The Distributional Implications of Group Lending

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1 Introduction

The ideology and practice of poverty alleviation has been deeply influenced by the idea that group lending can empower the poor by providing them access to credit. The Grameen Bank of Bangladesh first popularized group loans in the 1970s. Loans were made to groups of 5 members and borrowers were made jointly responsible for repayment. Default by any member made the others ineligible for future loans. It was believed that joint liability combined with social sanctions would induce borrowers to repay loans and thereby constitute a financially sustainable model of lending and self-employment among *the poorest of the poor*. Similar approaches were subsequently developed by literally hundreds of organizations across the world.

With the successful expansion of group lending in the nineties there emerged a theoretical literature which linked the features of microcredit contracts to repayment incentives. Borrower selection, peer monitoring, risk-pooling and social sanctions were shown to be potential mechanisms which allowed groups to mitigate some of the serious and well known informational and enforcement problems that afflicted credit markets (Stiglitz, 1990; Banerjee et al., 1994; Ghatak, 1999). This literature has been surveyed in Ghatak and Guinnane (1999) and Armendariz de Aghion and Morduch (2005).

More recently, the value of joint liability and social networks in expanding credit outreach has been questioned by both researchers and practitioners. The very poor seem to be under-

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represented in credit groups (Morduch, 1988) and appear to leave them at higher rates (Baland et al., 2008). The impact on repayment rates is also ambiguous because the financial distress of a few members increases the burden on the others who may in turn decide that group default is preferable. This ambiguity has been theoretically examined by Besley and Coate (1995) and it is illustrated emprically by Giné and Karlan (2009) who randomize assignment of individual and joint liability regimes in different regions in the Philippines and find no significant difference in default rates.

On the field, several prominent microfinance institutions have initiated a shift from group loans to individual contracts with members of groups. In 2002, the Grameen Bank replaced their hallmark model of group lending with Grameen II, which eliminated joint liability while maintaining the group structure to foster solidarity. The introduction of the new system appears to have brought back many former Grameen members and the total number of borrowers has increased from 3 to 8 million.[1] Particularly interesting is the admission by the bank that very poor individuals are often best served outside groups (Grameen Bank, 2009):

> A destitute person does not have to belong to a group...Bringing a destitute woman to a level where she can become a regular member of a group will be considered as a great achievement of a group.

This trend is by no means universal and the microfinance sector continues to be institutionally diverse. In India, for example, *Self Help Groups* which adhere fairly strictly to the joint-liability contract represent 73 per cent of the micro-finance sector[2] and micro-finance institutions often combine individual loans with the traditional group lending model.[3]

The purpose of our paper is to build on the theoretical work on group lending to better understand links between contractual structure, credit outreach and borrower welfare. As shown in the literature, there are many plausible mechanisms through which joint-liability can affect the performance of microcredit groups. We focus on the *ex-post* moral hazard problem of repaying a loan on completion of a successful project. We model a simple investment game in which

[1]Wright et al. (2006) consider membership until 2005 and report that "Grameen took 27 years to reach 2.5 million members- and then doubled that in the full establishment of Grameen II". The Grameen Bank's own website currently reports membership of about 8 million.

[2]See Srinivasan (2009), p 5, Table 1.2

[3]Ghate (2008) Table A.2 contains a classification of 129 recognized Micro-finance institutions all over India. Many of these are reported to offer both individual and group contracts

individuals can invest in a project of fixed size and are offered either individual contracts or group loans by a competitive banking system. Banks can impose a fixed non-pecuniary sanction on defaulting borrowers. With group loans, all members are sanctioned by the bank if the total amount borrowed by the group is not repaid. They may, in addition be social sanctions within a group.

We begin with a characterization of credit market equilibrium under the two types of contracts. Our first result shows that in the absence of social sanctions, the largest available loans are offered under individual and not group contracts. This is because repayment incentives under both group and individual liability are constrained by the same level of bank sanctions and under joint liability, successful borrowers have to compensate the banking system for failures within their group as well as for all groups which do not succeed in repaying their loans. This result is significant because it shows that joint liability *per se* cannot bring credit to the doorstep of those not currently served by the banking system. If outreach is greater under group lending, it is other features of these groups - social networks, sanctions and better project choices- that allow this sector to reach the poor.

For those requiring small loans, both types of contracts are offered by banks. We compare the welfare of given borrowers under group and individual loan contracts. Group loans can improve welfare by lowering the probability of being sanctioned by the bank. We show that, for fixed group size, the greatest welfare gains are for groups with the highest initial endowment of wealth. This happens because groups that require smaller loans also need fewer successful projects to repay them and the possibility of pooling risk is therefore greatest for these groups.

Social sanctions within groups can improve enforcement and outreach but we show that their effects depend critically on the nature of project uncertainty. When the level of uncertainty is very high, social sanctions effectively poor risk and can always improve outreach. In contrast, and more surprisingly, social sanctions can turn out to be ineffective when projects become less risky. The reason for this is that, given an expected project return, less risky projects yield less when successful and even arbitrarily large social sanctions can at most extract the full income from the project.

The existing literature on group lending has focussed almost entirely on two person groups. We consider gains from group size as a function of borrower wealth and find that this relationship is not monotonic. For high wealth (and small loans) larger groups are able to pool risks and optimally sized groups always have more than two members. For low wealth levels a fall in group size can increase borrower welfare.

Finally, we compare the potential of bank and social sanctions to improve repayment incentives and credit outreach. This is related to a well established debate in the development literature on the extent to which informal networks can substitute for market incentives in the presence of weak legal systems. We consider the implications of changing the mix of bank and social sanctions, given a fixed value of total sanctions that can be imposed on an individual. We show that while social sanctions can, at best and under limited conditions, substitute for bank sanctions, an increase in bank sanctions always increases outreach for both individual and group loans. For those already receiving group loans an increase in both types of sanctions raises welfare and these gains are concentrated among poorer borrowers.

Taken together, these results show that joint liability can increase borrower welfare but its ability to provide the poor access to credit depends on a complex set of factors and is often limited. Ultimately, the poorest households may be best served by providing them individual loans on more favorable terms and promoting alternative programs of poverty alleviation. It also seems that social networks, no matter how strong, can benefit from improved market institutions.

2 The model

We begin with a standard model of the credit market with wealth heterogeneity. Our principal unit of analysis is a set of households in a community.[4] Communities are of size n and contain households of homogeneous wealth w.[5] Community wealth varies according to some continuous distribution and we examine the role of credit contracts in mediating the relationship between wealth, investment and earnings.

Each household is risk-neutral and can choose to engage in a self employment project which requires indivisible investment of one unit and yields a return ρ with probability π and zero otherwise. There are no other project costs.[6]

[4] We use the terms households and individuals interchangeably.

[5] Most group-lending programs have tried to ensure that members within the group are similar in in terms of their initial endowments. At the start of the Indian microcredit program, for example, non-government organizations were issued guidelines by the Reserve Bank of India explicitly suggesting that they foster savings and credit groups among households of similar social standing.

[6] Costs of effort are easily incorporated. In our model the project returns can be interpreted as being net of these costs.

A competitive banking sector takes deposits and lends to individuals or to groups under joint liability contracts. Households that do not invest can obtain a risk-free gross return of r, which is also the opportunity cost of bank funds. If loans are not repaid, banks can impose a non-pecuniary sanction K on the borrower. In the case of non-repayment by a group, each member faces K. These sanctions provide no direct benefits to the bank and have no associated costs. Banks cannot directly observe project success and contract consists of a loan size, an interest rate and the bank sanction K.

For any household to invest in the project with borrowed funds, expected returns must be high enough to compensate investors for the opportunity cost of funds as well as the sanctions they face in the case of project failure. This requires a minimum return

$$\bar{\rho} = \frac{1-\pi}{\pi}K + \frac{r}{\pi}. \tag{1}$$

We assume a project return $\rho \geq \bar{\rho}$.

To focus on the role of joint liability in determining the nature of group loans, we abstract from questions of group formation and monitoring that have been studied by others. We take as given a fixed group size n and think of group projects as individual projects undertaken by each member of the group.

In addition to bank sanctions, group loans may be subject to social sanctions. We follow the existing literature on group lending in assuming that the maximum level of these sanctions is exogenously given. Social sanctions inflict a utility cost γ on sanctioned household and are costless to others in the group. These could, for example, represent a lost reputation. In practice, the costs and motives associated with sanctions within social networks are varied and complex. Our purpose here is only to explore the extent to which any cost of this kind can improve repayment incentives within groups.

The sequence of actions is as follows. A group with wealth w and n members may receive a loan providing each member (1 - w) to invest in the project. Project returns are realized and observed by group members. Successful members then simultaneously announce contributions towards bank repayment. If available contributions are high enough, repayment is made. If not, the bank sanctions each member K and non-contributing members may also be subject to social sanctions γ.

We compare group loans to individual contracts along two dimensions: outreach and borrower welfare. We start with a benchmark case in which only bank sanctions are available. We then introduce social sanctions and examine their role in increasing loan sizes and expected gains under group lending. Finally, we present some results on optimal group size and the desirable mix of social and bank sanctions.

2.1 Individual Loans

What is the largest loan an individual can get from the bank? Those with failed projects pay nothing, so if all successful borrowers repay, banks break-even by charging $\frac{r}{\pi}$. Borrowers prefer repayment to bank sanctions as long as $\frac{r}{\pi}L \leq K$. The largest loan available under an individual contract is therefore

$$L_i = \frac{\pi K}{r} \tag{2}$$

and the lowest wealth level at which individuals will be able to borrow enough for investing in the project is

$$w_i = \min(0, 1 - L_i)$$

Expected utility for a loan of size $L < L_i$ is $\pi\left(\rho - \frac{r}{\pi}L\right) - (1-\pi)K$ or

$$U_i = \pi\rho - rL - (1-\pi)K \tag{3}$$

If $w_i = 0$, then all households have access to credit. Since we are interested in the problem of outreach, we assume that parameter values are such that $w_i > 0$ or equivalently, $L_i < 1$. This implies $K < \frac{r}{\pi}$.

2.2 Group Loans

Under joint liability, incentives to repay depend on the number of successful members in the group and their repayment strategies. As in most such coordination games, there are many equilibria. Since we are interested in maximal outreach, we restrict our attention to the symmetric repayment equilibrium with the smallest positive contributions by each member. This assumes away coordination problems within the group.

In the case of individual contracts, all loans that get made by the bank have the same probability of repayment, π and the same interest rate, $\frac{r}{\pi}$. With joint liability, failures can be subsidized by successes within the group and, since smaller loans require fewer successes, interest rates are increasing in with loan size.

Let $B(n, j, \pi)$ be the probability of j or more successes in n Bernoulli trials with a probability of success on each trial equal to π. We refer to this by $B(j)$ if there is no ambiguity about the n and π in question. Now consider the following expression for each value of $j = 1, 2, \ldots n$:

$$\frac{n}{j}\frac{r}{B(n, j, \pi)}L$$

Suppose that repayment on a per member loan of L occurs if there are a minimum of j successes in the group. In this case banks would charge an interest rate of $\frac{r}{B(j)}$ and the above expression represents payments per successful member.

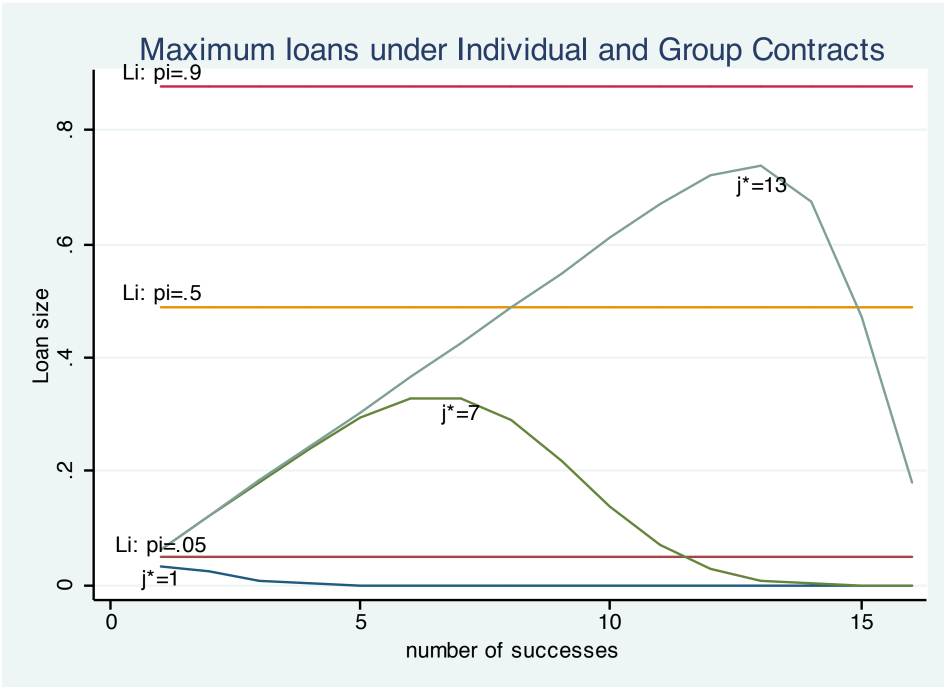
Repayment in turn depends on incentives, as captured sanctions K and γ, as well as the amount available from a successful project, ρ. A group loan of L per member is feasible if there exists a value of j such that

$$\frac{n}{j}\frac{r}{B(j)}L \leq \min(\rho, K + \gamma). \tag{4}$$

Total sanctions $K + \gamma$ determine repayment incentives, but payments cannot exceed the total return of a successful member, ρ. Social sanctions above $\rho - K$ therefore have no effect on repayment. If there are multiple values of j for which (4) is satisfied for a given loan size L, the smallest such value determines the group contract because it corresponds to the lowest interest rate. A group contract is therefore of the form $(L, \frac{r}{B(j(L))}, K)$ where $j(L)$ is the smallest number of successes required for repaying a per member loan of size L. The largest group loans L_g is the value of L for which (4) holds with equality.

While this means that small group loans will be charged lower interest rates because they require fewer successes for repayment, the largest group loans L_g cannot require a value of j which far exceeds the expected number of successes for individuals in the population. This is because, as j increases above its expected value, the probability of achieving j successes drops enough to cause $jB(j)$ and therefore the maximum loan size to fall.

The figure below shows how maximum loan sizes under individual and group contracts vary with the level of project uncertainty.



The following lemma defines j^*, the number of successes that correspond to the largest feasible group loan, L_g

Lemma 1 *The function $jB(n, j, \pi)$ starts at zero, takes the value $n\pi^n$ at $j = n$ and attains a maximum at $j^* \leq \lceil n\pi \rceil$. If $\pi < \frac{1}{n}$, it is decreasing throughout and if $\pi \geq \frac{n(n-1)}{1+n(n-1)}$ it is increasing throughout.*

The properties of this function will be useful in establishing many of our results.

3 Outreach: When do group loans improve access to credit?

Case 1: No social sanctions

We begin by characterizing the largest loans available under individual and group contracts respectively in the absence of social sanctions.

Recall from (1) that $\rho > K$, so with $\gamma = 0$, the constraint in (4) becomes

$$\frac{n}{j}\frac{r}{B(j)}L \leq K \tag{5}$$

The largest feasible group loan L_g is therefore given by

$$L_g = \frac{j^* B(j^*)}{nr} K \tag{6}$$

where j^* is defined above by Lemma 1. Our first result is that in the absence of social sanctions group loans are always smaller than those offered to individuals.

Proposition 1 *If group lending is characterized by joint liability but no social sanctions, the maximum loan size available to a group member, L_g is strictly smaller than L_i, the largest loan available under an individual contract.*

This implies that, in the absence of social sanctions, joint liability is associated with lower outreach than individual contracts and cannot allow a person to undertake the project as part of a group if they are denied the loan of the size they need as an individual. This result is driven by the fact that individuals who borrow are explicitly charged $\frac{r}{\pi}$ by a competitive bankings system. For group loans each successful borrower not only has to pay for failed projects within the group but, in addition, has to compensate banks for groups that do not have enough successes to repay the loan. The failure of these groups raises interests rates on group loans above r and therefore repayments for a loan of size L_i are greater than $\frac{rL_i}{\pi}$. As a result, group loans have to be smaller than L_i to ensure that successful borrowers have the correct incentives to honor their loans.

Social sanctions improve repayment incentives by relaxing (**??**) and increases in these sanctions can raise L_g until the point at which $\rho = K + \gamma$. At this point, the entire surplus from successful projects is extracted and the marginal effect of higher sanctions on loan size is zero. The effect of these sanctions on the maximum size of a group loan depends on parameter values and we show below, that for a wide range of these values, the maximum loan under a group contract is necessarily below that of an individual contract, *irrespective* of the level of social sanctions. Under these conditions, social sanctions cannot improve access to credit beyond what would occur under individual contracts.

Proposition 2 *If the level of social sanctions γ is greater than $\frac{(1-2\pi)K+r}{\pi}$, the largest individual loan can always be implemented as a group loan for a group of size 2, and for all group sizes if $n\pi$ is an integer and $\pi \leq \frac{1}{2}$. Further, if $r < (1-\pi)K$, households can always obtain group loans to invest in the project, independent of their initial level of wealth. For $\pi > \frac{1}{2}$ and $n > 2$, there always exist parameter values, for which the maximum group loan is less than the largest individual loan even with arbitrarily large social sanctions.*

Proof : We will first show that for $n = 2$, L_i is always implementable as a group loan when sanctions are high enough.

When γ is above $\frac{(1-2\pi)K+r}{\pi}$, the group can extract at least $\bar{\rho}$ from each successful member by threatening to sanction them. Repayments per successful group member for a loan of size L are given by $\frac{nr}{jB(j)}$, if j is the number of successes required in the group. We have to show that for $L = L_i$ and $n = 2$, there always exists j such that payments per member are less than $\bar{\rho}$.

Consider $j = 2$, then $B(2) = \pi^2$. Repayments per successful member for a loan of size L are then $\frac{r}{\pi^2}L$ and these have to be less than $\bar{\rho}$ for this to be a feasible contract. The largest group loan L_g, corresponding to $j = 2$ is therefore given by

$$\frac{r}{\pi^2}L_g = \frac{1-\pi}{\pi}K + \frac{r}{\pi}$$

or

$$L_g = \frac{(1-\pi)\pi K}{r} + \pi$$

$$L_g - L_i = (1-\pi)L_i + \pi - L_i = \pi(1-L_i) > 0 \quad (7)$$

This is larger than L_i since $L_i < 1$.

We now show that for any n, if $n\pi \leq m$, the median of the distribution, and $\pi \leq \frac{1}{2}$, L_i is always implementable. A special case is when $n\pi$ is an integer and therefore $m = n\pi$ (Kass and Buhrman).

Repayments per successful borrower at L_i are given by

$$\frac{n\pi}{jB(n,j,\pi)}K$$

and earnings are at least

$$\frac{1-\pi}{\pi}K + \frac{r}{\pi}$$

With $\pi \leq \frac{1}{2}$, both terms in the expression for earnings are at least equal to K (since $L_i < 1$ implies $\frac{r}{\pi} > K$). Repayment at $j = m$ is strictly less than $2K$ if $m \geq n\pi$ because $B(m) \geq \frac{1}{2}$ and is therefore always less than minimum earnings. With the sum of bank and social sanctions equal to $\bar{\rho}$, these payments can therefore be extracted.

3.1 Benefits from joint liability

Theorem 3.1 *In the absence of social sanctions and given group size, the benefits from group contracts are increasing in borrower wealth.*

Proof : For any wealth level w which requires bank financing, the minimum loan size needed for investment is given by $(1-w)$. Call this $L(w)$. We focus on feasible group contracts and examine the distribution of benefits of group lending contracts as a function of w . For a group lending contract to be feasible for loan size L, we require that there exists j such that

$$\frac{n}{j}L\frac{r}{B(n,j,\pi)} \leq K \tag{8}$$

Since n and π are fixed, we denote $B(n,j,\pi)$ by $B(j)$. Let j^* be the smallest j for which this is satisfied. Notice that the interest rate faced by the group will be lowest for this level of j. Since j^* satisfies (8), any group with j^* or more successes will have all successful borrowers repay to avoid sanctions. The interest rate charged to the group is $\frac{r}{B(j^*)}$.

The utility to an individual from a group loan of size j depends both on whether the individual's project has succeeded or not and whether the group has enough successes to repay the bank.

The expression for the expected utility per member from a group loan can therefore be written as the sum of two terms, one for the case of group default and the other for repayment.

If $j < j^*$, the bank will always sanction group members and the individual member will keep his return ρ if the project happens to be successful, which happens with probability $\frac{j}{n}$. When $j > j^*$, group repayment occurs, there are no bank sanctions, and each successful member pays $\rho - \frac{n}{j}\frac{r}{B(j^*)}L$. Expected utility from a feasible group contract is therefore

$$\sum_{k=0}^{j^*-1} \pi_k \left(\frac{k}{n}\rho - K\right) + \sum_{k=j^*}^{n} \pi_k \left(\frac{k}{n}\rho - \frac{r}{B(j^*)}\right)$$

We use the definition of $B(j^*) = \sum_{k=j^*}^{n} \pi_k$ to simplify the above expression to obtain expected utility from a group loan as:

$$U_g(j^*) = \pi\rho - rL - K\sum_{k=0}^{j^*-1} \pi_k \tag{9}$$

This is a function of the minimum number of successes j^* required to repay the loan, and since j^* is increasing in loan-size, and $U_g(j^*)$ is decreasing in j^*, groups with lower initial wealth that have to borrow more to finance the project have lower benefits from group loans.

We can now compare individual and joint liability contracts for the same loan size. Using (3) and (9), we obtain:

$$U_g - U_i = [B(j^*(L)) - \pi]K \tag{10}$$

The expected gain from group relative to individual contracts is simply equal to the difference in the probability of being sanctioned by the bank. It is true that successful members in groups pay more than they would under an individual contract when there are fewer than $n\pi$ successes in the group, but these additional payments are offset by the occasions on other group members pay off their loans.

We have not said anything yet about whether the expression in (10) is positive. It may well be that a group loan is feasible, in that groups have the correct incentives to repay, yet the expected utility of each their members is higher under an individual contract. This happens when, at the loan size required by the group, the number of success required for repayment $j^*(L)$ are high enough to result in $B(j^*(L)) < -\pi$. We discuss this in more detail below. For high enough wealth levels, this can never happen because only one successful project in the group is needed to repay the group loan. To find the range of wealth levels for which this is true, notice that the loan amount for which the group requires only one success for repayment is equal to $\frac{KB(1)}{nr}$. The corresponding wealth level is $w_h = 1 - \frac{KB(1)}{nr}$. For all groups whose members have initial wealth greater in $[w_h, 1]$, the expected gain from a group over an individual loan is given by:

$$U_g - U_i = [1 - (1 - \pi)^n - \pi]K = [(1 - \pi) - (1 - \pi)^n]K > 0$$

3.2 Variations in group size

Theorem 3.2 *For sufficiently small loan sizes, the gain from group lending is increasing in group size in some range* $(2, \prime n)$.

Proof : From the second result we see that the gain from group loans is given by the difference in repayment probabilities under the two types of contracts, i.e.

$$U_g(L) - U_I(L) = B(n, j^*(L(w)), \pi) \tag{11}$$

For groups with w close to 1, only one success is needed for repayment and since $B(n, 1, \pi)$ is increasing in n, these groups would raise total utility by increasing size to the largest value $n\prime$ for which $n(1 - w)\frac{r}{B(n\prime, i\pi)} < K$

3.3 Appendix

Proof of Lemma 1

We will first show that the function $jB(j)$ is decreasing to the right of $\lceil n\pi \rceil$. We know that both the mode and the median of a binomial distribution are at most $\lceil n\pi \rceil$ (Kass and Buhrman, 1990) Consider $j = Mode = median = \lceil n\pi \rceil$. The loan available at j is greater than at $j+1$ if $jB(j) > (j+1)B(j+1)$ or $jB(j+1) + j\pi_j > jB(j+1) + B(j+1)$ or $j\pi_j > B(j+1)$

Proof : The largest loan size available under an individual contract is given by $L_i = \frac{K\pi}{r}$ as seen in (2). This is not a feasible group loan if, for all $j \leq n$

$$\frac{n}{j} L_i \frac{r}{B(n, j, \pi)} > K$$

We show that this is indeed the case. Using (2), K can be expressed in terms of L_i and we can rewrite the above condition as

$$\frac{n}{j} L_i \frac{r}{B(n, j, \pi)} > \frac{rL_i}{\pi}$$

or alternatively as

$$n\pi > jB(n, j, \pi) \tag{12}$$

We will show that this is always true.

The LHS is the expectation of a Binomial distribution with paramters n and π and can be expressed as

$$n\pi = \sum_{k=0}^{n} k\pi_k$$

The RHS is bounded above by $\sum_{k=j}^{n} k\pi_k$ (because $jB(n, j, \pi) = j \sum_{k=j}^{n} \pi_k < \sum_{k=j}^{n} k\pi_k$) which is part of the expectation on the LHS. So (13) always holds.

Proof of Proposition 1

Proof : The largest loan size available under an individual contract is given by $L_i = \frac{K\pi}{r}$ as seen in (2). This is not a feasible group loan if, for all $j \leq n$

$$\frac{n}{j} L_i \frac{r}{B(n, j, \pi)} > K$$

We show that this is indeed the case. Using (2), K can be expressed in terms of L_i and we can rewrite the above condition as

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4 Appendix

Proof of Lemma 1:

Let $\mathcal{B}_j \equiv jB(j)$. Since $B(j) = 1$ when $j = 0$ and $B(j) = \pi^n$ when $j = n$, $\mathcal{B}_j$ equals zero and $n\pi^n$ at $j = 0$ and n respectively.

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