that his group members will pay up on his behalf. Second, consider which scheme provides access to credit to a greater number of poor households. In our data, households with intermediate landholdings (approximately 0.45 acres) are most likely to borrow through the TRAIL scheme, whereas in the GBL scheme the probability of participation is highest for landless households and declines monotonically in landholding. Thus GBL appears better able to provide credit access to the poorest households. Third, one needs to compare administrative costs and financial sustainability. TRAIL scores higher on these dimensions, owing to higher repayment rates and elimination of group meetings and savings requirements. Finally, for a complete welfare evaluation we would also need to compare the impact of both schemes on borrowers' agricultural operations, incomes and consumption levels. Those can only be studied after the experiment has run its full course. We therefore defer a more detailed analysis of impacts on borrowers to subsequent papers.

The paper is structured as follows. Section 2 describes how this paper relates to the existing literature. Section 3 describes the experimental design, the data and descriptive statistics. Section 4 presents the theoretical model and its predictions, which are tested empirically in Section 5. Section 6 discusses issues relating to the financial sustainability of the scheme and finally Section 7 concludes.

2 Relation to the Literature

In the Ghatak (2000) model of adverse selection, joint liability leads to positive assortative matching which in turn allows the MFI to achieve high repayment rates. However, the empirical evidence on whether joint liability does actually have this positive effect on repayment rates is mixed. Whereas recent papers by Attanasio, Augsburg, Haas, Fitzsimons, and Harmgart (2011) and Carpena, Cole, Shapiro, and Zia (2010) find experimental evidence that joint liability loans have higher repayment and lead to greater entrepreneurial activity and food consumption than individual liability loans, Giné and Karlan (2010) find that repayment rates are equally high for individual liability loans and joint liability loans. Although our paper also examines individual liability loans (in the TRAIL scheme) it is important to note that the screening mechanism that we use is quite different. Specifically in the TRAIL scheme, we rely on an alternative mechanism by which safe borrowers are selected for loans – viz. the recommendation by an informed agent hired from the local community. There is no need to impose any additional lending criteria. For example, in the individual lending program studied in Attanasio, Augsburg, Haas, Fitzsimons, and Harmgart (2011) the lender did not have any predetermined collateral requirements but took collateral if available and as a result more than 90 per cent of the individual loans were collateralised (see Attanasio, Augsburg, Haas, Fitzsimons, and Harmgart, 2011, page 15). In the study by Giné and Karlan (2010), participants had to accumulate a certain amount of savings before they qualified for a loan. These conditions would naturally prevent the very poor from getting access to these loans. Both the TRAIL and the GBL schemes studied in this paper were considerably more pro-poor; in fact loans could only be granted to households that owned less than 1.5 acres of land. Overall our finding that TRAIL loans have higher repayment rates than joint liability GBL loans is evidence that with a well designed alternative method of screening safe borrowers one can generate higher repayment rates in individual liability loans than in joint liability group loans.

Giné and Karlan (2010) also suggest another reason why MFIs might find it difficult to switch to individual liability micro-loans: in their study loan officers were relatively unwilling to enter villages that were randomly assigned to individual liability. In contrast, the TRAIL scheme was implemented by agents hired locally so that an MFI official's refusal to enter a village to implement the individual liability scheme is unlikely to be an issue. In all villages the first person approached agreed to become an agent, so coverage of villages in our scheme was comprehensive and avoided problems of endogenous assignment.

The AIL model employs a lending approach that India's central bank has been promoting recently with a view to increasing the rural population's access to financial services. 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 the best of our knowledge the performance of these schemes have not been systematically investigated. Concerns have also been raised about the abuse of discretionary power by agents in such schemes. Our results show such concerns can be addressed by designing a suitable incentive scheme for the agent. The agents in our model play the same role that the RBI envisions for BFs: they refer clients to the formal lender, pursue the clients' loan applications and facilitate transactions between the lender and the client. The final decision on whether to approve the loan rests with the lender.[4] Similar programmes (where the agent played a role closer to the BCs) have been implemented in several countries in Asia, but with limited success.[5] 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. The AIL approach we develop has measures designed to limit the agent's discretionary power and, with it, the opportunities for collusion. To this purpose, (a) the MFI directly advances the loans, (b) only a random subset of those recommended by the agent are selected, (c) a cap is imposed on borrowers' cultivable land, and (d) the agent is incentivized by commissions.

These regulations make our agents more similar to BFs than BCs, and are consistent with the lessons learnt from the mechanism design literature. The idea of employing members of the local community to recommend and monitor borrowers originates from a large literature in contract theory on 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). While much of this literature has found that the use of an informed third party as intermediary increases the principal's payoff, despite the hazards of opportunistic behavior of middlemen, this literature has also highlighted the problems

[4]Banking correspondents, on the other hand, can disburse small loans and collect deposits as well and they can make the final decision on whether to provide the loan or not.

[5]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).

associated with delegating discretionary power to an informed third-party. It has shown that these problems can be controlled by a variety of means, such as constructing appropriate incentive schemes for middlemen and constraining the extent of their discretion. Features (a), (b), and (c) are designed with this purpose in mind, and (d) ensures that the interests of the agent are aligned with those of the MFI.[6] To the best of our knowledge, ours is the first systematic analysis of the effectiveness of an incentive-based agent-intermediated lending program.

3 Experimental Design and Data

The interventions being tested in this project were implemented by Shree Sanchari (SS), an MFI based in Kolkata, in 72 villages in the Hugli and West Medinipur districts of West Bengal, India.[7] The 72 villages were chosen randomly from within the potato-growing belt in these districts, subject to a requirement of a minimum distance of 8 km between every pair of villages. In 24 of the 72 villages, SS introduced the traditional group-based lending (GBL) scheme, with certain non-standard loan features described further below. In the remaining 48 villages, it implemented the agent-intermediated lending approach: in 24 of the 48 villages it implemented the trader agent-intermediated lending (TRAIL) scheme, and in the remaining 24 it implemented the local government (gram panchayat) appointed agent-intermediated lending (GRAIL) scheme. The allocation of villages to the treatment arms was random. Prior to this project, Shree Sanchari had had no operations in any of these 72 villages.

The interventions began in October 2010 and are expected to continue until July 2013. Loans are given at an annual interest rate of 18 percent. The first cycle of loans was disbursed in October-November 2010 coinciding with the planting season for potatoes. The loan size was capped at Rupees 2000 (equivalent to approximately $US40). The repayment due four months later was Rupees 2120 (1.06×2000). Upon full repayment, the borrower

[6]There is supporting empirical evidence that a scheme combining randomization, limited discretion, and incentives can effectively reduce corruption. In their field experiment testing measures to reduce corruption in environmental audits of industrial plants, Duflo, Greenstone, Pande, and Ryan (2012) find that random assignment to plants, a fixed payment from a central pool (as opposed to payment by the plants) and a bonus for accurate reporting resulted in auditors reporting more truthfully.

[7]Sixty-eight of these 72 villages were in a sample drawn for a previous project conducted by a subset of the authors in this project (Mitra, Mookherjee, Torero, and Visaria, 2012). The districts were chosen because they grown some of the largest quantities of potatoes in West Bengal, a state that produces about a third of all potatoes grown in India.

became eligible to borrow Rupees 2660 (133 percent of 2000) in Cycle 2, and loan sizes in subsequent cycles became progressively larger. Borrowers who repaid less than 50 percent of the repayment obligation in any cycle 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 repayment is calculated at the prevailing price of potato bonds.[8] While the loans were meant to be agricultural loans, households were not required to state the intended or actual use of the loan.[9]

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

In 24 villages, Shree Shanchari appointed as its local agent a trader based in the local community. One agent was chosen per village. To select the agent, SS 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.[10] The agent was asked to recommend 30 village residents owning less than 1.5 acres of agricultural land, as potential borrowers. Ten of these 30 individuals were selected into the scheme through a lottery conducted in the presence of village leaders, and were offered the TRAIL loan. Shree Sanchari's loan officers visited these individuals in their homes to disburse the loans.

The contract with the agent was structured as follows. The agent was required to post a deposit of Rs 50 per recommended borrower who took up the loan offer. She would subsequently receive as commission 75 percent of the interest paid by each borrower whom she had recommended. The initial deposit would be refunded to the agent at the end of two years in proportion to loan repayment rates by the recommended borrowers. The agent's contract could be terminated at the end of any cycle in which 50 percent of the borrowers

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

[9] 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 SS or any other formal or informal source.

[10] 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 would go down the list in this manner until the position was filled. In practice, the first person offered the position accepted it in each village.

failed to repay. All agents who survived in the program for two years would receive a special holiday package at a local sea-side resort. Anecdotal evidence suggests that in addition to these formal incentives, TRAIL agents also believed their participation in the scheme could improve their reputations and market share within the villages.

3.2 The Group-based Lending (GBL) Scheme

In the 24 GBL vilages, Shree Sanchari followed its standard protocol for setting up joint liability groups. In February-March 2010, SS invited villagers to form 5-member groups, meet weekly in the presence of SS loan officers, and make weekly savings deposits. 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 Rs 2,000 in Cycle 1, for a total of Rs 10,000 for the entire group. Similar to TRAIL loans, repayment was due in a single installment at the end of 120 days.[11] All group members shared liability for the entire Rs 10,000: if there was less than full repayment at the end of any cycle then all members would be disqualified for any future lending; if the loans were fully repaid all members were eligible for a new loan of size 133 percent of the previous loan. Bi-monthly group meetings and mandated savings continued throughout each cycle, as per SS's standard protocol. To cover their administrative costs SS retained 75 percent of the interest received.

3.3 Data and Descriptive Statistics

The bulk of our data consist of responses to multiple rounds of household surveys in the 72 villages. Survey rounds are conducted every four months, and collect 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. A sample of 50 households was selected in each village. Sample households belong to one of three categories. Ten households per village were recommended for loans (in TRAIL villages)/formed groups (in GBL villages) and then were randomly selected to receive loans. These are called the *Treatment* households. Another 10 households were recommended (in TRAIL villages) or formed groups (in GBL villages)

[11] Since our experiment does not include a treatment with GBL loans with the standard short duration, we cannot examine how this longer repayment duration affects take-up, repayment and loan usage. For evidence on this issue, see Field and Pande (2008) and Field, Pande, Papp, and Rigol (2012).

but were not selected to receive loans: we call these *Control 1* households. Finally, we also interviewed 30 households that were not recommended (in TRAIL villages)/did not form groups (in GBL villages). These 30 households were chosen as follows: first, we purposively selected households to ensure that all 24 sample households from the Mitra, Mookherjee, Torero, and Visaria (2012) study were included.[12] Once this was done, any remaining additional sample slots were filled through a random draw of non-treatment and non-Control 1 households from the village.

Panels A and B in Table 1 describe the village and household characteristics in the two treatment arms. The average village has about 350 households. Sixty percent of these households have electricity connection. Only a third of the villages have a metalled road. A little over three quarters of the villages had a primary school, but only about a quarter had a primary health center. Bank branches were present in only 15 percent of the villages. About 5 percent of the households own no land. More than 40 percent of village households are very small landowners. As can be seen in Panel A, there are no significant differences in these village characteristics across the two treatment groups.

We do not use our full sample of 50 households per village to check if household characteristics are balanced across the two treatment groups. In TRAIL villages, 20 out of the 50 households (*Treatment* and *Control 1*) are a subset of those that the agent recommended as borrowers for the TRAIL scheme. In GBL villages, 20 out of the 50 households (*Treatment* and *Control 1*) are a subset of those that chose to form GBL groups that survived until October 15, 2010. The *Treatment* and *Control 1* households may not be representative of the average household in the village. The 30 *Control 2* households were selected randomly from those households that were not recommended (did not form groups) and thus are also not necessarily representative of the average household. Since the TRAIL and GBL schemes are different, there is no reason to believe that households that are selected into (or out of) the schemes will be similar across TRAIL and GBL villages. Instead, to test for the balance of household characteristics across treatment groups, we restrict the sample to the 24 households that were originally surveyed in the Mitra, Mookherjee, Torero, and Visaria (2012) study, since that sample was chosen well before the lending schemes were introduced or even designed. Since all these households were also included in our current surveys, we show in Panel B of Table 1 the characteristics of this set of households, as collected in the

[12]Those 24 households were a stratified (by land-size) random sample of all households that had cultivated potatoes in the year 2007.

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
Percent households landless	0.05	0.01	0.04	0.01	0.01
Percent households $0 - 1.25$ acres	0.43	0.04	0.43	0.03	0.00
Percent households $1.25 - 5$ acres	0.17	0.03	0.16	0.02	0.01
Percent households > 5 acres	0.01	0.01	0.01	0.00	0.00
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	0.07	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 credit taken	13760.90	936.62	12952.11	884.04	808.79
Mean interest rate	0.19	0.01	0.21	0.01	-0.02
Joint Significance of Household Variables‡					23.77

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

2010 Cycle 1 surveys. For most characteristics, there are only minor differences across the two treatment arms. Twenty-eight percent of households belong to Scheduled Castes or Scheduled Tribes. Most household heads interviewed are middle-aged males. A little over half of the household heads had completed primary school. About 56 percent of household heads were primarily occupied in cultivation. In the potato planting season the average household took a loan of about Rupees 13000 for agricultural or business purposes, and paid a mean interest rate of about 20 percent per annum. There are significant differences in some characteristics: GBL households were less likely to be non-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: Credit Market Characteristics

	All sources	Trader/moneylender	Institutional
Proportion of Households that borrowed	0.67	0.56	0.26
Total borrowing (Rupees)	11567.56	5462.42	16155.71
	(14971.27)	(7793.65)	(16770.31)
Average Loan Size (Rupees)	4915.45	2754.78	16260.44
	(9231.84)	(4834.18)	(15997.79)
Interest rate (per annum)	0.23	0.25	0.15
	(0.22)	(0.25)	(0.06)
Duration (days)	157.83	122.41	309.67
	(88.38)	(24.07)	(101.73)
Collateralized	0.14	0.01	0.77
	(0.34)	(0.11)	(0.42)

Notes:
The sample consists of all households in TRAIL and GBL villages. All loan characteristics are summarized for loans taken by the household in Cycle 1, for agricultural or business purposes. Loans from Shree Sanchari 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.

Table 2 describes characteristics of the agricultural or business-purpose loans that sample households took in Cycle 1. Two-third of the 2400 households in the sample had borrowed for these purposes. The average household borrowed about Rupees 11500. Traders and moneylenders lent only about half this amount. The average loan from a trader or moneylender was only Rupees 2755. They charged an annual interest rate of 25 percent, was given for a 4-month duration, and was almost never collateralized.[13] In contrast, institutional loans from banks, credit cooperatives or microfinance institutions (other than SS) were six times larger, charged significantly lower interest and had an average duration of close to one year. However, three-quarters of institutional loans required collateral.

4 The Theoretical Model

Our theoretical framework uses Ghatak (2000)'s adverse selection model as a point of departure. In the Ghatak model, borrowers do not have collateralizable wealth, and all lenders are equally uninformed about borrowers' risk types. Borrowers know the riskiness of their own and each other's projects. All projects require one unit of capital. A safe project succeeds with probability $p_s \in (0, 1)$, whereas a risky project succeeds with a strictly lower probability, p_r. All loans are of the same size, and so lenders charge the same interest rate to all borrowers. There is limited liability: borrowers repay the loan only if the project is successful. The model abstracts from repayment incentives and assumes borrowers repay whenever they have the means to do so. In a Supplementary Appendix (included with this submission) we show how our model can be extended to incorporate moral hazard in repayment. In the baseline model, all incentive problems arise due to asymmetric information about borrower risk type. 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.[14]

[13]The data show that 94 percent of these loans were inter-linked with sales in the input market: households reported that they had purchased inputs such as seeds, fertilizer or pesticides from a trader on credit, and that they would pay for it at a future date. We asked the household to report the price they would have been charged for the input if they had paid in cash, the amount they would actually pay, and the date when they were expected to make the payment. We used these data to compute the loan size, duration and interest rate for all such inter-linked loans.

[14]Such a scheme would induce borrowers to self-select into homogenous risk-type groups, with low- and high-risk groups applying for different contracts. If such a separating scheme is not feasible, offering the same joint liability contract to both groups could also be welfare improving. Under the plausible assumption that the extent of joint liability cannot exceed the extent of individual liability, Gangopadhyay, Ghatak, and Lensink (2005) have noted that the only feasible separating scheme is one in which the MFI offers both joint liability and individual liability loans, and the low-risk groups would select joint liability contracts whereas the high-risk borrowers would apply for individual liability loans.

In the Ghatak model, informal lenders are just as uninformed as the MFI about borrower risk types.[15] The MFI is different from the informal lenders only in that it has access to loanable funds at a lower rate, and the ability to offer joint liability loans. Instead, we assume that informal lenders are informed about the risk type of certain borrowers in the market. The uninformed MFI appoints these lenders as its "agents", in order to take advantage of this information. In particular, we assume that the informal credit market is segmented, where 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 low-risk borrowers within their segments. All segments have the same ratio θ of risky to safe types of borrowers.

We extend the Ghatak model in another dimension by allowing the amount of cultivable land, denoted by $a \geq 0$, to vary across borrowers. Since landholding is observable, this allows us to examine the relative success of AIL and GBL in targeting borrowers of varying wealths. To keep matters simple, we preserve all other aspects of the Ghatak model. All borrowers and lenders are risk neutral. Informal lenders face no capacity constraints, and all of them have the same opportunity cost ρ_I per unit of loanable funds. All projects involve a fixed scale of cultivation and a given need for working capital, so loan sizes do not vary.[16] Let the scale of cultivation be normalized to one unit of land, and the required loan size to be normalized to one rupee. If $a < 1$, the borrower needs to lease in $1 - a$ units of land in order to cultivate. As a increases, the distortions associated with tenancy, for example, due to inferior land quality or Marshallian undersupply of effort, are reduced. As a result, project returns increase in a. If his project succeeds, a borrower of type $i \in \{r, s\}$ with landholding a obtains a payoff $R_i(a)$. Additional assumptions on this payoff (analogous to those in the Ghatak model) will be provided below. We also make the simplifying assumption that the probability of success is independent of landholding.[17] Higher landholdings are also associated with a higher outside option for the borrower, should he decide not to pursue

[15]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).

[16]The model can be extended to allow for variable scale of cultivation and variable loan sizes. This complicates the analysis by allowing lenders to offer interest rates that vary with loan size as a way of screening for borrower risk type. However, the main qualitative properties continue to apply.

[17]Relaxing this assumption complicates the analysis and makes the predictions less sharp. In any case, loan repayment rates do not vary with borrowers' landholdings in our data.

the cultivation project. For instance, a landowner always has the option of leasing out his land. It is reasonable to suppose that the outside option is linear in a. We normalize and postulate that the outside option equals a.

First, consider the informal market before the MFI enters. 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, and also distinguished by borrower landholding a: $\{r_s(a), r_r(a), r(a)\}$ respectively denoting interest rate offered to own-segment safe borrowers, own-segment risky borrowers, and other-segment borrowers, of landholding a. Following Ghatak (2000), we impose the assumptions below to ensure that an equilibrium exists in the informal market:

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

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

$$p_s R_s(a) > \rho_I + a \tag{3}$$

Equation (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 (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 (3) states that the safe project is socially productive.

Proposition 1 *There is a unique equilibrium outcome in the informal market, in which safe types who own land a borrow from their own-segment lender at interest rate $r_s(a) \equiv R_s(a) - \frac{a}{p_s}$, while risky types borrow (from any lender) at interest rate $r_r \equiv \frac{\rho_I}{p_r}$.*

The informal lender can use her privileged information to identify the safe clients in her segment, and charge 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 her segment. However, all informal lenders compete over risky borrowers, and so she earns zero expected profits from lending to own-segment risky borrowers. The proof of this and all subsequent results are presented in Appendix A-1.

From equation (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. Also, r_r does not depend on the borrower's level of landholding, whereas $r_s(a)$ does. The shape of this relationship between a and $r_s(a)$ depends on the return function $R_i(a)$. If $R_i'(a)$ is above (below) $\frac{1}{p_s}$, then r_s rises (falls) with a. Our model is thus consistent with non-monotone relationships between landholding and interest rates, as well as monotone relationships, depending on the behavior of the $R_s(a)$ function.

Denote the payoff that a borrower of type (i, a) earns from his informal loans as $\overline{u}_i(a)$. Proposition 1 implies that $\overline{u}_s(a) = a$, whereas $\overline{u}_r(a) = p_r R_r(a) - \rho_I > a$. Similarly denote the profit that the informal lender makes from lending to a borrower of type (i, a) as $\Pi_i(a)$. In equilibrium, lenders make positive profits on the loans they make to their own-segment safe borrowers: $\Pi_s(a) = p_s R_s(a) - \rho_I - a$, but they break even on loans to risky borrowers: $\Pi_r(a) = 0$.

4.1 Agent-Intermediated Lending: TRAIL

Now consider what happens when the MFI enters the village and appoints one of the lenders as an agent. The TRAIL scheme is represented by two parameters chosen by the MFI: an interest rate r_T on the loan advanced to the borrower whom the agent recommended, and a commission rate K representing a fraction of the interest repayments made by the recommended borrowers that is payable to the agent. The sequence of moves is as follows: the agent recommends a borrower, who is then offered a loan of unit size at the interest rate r_T.[18] The borrower either accepts or refuses this offer. After this the informal credit market operates as described previously, with the only difference that a borrower who accepts a TRAIL loan no longer participates in the informal market. All borrowers with loans operate their projects, and those with returns above the interest rate on their respective loans make repayments to their respective lenders. Finally, the MFI pays the agent Kr_T if the borrower he recommended repaid the TRAIL loan, and 0 otherwise.

[18] We explain later how the results extend when the agent is asked to recommend more than one borrower, in the manner that TRAIL is designed.

It is evident that the pattern of interest rates in the informal market will be unaffected by the entry of the MFI. The TRAIL loan would be accepted by a borrower only if r_T is lower than the interest rate he expects to pay in the informal market. Without loss of generality, r_T must lie below the competitive interest rate for high-risk borrowers, r_r, otherwise no one would accept a TRAIL loan. We assume that r_T is set below the interest rates paid by low risk borrowers for some land-holdings, so the MFI offer would attract some low-risk borrowers.

4.1.1 TRAIL Without Collusion

To start with, suppose that the agent and the borrower whom she recommends play non-cooperatively. Which type of borrower will the agent recommend? Note that the agent faces a trade-off between the expected commission and possible profits foregone. If she recommended a safe borrower from her own segment, the TRAIL loan would be repaid with the highest probability and thus generate the highest commission for her, but would also cause her to lose the monopoly profit she currently earns from this borrower. In contrast, there is no loss of profit from recommending either a high-risk type from her own segment, or a borrower from any other segment. Between the two, she would prefer to recommend a randomly chosen other-segment borrower, since he would be expected to repay with a higher probability. Thus the agent's choices of whom to recommend narrow down to a low-risk type from her own segment, generating an expected commission of $Kp_s r_T$ but an expected loss of $\Pi_s(a) = p_s r_s(a) - \rho_I$, versus an other-segment borrower generating an expected commission of $K\overline{p}r_T$. The loss from recommending a safe borrower $\Pi_s(a)$ varies monotonically with the informal interest rate for that borrower, subject to the constraint that the borrower accepts the TRAIL loan if offered, i.e., $r_s(a) \geq r_T$. Let a^* denote the landholding a associated with the safe-type borrower with the lowest interest rate among those willing to accept the TRAIL loan. It follows that it is optimal for the agent to recommend own-segment safe borrower with landholding a^* if the commission rate is high enough:

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

and a borrower from a different segment otherwise.[19]

[19]Since we assumed above that r_T lies below the informal interest rate for some safe borrowers, $\overline{K}$ is well-defined.

Proposition 2 *Assume the agent and borrowers play non-cooperatively. Then the AIL agent recommends an own-segment safe borrowers (with landholding a^*) if and only if the commission rate satisfies $K \geq \overline{K}$, and a randomly chosen borrower from a different segment otherwise.*

When the agent is asked to recommend more than one borrower, the analysis above indicates that the agent will recommend them in the following order. The agent will first recommend safe borrowers in her own segment, subject to the constraint that the TRAIL interest rate is below the informal interest rate they are currently paying. If the number of such borrowers is smaller than the number the agent is asked to recommend, the agent will next select randomly chosen members from other segments.

4.1.2 TRAIL With Collusion

Now consider what happens when TRAIL is subject to collusion.[20] The collusion process is modeled as follows: the lender offers to recommend the borrower to the MFI in exchange for a bribe b. This is a take-it-or-leave-it offer: if the borrower refuses to pay the bribe, the lender does not recommend the borrower; instead they transact in the informal credit market as described in Proposition 1. Therefore, the lender sets the bribe b at a level that leaves the borrower with at least the utility he would earn in the informal credit market, $\overline{u}_i(a)$. It turns out that:

Proposition 3 *If the agent and borrowers collude, it is never optimal for the lender to recommend own-segment safe borrowers. On the other hand, it is always optimal to recommend a borrower from other segments.*

The intuition behind Proposition 3 is the following. Given that the lender has all the bargaining power, she can extract the entire surplus that the borrower stands to earn as a result of her recommendation. This is achieved by setting the bribe at a level that leaves the borrower with exactly the same utility he would obtain by rejecting the collusive

[20] Collusion could be costly for several reasons. For example, the agent may suffer a loss of reputation if the collusion is uncovered (with an exogenous probability), or bribes could be costly to exchange and could cause deadweight losses. We refrain from modeling these costs explicitly; instead we consider two polar cases where the size of these costs is either negligible or very large. With these polar cases in place, we study the consequences of collusion on our variables of interest.

offer. Thus, the lender effectively becomes the residual claimant of the own-segment safe borrowers' projects. If she recommends such a borrower, her net payoff is

$$= \quad \text{commission} + \text{bribe} - \text{profits from lending to this borrower} = \quad \rho_I - (1-K)p_s r_T$$

Analogously, the net payoff from recommending an own-segment risky type is

$$\rho_I - (1-K)p_r r_T$$

and so the agent prefers to recommend a risky rather than a safe type from her own segment. In stark contrast with the no-collusion case, it is never optimal for the agent to recommend her safe clients.

However, an even more attractive option is to recommend other-segment borrowers. If possible, it is optimal for the lender to set the bribe at a level that attracts only the safe borrowers from the other segment, because the lender stands to gain a high expected commission, but incurs a zero opportunity cost (because the lender did not earn any profits from such borrowers in the first place). Call this option (i). If this option is not available, the lender considers two alternatives: (ii) lowering the bribe so that both the risky and safe borrowers from other segments want the loan, or (iii) raising the bribe so that only the risky borrowers want the loan. Between (ii) and (iii), the trade-off is between the higher expected commission from attracting both safe and risky borrowers ($K\overline{p}r_T$ instead of $Kp_r r_T$), and the lower bribe necessary to attract both risky and safe borrowers from other segments. If she chooses option (i) or (ii), she recommends an other-segment borrower with landholding such that $p_s R_s(a) - a$ is maximized. In option (i) this comes from the fact that the lender is the residual claimant of the project and wants to maximize the expected returns. In option (ii) this result is due to the fact that the lender tries to maximize the bribe. There can also be circumstances where option (iii) is best, so that it is also optimal for the lender to recommend a high-risk type from her own segment.

It follows, therefore, that the agent recommends safe types from her own segment only if she does not collude with borrowers, and the commission rate is high enough. We refer to this as a situation where TRAIL is *effective*. The preceding results therefore provide a way for us to empirically test for the effectiveness of TRAIL, and derive some further testable predictions about the agent's recommendation behavior, conditional on TRAIL effectiveness.

4.2 Group-based Lending: GBL

In this sub-section we discuss how groups form under the group-based joint liability lending scheme offered by the MFI. As in Ghatak's analysis, we make the simplifying assumption that groups are of size two.[21] The group is jointly liable to repay $2r_T$.[22] We abstract from the possibility that the limited liability constraint binds for some landholding sizes, by assuming that $2r_T \leq R_s(a)$ for all a. This ensures that even if only one member's project succeeds, the loan can be repaid. As in the preceding section, we assume borrowers repay their liabilities whenever they have the resources to do so. Borrowers have to attend group meetings and make regular savings to qualify for a group loan. This imposes an additional cost γ_i for risk type i.

In the GBL scheme being examined here all groups were charged the same interest rate. No attempt was made to induce groups of differing risk profiles to self-select into different group loan contracts. Therefore, unlike Ghatak (2000), in our model of group-based lending there is no menu of different joint liability contracts.[23] However, borrowers have the choice to form a group and apply for the GBL loan, or obtain an individual liability loan in the informal market. We also continue to assume that r_T is smaller than the maximum interest rate offered to safe types in the informal market.

Under these assumptions, groups will form through positive assortative matching (PAM) of risk types, similar to Ghatak (2000). To see this, note first that when a borrower of type (i, a) forms a group with a borrower of type (j, a') he earns an expected payoff of

$$U_i(r_T, a) = p_i \left[R_i(a) - (2 - p_j)r_T\right] - \gamma_i \tag{5}$$

Given this, a safe borrower has more to gain than a risky borrower from teaming up with a safe borrower. Therefore, safe types will form groups with other safe types, and risky types will form groups with other risky types. Note also that since repayment probabilities and independent of landholding, borrowers are indifferent about the landholding of their group

[21]Appendix A-1 presents an extension of the model to groups of larger size in the presence of endogenous repayment incentives.

[22]Ghatak (2000) allowed for more than full joint liability, i.e., a successful borrower repays her loan r_T plus a joint liability larger than r_T when her partner fails. However Gangopadhyay, Ghatak, and Lensink (2005) have shown that ex post incentive compatibility requires that the extent of joint liability cannot be greater than the extent of individual liability.

[23]Shree Sanchari's standard GBL protocol does not allow for different loan contracts. To our knowledge, most microfinance institutions in practice offer a single joint liability contract.

members. Therefore, to keep the analysis simple, we assume from here on that groups are comprised of borrowers of the same risk type and the same landholding level.

However, groups will only form among individuals who choose to participate in the GBL scheme. When a borrower of type (i, a) receives the group loan instead of his equilibrium informal market loan, his expected gain is

$$U_i(r_T, a) - \overline{u}_i(a) = p_i\left[R_i(a) - (2 - p_i)r_T\right] - \gamma_i - \overline{u}_i(a). \tag{6}$$

For a safe type borrower with land a, this expression reduces to

$$U_s(r_T, a) - \overline{u}_s(a) = p_s[r_s(a) - (2 - p_s)r_T] - \gamma_s \tag{7}$$

which implies that the gain is higher for borrowers who face a higher interest rate in the informal sector, which is in turn a function of their landholding. Thus, among safe borrowers, those who pay higher interest rates will be more likely to self-select into the GBL scheme.

Which risk types are likely to form groups? A risky borrower who participates in the informal market expects to gain

$$U_r(r_T, a) - \overline{u}_r(a) = \rho_I - p_r(2 - p_r)r_T - \gamma_r \tag{8}$$

Comparing this with equation (7), we see that it is unclear whether a safe or a risky type stands to gain more from participating in the GBL scheme. By equation (3), we have $p_s r_s(a) > \rho_I$. This makes the GBL loan more attractive to the safe than the risky type, but on the other hand the safe type expects to make a higher repayment $p_s(2 - p_s)r_T$ than the risky type does. To add to the ambiguity, the costs γ_i of attending group meetings and meeting savings requirements may also differ between the two types in a way that is difficult to predict *a priori*.

4.3 Summary of Theoretical Predictions

As we have seen above, the TRAIL model delivers different predictions depending on whether the TRAIL scheme is *effective* – in other words, whether TRAIL agents do not collude, and are suitably incentivized to recommend own-segment safe borrowers. Since it is difficult in practice to gauge whether agents colluded with borrowers, or to test directly for whether the commission rate is high enough, we test if the TRAIL scheme was effective by testing for its implications.

(a) *Was the TRAIL scheme effective?* We say that TRAIL was effective if the likelihood of a borrower being recommended by the agent was higher for safe borrowers within the agent's own segment, subject to the constraint that the TRAIL interest rate was lower than their informal interest rate.

If the TRAIL scheme was effective, the model predicts the following comparisons:

(b) *Risk Selection comparison between TRAIL and GBL:* The definition of effectiveness of TRAIL implies that TRAIL agents are biased in favor of recommending safe borrowers from their own segment. In contrast, in the GBL scheme it is unclear whether safe or risky borrowers will form groups. Since borrowers in the GBL scheme are also subject to the same participation constraint as in the TRAIL scheme, it follows that individuals recommended by the TRAIL agent must be (weakly) safer than individuals who form groups in the GBL villages. Hence we expect groups that form in GBL to pay higher informal interest rates on average, compared with those recommended by TRAIL agents.

(c) *Comparisons of targeting across landholding categories:* For safe borrowers there is a relationship between landholding level and the informal interest rate. Therefore, the landholding level of selected borrowers should vary between the TRAIL and GBL schemes. The TRAIL agent recommends safe borrowers with landholding corresponding to low interest rates. On the other hand, in the GBL scheme it is unclear whether safe or risky borrowers will form groups. Therefore, compared to self-selected borrowers in the GBL scheme, recommended borrowers in the TRAIL scheme are more likely to be in landholding categories that correspond to lower interest rates. The actual relationship between landholding and the safe-type's interest rate ($r_s(a)$) will determine whether landholding levels will be higher or lower among TRAIL recommended individuals relative to GBL self-selected individuals.[24]

(d) *Repayment rate comparisons:* As we saw above, if the TRAIL scheme is effective, recommended borrowers in TRAIL villages are (weakly) safer than borrowers who form groups in GBL villages and therefore they are able to repay with higher probability.

[24]Recall that the interest rate r_r that risky types pay in the informal market is independent of landholding. So if the proportion of safe types does not vary with a, one can take the average interest rate (across safe and risky types), and note that the differential between landholding levels in GBL and TRAIL will be driven exclusively by the shape of this average interest rate (as a function of landholding.)

However, even if a GBL borrower's project fails with higher probability than a TRAIL borrower's project, he may not default with the same high probability, because his group-member may repay on his behalf. It is thus unclear which of the two schemes will generate a higher repayment rate.[25]

(e) *Comparisons of Welfare and Loan Take-up:* The theoretical model does not have clear predictions about which scheme generates higher welfare gains for borrowers. Although both TRAIL and GBL loans charge the same interest rate, GBL borrowers expect to repay a larger amount because members are liable for their peer's loan as well as their own. In addition, GBL borrowers incur the cost of attending group meetings and achieving savings targets. On the other hand, the group liability in GBL loans also delivers insurance to each borrower in the group: even if his own project fails, his group-member may repay the loan on his behalf and thus allow him to borrow again in the next cycle. Thus GBL loans could offer higher benefits in addition to imposing higher costs.

5 Empirical Results

In this section we present empirical evidence on whether the TRAIL scheme we implemented was effective, and compare risk type, landholding patterns, repayment rates and take-up rates between the TRAIL and GBL schemes.

5.1 Was the TRAIL scheme effective?

Our model predicts that if the TRAIL scheme incentivized the agent sufficiently and the agent did not collude with borrowers, then she is more likely to recommend safe borrowers within her own network, from among those paying informal interest rates higher than the TRAIL interest rate.. Among those own-segment safe borrowers who were willing to accept a TRAIL loan, (i.e. paying an informal interest rate above 18 percent), she is more likely to recommend those paying a lower informal interest rate. In other words, the likelihood

[25]However, if we allow for moral hazard in repayment incentives, then GBL groups may also be subject to contagious defaults, where a member with a successful project default on his own loans when his group-member's project fails. In that case the GBL scheme will generate lower repayment rates compared to the baseline GBL considered here.

of recommendation should decline in the informal interest rate paid by the borrower, conditional on this interest rate being greater than 18 percent, and on the borrower belonging to the same segment as the agent.. Since we cannot observe the agent's own segment, we operationalize it as the agent's network (specifically own-clientele).

Table 3: Was the TRAIL scheme effective?

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

	(1)	(2)	(3)	(4)	(5)
	TRAIL				GBL
			Own-clientele		
			Yes	No	
Buy from agent	0.009				
	(0.048)				
Borrow from agent	0.166***	0.168***			
	(0.037)	(0.035)			
Work for agent	0.033				
	(0.057)				
Household Borrows in Cycle 1		0.012	-0.175	0.071	0.016
		(0.099)	(0.234)	(0.105)	(0.102)
Household Borrows in Cycle 1 × Interest rate $[0 - 18\%]$		0.290	1.823	-0.179	0.474
		(0.705)	(1.792)	(0.703)	(0.526)
Household Borrows in Cycle 1 × Interest rate $\geq 18\%$		-0.044	-0.927***	0.215	0.073
		(0.220)	(0.205)	(0.198)	(0.075)
Landholding	0.203	0.185	0.643*	0.042	-0.227
	(0.136)	(0.138)	(0.366)	(0.148)	(0.171)
Landholding Squared	-0.223**	-0.199**	-0.614**	-0.051	0.041
	(0.091)	(0.093)	(0.238)	(0.101)	(0.098)
Constant	0.351***	0.382***	0.516***	0.390***	0.477***
	(0.042)	(0.039)	(0.099)	(0.043)	(0.061)
Sample Size	1,031	197	834	1,037	1,031

Notes:
All columns show linear probability estimates that a household was recommended/selected into the scheme. In Columns (1) – (4) the sample consists of all sample households in TRAIL villages; in column (5) the sample consists of all sample households in GBL villages. The regressions in column (1) also include the religion (Hindu) and caste (SC, ST and OBC) of the household and interactions of the religion and caste of the household with that of the agent. All households in the sample own no more than 1.5 acres of land. The interest rate 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. Standard errors in parentheses are clustered at the village level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

Being own-clientele can be defined in a number of different ways. In our household surveys we asked households if they had borrowed from the agent, worked for the agent or bought from the agent in the past three years. We also have information about the religious and caste identity of both the household head and the agent, and thus can measure if they belong to the same community. These are different ways of defining own-clientele. In Table 3, column (1) we present the results from a linear probability regression for whether a household was recommended to the MFI for a TRAIL loan. We are specifically interested in whether being own-clientele matters. The credit network was the only network that had a significant impact on the likelihood of recommendation: a household was 16.6 percentage points more likely to be recommended for the loan if it had borrowed from the agent in the past. For the rest of the paper we define being own-clientele as having borrowed from the agent in the past three years.

In columns (2) to (5) we check if the interest rate the household paid in the informal market influenced the probability of recommendation. We can therefore predict the likelihood of any member of the sample being recommended by the agent, on regressors which include dummies for being in network, interest rates paid by the borrower on informal loans and interactions between these.

The interest rate data are collected by asking households in the household surveys to report all loans they have taken in the past 4 months, along with the name of the lender, the purpose of the loan, the contractual terms of the loans and all repayments made so far. We include a dummy variable indicating if in Cycle 1 the household had taken an informal loan for an agricultural or business purpose from a trader or moneylender. This is then interacted with the average interest rate the household paid on such loans. However we allow for a "break" in the relationship (using a spline) between the average interest rate and the likelihood of recommendation, at 18 percent per annum. The results in column (2) show that even when we control for the interest rate on informal loans, being own-clientele continues to have a large and statistically significant effect on the likelihood of being recommended for a loan in TRAIL.[26]

[26]Since our household survey data were collected after Cycle 1 loans had been disbursed, one might worry that *Treatment* households' access to and use of credit from the informal market may have been influenced by the fact that they had received a low-interest loan from SS through the TRAIL scheme. To avoid this concern, we also ran the regressions in Tables 3 – 5 without including the *Treatment* households. The results are qualitatively unchanged. In columns (1) and (2) in Table 5 (below) where we compare the interest rates paid by borrowers selected into GBL with those not selected, including the *Treatment* households would actually lower the likelihood of finding a significant difference: assuming an upward sloping supply curve for loans, if the SS loan caused *Treatment* households to borrow less from the informal market, their informal interest rate would be *lower* than for comparable households who were not randomly selected to receive the SS loan.

Next, we break down the sample into those who had borrowed from the agent in the past (in column 3) and those who had not (in column 4). If TRAIL was effective: (*i*) among those being own-clientele, the likelihood of recommendation should be initially increasing in the informal interest rate up to a rate similar to the MFI interest rate of 18 percent (since the likelihood of their wanting a TRAIL loan will be increasing in their interest rate conditional on this rate being below 18 percent), and decreasing thereafter (since these borrowers would definitely be interested in the TRAIL loan, but the likelihood of their being recommended by the agent would be lower the higher their informal interest is); (*ii*) for others (not being own-clientele), the likelihood of recommendation should be throughout unrelated to the informal interest rate (since the agent is likely to be uninformed about their interest rate).

Columns (3) and (4) of Table 3 show that these predictions are indeed borne out in the data. For own-clienteles, the likelihood of recommendation rises with the interest rate until it reaches 18 percent, and falls thereafter. For others (not own-clientele) members there is no systematic relationship with the interest rate.

Column (5) presents the same specification as column (2), but for the likelihood that a household forms a group in the GBL village. Note also that since there is no agent in the GBL scheme, we do not include variables measuring if the household belongs to own-clientele. There is no break at 18 percent. The probability that a household forms a group increases continuously as the informal interest rate increases – the effect is however not statistically significant. There is no evidence that the selection likelihood decreases with risk type – there is no force in the GBL scheme that causes only households that pay relatively low-interest rates to select in.

5.2 Risk-Selection

Further evidence about the effectiveness of the TRAIL scheme is provided in columns 1 and 2 of Table 4, which examines the determinants of the informal interest rates. Here we restrict the sample to all sample households in TRAIL villages. Recall that if the TRAIL scheme was effective, then among her own-segment safe borrowers, the TRAIL agent should recommend those who pay relatively low interest rates.[27] If this is true, then own-clientele recommended borrowers should pay relatively lower interest rates than own-clientele *Control*

[27] The average interest rate at which the household borrows in the informal market is one measure of the riskiness of household.

Table 4: Was the TRAIL scheme effective? Further evidence

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

	Own-clientele Borrowed from Agent OLS (1)	Own-clientele Borrowed from Agent Heckman (2)	Own-clientele Same Religion OLS (3)	Own-clientele Same Religion Heckman (4)	Own-clientele Same Caste# OLS (5)	Own-clientele Same Caste# Heckman (6)
Own-clientele	0.045	0.045*	0.031	0.031	-0.038	-0.038*
	(0.034)	(0.027)	(0.024)	(0.030)	(0.025)	(0.021)
Recommended	0.017	0.017	0.030	0.030	0.008	0.008
	(0.016)	(0.017)	(0.028)	(0.040)	(0.026)	(0.022)
Own-clientele × Recommended	-0.073**	-0.073**	-0.035	-0.035	-0.010	-0.010
	(0.027)	(0.036)	(0.033)	(0.043)	(0.030)	(0.030)
Landholding	0.093	0.117	0.088	0.110	0.094	0.100
	(0.068)	(0.074)	(0.069)	(0.074)	(0.069)	(0.074)
Landholding Squared	-0.068	-0.086*	-0.063	-0.079	-0.063	-0.068
	(0.045)	(0.051)	(0.046)	(0.052)	(0.044)	(0.051)
Inverse Mill's Ratio (λ)		0.036		0.032		0.009
		(0.040)		(0.040)		(0.041)
Constant	0.216***	0.174***	0.197***	0.159***	0.234***	0.223***
	(0.013)	(0.047)	(0.028)	(0.052)	(0.017)	(0.049)
Sample Size	441	916	441	916	441	916

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 consists of all sample households in TRAIL villages. Standard errors in parentheses are clustered at the village level in columns (1), (3) and (5). Columns (2), (4) and (6) report the results of the second step of Heckman two-step regressions, where the first stage selection regression estimates the likelihood that the household borrows in Cycle 1. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.
#: Since Muslims typically do not report a caste, they are coded as having the same caste as the agent if the agent is also Muslim.

2 borrowers. Thus, in each column, the coefficient on the interaction term Own-clientele × Recommended should be negative. In column (1) we see that own-clientele recommended households paid interest rates that were 7.3 percent lower than *Control 2* households, the difference being statistically significant at 5 percent level. The coefficient is identical both in terms of magnitude and level of significance in column (2), where we present the second step of a Heckman regression, which accounts for the endogeneity of the decision to take a productive purpose informal loan in Cycle 1. Note also that the agent's recommendation decisions appear to be specifically guided by their information about households who belong to their informal credit market segment. When we define the agent's network using her religion (columns 3 and 4) or caste identity (columns 5 and 6), we no longer see significant differences in the interest rates paid by recommended versus non-recommended borrowers. Agents are indeed using the information they have about households who have borrowed from them in the past to select whom to recommend for the TRAIL loan.[28]

We now examine risk selection in GBL. The results are presented in columns (1) and (2) of Table 5. Both the OLS regression in column (1) and the second stage Heckman regression in column (2) (which corrects for endogeneity of the decision to borrow on the informal market in Cycle 1) show that selected households in GBL households pay about 4 percent higher interest rates on informal loans compared to households that chose not to form groups (*Control 2* households). This effect is large, and is almost statistically significant ($p-value = 0.10$). Finally, a direct outcome of an effective TRAIL scheme is that individuals recommended by the TRAIL agent must be (weakly) safer than individuals who form groups in the GBL villages. Hence we expect groups that form in GBL to pay higher informal interest rates on average, compared with those recommended by TRAIL agents. We test this prediction in columns (3) and (4) in Table 5. The sample in these two columns consist only of Recommended/Selected households, in both TRAIL and GBL borrowers. The second stage of the Heckman regression in column (4) show that recommended households in TRAIL villages pay about 5 percentage point lower interest rates on informal loans than households that formed groups in GBL villages – the magnitude of the coefficient is similar in column (3) but the estimates are less precise.

5.3 Targeting by Landholding Levels

Taken together, the results in Tables 3 – 5 provide systematic evidence that TRAIL agents were incentivized to recommend safe borrowers who paid low interest rates. In contrast to the GBL scheme, the TRAIL scheme caused relatively safe borrowers to be selected for the MFI's loans. However, arguably, MFIs are not motivated merely to screen borrowers by risk type. A stated goal of many MFIs is to increase credit access for the poor. Both the TRAIL and the GBL loans were only available to households with less than 1.5 acres of land and thus target the poorer section of rural West Bengal society by construction.[29] However, it is worth investigating whether even within this section, there are differences in how the two

[28]This corroborates the results in Table 3 – it is prior borrowing from the agent that provides the best way for the agent to judge the riskiness of the household.

[29]Ninety-six percent of households who were recommended by TRAIL agents or formed a group in GBL villages (*Treatment* and *Control 1*) owned less than 1.5 acres of land. In contrast around 81 percent of *Control 2* households owned less than 1.5 acres.

Table 5: Does GBL Attract Riskier Borrowers?

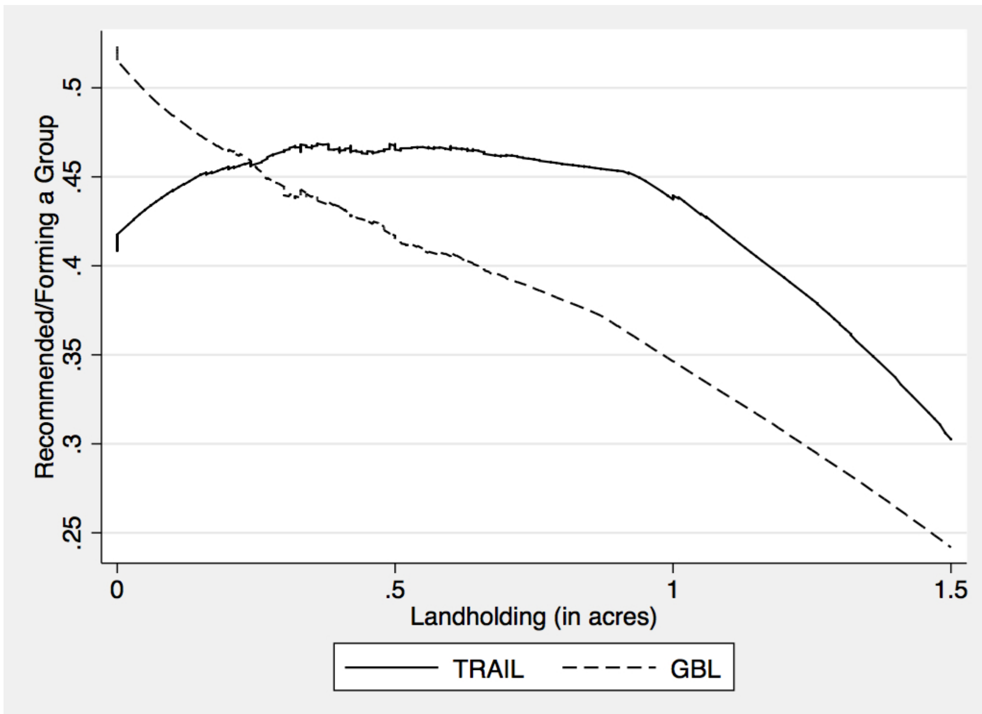
(Dependent Variable: average interest rate paid on informal loans)

	GBL		TRAIL v GBL	
	OLS	Heckman	OLS	Heckman
	(1)	(2)	(3)	(4)
Selected (*Treatment* and *Control 1*)	0.041	0.040		
	(0.024)	(0.028)		
TRAIL			-0.056	-0.055**
			(0.044)	(0.025)
Landholding	-0.054	-0.013	0.020	0.051
	(0.116)	(0.132)	(0.128)	(0.117)
Landholding Squared	0.012	-0.009	-0.021	-0.036
	(0.076)	(0.089)	(0.079)	(0.082)
Inverse Mill's Ratio (λ)		0.039		0.036
		(0.069)		(0.066)
Constant	0.199***	0.155*	0.259***	0.223***
	(0.026)	(0.084)	(0.039)	(0.073)
Sample Size	422	940	415	823

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 GBL villages. The sample in columns (3) and (4) consists of Recommended (*Treatment* and *Control 1*) households in TRAIL and GBL villages. Columns (2) and (4) 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. Standard errors are in parenthesis. In columns (1) and (3), standard errors are clustered at the village level. $^{***}: p < 0.01, ^{**}: p < 0.05, ^{*}: p < 0.1$.

schemes target the poorest of the poor. In Table 6 we once again present linear probability estimates of the likelihood that a household was selected, i.e., recommended by the TRAIL agent or self-selected to form a group. Note that the probability of recommendation by the TRAIL agent followed an inverted-U shaped pattern with borrower's landholding. As borrower's landholding increased from zero to 1.5 acres, the probability of landholding first increased and then decreased. In contrast, column (2) shows that in GBL villages, the probability that a household formed a group decreased as landholding increased, although the coefficient is not significantly different from zero. This finding is echoed in the graph shown in Figure 1, which presents the lowess plot of likelihood of recommendation/selection into group in TRAIL and GBL on landholding. In TRAIL villages, the likelihood that the agent recommends a household is low at very low levels of landholding, and then rises, before falling again beyond a landholding level of 0.45 acres. In contrast, the likelihood that a household forms a group in GBL villages is highest at zero landholding and decreases monotonically as landholding increases.

Figure 1: Targeting by Landholding



In columns (3) and (4), instead of allowing for quadratic relationship with landholding, we include a dummy variable for whether the household is landless. Column (4) makes it clear that in GBL villages, it is the landless who are significantly more likely to form groups. This result is reinforced through the regressions on a pooled sample of households in TRAIL and GBL villages, reported in columns (5) and (6). Relative to the TRAIL scheme, the GBL scheme is 16 percentage points more likely to target landless households. This suggests there is a risk/targeting trade-off. The TRAIL scheme is better able to select safe borrowers than the GBL scheme is, but by the same token it is less likely to target the very poorest section of the village population.

Table 6: Landholding Patterns of Selected Borrowers: TRAIL v. GBL

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

	(1) TRAIL	(2) GBL	(3) TRAIL	(4) GBL	(5) Pooled	(6) Pooled
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)			
Landholding	0.208*	-0.177				
	(0.123)	(0.165)				
Landholding Squared	-0.236**	0.014				
	(0.086)	(0.093)				
Landless			-0.010	0.112*	-0.037	-0.028
			(0.052)	(0.063)	(0.053)	(0.055)
GBL					-0.051	-0.053
					(0.035)	(0.033)
Landless × GBL					0.161*	0.159*
					(0.090)	(0.091)
Non Hindu	0.030	-0.059	0.030	-0.056		-0.061
	(0.143)	(0.108)	(0.140)	(0.108)		(0.058)
Non Hindu × Agent Hindu	-0.098		-0.097			
	(0.132)		(0.130)			
SC	0.544***	-0.028	0.534***	-0.018		-0.037
	(0.031)	(0.067)	(0.035)	(0.066)		(0.041)
SC × Agent High Caste	-0.610***		-0.589***			
	(0.036)		(0.037)			
ST	-0.198*	0.024	-0.177	0.017		-0.015
	(0.108)	(0.152)	(0.104)	(0.147)		(0.089)
ST × Agent High Caste	0.218		0.194			
	(0.166)		(0.157)			
OBC	-0.005	0.110	-0.007	0.110		0.060
	(0.077)	(0.108)	(0.078)	(0.107)		(0.068)
Purchased on credit	0.075**	0.065	0.074**	0.069		0.074**
	(0.028)	(0.050)	(0.027)	(0.049)		(0.028)
Received government transfers	0.022	0.054	0.027	0.058		0.055**
	(0.023)	(0.039)	(0.025)	(0.039)		(0.023)
Constant	0.037	0.392***	0.051	0.316**	0.454***	0.258***
	(0.098)	(0.130)	(0.099)	(0.120)	(0.014)	(0.095)
Sample Size	1,031	1,037	1,031	1,037	2,068	2,068
Number of Villages	24	24	24	24	48	48

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. Regressions in columns (1) – (4) and (6) also control for age, gender, educational attainment, primary occupation of the household head and household size. Column (6) is a parsimonious regression.

5.4 Repayment Patterns

Recall that the theoretical model could not predict whether repayment rates would be higher on TRAIL loans or on GBL loans. As we have seen, TRAIL borrowers are safer than GBL borrowers and therefore their projects are more likely to succeed. However, controlling for the risk type of all group members, we expect default rates to be lower in the GBL scheme since all members' loans might be repaid even if not all members' project succeeds. It is therefore an empirical question whether repayment rates are higher or lower in the TRAIL scheme.

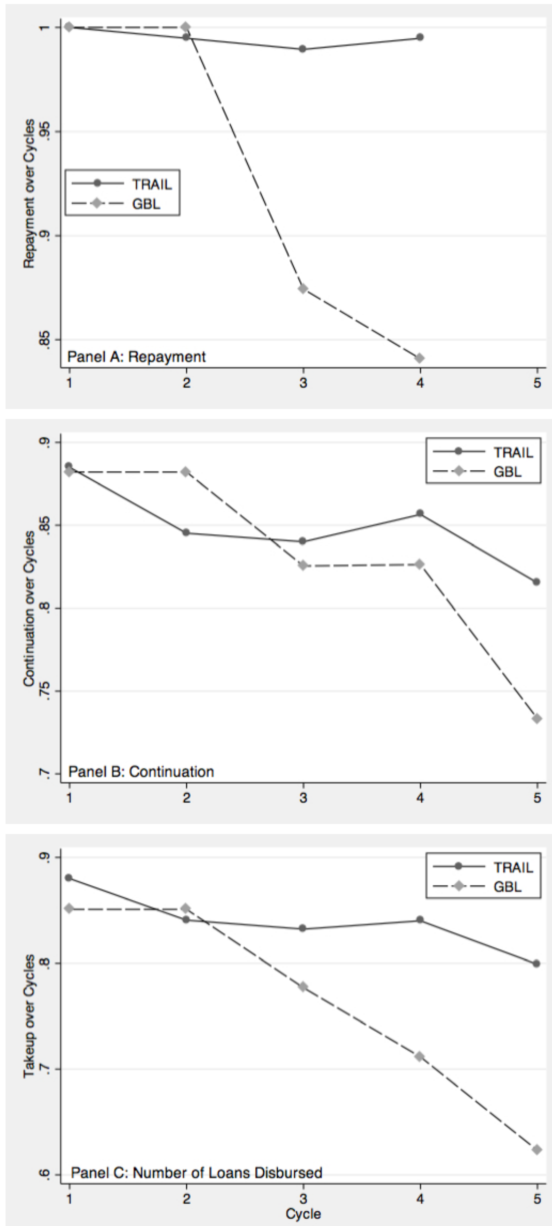
Panel A in Figure 2 presents the repayment rates in both treatment arms for each of the first four loan cycles. Note that repayment rates are high in both schemes. The average repayment rate at the end of four cycles was 99 percent on TRAIL loans and 83 percent for GBL loans. However note also that repayment rates have fallen from 100 percent on Cycle 1 and 2 loans under both schemes, to 99 percent and 83 percent on Cycle 4 TRAIL and GBL loans respectively. The regression results in Panel A, Table 7 control for borrower characteristics and confirm this pattern. In Cycle 3 the repayment rate on TRAIL loans was 8.7 percentage points higher than on GBL loans. This difference grew to 15 percentage points in Cycle 4. Thus, on the basis of repayment rates alone, the TRAIL scheme is more likely to be financially sustainable than the GBL scheme.

5.5 Take-up and Continuation Rates

Borrowers' expected welfare gains from participation in the loan schemes are likely to influence their take-up of the loans. However the theoretical model does not have clear predictions about which scheme generates higher welfare gains for borrowers. The TRAIL scheme imposes lower costs since there are no savings requirements or group meetings, and there is no liability for group members' loans. However the group liability in GBL loans also delivers insurance to each borrower in the group: even if his own project fails, his group-member might repay the loan on his behalf and thus allow him to borrow again in the next cycle. Thus GBL loans could offer higher benefits in addition to imposing higher costs.

Panel B in Figure 2 plots the average take-up rate for households who were offered the

Figure 2: Loan Performance: Takeup/Continuation and Repayment



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 7: Loan Repayment and Take-up Rates: TRAIL v. GBL

	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
Panel A: Loan repayment rate					
TRAIL			0.087*	0.150***	
			(0.044)	(0.053)	
Constant			0.640***	0.796***	
			(0.187)	(0.095)	
Sample size			364	348	
Panel B: Household-level take-up/continuation rate of loans					
TRAIL	-0.011	-0.054	0.005	0.018	0.065
	(0.054)	(0.055)	(0.067)	(0.068)	(0.080)
Constant	0.633***	0.590***	0.603***	0.384*	0.403
	(0.146)	(0.153)	(0.164)	(0.218)	(0.248)
Sample size	438	438	437	413	387
Panel C: Proportion of originally eligible households who received loans					
TRAIL	0.029	-0.010	0.055	0.128	0.176*
	(0.074)	(0.077)	(0.090)	(0.092)	(0.104)
Constant	0.851***	0.851***	0.777***	0.712***	0.623***
	(0.060)	(0.060)	(0.077)	(0.079)	(0.093)
Sample size	48	48	48	48	48

Notes:
Linear probability estimates. In Panel A the dependent variable takes value 1 if the loan is fully repaid within 30 days of its due date. In Panels B and C it takes value 1 if a borrower accepted the MFI's loan in the particular cycle. In Panel A the sample consists of all households in TRAIL and GBL villages who accepted the MFI's loan in that cycle; in Panel B it consists of all borrowers in TRAIL and GBL villages who were offered the MFI's loan in that cycle; in Panel C it consists of all 10 borrowers in each TRAIL and GBL village who were randomly chosen to be treatment households before Cycle 1 began. Regressions control for landholding and its square. Repayment rates were 100 percent in Cycles 1 and 2. Standard errors, clustered at the village level, are in parentheses. $^{***}p < 0.01,^{**} p < 0.05,^{*} p < 0.1$.

loans in the two schemes, with each dot representing the take-up rate among households in a particular scheme in a particular cycle. Take-up rates were highest in Cycle 1 and identical in both schemes at 99 percent. Subsequently, they have been falling faster for GBL loans than for TRAIL loans. A formal test of this difference is presented in Panel B of Table 7 where we show results from a regression of the take-up rate on a dummy for households who were in TRAIL villages. As can be seen in each subsequent cycle the coefficient on the TRAIL dummy has been growing larger, although it is not significantly different from zero in any of the columns.

In Panel C of Figure 2 and Table 7, we examine the impact of the two schemes on financial inclusion. In each village, 10 households were eligible to participate in the loan scheme starting in Cycle 1. In each cycle we ask what proportion of these 10 households receives a loan from the MFI. Clearly, failure to receive a loan in any cycle may be the result of different factors: non-repayment in a previous cycle resulting in disqualification for future loans, dissolution of GBL groups or a voluntary choice not to borrow.[30] Thus this is an empirical measure of the probability that the TRAIL or GBL scheme might provide long-term access to credit to such households. Panel C of Figure 2 shows that credit access is higher in TRAIL villages than in GBL villages. However, as Panel C of Table 7 shows, this difference is not significant in Cycles 1 – 4, and becomes significant in Cycle 5. In Cycle 5, only 62 percent of the initially selected households took the GBL loan, whereas a significantly higher 80 percent of the initially selected households took the TRAIL loan. This suggests that as time progresses, the TRAIL scheme outperformed the GBL scheme at providing continued access to credit and hence financial inclusion.

6 Was the TRAIL scheme financially sustainable?

We have shown that the financial performance of the TRAIL scheme as implemented in this project was superior to the GBL scheme: it had higher repayment rates and higher take-up and financial inclusion rates than the GBL scheme. It also imposed lower costs on borrowers by avoiding group meetings and savings requirements.

An important question is whether an MFI can break even when it runs a scheme such as

[30] In one GBL village, no group survived until the cut-off date of October 15, 2010; in two GBL villages, one treatment group broke up after the lottery.

this. Our calculations suggest that it cost Shree Sanchari considerably less to operate the TRAIL scheme than the GBL scheme. The bulk of the cost difference comes from the loan officers' salaries and transport expenses for the bi-monthly group meetings. This item cost Rupees 1125 per month (at 2012 prices) per village. In contrast, loan officers visited TRAIL villages only once in four months, and thus the personnel and travel cost was only Rupees 31.25 per month per village. In addition, Shree Sanchari 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: a difference of almost Rupees 1400. Hence the TRAIL scheme had lower administrative costs than GBL.

To check if the TRAIL scheme allowed the MFI to break even, next we compute the revenue it generated. In the TRAIL scheme Shree Sanchari could expect to earn at best Rupees 75 in Cycle 1 and Rupees 300 in Cycle 7.[31] Given the observed near-100 percent repayment rate in our TRAIL villages, it appears that the TRAIL scheme as currently designed generates enough income for the MFI to pay for the costs of administering it. However, it does not cover the MFI's costs of borrowing. At the prevailing borrowing rate of 12 percent per annum, the MFI cannot break even. Either the commission rates would need to be lowered, or the interest rate charged to borrowers would need to be raised.

Of course, such changes could lead to other concerns. Recall that agents were incentivized through commissions that depended on timely repayment by borrowers. Clearly, the commission rate is an important element influencing whether the TRAIL scheme was effective. It is not clear from our results how far the commission rate could be lowered before agents stopped selecting safe borrowers. That said, some agents have indicated to us in informal conversations that they would be willing to accept a lower commission rate if the scale of operation is increased: agents appear to care about the total size of the commission they receive rather than the commission rate per loan. In future research we hope to investigate to what extent the commission rate can be lowered while simultaneously expanding the scale of the scheme, thus ensuring fiscal sustainability as well as expanding outreach.

[31] 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% of this, Rupees 300. Since a cycle lasts 4 months this works out to a revenue of Rupees 75 per month per village. A similar calculation can be done for all cycles.

7 Concluding Comments

We designed a micro-lending approach that relies on agents recruited from within the local community. To do this we conducted a field experiment where this agent-intermediated lending approach was implemented in 24 villages and compared with the group-based lending approach implemented in another 24 villages. We constructed a theoretical model to understand the incentives of the agents and generate predictions about risk-selection, targeting, take-up and repayment rates under alternative scenarios and used data about agents' recommendations of borrowers, take-up of loans by borrowers, repayment rates, and interest rates that borrowers paid in the informal credit market to test these predictions.

Our results indicate that the TRAIL scheme was effective. In other words, there is no evidence that TRAIL agents recommended borrowers in return for side-payments; instead it appears that agents were incentivized to recommend safe clients from within their lending network. This selection of safe borrowers into the lending scheme represents a significant improvement over vertical credit market linkage models that have previously been implemented in different parts of the world. However, we also find evidence of a selection/targeting trade-off: TRAIL agents recommend households with intermediate landholdings, whereas GBL groups are likely to be formed by households with low landholdings. Thus the GBL scheme is better able to target the poorest section of the rural population. Both repayment rates and take-up rates were higher in the TRAIL scheme than in the GBL scheme.

As our theoretical model shows, the critical element influencing whether the TRAIL scheme was effective is the commission rate offered to the TRAIL agent. In our scheme, borrowers were charged an 18 percent rate of interest, and agents received 75 percent of the interest payments made by borrowers whom they recommended. Although it is clear that the TRAIL scheme outperformed the GBL scheme financially, it is also clear that given the prevailing borrowing rate of 12 percent per annum, it still does not allow an MFI to break even. In future work we hope to experiment with the commission rate and the scale of the program to identify the conditions under which the TRAIL scheme is both effective and financially sustainable.

The results suggest that with an appropriate commission rate for agents, the AIL approach could be a feasible and sustainable approach to delivering microcredit in a rural developing country context. Agents can be incentivized to use their prior knowledge about rural households to recommend safe borrowers, so as to ensure high repayment rates. With lower default rates, the borrowers also remained eligible for larger loans as cycles continued, thus providing a higher degree of financial inclusion than the traditional group-based lending scheme did.

At this stage it is premature to comment on the broader welfare or policy implications of these different approaches. To do this, we need to assess the impacts of the different treatments on cultivation, profits, household incomes and assets. These will be discussed in future work.

References

Attanasio, O., B. Augsburg, R. D. Haas, E. Fitzsimons, and H. Harmgart (2011): "Group Lending or Individual Lending? Evidence from a Randomised Field Experiment in Mongolia," Mimeo, IFS.

Banerjee, A., E. Duflo, R. Glennerster, and C. Kinnan (2011): "The miracle of microfinance? Evidence from a randomized evaluation," Mimeo, MIT, JPAL.

Banerjee, A. V., and E. Duflo (2011): Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty. Public Affairs.

Besley, T., and S. Coate (1995): "Group lending, repayment incentives and social collateral," Journal of Development Economics, 46(1), 1 – 18.

Carpena, F., S. Cole, J. Shapiro, and B. Zia (2010): "Liability Structure in Small-scale Finance. Evidence from a Natural Experiment," Discussion paper, World Bank Policy Research Working Paper 5427.

Casini, P. (2010): "Competitive Microcredit Markets: Differentiation and ex-ante Incentives for Multiple Borrowing," Licos discussion papers 26610, LICOS - Centre for Institutions and Economic Performance, K.U.Leuven.

Celik, G. (2009): "Mechanism Design with Collusive Supervision," Journal of Economic Theory, 144(1), 69 – 95.

Demont, T. (2012): "The Impact of Microfinance on the Informal Credit Market: An Adverse Selection Model," Discussion paper, Namur.

Desai, J., K. Johnson, and A. Tarozzi (2011): "On the Impact of Microcredit: Evidence from a Randomized Intervention Rural Ethiopia," Mimeo, Duke University.

Duflo, E., M. Greenstone, R. Pande, and N. Ryan (2012): "Truth-telling by Third-party Auditors and the Response of Polluting Firms: Experimental Evidence from India," Discussion paper, Mimeo, MIT.

Faure-Grimaud, A., J. J. Laffont, and D. Martimort (2003): "Collusion, Delegation and Supervision with Soft Information," Review of Economic Studies, 70, 253 – 275.

Field, E., and R. Pande (2008): "Repayment frequency and default in micro-finance: Evidence from India," Journal of the European Economic Association, 6(2-3), 501 – 509.

Field, E., R. Pande, J. Papp, and N. Rigol (2012): "Does the Classic Microfinance Model Discourage Entrepreneurship Among the Poor? Experimental Evidence from India," Discussion paper, Duke University.

Floro, M. S., and D. Ray (1997): "Vertical Links Between Formal and Informal Financial Institutions," Review of Development Economics, 1(1), 34 – 56.

Fuentes, G. (1996): "The Use of Village Agents in Rural Credit Delivery," Journal of Development Studies, 33(2), 188 – 209.

Gangopadhyay, S., M. Ghatak, and R. Lensink (2005): "Joint Liability Lending and the Peer Selection Effect," Economic Journal, 115, 1005 – 1015.

Ghatak, M. (2000): "Screening by the company you keep: joint liability lending and the peer selection effect," Economic Journal, 110(465), 601 – 631.

Giné, X., and D. Karlan (2010): "Group versus individual liability: Long-term evidence from Philippine microcredit lending groups," Discussion paper, Yale University.

Gine, X., K. Krishnaswamy, and A. Ponce (2011): "Strategic Default in Joint Liability Groups: Evidence from a Natural Experiment in India," Mimeo, World Bank and CGAP and World Justice Project.

Guha, B., and P. R. Chowdhury (2012): "Borrower Targeting under Micro-finance Competition with Motivated MFIs," Discussion paper, Singapore Management University, School of Economics.

Jain, S. (1999): "Symbiosis vs crowding-out: The interaction of formal and informal credit markets in developing countries," Journal of Development Economics, 59(2), 419 – 444.

Jain, S., and G. Mansuri (2003): "A little at a time: the use of regularly scheduled repayments in microfinance programs," Journal of Development Economics, 72(1), 253 – 279.

Karlan, D., and S. Mullainathan (2010): "Rigidity in Microfinancing: Can One Size Fit All?," Discussion paper, QFinance.

Karlan, D., and J. Zinman (2011): "Expanding Microenterprise Credit Access: Using Randomized Supply Decisions to Estimate the Impacts in Manila," Review of Financial Studies, Forthcoming.

Laffont, J. J., and D. Martimort (1998): "Collusion and delegation," RAND Journal of Economics, 29, 280 – 305.

——— (2000): "Mechanism design with collusion and correlation," Econometrica, 68, 309 – 342.

Maloney, C., and A. B. Ahmad (1988): Rural Savings and Credit in Bangladesh. University Press Ltd., Dhaka Bangladesh.

McIntosh, C., and B. Wydick (2005): "Competition and Microfinance," Journal of Development Economics, 78, 271 – 298.

Melumad, N. D., D. Mookherjee, and S. Reichelstein (1995): "Hierarchical Decentralization of Incentive Contracts," RAND Journal of Economics, 26, 654 – 672.

Mitra, S., D. Mookherjee, M. Torero, and S. Visaria (2012): "Asymmetric Information and Middleman Margins: An Experiment with West Bengal Potato Farmers," Discussion paper, Mimeo, Hong kong University of Science and Technology.

Mookherjee, D., and M. Tsumagari (2004): "The Organization of Supplier Networks: Effects of Delegation and Intermediation," Econometrica, 72(4), 1179 – 1219.

Motta, A. (2011): "Collision and Selective Supervision," Discussion paper, UNSW, Australia.

Navajas, S., J. Conning, and C. Gonzalez-Vega (2003): "Lending technologies, competition and consolidation in the market for microfinance in Bolivia," Journal of International Development, 15(6), 747 – 770.

Onchan, T. (1992): "Informal Rural Finance in Thailand," in Informal Finance in Low-Income Countries, ed. by D. W. Adams, and D. Fitchett. Westview Press, Boulder, CO.

Park, A., and C. Ren (2000): "Microfinance with Chinese Characteristics," World Development, 29(1), 39 – 62.

Srinivasan, N. (2008): Microfinance India. State of the Sector Report. SAGE.

Wells, R. J. G. (1978): "An Input Credit Programme for Small Farmers in West Malaysia," Journal of Administration Overseas, 17, 4 – 16.

Appendix

A-1 Proofs

Proof of Proposition 1

We first establish the following Lemma.

Lemma 4 *Safe type borrowers never borrow from a lender in a different segment, in any pure strategy equilibrium.*

Proof. Each lender can commit to a contract, consisting of a triple

$$\Gamma = \{r_s(a), r_r(a), r(a)\},$$

defining interest rates offered respectively to own-segment safe borrowers, own-segment risky borrowers, and other-segment borrowers, for a given autarky option a. Use $\widetilde{r}(a)$ to denote the lowest interest rate offered to borrowers in this segment by lenders in other segments. Given a, the lender's best reponse is

$$r_i^*(a) = \arg\max_{r_i} r_i(a) \;\; i = r, s \tag{A-1}$$

subject to

$$r_i(a) \leq \widetilde{r}(a) \tag{A-2}$$

$$r_i(a) \leq R_i(a) - \frac{a}{p_i} \tag{A-3}$$

$$r_i(a) \geq \frac{\rho_I}{p_i}, \tag{A-4}$$

where the incentive-compatibility constraint (given by equation (A-2)) for each type of borrower requires that it is in the self-interest of a borrower to choose the own-segment lender's contract, rather than borrowing from the competitive market. The participation constraint (equation (A-3)) of each borrower requires that the expected payoff of a borrower from the contract is at least as large as the value of her autarky option. Finally, the break-even constraint (equation (A-4)) of the lender requires that the expected repayment from each loan is at least as large as the opportunity cost of capital, ρ_I. As long as the break-even (equation (A-4)) constraint is satisfied, the optimal interest rate can be written as

$$r_i^*(a) = \min\left\{\widetilde{r}(a), R_i(a) - \frac{a}{p_i}\right\} \tag{A-5}$$

Consider now the market for borrowing across segments. Denote by α and $(1-\alpha)$ respectively the fraction of risky and safe types that borrow from a lender in a different segment. We argue that that in any equilibrium α must equal 1. Suppose not. If $\alpha \neq 1$, a positive fraction of the safe borrowers borrow from a lender in another segment. For this to be the case, the most competitive interest rate in the informal market, $\widetilde{r}(a)$, must satisfy the participation constraint for the safe borrowers:

$$\widetilde{r}(a) \leq R_s(a) - \frac{a}{p_s}. \tag{A-6}$$

The break-even constraint of the lender requires that the expected repayment from each loan in the competitive market is at least as large as the opportunity cost of capital, i.e., $\widetilde{r}(a) \geq \frac{\rho_I}{\alpha p_r + (1-\alpha)p_s}$. Hence, from equations (A-5) and (A-6) it follows that $r_s^*(a) = \min\left\{\widetilde{r}(a), R_s(a) - \frac{a}{p_s}\right\} = \widetilde{r}(a)$. Given that $r_s^*(a) = \widetilde{r}(a) \geq \frac{\rho_I}{\alpha p_r + (1-\alpha)p_s} > \frac{\rho_I}{p_s}$ for each $\alpha \in (0,1)$,[32] the break-even constraint (equation (A-4)) is also satisfied. Hence, there is a strictly profitable deviation where the lenders offer $r_s^*(a)$ and attract all the own-segment safe borrowers. It follows that $\alpha \neq 1$ cannot be an equilibrium. ■

We are now in a position to prove Proposition 1. If an equilibrium exists, Lemma 4 implies only high risk types can borrow from a lender in a different segment. Hence, the break-even constraint for lenders requires that $r(a) \geq \frac{\rho_I}{p_r}$. Moreover, we claim that in equilibrium $\widetilde{r}(a) = \frac{\rho_I}{p_r}$. Suppose not. Then a lender could reduce $r(a)$, attract all the risky borrowers, and make a positive profit. If $R_r(a) - \frac{a}{p_r} < \frac{\rho_I}{p_r}$ there is no interest rate that satisfies both the break-even constraint and the risky borrowers' participation constraint in the competitive market. If $R_r(a) - \frac{a}{p_r} < \frac{\rho_I}{p_r}$, the lenders set $r(a) = r_r(a) = \frac{\rho_I}{p_r}$ and neither the own-segment nor the other-segment risky borrowers accept the contract.

We now show that there is an equilibrium in which lenders offer $R_s(a) - \frac{a}{p_s}$ to safe borrowers in their own segment, and $\frac{\rho_I}{p_r}$ to everyone else. All borrowers borrow from the lender in their own segment. To show this we consider different cases below.

1. Consider first the case where $R_s(a) - \frac{a}{p_s} \geq \frac{\rho_I}{\overline{p}}$. If this condition holds, we will show that $\alpha = 1$ cannot hold in equilibrium because there is a profitable deviation where a lender can attract safe borrowers from other segments. Given that we proved that $\alpha \neq 1$ cannot hold in equilibrium either, we conclude that there is no equilibrium if $R_s(a) - \frac{a}{p_s} \geq \frac{\rho_I}{\overline{p}}$. To see this point note that from $\frac{\rho_I}{p_r} > \frac{\rho_I}{\overline{p}}$ follows that $r_s^*(a) \geq \frac{\rho_I}{\overline{p}}$. Consider now the following sub-cases:

   a) $R_r(a) - \frac{a}{p_r} < R_s(a) - \frac{a}{p_s}$. In this case there is a profitable deviation where a lender (i) offers any $r(a)$ in the interval $\left(\max\left[R_r(a) - \frac{a}{p_r}, \frac{\rho_I}{p_s}\right], r_s^*(a)\right)$ (ii) induces the risky borrowers

[32]Note that from equation (1) follows that any interest rate that satisfies the safe farmers' participation constraint also satisfies the risky farmers' participation constraint. Hence, $\alpha = 0$ is not admissible.

from other segments to refuse the contract because $r(a) > R_r(a) - \frac{a}{p_r}$, (iii) induces the safe borrowers from other segments to accept because $r(a) < r_s^*(a)$ (vi) and makes positive profits because the break even condition is strictly satisfied, i.e., $r(a) > \frac{\rho_I}{p_s}$.

b) $R_r(a) - \frac{a}{p_r} \geq R_s(a) - \frac{a}{p_s}$. To begin with assume that $R_s(a) - \frac{a}{p_s} > \frac{\rho_I}{\overline{p}}$. Hence, $r_s^*(a) > \frac{\rho_I}{\overline{p}}$. In this case there is a profitable deviation where a lender (i) offers any $r(a)$ in the interval $\left(\frac{\rho_I}{\overline{p}}, r_s^*(a)\right)$ (ii) induces the risky borrowers from other segments to accept the contract because $r(a) < r_r^*(a) = \frac{\rho_I}{p_r}$ (iii) induces the safe borrowers from other segments to accept because $r(a) < r_s^*(a)$ and (vi) makes positive profits because the break even condition is strictly satisfied, i.e., $r(a) > \frac{\rho_I}{\overline{p}}$. Note that this profitable deviation exists only if $R_s(a) - \frac{a}{p_s} > \frac{\rho_I}{\overline{p}}$. On the other hand, in the non-generic case where $R_s(a) - \frac{a}{p_s} = \frac{\rho_I}{\overline{p}}$, there is no profitable deviation. Indeed, $r_s^*(a) = \min\left\{\frac{\rho_I}{p_r}, \frac{\rho_I}{\overline{p}}\right\} = \frac{\rho_I}{\overline{p}}$ and the only profitable deviation would involve offering $r(a) = \frac{\rho_I}{\overline{p}}$ and attracting both types of borrowers. This deviation yields zero profit. Hence an equilibrium exists where $\{r_s^*(a), r_r^*, r^*\} = \left\{\frac{\rho_I}{\overline{p}}, \frac{\rho_I}{p_r}, \frac{\rho_I}{p_r}\right\}$.

2. Consider now the case where $R_s(a) - \frac{a}{p_s} < \frac{\rho_I}{\overline{p}}$. Given that $\frac{\rho_I}{\overline{p}} < \frac{\rho_I}{p_r}$, this implies that $R_s(a) - \frac{a}{p_s} < \frac{\rho_I}{p_r}$ and so $r_s^*(a) = R_s(a) - \frac{a}{p_s} < \frac{\rho_I}{\overline{p}}$. Consider now the following sub-cases:

a) $R_r(a) - \frac{a}{p_r} < R_s(a) - \frac{a}{p_s}$. In this case, there is a profitable deviation where a lender (i) offers any $r(a)$ in the interval $\left(\max\left[R_r(a) - \frac{a}{p_r}, \frac{\rho_I}{p_s}\right], R_s(a) - \frac{a}{p_s}\right)$ (ii) induces the risky borrowers from other segments to refuse the contract because $r(a) > R_r(a) - \frac{a}{p_r}$, (iii) induces the safe borrowers from other segments to accept because $r(a) < r_s^*(a) = R_s(a) - \frac{a}{p_s}$ (iv) makes positive profits because the break even condition is strictly satisfied, i.e., $r(a) > \frac{\rho_I}{p_s}$.

b) $R_r(a) - \frac{a}{p_r} \geq R_s(a) - \frac{a}{p_s}$. In this case there is no profitable deviation. Increasing $r(a)$ above $r^*(a) = \frac{\rho_I}{p_r}$ entails (i) losing all the risky borrowers to the competition in case $R_r(a) - \frac{a}{p_r} \geq \frac{\rho_I}{p_r}$, or (ii) no effect at all if $R_r(a) - \frac{a}{p_r} < \frac{\rho_I}{p_r}$ (i.e., the risky borrowers are not willing to borrow in the first place.) Decreasing $r(a)$ below $r^*(a)$ would violate the break even condition unless the lower interest rate would manage to attract safe borrowers form other segments. Given that $R_s(a) - \frac{a}{p_s} < \frac{\rho_I}{\overline{p}}$ (i.e., the safe borrowers are not willing to accept the interest rate $\frac{\rho_I}{\overline{p}}$), the lender should reduce $r(a)$ below $\frac{\rho_I}{\overline{p}}$ in order to attract the safe borrowers from other segments. Note that the risky borrowers are also willing to borrow at $r(a)$ because (i) any interest rate that satisfies the safe borrowers' participation constraint also satisfies the risky borrowers' participation constraint, i.e., $R_r(a) - \frac{a}{p_r} \geq R_s(a) - \frac{a}{p_s}$, and (ii) the risky borrowers prefer $r(a)$ to the own segment interest rate, i.e., $r(a) < \frac{\rho_I}{\overline{p}} < r_r^*(a) = \frac{\rho_I}{p_r}$. Hence, offering $r(a) < \frac{\rho_I}{\overline{p}}$ would violate the break even constraint, i.e., $r(a) \geq \frac{\rho_I}{\overline{p}}$. It follows that triple $\{r_s^*(a), r_r^*, r^*\} = \left\{R_s - \frac{a}{p_s}, \frac{\rho_I}{p_r}, \frac{\rho_I}{p_r}\right\}$ is an equilibrium if $R_s - \frac{a}{p_s} < \frac{\rho_I}{\overline{p}}$ and $R_r(a) - \frac{a}{p_r} \geq R_s(a) - \frac{a}{p_s}$. QED

Proof of Proposition 3

These are the options available to the lender:

Proof.

a) By recommending the own-segment safe borrower (s, a) and setting

$$b_s^*(a) \equiv p_s R_s(a) - p_s r_T - a$$

the lender ensures that the safe borrower is indifferent between accepting and refusing the offer.[33] The lender's expected gain is

$$\underbrace{Kp_s r_T}_{\text{commission}} - \underbrace{\Pi_s(a)}_{\text{lender's opportunity cost}} + \underbrace{b_s^*(a)}_{\text{bribe}} =$$
$$= Kp_s r_T - (p_s R_s(a) - \rho_I - a) + (p_s R_s(a) - p_s r_T - a)$$
$$= \rho_I - (1 - K) p_s r_T$$

b) The "socially productive" own-segment risky borrower (s, a) outside option from the collusive agreement is $\overline{u}_r(a) = p_r R_r(a) - \rho_I$. By recommending the "socially productive" own-segment risky borrower (r, a) and setting

$$b_r^* \equiv (p_r R_r(a) - p_r r_T) - (p_r R_r(a) - \rho_I) = \rho_I - p_r r_T$$

the lender ensures that the risky borrower is indifferent between accepting and refusing the offer. The lender's gain is

$$\underbrace{Kp_r r_T}_{\text{commission}} - \underbrace{\Pi_r(a)}_{\text{lender's opportunity cost}} + \underbrace{b_r^*}_{\text{bribe}} =$$
$$= Kp_r r_T + \rho_I - p_r r_T$$
$$= \rho_I - (1 - K) p_r r_T$$

c) The "socially unproductive" own-segment risky borrower (s, a) outside option from the collusive agreement is $\overline{u}_r(a) = a$. From the definition of "socially unproductive" it follows that the lender needs to offer a negative bribe $b^*(a) = p_r R_r(a) - p_r r_T - a < 0$ in order to ensure that the risky borrower is willing to accept the offer. The lender's gain would be

$$\underbrace{Kp_r r_T}_{\text{commission}} - \underbrace{\Pi_r(a)}_{\text{lender's opportunity cost}} + \underbrace{b^*(a)}_{\text{bribe}} =$$
$$= Kp_r r_T + (p_r R_r(a) - p_r r_T - a).$$

d) If $b_s^* > b_r^*$, the lender can recommend the other-segment borrower, set the bribe to b_s^* and attract only the other-segment safe borrowers. Note that the risky borrowers are not attracted by the deal because $b_s^* > b_r^*$ and so they strictly prefer not be recommended. The lender's gain is

$$\underbrace{Kp_s r_T}_{\text{commission}} - \underbrace{0}_{\text{lender's opportunity cost}} + \underbrace{b_s^*}_{\text{bribe}} =$$
$$= Kp_s r_T + p_s R_s(a) - p_s r_T - a$$

e) If $b_r^* > b_s^*$, the lender can recommend the other-segment borrower, set the bribe to b_r^* and attract only the other-segment risky borrowers. Note that the safe borrowers are not attracted by the

[33] The safe farmer is indifferent because she obtains an expected payoff equal to a in both cases. Indeed, the own-segment safe farmer (s, a) outside option from the collusive agreement is $\overline{u}_s(a) = a$.

deal because $b_r^* > b_s^*$ and so they strictly prefer not be recommended (i.e., the bribe b_r^* is too high.) The lender's gain is the same as in point 2

$$\underbrace{Kp_r r_T}_{\text{commission}} - \underbrace{0}_{\text{lender's opportunity cost}} + \underbrace{b_r^*}_{\text{bribe}} =$$

$$=Kp_r r_T + \rho_I - p_r r_T$$

$$=\rho_I - (1-K)p_r r_T$$

f) If the lender set the bribe to $\min[b_r^*, b_s^*]$ both the other-segment safe and the risky borrowers are attracted. The lender's gain is

$$\underbrace{K\overline{p}r_T}_{\text{commission}} - \underbrace{0}_{\text{lender's opportunity cost}} + \underbrace{\min[b_r^*, b_s^*]}_{\text{bribe}} =$$

$$=K\overline{p}r_T + \min[p_s R_s(a) - p_s r_T - a, \rho_I - p_r r_T]$$

By assumption, option **a** is strictly dominated by option **b**. Therefore, option **a** is never selected. If $b_s^* > b_r^*$, the lender prefers option **d**; accordingly she recommends other-segment safe borrowers with a level of landholding a such that $p_s R_s(a) - a$ is maximized. If $b_r^* > b_s^*$, the optimal candidates are options **b**, **e** (which yield the same gain) and **f**. The trade off is between obtaining a higher expected repayment (that is, $K\overline{p}r_T$ under option **f** but only $Kp_r r_T$ under option **b** and **e**), and a lower bribe (that is b_s^* under option **f** and $b_r^*(> b_s^*)$ under option **b** and **e**). If option **f** is selected, then the lender targets other-segment borrowers with a level of landholding a such that $p_s R_s(a) - a$ is maximized. Otherwise, if options **b** or **e** are selected the lender targets risky borrowers with any level of landholding.

■

Supplementary Appendix. Extension to Incorporate Repayment Incentives

In this appendix we explain how our model can be extended to incorporate endogenous repayment incentives.[34] Borrowers can now default on their loan, even if their project is successful and the returns are large enough to repay the debt. We refer to this as an *intentional default*.

The Informal Credit Market

In the informal market, informal lenders are assumed to observe the outcome of the project and thus infer whether any default is intentional. The lender can costlessly impose a sanction $s_i^s(a)$ following an intentional default by a borrower of type i belonging to her segment, and $s_i^o(a)$ for a borrower belonging to a different segment, where

$$s_i^s(a) \geq s_i^o(a). \tag{A-7}$$

The sanction can take the form of denial to future credit access, or damage the reputation of the borrower. It is natural to assume that these sanctions are increasing in landholding, since borrowers with more land have more at stake if future credit is denied to them or is made available at higher cost.

Consequently a borrower of type (i, a) with an informal loan from a lender in segment $k \in \{s, o\}$ carrying interest obligation r will not default on the loan if and only if

$$r \leq s_i^k(a) \tag{A-8}$$

Conditions (1) and (2) for the existence of an equilibrium in the informal market will now be replaced by (while we continue to assume (3))

$$R_r(a) - \frac{a}{p_r} \geq \min\left\{R_s(a) - \frac{a}{p_s}, s_s^o(a)\right\} \tag{A-9}$$

$$\min\left\{R_s(a) - \frac{a}{p_s}, s_s^o(a)\right\} < \frac{\rho_I}{\overline{p}} \tag{A-10}$$

The reason is that if lenders from a different segment seek to attract away borrowers from a given segment, they would now need to offer an interest rate low enough to prevent intentional default: the interest rate cannot be higher than the imposable sanctions, i.e., $s_s^o(a)$.

Proposition 5 *With ex post moral hazard, the following is an equilibrium in the informal market*

$$\{r_s^*(a), r_r^*, r^*\} = \left\{\min\left\{\frac{\rho_I}{p_r}, R_s(a) - \frac{a}{p_s}, s_s^s(a)\right\}, \frac{\rho_I}{p_r}, \frac{\rho_I}{p_r}\right\}.$$

[34] We can also trivially extend the model to incorporate one form of ex ante moral hazard, where borrower effort e affects the project return $R_i(a, e)$ in the successful state, but does not affect the likelihood of success or the return in the failure state. If $C_i(e)$ denotes the cost of effort of type i, the borrower will select an effort $e_i(a)$ to maximize $p_i[R_i(a, e) - r] - C_i(e)$, which is independent of the interest rate. In that case we can redefine the return function to be $R_i^*(a) \equiv R_i(a, e_i(a))$ and apply the same analysis.

Moreover, the outcome of any other equilibrium is the same as that of this one.

This result extends Proposition 1. The interest rate for risky types is unaffected, while that for safe types is affected only if informal lenders are not able to levy sanctions for default larger than the interest rates they charge. If the sanctions are smaller, the interest rate is pegged at the level of the sanction, thereby leaving the safe types with some surplus.

TRAIL

Turning now to TRAIL, we assume that an intentional default on a TRAIL loan can also be costlessly punished by the TRAIL agent by imposing a similar sanction as on a default on an informal loan. Such sanctions will be imposed when the agent and the borrower do not collude, since the borrower's default causes the agent to lose his commission. They will not be imposed when the agent and the borrower collude, since they impose deadweight losses on the borrower. Moreover, any default (intentional or otherwise) is punished by the MFI in the form of denial of future access to a TRAIL loan. To simplify the analysis we assume that sanctions depend neither on the type of the borrower, nor on his segment of origin. We also suppress the notation for landholding size; since this is an observable characteristic and there are no capacity constraints in lending the market for borrowers of a given landholding can be separated from that of any other landholding.

Let s and F denote the sanction imposed by the lender and the MFI respectively. Assume to start with that the borrower and the agent do not collude. If the project is successful a borrower of risk-type i repays the TRAIL loan carrying interest r_T if

$$r_T \leq \min\{s + F, R_i\}. \tag{A-11}$$

It is natural to assume that TRAIL loans have been designed so as to satisfy the limited liability constraint $r_T \leq R_i$ for both risk types i. Then the only question is whether r_T is above or below $s+F$. If it is above, no TRAIL loan will get repaid, which is also not what we see in the data. Note also that for TRAIL loans to be attractive to borrowers, r_T has to be below the informal interest rate, which in turn has to be below $\min\{s, R_i\}$, so (A-11) will be satisfied by any type that gets loans in the informal market. Hence it seems reasonable to suppose that (A-11) holds for both types, and our analysis of TRAIL remains unaffected.[35]

Consider now the case where the borrower and the lender can collude. The collusion process is amended as follows: the lender makes a take-it-or-leave-it offer to the borrower. This offer requires the borrower to pay a bribe b in exchange for being recommended. The offer also specifies whether or not the borrower will default in case the project is successful. If the borrower refuses the offer, the game is played non-cooperatively. It is easy to see that intentional default might be optimal for the coalition: the trader forgoes the commission, Kr_T, but the borrower avoids repaying the entire interest rate, leaving the coalition with a net gain equal to $(1 - K)r_T$. This gain needs to be traded off against the penalty, F. Without an explicit form for F, the comparison could go either

[35]More generally, if condition (A-11) does not hold for only the risky type, the agent's return from recommending safe borrowers from his own segment is unaffected, the return from recommending risky borrowers from his own segment is zero, and from recommending other-segment borrowers is reduced. Hence it is still optimal to recommend own-safe borrowers if the commission rate is above the threshold in the case where there is no moral hazard. If the situation is reversed and safe types do not repay their loans while risky types do, then recommending own-risky types is optimal for the agent. Finally, if neither type repay TRAIL loans then the agent is indifferent who to recommend, but this case seems empirically irrelevant.

way. Note also that the gain from an intentional default depends neither on the borrower's risk type nor on the segment of origin. Consequently our previous result Proposition 3 concerning selection incentives of the agent continues to hold.[36] Hence the predictions of the model concerning selection patterns under TRAIL continue to apply with ex post moral hazard.

GBL

We turn now to examine how GBL is affected by ex post moral hazard. Here matters are more interesting. As in TRAIL, when a group does not repay, all group members are sanctioned F by the MFI. Moreover, the members of the group whose projects were unsuccessful can harness social capital and impose sanctions which (costlessly) inflict a utility cost s_g on those whose projects were successful and were in a position to cover for their liability. We restrict attention to symmetric repayment norms where successful members split the joint liability tax equally.

Suppose to start with that groups are homogenous with respect to risk type and landholding; we shall investigate the conditions for this subsequently. A homogeneous group with n members where repayment takes place with x successes or more within the group involves the following repayment incentive constraint:

$$\frac{n}{x}r \leq \min\{F + s_g, R_i\} \tag{A-12}$$

Let us denote this type of group by (n, x) and the minimum value of x for which this constraint holds by S. Note that S is a function of exogenous parameters such as sanctions F, s_g besides n, R_i, and represents a measure of the stringency of the repayment incentive constraint. Whenever S exceeds 1, the repayment behavior of members with successful projects depends on how many other members in the group have successful projects. The failure of others encourages even successful members to default, the phenomenon of *contagious default*. This does not occur in TRAIL. The repayment rate in an (n, x)-group of homogenous risk type i is

$$\pi_g(n, x) = \text{Prob}[\text{B}(n, p_i) \geq x] \tag{A-13}$$

and per borrower welfare is

$$W_g(n, x) = p_i R_i - C_g(n, x) \tag{A-14}$$

where

$$\begin{aligned} C_g(n, x) \equiv \quad & p_i[\textstyle\sum_{i=x-1}^{n-1} b_i(n-1, p_i)\frac{nr_T}{i+1} + \text{Prob}[\text{B}(n-1, p_i) < x-1](F + s_g)] \\ & +(1-p_i)\text{Prob}[\text{B}(n-1, p_i) < x]F \end{aligned}$$

The notation $\text{B}(n, p)$ denotes a binomial random variable with n trials and success probability p_i, and $b_i(n, p_i)$ is the probability of exactly i successes. If $S < n$, the group has to choose threshold number of successes $x \in \{S, S+1, ., n\}$.

[36] If default sanctions depend on risk type and segment of origin, the relative gains from intentional default would depend on the borrower's characteristics. Without an explicit form for F, we cannot check that our previous results concerning selection still hold. For example, it might be optimal for the lender to select a certain type of borrower from a certain segment, on the basis that the gains from the intentional default are higher. Nonetheless, this would affect the results in Proposition 3 only when intentional default is optimal, and occurs in equilibrium. If intentional default is not optimal, the lender continues to recommend borrowers according to the rule in Proposition 4. Given that our empirical results indicates that TRAIL is effective, and default is rare, this case does not seem pertinent.

It is easy to check that it is optimal for the group to always choose $x = S$.[37] Intuitively, a group loan involves (i) a joint liability tax (JLT) imposed on successful members when they cover for the liability of other unsuccessful members, and (ii) a group cover (GC) obtained by unsuccessful members when other successful members cover their liability. Increasing x reduces the extent of GC as well as of JLT. The benefit of the former outweighs the latter, as an implication of the incentive constraint holding at x. Owing to this result, we shall assume from now on that a group with n members will use the threshold S, which is defined by the incentive constraint.

Repayment Rates and Welfare Comparison

What are the implications for repayment rates in GBL, and how do they compare with TRAIL? If TRAIL is effective it is characterised by a repayment rate of p_s. Controlling for risk type, the repayment rate in GBL could be above or below the TRAIL repayment rate depending on how severe the repayment incentive constraint is. For example, consider the case of $n = 2$. If $S = 1$, GBL attains a higher repayment rate than TRAIL, but it attains a lower repayment rate if $S = 2$. In the former case, the GBL loan is repaid if at least one member has a successful project. In the latter, there is contagion in default: both members have to be successful for the loan to be repaid.[38] If $n > 2$, our result holds when we consider the polar extremes of $S = 1$ and $S = n$. For intermediate values of S, the comparison depends on the riskiness of the project. Specifically, for values of n between 1 and 5, it can be shown that there exists a threshold $\overline{p}(n, S) \in (0, 1)$ such that TRAIL attains a higher repayment rate if and only if $p_i < \overline{p}(n, S)$.[39] In other words, TRAIL attains higher repayment rates for riskier projects. Intuitively the scope for contagious default in GBL is greater when individual projects are riskier. This helps explain the insistence of most MFIs that their group loan clients pursue extremely safe projects.

Finally, we consider the question of whether GBL will encourage homogenous groups to form, and how borrower welfares compare between GBL and TRAIL ignoring the costs of group meetings and savings requirements in GBL. The latter helps predict relative takeup rates under the two schemes, besides being interesting in its own right. We show that the welfare comparison can go either way, and GBL may or may not be characterized by positive assortative matching (PAM) by risk type, depending on parameter values. We simplify the analysis by assuming that $F + s_g$ is smaller than the project return for both types. Then the incentive constraint applies the same way for both types, and S is defined independent of the composition of the group.

Proposition 6 *Assume there is ex post moral hazard, group size $n = 2$ and that the default sanction $F + s_g$ is smaller than the project return for both types.*

[37] This follows from checking that the expected cost $C_g(n, x)$ is increasing in x. The effect of increasing x by one unit on C_g is equal to

$$b_{x-1}(n-1, p_i)\left[(F + s_g) - \frac{n}{x}r\right]$$

which is positive as a result of the incentive constraint (A-12) holding at x.

[38] Besley and Coate (1995) make a similar point. They show that repayment rates in GBL (with $n = 2$) are higher than standard individual lending if and only if social capital within the group is high enough. In our framework this would be the case where s_g is large and, consequently, $S = 1$. Here, we go beyond Besley and Coate (1995) by extending the analysis to the case $n > 2$, incorporating borrower heterogeneity and by providing results on welfare comparisons and matching patterns in GBL.

[39] This is verified directly by working out the expressions for the GBL repayment rate which equals the probability of at least S successes in n Bernoulli trials as a function of p_i the success probability on any single trial.

a) *If $S = 1$ and $r_T > F$, GBL satisfies PAM and safe type borrowers attain lower welfare in GBL compared with TRAIL.*

b) *If $S = 1$ and $r_T \leq F$, GBL does not satisfy PAM and attains higher welfare than TRAIL.*

c) *If $S = 2$, GBL satisfies PAM and safe type borrowers attain lower welfare in GBL compared with TRAIL.*

To explain this result, borrower payoffs in GBL are affected in opposite directions by JLT and GC, the relative strengths of which depend on the relative values of r_T and F. When $S = 1$, teaming up with a safe rather than risky borrower for type i involves both a lower JLT and a higher GC. The value of this to a borrower of type i is proportional to $p_i r_T + (1 - p_i)F = F + p_i(r_T - F)$, which is rising in p_i if and only if $r_T > F$. Hence PAM holds when $S = 1$ and $r_T > F$, whilst it does not hold if $r_T < F$. On the other hand, when $S = 2$, PAM always holds because GBL offers no GC, so teaming up with a safe rather than risky borrower only involves a lower JLT, which is always more valuable to a safe type. For the same reason the welfare comparison between GBL and TRAIL also depends on the relative strengths of JLT and GC: when GBL satisfies PAM the JLT dominates the GC, and borrowers are worse off compared with TRAIL.

Note that the condition that $2r_T \leq \min\{F + s_g, R_i\}$ does not impose any restriction on the value of r_T relative to F. Hence welfare comparisons between TRAIL and GBL can go either way. TRAIL outperforms GBL if and only if $r_T > F$, a condition which states that in the absence of sanctions imposed by the agent (in TRAIL) or by group members (in GBL), the loans would not be repaid. We cannot check this empirically given the setup of the current experiment. Note however that the preceding Proposition shows that in the case of two person groups that if GBL exhibits PAM, then it will attain lower welfare than TRAIL. If this result holds for larger values of n, which we have not yet been able to verify, it would provide one way of inferring welfare comparisons: if both TRAIL and GBL exhibit similar composition of borrowers, then TRAIL will generate higher welfare.

If the MFI by itself (i.e., without the help of an agent or group sanctions) can impose strong enough sanctions to ensure loan repayment $r_T < F$ and $S = 1$ we see that GBL will induce heterogeneity of risk type within groups. This outcome would be even more likely if we were to assume that the sanctions s_g and F depend on the borrower's risk type. Then S would also depend on the composition of the group. For example, teaming up with a risky type might reduce S, which could increase GC and reduce JLT.

Welfare comparisons are further complicated by the peculiar characteristics of GBL. In GBL, borrowers have to attend group meetings, and meet saving requirements in order to qualify for a group loan. On the other hand, GBL has a built-in feature of group insurance, where successful members subsidize unsuccessful members. In the presence of risk aversion this aspect of GBL would make it more attractive. Our welfare calculations ignored this and focus entirely on comparison of expected costs. Hence it is difficult to obtain any general results concerning welfare comparisons between TRAIL and GBL.

Note two other features of relevance to the empirical analysis. It is not possible to infer anything concerning welfare comparisons from repayment rate comparisons: when $n = 2$ and $S = 1$ repayment rates are higher in GBL but welfare comparisons can go either way. Also there may be heterogeneity across groups with respect to social capital measured by s_g, for the same project success probability p and all other parameters. A group with a high s_g can have $S = 1$ while another with low s_g could have $S = 2$. The former will have a higher repayment rate than TRAIL, while the latter has a lower repayment rate. So there is scope for additional heterogeneity within GBL in this respect, compared with TRAIL.

Proof of Proposition 6

Proof. To show (a) note that the expected cost for a member with risk type i of forming a group with a risk type j is

$$C_g^{ij}(2,1) = p_i[(1-p_j)2r_T + p_j r_T] + (1-p_i)(1-p_j)F$$

which implies that

$$C_g^{sr}(2,1) - C_g^{ss}(2,1) = (p_s - p_r)[p_s r_T + (1-p_s)F]$$

and

$$C_g^{rr}(2,1) - C_g^{rs}(2,1) = (p_s - p_r)[p_r r_T + (1-p_r)F]$$

from which the result follows. In case (b) we have $S = 1$ which implies $2r_T > F + s_g > r_T$. Now

$$C_g^{ij}(2,2) = p_i[p_j r_T + (1-p_j)(F+s_g)] + (1-p_i)F$$

implying that

$$C_g^{ir}(2,2) - C_g^{is}(2,2) = (p_s - p_r)p_i(F + s_g - r_T)$$

which is higher for the safe type than the risky type.

Turn now to the welfare comparison. The welfare in TRAIL when the latter is *effective* and the borrower risk neutral is

$$W_t = p_s R_s - C_t \tag{A-15}$$

where

$$C_t \equiv p_s r_T + (1-p_s)F \tag{A-16}$$

Result (a) follows from observing that $C_g(2,1) - C_t = p_s(1-p_s)r_T + (1-p_s)F[(1-p_s)-1] = (1-p_s)p_s r_T - (1-p_s)p_s F$. Result (b) follows from a simple observation. We have just showed that if $r_T \leq F$ a homogenous GBL group outperforms TRAIL. If a heterogenous group achieves a higher welfare than a homogenous one, then it must outperform TRAIL as well. Result (c) is straightforward: $C_g(2,2) = p_s[p_s r_T + (1-p_s)(F+s_g)] + (1-p_s)F$ is unambiguously larger than $C_t = p_s r + (1-p_s)F$. ■