Solidarity Behind Microfinance

Vittoria Cerasi* Lucia Dalla Pellegrina†

VERY PRELIMINARY DRAFT

Abstract

In this paper we analyse the role of peers' solidarity in fostering investment in production in the context of microfinance. When there is asymmetric information between lenders and borrowers on the use of borrowed funds and loans are not collateralized, there is a high chance that borrowers use loans for current consumption sacrifying productive projects. We study the effect of solidarity in the form of insurance from a network of relatives on borrowers' intertemporal preference for consumption and its impact on myopic behavior. The main result of the model is that solidarity might increase the share of funds devoted to investment but it might also reduce the amount of the loan in equilibrium. This result is in accordance with several features of micro-lending. We test the model using survey data from the World Bank on a sample of households in Bangladesh during the period 1991-1992. Empirical findings support the predictions of the model.

Key words: Microfinance; credit rationing; social networks.
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*Milano-Bicocca University, Statistics Department, Via Bicocca degli Arcimboldi, 8, Milan (Italy). e-mail: vittoria.cerasi@unimib.it

†Milano-Bicocca University, Statistics Department, Via Bicocca degli Arcimboldi, 8, Milan (Italy), and Paolo Baffi Centre on Central Banking and Financial Regulation, Bocconi University, Via Roentgen, Milan (Italy). e-mail: lucia.dallapellegrina@unibocconi.it.

1 Introduction

The most well-known strength of microfinance, in particular of group-lending, is the ability to substitute physical collateral with other mechanisms such as as group liability, peers monitoring, social stigma, etc. designed to foster loan repayment. These mechanisms seem to be effective as for instance for the three Bangladeshi Microfinance Institutions in our empirical analysis repayment rates reach almost 95 per cent.

The problem of lack of incentives is particularly severe for Microfinance Institutions (MFi, hereafter) given that they target poor people who lack physical guarantees (see for example Ghosh et al., 2000) and have a myopic approach to the future. Preference for present consumption is likely to be stronger because of high discounted rate undermining investment in productive projects with uncertain future income. This is mainly due to lower life expectancy, higher discouragement and vulnerability also due to the absence of public assistance or to the lack of savings acting as buffer against unexpected shocks.

One important feature ensuring the success of microfinance is consists in exploiting peers' information about the nature of each other's projects at the stage of group formation (Ghatak, 1999 and 2000) through which MFi are able to exploit the incentive to collect information by peers about each others when banks' monitoring costs are high. Despite ex-ante peers' information is important in explaining the success of microfinance (Wydick, 1999; Wenner, 1995), it is not enough to avoid opportunistic behavior by the borrower when there is ex-ante moral hazard (Stiglitz, 1990), as for instance a diversion of funds from business to household needs which decreases project revenue (Menon 2003; Armendariz de Aghion and Morduch 2005, Gine et al., 2006).

The literature has suggested also social sanctions as an alternative device to overcome the problem of ex-ante moral hazard (see Besley and Coate, 1995, for a pioneering approach). In order to enhance effort, ex-post punishments are imposed by individuals who are close enough to the borrower. In particular, each borrower might denounce peers' misbehavior to the village community in

order to prevent opportunistic actions. Peers can simply shun neighbors who deviate, imposing both economic and social costs.

The focus of our paper is on solidarity as a way to reduce opportunistic behavior by borrowers. Our approach is similar in the spirit to the idea of social sanctions. However solidarity has not received much attention within the microfinance literature, besides the fact that group lending involves joint liability. There is anecdotal evidence that solidarity matters in microfinance. Officiers from several MFi, for example, seem to give much importance to such behaviors. "In the weekly meetings, FINCA employees explicitly encourage clients to develop solidarity, both to enhance their social capital as well as to monitor and enforce the loans" (Karlan, 2005).

We interpret solidarity as a form of mutual insurance between individuals, in particular relatives, who provide financial aid in case of negative shocks. Similarly to social sanctions[1], solidarity transfers are denied to the borrower in case of misbehavior and are effective if provided by those who are best informed on the borrower's actions.

It is important to stress that not necessarily denial of solidarity comes from individuals who have been damaged by a defaulting borrower, i.e. other group members[2]. What is instead essential is that solidarity providers have a privileged relationship with the borrower so as to share information with her. In fact we model solidarity transfers as positively dependent on effort[3], which we presume

[1] "Social sanctions could include exclusion from other financial transactions (such as informal insurance) or other economic or social penalties" (Nissanke, 2002). Even if the term "other financial transactions" may refer to future loans, it can be easily extended to solidarity transfers.

[2] As far as social sanctions are concerned, some authors (see for example Besley and Coate, 1995) interpret them as being imposed by other group members. Others (see for example Nissanke, 2002) state that defaulters are subject to effective and severe sanctions by the whole community, in the form of a social stigma, not necessarily by those who are directly damaged by the default. The reasons why individuals who are not necessarily group members impose sanctions or deny solidarity could be many. For example if they belong to the same network they may be indirectly damaged through a loss of reputation. Or simply, due to their particular relationship with the borrower, they can also be driven more by socially disciplining features rather than the willingness to strike back, thus punishing even in the case they are not damaged.

[3] As a social insurance they fully or partially compensate the loss component due to unexpected negative events.

easily observable by individuals who are close to the borrower.

The model in the paper aims at analysing whether more solidarity reduces ex-ante moral hazard. The idea is that there are counterbalancing effects. On the one hand, greater solidarity might induce borrowers to invest more in the risky project since the expected return from investment is higher due to the positive income in the default state. On the other hand, by providing insurance, solidarity might discourage effort due to a softer punishment in the unlucky states.

Although solidarity, similarly to social sanctions, may be an efficient mechanism to foster investment, it might be ineffective to prevent strategic default –ex-post moral hazard– since it lacks the power of enforcing debt repayments once the returns on borrowers' investments have been realized (Armendariz and Morduch, 2000). We allow for this possibility by considering that the borrower' solidarity network has access to privileged –as compared to the lender– but still imperfect information[4].

Typically, dynamic incentives based on the threat of non-refinancing are a useful instrument to avoid that such behavior takes place involving lenders' losses. Despite not completely solving the problem of free-riding within the group and the possibility that borrowers default in the last stage of the game, the mechanism of repeated small loans designed by MFi seems to reflect their willingness to curb ex-post moral hazard. We do not explicitly account for this feature in the model, while we control for this in the empirical analysis.

We focus instead on another type of incentive by looking at a loan contract compatible with a non-strategic default condition for the borrower[5]. Therefore, in the model we endogenize the amount lent by accounting for the possibility that the lender grants loans conditionally on the borrower's ability to access

[4] We assume that solidarity network can observe the full amount of invested funds without distinguishing the share of the loan which is invested from the full amount o the loan granted. This corresponds to observing investment without knowing how muh has been borrwed.

[5] The Grameen II project, for example, seems to incorporate this possibility, since it is less focused on incentives generated within the group, leaving more opportunities to concentrate also on individual lending.

intrahousehold transfers, which in turns affects her effort. Empirically, we look at the possibility that MFi in the dataset already use this device in order to prevent ex-post moral hazard.

Finally, we test our theoretical findings using data from the World Bank on a sample of households in Bangladesh during the period 1991-1992. Empirical findings support the predictions of the model, suggesting that when solidarity network's financial capability is relatively high, more solidarity increases the share of funds devoted to investment but also reduces the amount of the loan in equilibrium. Furthermore, data predict that MFi provide loans amounts which are compatible with borrowers' non strategic default behavior.

The paper is organized as follows. In the next section we present the theoretical model. Section 3 illustrates the dataset. In Section 4 we discuss the empirical approach and results. Section 5 concludes.

2 The Model

We consider a two-period model and three dates $t = 0, 1, 2$ where an agent maximizes her linear intertemporal utility. There are risky productive projects in the economy. The agent can decide between investing in the productive project and delay consumption or consume in the first period. Given that she has no initial capital to be used as input for production, she has to borrow it from a lender. No collateral is required by the lender.

The amount borrowed L can be divided in $t = 1$ according to a share $a \in [0, 1]$ between consumption $C = aL$ and investment $I = (1 - a)L$. The productive project is risky: by investing I in $t = 1$ each unit returns R in $t = 2$ with probability p and zero otherwise. Further, investing in the productive project yields a positive net present value, namely $pR > 1$.

We assume that the cash flow of the project is observable, while the share invested a is not observable to outsiders. Therefore the loan contract can be

written conditional on the project return R but not on the share invested. The loan contract requires the borrower to repay R_l to the lender in $t = 2$ only in case of project success, while zero otherwise due to limited liability and absence of collateral.

The borrower's choice is between immediate consumption C in $t = 1$ or delayed consumption in $t = 2$ as a result of a risky investment which might also return zero income due to failure. All individuals in the economy are risk neutral. However the agent faces an intertemporal preference rate $\beta \in (0, 1)$ so that delaying consumption by one unit requires a future consumption larger than one to match today sacrifice.

Let us summarize the timing of the model as follows:

In $t = 0$: the agent borrows L from the lender;

In $t = 1$: the agent chooses the share of loan to consume and to invest, resp. $\{a, (1 - a)\}$;

In $t = 2$: the productive project returns R or 0 and the cash flow is divided according to the loan contract.

Let us analyze the intertemporal choice of the agent, given that her choice of the share invested $(1 - a)$ is not observed by the lender.

BENCHMARK CASE (no solidarity)

Assuming a linear utility in each period consumption level $u(C) = C$, the agent's expected utility is

$$EU = C + \beta p \left(RI - R_l\right) \tag{1}$$

where $C = aL$ is the first period consumption, $I = (1 - a)L$ is the investment in the productive project, R is the return of each unit invested in case of success and R_l is the revenue to the lender in case of success. The lender is willing to provide funding as far as the expected revenue on the loan equates the capital

lent[6], i.e.

$$pR_l = L \tag{2}$$

We can rewrite the expected utility in terms of the share of consumption a and amount of loan L as follows:

$$EU = aL + \beta p \left[R(1-a)L - \frac{L}{p} \right]$$

For a given size of the loan L the optimal share of consumption from the agent's point of view is given by the first order condition

$$\frac{dEU}{da} = 1 - \beta pR \geq 0$$

When $\beta pR < 1$ the optimal share of consumption is $a^* = 1$. In other words, unless the intertemporal rate of substitution β is close to one, that is the agent cares about the future as much as about the present, she will consume all the loan in the first period. This benchmark case shows that, unless the share to be invested is valued more in the future, risking in a productive project is not worth.

Now let us introduce the idea that family ties might provide an insurance policy to the agent in case of default. If this insurance is tied to the amount of the investment, since peers can observe it, future consumption through investment could be rewarded.

Agents providing solidarity transfers can observe the total amount invested by the borrower $I = (1-a)\,L$ and the return of the project in the second period so as to provide transfers only if the project fails. This implies that transfers are conditional on the amount invested, share $1-a$, which can be interpreted as effort, on the amount lent, L, and on the financial capability of the solidarity network. We measure the degree of solidarity with the variable $\theta > 0$ and define total solidarity transfers as $S = I^\theta = [(1-a)\,L]^\theta$.

Solidarity might have two different effects on the solution of the model. Greater solidarity, by providing insurance in the bad state, when the project

[6] We assume that the MFi faces competition or that it is an NGO which merely attempts to break even (Armendariz and Morduch, 2003).

fails, might induce the agent to invest more as the income in the default state increases and therefore the expected value of the strategy of investing is greater. On the other hand, by providing insurance against the unlucky state, it might discourage effort. We show under which conditions solidarity fosters investment.

We carry out this analysis in two steps. Initially, we assume that the amount lent is of fixed size. However since for a given size of the loan, the borrower might behave opportunistically (by choosing a small a she can still exploit the solidarity network when investing and the project fails), we will relax this assumption. Although the lender cannot observe the share of investment, he can anticipate this attitude and can reduce the amount of the loan in order to avoid strategic default.

Therefore as a second step we solve the model by introducing a non strategic default constraint. In this way the share of funds to be invested affects the amount lent. In the reminder we separately analyze the two steps.

2.1 Fixed loan size

The agent chooses a in order to maximize her expected intertemporal utility, subject to a participation constraint of the lender. The borrower's expected utility is:

$$EU = C + \beta \left\{ p \left[RI - R_l \right] + (1 - p) S \right\} \tag{3}$$

where $S = \left[(1 - a) L \right]^{\theta}$ is the solidarity transfer in case of project default. The lender's participation constraint is given by (2) as before.

The higher is a, the higher is the first period consumption, while lower either the borrower's return net of lender's compensation, R_l, and the solidarity transfer. Hence the overall borrower' second period consumption is lower.

Note that the participation constraint of the lender only depends on the probability of success and not on the choice of a since it is non-observable for the lender.

The first order condition of the maximization problem is the following:

$$1 = \beta \left\{ pR + \frac{(1-p)\,\theta}{[(1-a)\,L]^{1-\theta}} \right\} \tag{4}$$

Rearranging (4), we obtain:

$$a^* = 1 - \frac{1}{L} \left[\frac{(1-p)\,\theta}{\frac{1}{\beta} - pR} \right]^{\frac{1}{1-\theta}} \tag{5}$$

Hence, assuming that $\frac{1}{\beta} - pR > 0$[7], it is more likely that for mildly low values of theta ($0 < \theta < 1$, when theta is close to 1)[8] $\frac{\partial a^*}{\partial \theta} < 0$, while it is more likely for relatively high values of theta ($\theta > 1$, when theta is close to 1)[9] $\frac{\partial a^*}{\partial \theta} > 0$. In all the other cases much depends on the term in squared brackets (see the Appendix for details).

In conclusion, when the amount lent is exogenous, the effect of increasing solidarity through a higher intrahousehold network financial capability may bring either to an increase or to a decrease of the share of the loan which is invested depending on the capability of the solidarity network, the project return, and preference for present consumption. However, since in (5) $\frac{\partial a^*}{\partial L} > 0$, it turns out that it is worth for MFi to provide borrowers with greater loans in order to increase their incentive to invest and to repay the loan. This result is in contradiction with the practice of MFi to lend small sums in general, and most importantly, with the practice of supplying different amounts according to different characteristics, such as for example uneven access to solidarity transfers.

[7] From our standpoint this is the interesting case which can be justified in a context of poor borrowers since they have a low intertemporal substitution rate. If this condition does not hold it would always be convenient to invest all the loan, regardless of solidarity transfers, as shown in the benchmark case.

[8] Note that for very low values of θ we can obtain corner solutions, that is $a = 1$, meaning that all the loan is consumed in the first period.

[9] Note that for very high values of θ, a^* tends to $1 - \frac{1}{I}$ and we can obtain corner solutions, that is $a = 0$ in case I is lower than 1, meaning that all the loan is invested in the first period. This might however not be beneficial to the lender since the borrower could ex post decide to forego the output in order to access solidarity transfers.

2.2 Endogenous loan size and non-strategic default incentives

Although from the previous analysis it appears that under some conditions solidarity might to be good in order to promote investment, it may also harm lenders. In fact, borrowers could decide to reduce their second period expected output through increasing a because of the compensation mechanism set up by solidarity in case of default.

Suppose that in order to avoid strategic default of this kind the lender supplies funds according to a condition for which the borrower finds preferable to invest and then to repay the loan rather than benefitting from solidarity transfers.

In this case to the previous maximization problem of the borrower we add the following non strategic default constraint:

$$p\left[R\left(1-a\right)L-R_l\right]\geq\left(1-p\right)\left[\left(1-a\right)L\right]^{\theta}$$

>From the constraint we can retrieve the amount of funds borrowed conditional on the anticipated choice of a:

$$L\leq\left(\frac{\left(1-p\right)\left(1-a\right)^{\theta}}{pR\left(1-a\right)-1}\right)^{\frac{1}{\theta-1}}=\widetilde{L} \tag{6}$$

Note that in order to avoid strategic default, the lender keeps the amount of the loan below a certain threshold[10], $\widetilde{L}$. The constraint is binding since it is in the lender's interest to increase the quantity of funds lent, subject to the non-strategic default constraint.

Now, as opposite to what we found in the previous version of the problem, this is compatible with the decision of MFi to provide repeated small loans to their customers. However, now the sum lent depends on the borrower's behavior in terms of her choice of a, which in turns depend on solidarity.

[10] Nothe that $\frac{\partial L}{\partial a}<0$ if $\theta>0$; $\frac{\partial L}{\partial a}<0$ if $0<\theta<1$.

The first order condition of this problem[11] still leads to (5). However now L is determined according to (6). Expliciting L and rearranging we obtain:

$$a^* = 1 - \left(\frac{pR - \frac{1}{(1-a)}}{\frac{1}{\beta} - pR} \right)^{\frac{1}{1-\theta}}$$

We are interested in finding how does a vary when θ changes. From the Implicit Function Theorem it is possible to show (see Appendix) that, under some conditions, $\frac{\partial a}{\partial \theta} < 0$, that is the borrower increases the share of invested funds as the solidarity network financial capability increases.

The analysis brings to the following conclusions. First, it is more likely that $\frac{\partial a}{\partial \theta} < 0$ for relatively high values of θ, that is when the solidarity network financial capability is high. In particular, when $\theta > 1$ it is always the case that $\frac{\partial a}{\partial \theta} < 0$. When $0 < \theta < 1$, instead, it is more likely that $\frac{\partial a}{\partial \theta} < 0$ when θ departs from 0 and approaches 1. Moreover, in this scenario it is easier that for a given θ the sign of the derivative is negative when pR and β are high, that is when projects have relatively high expected returns.

Both these conditions seem to reflect the structure of lending in less developed countries where MF programs are designed to face problems of forbidden access to banking for individuals that lack collateral but have structured and generous solidarity networks, and good projects, despite their present value is small due to their low preference for future consumption.

In the next sections we test the predictions that turn out from this theoretical analysis on households borrowing from group lending programs in Bangladesh. We also compare results from the model with endogenous loan with those obtained in the previous version of the model.

[11] The f.o.c. for utility maximization is the following: $L + a\frac{\partial L}{\partial a} + \beta \left\{ -pRL + [pRL(1-a) - 1] \frac{\partial L}{\partial a} + (1-p)\theta [(1-a)L]^{\theta-1} \left[-L + (1-a)\frac{\partial L}{\partial a} \right] \right\} = 0$ where $\frac{\partial L}{\partial a} = L \left\{ \frac{pR}{pR(1-a)-1} - \frac{\theta}{(1-a)} \right\} \frac{1}{1-\theta}$.

3 The Data

Data were collected in a survey carried out on 1,798 households in rural Bangladeshi villages by the Bangladesh Institute of Development Studies at the World Bank in 1991/92[12].

The sample consists of three randomly selected villages from each of the 29 districts (thanas) surveyed. In 24 of these districts, a microcredit program (Grameen, Bangladesh Rural Advanced Committee or Bangladesh Rural Development Board) had been in operation for at least three years. A total of 20 households in each village were surveyed.

Although the survey has been conducted three times during the period, here we concentrate on the first round (November-February), which is the most reliable setup in order to provide clear answers to our theoretical issues, since much information is missing in the remaining two.

Among all the household surveyed 816 joined group lending programs. We concentrate on these, since they better fit our theoretical setup. In particular, households who are accorded loans from the three MFi mentioned above all faced the same constant interest rate (16 per cent at the time of the survey) an are not required to provide collateral.

In fact, different objective functions and market structure of lenders (think for example about monopolistic or oligopolistic moneylenders) would complicate the theoretical framework without providing clear-cut predictions.

Our proxy for the share of invested funds is a dummy variable which takes the value of 1 when the household ex post declares that has devoted the loan to productive uses (farming or other self-employed activities).

Among the 816 households borrowing from group lending programs 83 per cent stated that they have used funds for production, while the remaining ones

[12] Although microfinance has made further improving steps in recent years, still group lending is the core of credit services provided by institutions like the GB, BRDB or BRAC. Informal and bank credit are also granting almost the same services as in 1991/1992. Hence, in order to analyze recent issues raised in the microfinance literature, the dataset seems not to supply aged information.

declared that they made personal use, such as dowries, food or medical expenses. Thus, on average, our variable a in the model should amount to 0.17.

The variable which we consider eligible to capture the degree of solidarity is the intrahousehold network financial capability (θ in the model), represented by the number of close relatives (parents and siblings) owning land. In fact, land is considered the more reliable measure of wealth in such contexts. In the dataset the number of parents and siblings owning land is 3.6, with a maximum of 20.

The amount of the actual –or ex-post– transfers received by the households is also available in the data. However, we do not use this as an independent determinant of the share of invested funds for two reasons. First, according to the model, ex-post transfers include the choice of the share of invested funds itself, instead of representing the potential degree of solidarity which the borrower can access. Second, from an econometric perspective, actual transfers are endogenous with respect to the dependent variable. Our choice is thus to use a measure of potential solidarity which is not related to unmeasurable characteristics of the household affecting the share of invested funds.

Households own 0.4 acres of land on average, a fact that reflects the well known principle set up by the Grameen Bank and other MFi in order to select poor borrowers. This control variable is crucial to our purposes and always needs to be coupled with the number of relatives owning land in order to clean the presence of our main regressor from possible correlation with borrowers' wealth.

Information about the type of activity carried out by the household head may be important in order to capture possible differences in the project expected returns (pR in the model). Since we believe that important differences exist between returns from farming and non farming activities[13], we build two dummies capturing this. Within the sample, 68 per cent of the household are farmers (raise crops or rear animals) while 57 per cent conduct other non-

[13] For example, due to floods and adverse climate conditions, it is likely that farming has higher probabilities of insuccess.

agricultural activities. The remaining ones are non-self employed[14].

Some other variables are used to gather information on the intertemporal preference rate, β. The average age of the household head –who is male in 94 per cent of the cases– and his/her spouse is 34 and they attended school for slightly more than two years. On average household are made of five members, household head and spouse have 2 parents alive (within four), eight siblings and six children. The number of children, in particular, seems a good measure of weight accorded to future consumption (i.e. the higher the number of children, the higher is β).

In order to check the robustness of our results we also account for possible shocks occurred to household members. In fact, funds might be subtracted from productive uses in case some household member suffers a disease and requires medical assistance or medicines. Even in case of marriage it is possible that productive projects are foregone in order to provide dowries. The number of household members who have been hit by some injury is 1 on average, with a maximum of 7, while 1.4 per cent of the households provided their daughters with a dowry.

The presence of other sources of credit should also be controlled since it may as well account for differences in the share of funds conveyed towards production. Five and two per cent of the households have been accorded loans from informal moneylenders[15] and banks respectively. The average loan accorded by informal lenders amounts to 3,775 while it is 3,595 taka if loans come from banks, although the standard errors are quite high. Loans from MFi are instead 7,546 taka on average.

Finally, borrowers are asked what is the optimal loan size if they do over again. We consider this as the best available measure for the threat of non-refinancing. Basically, the larger is the future desired loan the higher the threat.

[14] Note that in most of the cases microfinance helps borrowers to start a new productive activity. These are ex post data, meaning that they already encompass the productive use of funds made by households who have been accorded loans in the past.

[15] Among this category we include input suppliers, merchants, landlords, relatives and friends.

We summarize all variables in the appendix.

4 Empirical Analysis

Given the available data, the model previously analyzed leads to estimate the following equation:

$$y_{ij} = r_{ij\alpha}\alpha_0 + h_{ij}\alpha_1 + A_{ij}\alpha_2 + \mu_j + \epsilon_{ij} \tag{7}$$

where i identifies the household, which is the unit of observation, and j refers to the village.

y_{ij} is the productive use dummy variable, r_{ij} is the number of relatives owning land, while h_{ij} is the household land. A_{ij} is a set of control variables. Finally, μ_j are village specific-effects, while ϵ_{ij} is an idiosyncratic error, such that $E(\epsilon_{ij}|r_{ij}, h_{ij}, A_{ij}, \mu_j) = 0$.

In particular, since y_{ij} is a dummy, we assume that

$$P_{ij} = F\left(I_{ij}\right)$$

where F is the cumulative distribution function of the standard normal, and P_{ij} is the value it takes in $I_{ij} = r_{ij\alpha}\alpha_0 + h_{ij}\alpha_1 + A_{ij}\alpha_2 + \mu_j$, that is the probability P_{ij} that $y_{ij} = 1$.

We use probit techniques to estimate equation (7) checking the robustness of our findings by changing the set of variables included in the vector A.

4.1 Results

Regression output is summarized in Tables 1 and 2. Table 1 refers to the version of the model with exogenous loan amount, while Table 2 refers to the version with endogenous one. The difference between the two, from an empirical standpoint, consists in controlling for the sum borrowed: we do it in the former case, while in the second we do not.

In each regression we control for household characteristics which can affect the use of borrowed sums, such as the average age of the household head and spouse, their education, the gender of the household head, the number of household members and the relationship network of the house measured by the number of relatives alive. In this case we separate parents and siblings from children, since the latter should better reflect the intertemporal preference rate of borrowers. Moreover, we always account for the main activity carried out from the household head, being this a farming or a non-farming one, and leave non self-employed as a residual class.

In particular, in the first column of each table we do not control for other sources of lending and possible shocks occurred to the household, which may divert funds from production. In the second column we control for the former in form of a dummy which takes the value 1 when the household also borrowed from informal lenders or banks, separating the two alternative sources. In the third column we adopt the same approach including a variable measuring the amount of loans from sources different from group lending instead of the dummy. In the fourth column we add variables capturing shocks, in the form of disease or dowry.

Columns (5) and (6) are for robustness check. Here we take the first basic result of column (1) and remove our main regressor, that is the number of close relatives owning land. In column (5) we do not add any substitute for this, but check whether the number of relatives alive is significant. In this case it would mean that it would not be relatives' wealth to raise the propensity to invest $(1 - a)$ but simply the relationship network, regardless of its financial capability. In column (6), in order to verify the same point, we also remove the number of household members, due to its possible collinearity with the number of relatives (children in particular) who are alive.

Starting from Table 1 we can observe that our measure of the solidarity network financial capability is significant with positive sign, suggesting that when the number of relatives owning land increases the probability that the

borrower uses funds for productive activities increases.

The marginal effect is on average 1.3, meaning that having one additional relative with land leads to an increase in the probability by 1.3 per cent. Considering for example that the household with the higher number of landed relatives has twenty, it means that its members have a 26 per cent higher probability of devote loans to production as compared to those not having access to transfers.

Our measure of household wealth, captured by land ownership, is significant and with a positive sign. This is interesting, but somehow expected, as it means that when resources constraints are less binding, households do not need to use borrowed funds to consume while waiting that output materializes, hence they are more likely to invest the full loan. Moreover, this result explains why, while MFi target landless borrowers, those who are richer amongst the poor are also more likely to repay, and thus preferred by lenders.

Looking at the household characteristics, we see that younger people are more likely to increase the probability of devoting sums to productive purposes, and this should reflect their higher intertemporal preference rate, according to our theoretical analysis. Another result which is not surprising and has the same explanation as the previous one, is the sign of the parameter associated to the number of children. This is sometimes significant, although weakly, or close to be.

The result for education is somehow surprising, since it seems that the more educated the household head and spouse the less they invest. One possible explanation is that highly educated household members are also more productive, and need to invest less in order to achieve the same output of less educated individuals. Another explanation could be the fact that they are richer[16], deliberately borrow for non-productive purposes, and are confident to being able to repay through other sources of wealth or income.

The household head being male is also a strong result, showing that male heads are more likely to invest in production rather that women, although there is not a significant number of households managed by women as to exclude the

[16] This might be captured by human capital instead of land ownership.

possibility that this is driven by one or a few cases only. Nonetheless, there might be several explanations for this fact, some for example linked to child rearing and education (Jackson, 1996), which are in line with some previous empirical findings (Pitt and Khandker, 1998; Kritikos et al., 2005).

Carrying out self-employed (farming or non-farming) activities increases the probability that funds are devoted towards production. This is somehow trivial and also an endogenous outcome, since often the purpose of group lending is to induce workers to become self-employed. However, the interesting feature is that non-farmers invest more than farmers, and it should in principle reflect the effect of a higher expected output on the share of funds invested, as analyzed in the model. In fact, if non-agricultural activities have a higher expected output –and this is plausible given the higher probability of failure of agricultural projects in this context[17]– our theoretical results find support in the data.

Our measures of shocks are also significant with the expected –negative– sign, suggesting that injuries and particularly dowries are very likely to divert funds from productive purposes, as one can observe from column (4) in each table.

As far as the other sources of lending are concerned (see all columns but (1)), it is interesting to note that their presence and amount go both in the direction of reducing the probability of investing in production. This result is definitely stronger for informal lending. It might be due to the high correlation of informal lending with shocks. In fact, despite we control for illness and dowries, it may be that they do not exhaust all the possible types of shocks which are faced with intrahousehold borrowing. It is interesting to note that microfinance seems to perform better than the other two types of credit. This is consistent with empirical evidence (Dalla Pellegrina, 2008), although these results may suffer from selection problems affecting bank and informal credit in particular.

Looking at the last two columns of each regression output it can be verified that what matters in order to increase the propensity to invest is the wealth

[17] Think about repeated floods in Bangladesh.

of the borrowers' relationship network. In fact, by removing the number of relatives owning land or the number of household members from regressions we do not obtain any significant increase of the parameters associated to the number of relatives who are alive[18].

We also run all the regressions in Tables 1 and 2 taking account of the measure of desired future loans. Results, although not explicitly reported in the regression output, show no significance of the parameter associated to this variable in case we control for the actual (current) loan amount (Table 1). The parameter, instead becomes significant and positive once we remove the loan amount, suggesting that the threat of non refinancing is effective. However, the presence of this control does not affect the sign and significance of the number of relatives owning land.

Finally, comparing Tables 1 and 2, one can observe that the results discussed so far do not substantially differ if we estimate the probability of investing with or without including the amount of the loan. However, it is interesting to look at the only difference, that is the sign –positive– and significance of the parameter associated to the sums accorded through group lending (Table 1). This useful to verify whether it is the case that MFi exogenously accord the amount lent or loans are endogenously determined. Apart from the predictions in terms of the effects of increasing solidarity[19], the version of the model with exogenous loan amount stated that increasing it would lead to a lower propensity towards investing. Hence, empirical evidence contradicts this theoretical prediction leaving room to the possibility that the loan amount is actually endogenously determined as a consequence of the strategy adopted by MFi in order to prevent the borrower' strategic default.

[18] Actually, the parameter slightly increases but does not become significant in any case.

[19] In the version of the model with exogenous principal these were ambiguous, meaning that only under some conditions increasing solidarity led to an increase in the of the propensity towards investing. However, from the empirical analysis the effect seems one-way, and not the result of multiple equilibria.

5 Concluding remarks

In this paper we study how solidarity may enhance investment when there is asymmetric information in credit markets and borrowers have no collateral endowments. Throughout the analysis, we assume that borrowers have a strong preference for current consumption, represented by low intertemporal preference rates, as is the case for less developed countries where MFi operate.

We model a situation where borrowers choose the share of funds to consume in the current period, which is complement to that invested in a productive project which returns a random output in the future. Their investment effort is therefore represented by sacrificing present consumption.

In such a framework, the impact of solidarity transfers may be in principle ambiguous. On the one hand higher transfers increase borrowers' willingness to sacrifice present consumption because they are provided by individuals who have information on the level of effort exerted. On the other hand, they enhance myopic behaviors due to the buffer-effect represented by solidarity in case of default.

In the theoretical part we show that when solidarity network's financial capability is relatively generous, more solidarity increases the share of funds devoted to investment but also reduces the amount of the loan in equilibrium. This second effect, in particular, stems from the non-strategic default devices set up by MFi in order to enforce loan repayment. These results are consistent with some typical features of MFi loans lending small sums in context where social ties are important and solidarity networks are structured and generous.

We test the model using data from the World Bank on a sample of households in Bangladesh during the period 1991-1992. Empirical findings suggest that the probability that borrowers invest their loan in productive activities positively depends on their intrahousehold network financial capability, represented by the number of relatives owning land, which has been selected as an exogenous measure of potential transfers. Moreover, econometric specifications that account for measures of the threat of non refinancing, although significant,

do not affect our main results.

In conclusion, this work provides two main implications. First, it is important that MFi account not only for incentive mechanisms that lay within groups in case of joint liability but also on those relying to the borrower's social network. A corollary of this is that there are instruments to enforce ex-ante good behaviors even in the case of individual lending, a point that seems particularly important for the Grameen II project. Second, it is possible for MFi to accord loans which are compatible with the reduction of ex-post moral hazard in the form of strategic default. By doing this, MFi also modify the structure of ex-ante incentives which become jointly determined with the amount borrowed.

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Appendix

Fixed loan size

$$\frac{\partial a}{\partial \theta} = \frac{\partial\left(1-\frac{1}{L}\left(\frac{(1-p)\theta}{\frac{1}{\beta}-pR}\right)^{\frac{1}{1-\theta}}\right)}{\partial\theta} =$$

$$= \underbrace{\frac{1}{I}}_{>0}\left[-\frac{1}{(\theta-1)^2}\left(\ln\frac{(1-p)\theta}{\frac{1}{\beta}-Rp}\right)-\frac{1}{(1-\theta)\theta}\right]\underbrace{\left(\frac{(1-p)\,\theta}{\frac{1}{\beta}-Rp}\right)^{\frac{1}{1-\theta}}}_{>0}$$

The term in squared brackets is negative if:$-\frac{(1-\theta)}{\theta} < \ln\frac{\theta(1-p)}{\frac{1}{\beta}-Rp}$

Hence, for:

1) Very low $\theta : 0 < \theta < 1$, $0 < \frac{\theta(1-p)}{\frac{1}{\beta}-Rp} < 1$ it could be either $\frac{\partial a}{\partial \theta} < 0$ or $\frac{\partial a}{\partial \theta} > 0$

2) Mildly low $\theta : 0 < \theta < 1$, $\frac{\theta(1-p)}{\frac{1}{\beta}-Rp} > 1$ always $\frac{\partial a}{\partial \theta} < 0$

3) Mildly high $\theta : \theta > 1$, $0 < \frac{\theta(1-p)}{\frac{1}{\beta}-Rp} < 1$ always $\frac{\partial a}{\partial \theta} > 0$

4) Very high $\theta : \theta > 1$, $\frac{\theta(1-p)}{\frac{1}{\beta}-Rp} > 1$ it could be either $\frac{\partial a}{\partial \theta} < 0$ or $\frac{\partial a}{\partial \theta} > 0$

Endogenous loan size

$$a^* = 1 - \left(\frac{pR-\frac{1}{(1-a)}}{\frac{1}{\beta}-pR}\right)^{\frac{1}{1-\theta}}$$

$$F(a,\theta,p,R,\beta) = a - 1 + \left(\frac{pR-\frac{1}{(1-a)}}{\frac{1}{\beta}-pR}\right)^{\frac{1}{1-\theta}} = 0$$

By the Implicit Function Theorem:$\frac{\partial a}{\partial \theta} = -\frac{\frac{\partial F}{\partial \theta}}{\frac{\partial F}{\partial a}}$

$$\frac{\partial F}{\partial \theta} = \frac{\partial\left(a-1+\left(\frac{pR-\frac{1}{(1-a)}}{\frac{1}{\beta}-pR}\right)^{\frac{1}{1-\theta}}\right)}{\partial\theta} = \frac{1}{\theta^2-2\theta+1}\left(\ln\frac{Rp\beta-\beta-Rap\beta}{Rap\beta-Rp\beta-a+1}\right)\left(\frac{Rp\beta-\beta-Rap\beta}{Rap\beta-Rp\beta-a+1}\right)^{\frac{1}{1-\theta}} =$$

$$= \underbrace{\frac{1}{(\theta-1)^2}}_{>0}\ \underbrace{\left(\ln(1-a)^{1-\theta}\right)}_{\substack{<0 \text{ if } 0<\theta<1 \\ >0 \text{ if } \theta>1}}\ \underbrace{(1-a)}_{>0}$$

Hence: $\frac{\partial F}{\partial \theta} < 0$ if $0 < \theta < 1$; $\frac{\partial F}{\partial \theta} > 0$ if $\theta > 1$

$$\frac{\partial F}{\partial a} = \frac{\partial\left(a-1+\left(\frac{pR-\frac{1}{(1-a)}}{\frac{1}{\beta}-pR}\right)^{\frac{1}{1-\theta}}\right)}{\partial a} =$$

$= 1 - \frac{\beta}{(1-a)^2(1-\theta)[1-Rp\beta]} (1-a)^{\theta}$

Note that if $\theta > 1$:

$\frac{\partial F}{\partial a} = 1 - \underbrace{\frac{\beta}{(1-a)^2(1-\theta)[1-Rp\beta]}}_{>0 \quad <0 \quad >0} \underbrace{(1-a)^{\theta}}_{>0}$

Hence:

a) if $\theta > 1$: $\frac{\partial F}{\partial a} > 0$, and consequently $\frac{\partial a}{\partial \theta} < 0$

b) if $0 < \theta < 1$:

in order for $\frac{\partial F}{\partial a} < 0$, such that $\frac{\partial a}{\partial \theta} < 0$, we need:

$(1-a)^{2-\theta} (1-\theta) [1-Rp\beta] < \beta$

This holds for:

large θ (approaching 1), large β, large pR.

Table 1 – Effect of solidarity on the use of MF loans when the loan amount is exogenously fixed

Dependent variable: dummy productive use of loan (yes=1)						
	(1)	(2)	(3)	(4)	(5)	(6)
N. Relatives own land	0.049*	0.062**	0.067**	0.064**		
	(0.029)	(0.030)	(0.030)	(0.030)		
Land	0.267*	0.279*	0.253*	0.251*	0.292**	0.308**
	(0.138)	(0.148)	(0.142)	(0.145)	(0.142)	(0.141)
Group lend. (loan amount)	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.019*	-0.022**	-0.023**	-0.023**	-0.024**	-0.025**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Education	-0.129***	-0.128***	-0.130***	-0.133***	-0.108***	-0.103***
	(0.036)	(0.038)	(0.038)	(0.038)	(0.036)	(0.035)
HHead is male	0.746**	0.819**	0.796**	0.774**	0.671**	0.724**
	(0.321)	(0.330)	(0.327)	(0.330)	(0.319)	(0.312)
N. HH members	0.038	0.035	0.045	0.039	0.049	
	(0.057)	(0.058)	(0.058)	(0.060)	(0.057)	
N. Relatives alive	0.002	0.006	0.003	0.002	0.023	0.021
	(0.021)	(0.022)	(0.022)	(0.022)	(0.020)	(0.019)
Children alive	0.020	0.032	0.031	0.050	0.038*	0.055*
	(0.035)	(0.036)	(0.036)	(0.037)	(0.018)	(0.029)
Farming	0.129	0.236	0.202	0.201	0.256	0.263
	(0.179)	(0.186)	(0.184)	(0.185)	(0.181)	(0.181)
Non-farming	1.095***	1.093***	1.071***	1.047***	1.013***	1.030***
	(0.168)	(0.176)	(0.173)	(0.178)	(0.169)	(0.168)
Informal cr. (dummy)		-1.506***				
		(0.298)				
Bank cr. (dummy)		-1.391**				
		(0.664)				
Informal cr. (loan amount)			-0.000***	-0.000***	-0.000***	-0.000***
			(0.000)	(0.000)	(0.000)	(0.000)
Bank cr. (loan amount)			-0.000*	-0.000*	-0.000*	-0.000
			(0.000)	(0.000)	(0.000)	(0.000)
Injury (N. hh memers)				-0.129*		
				(0.072)		
Dowry (dummy)				-1.626**		
				(0.646)		
Constant	-0.455	-0.680	-0.636	-0.521	-0.561	-0.439
	(0.604)	(0.614)	(0.611)	(0.623)	(0.613)	(0.593)
Observations	816	816	816	816	816	816
LR chi2	159.62	188.21	177.21	187.69	172.09	171.35
chi2 df	60	62	62	64	61	60
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R2	0.2683	0.3163	0.2978	0.3155	0.2892	0.2880

Standard errors in parentheses
significant at 10%; ** significant at 5%; *** significant at 1%
Marginal effects to be computed.

All regressions have been run controlling for the optimal desired size of the loan in case of future borrowing. This measure is not significant in any specification and does not affect the sign and significance of the number of relatives owning land.

Table 2 – Effect of solidarity on the use of MF loans with endogenous loan amount

Dependent variable: dummy productive use of loan (yes=1)						
	(1)	(2)	(3)	(4)	(5)	(6)
N. Relatives own land	0.045	0.058*	0.061**	0.058*		
	(0.028)	(0.030)	(0.029)	(0.030)		
Land	0.274**	0.290**	0.266*	0.267*	0.303**	0.320**
	(0.135)	(0.144)	(0.139)	(0.142)	(0.138)	(0.137)
Age	-0.015	-0.017	-0.017*	-0.017	-0.018*	-0.020**
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
Education	-0.121***	-0.116***	-0.120***	-0.122***	-0.101***	-0.096***
	(0.034)	(0.036)	(0.036)	(0.037)	(0.034)	(0.034)
HHead is male	0.695**	0.755**	0.734**	0.713**	0.633**	0.685**
	(0.321)	(0.330)	(0.327)	(0.330)	(0.321)	(0.314)
N. HH members	0.037	0.035	0.044	0.042	0.048	
	(0.056)	(0.057)	(0.057)	(0.059)	(0.056)	
N. Relatives alive	0.003	0.007	0.004	0.002	0.023	0.021
	(0.021)	(0.022)	(0.021)	(0.021)	(0.019)	(0.019)
Children alive	0.012	0.023	0.022	0.034	0.027*	0.045*
	(0.034)	(0.035)	(0.035)	(0.036)	(0.013)	(0.021)
Farming	0.205	0.305*	0.275	0.281	0.321*	0.327*
	(0.176)	(0.182)	(0.180)	(0.181)	(0.178)	(0.178)
Non-farming	1.121***	1.117***	1.098***	1.077***	1.048***	1.067***
	(0.165)	(0.172)	(0.170)	(0.174)	(0.166)	(0.165)
Informal cr. (dummy)		-1.447***				
		(0.291)				
Bank cr. (dummy)		-1.233*				
		(0.637)				
Informal cr. (loan amount)			-0.000***	-0.000***	-0.000***	-0.000***
			(0.000)	(0.000)	(0.000)	(0.000)
Bank cr. (loan amount)			-0.000*	-0.000*	-0.000	-0.000
			(0.000)	(0.000)	(0.000)	(0.000)
Injury (N. hh memers)				-0.127*		
				(0.070)		
Dowry (dummy)				-1.378**		
				(0.649)		
Constant	-0.392	-0.594	-0.546	-0.435	-0.492	-0.371
	(0.597)	(0.606)	(0.603)	(0.615)	(0.606)	(0.586)
Observations	816	816	816	816	816	816
LR chi2	145.77	173.06	161.72	170.29	157.35	156.62
chi2 df	59	61	61	63	60	59
Prob > chi2	0.00	0.00	0.00	0.00	0.00	0.00
Pseudo R2	0.2450	0.2909	0.2718	0.2862	0.2645	0.2632

Standard errors in parentheses
significant at 10%; ** significant at 5%; *** significant at 1%
Marginal effects to be computed.

All regressions have been run controlling for the optimal desired size of the loan in case of future borrowing. This measure is positive and significant in any specification but does not affect the sign and significance of the number of relatives owning land.

Table 3 – Descriptive statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Productive use of funds	816	0.838235	0.368461	0	1
Age	816	34.68627	11.35196	8	72.5
Education	816	2.041667	2.501186	0	13
HHead is male	816	0.943628	0.230781	0	1
N. of persons in the HH	816	5.253676	1.984754	1	17
N. parents alive	816	1.893382	1.273479	0	4
N. siblings alive	816	8.297794	3.892834	0	25
N. children alive	816	6.370098	4.178565	0	24
Farmer	816	0.685049	0.464781	0	1
Non-farmer	816	0.571078	0.495226	0	1
Injury	816	1.053922	1.133769	0	7
Dowry	816	0.014706	0.120447	0	1
Informal cr. (dummy)	816	0.051471	0.231925	0	1
Bank cr. (dummy)	816	0.025735	0.158442	0	1
Informal cr. (amount)	40	3,775.5	3986.736	1,000	17,000
Bank cr. (amount)	21	3,595.238	2154.176	1,000	9,500
Group lending (amount)	816	7,546.803	6827.32	1,000	54,014
Optimal size future loan	816	14,293.9	16843.05	1,000	200,000
HH land	816	0.405678	0.915796	0	13.65
N. relatives own land	816	3.601716	3.954893	0	20

Table 4 – correlations

	Prod.. use	Age	Educ.	HHead male	N. pers.	N. par. alive	N. siblings alive	N. children alive	Farmer	Non farmer	Injury	Dowry	Informal cr. (dum)
Productive use	1												
Age	-0.0119	1											
Education	-0.0346	0.0936	1										
HHead male	0.0802	0.2302	0.0753	1									
N. of pers. in HH	0.0595	0.4058	0.197	0.1572	1								
N. parents alive	0.026	-0.4154	0.0453	0.205	-0.1543	1							
N. siblings alive	0.0379	-0.1921	0.1065	0.1785	-0.0698	0.4593	1						
N. children alive	0.0262	0.6904	0.0924	0.0878	0.6651	-0.3018	-0.0938	1					
Farmer	0.1105	0.1115	0.0894	0.1203	0.108	-0.0008	0.0967	0.1024	1				
Non-farmer	0.2245	0.0131	-0.0138	0.0351	0.0771	0.0636	-0.0113	0.0294	-0.0172	1			
Injury	0.0238	0.0936	0.0505	0.0304	0.2033	-0.0742	-0.0184	0.1584	-0.0562	0.015	1		
Dowry	-0.1675	0.1169	-0.0102	-0.0143	0.0254	-0.0698	-0.0251	0.133	-0.0048	-0.0793	-0.0328	1	
Informal cr. (dum)	-0.204	0.0276	0.1179	0.0314	0.0649	-0.0229	0.07	0.0867	0.0026	-0.0426	0.1341	0.1486	1
Bank cr. (dum)	0.0294	-0.0705	0.0019	0.0397	-0.0364	-0.0107	0.083	-0.0589	0.0436	-0.0312	0.0401	-0.0199	0.0307
Group lending (am.)	0.1897	0.0994	0.0717	0.0192	0.1526	-0.0502	0.0097	0.0806	0.1055	0.1798	0.0432	0.0017	-0.0383
Optimal size fut. loan	0.1167	0.1141	0.0761	0.0358	0.1697	-0.0577	0.024	0.099	0.0489	0.1822	0.078	0.0057	0.0381
HH land	0.0879	0.1089	0.2695	0.0379	0.22	-0.094	-0.0502	0.1259	0.2478	-0.0267	0.066	-0.0255	-0.0036
N. rel. own land	0.1191	-0.0516	0.2954	0.0305	0.0821	0.2359	0.3889	0.0275	0.2441	-0.014	-0.0237	-0.065	0.0144
	Bank cr. (dum)	Group lending (am.)	Optimal size fut. loan	HH land	N. rel. own land								
Bank cr. (dum)	1												
Group lending (am.)	0.0046	1											
Optimal size fut. loan	0.0473	0.552	1										
HH land	-0.0103	0.1097	0.0915	1									
N. rel. own land	-0.011	0.1389	0.1052	0.2844	1								