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To switch or not to switch - Can individual lending do better in microfinance than group lending?

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Abstract

These days it has been witnessed, that banks offer individual loans instead of group loans and develop products based on individual liability in developing countries. In order to study this surprising turn, we expand the conventional approach on decision making of individuals. A social prestige function is introduced that reflects the non-monetary impacts of group membership on the individual and on her decisions. If a borrower possesses more than a critical level of wealth, it is optimal for her to switch to individual borrowing. From a welfare perspective, a mixture of individual and group loans is desirable. However, the average borrower switches from group to individual lending too soon.

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1 Introduction

Group lending is said to be the key factor in microfinance by mitigating information problems and therewith increasing repayment rates. In recent years, however, individual loans have also be given to poor people in developing countries. But which type of loan would be the best for the borrower? And which model of lending would maximize the economy's welfare? The purpose of this article is to provide a theory which answers these open questions.

In general, microfinance has been considered to be a major innovation to allow the poor to work their way out of poverty. With the help of small group loans that do not require collateral, the poor are able to start their own businesses. Prof. Mohammad Yunus, awarded the Nobel peace prize in 2006, founded the Grameen Bank in 1983 (Yunus, 1999). The bank lends small amounts of money to groups usually made of five poor people. The borrowers monitor each other and are liable for the repayment of the whole loan on time. In 1997, a conglomeration of 2,900 people from 137 countries, the Microcredit Summit, raised 2 billion US$ (Morduch, 1999, p. 1571) to provide microcredits to 100 million families worldwide within 9 years. In 2006, the campaign was renewed until 2015 with the objectives to give 175 million US$ of "...loan for self-employment and other financial and business services..." to the poorest families and "...ensure that 100 million families rise above the US$1 threshold adjusted for purchasing power parity..." (www.microcreditsummit.org). This proves strong and broad support for the idea of microfinance. However one can ask, whether this super hype is justified.

The majority of economists, including Stiglitz (1990), Varian (1990), Banerjee et al. (1994), Besley and Coate (1995), Armandáriz de Aghion and Morduch (2000), (2005), Armandáriz de Aghion and Gollier (2000), Laffont and Rey (2003), and Khandker (2005) believe in group lending in microfinance. They show theoretically that group lending is the key to the success of these programs by mitigating information asymmetries. See Ghatak and Guinanne (1999) for a survey. Once the first wave of enthusiasm had settled, the subject of microcredit, in particular group lending, was rarely discussed. It seems that once the concept of group loans had been understood, economists were not too critical when it came to group lending.

The first step in a more critical direction was made by Rai and Sjöström (2004). In their paper they show theoretically that, within their specific framework, repayments for other borrowers are efficient even if the borrowers are not contractually obliged to do so. Madajewicz (2004), Conning (2005), Karlan (2007), Gine and Karlan (2007), and Dichter and Harper (2007) also suggest that individual loans might be better suited to provide poor entrepreneurs with a way out of poverty. This perspective was most clearly spelled out by Bateman (2010) who claims "... that the role of microfinance in development policy urgently needs to be reconstructed".

Looking at the market, the picture has changed. Banks like ASA in Bangladesh or BancoSol in Bolivia offer individual loans in addition to group loans. Also Grameen bank developed the Grameen II scheme (Giné and Karlan, 2008) which also contains individual aspects for lending to poor people without requiring collateral. Ledgerwood and White (2006) suggest that in the future there will be no sustainable microfinance institution (MFI) that does not provide individual loans.

In our paper, we take a critical look at the past when group loans were the only type of credit in the market. We provide a model which shows that individual and group lending in the market can perform better. One might wonder whether there has been too much group lending in microfinance?

We model a loan market where individual and group loans exists side-by-side[1]. We assume that the individual loans are given without collateral or additional monitoring. We find support for this in Gine and Karlan (2007). In our model, we assume there to be risk-averse entrepreneurs, banks and insurer. The entrepreneur would like to invest in a project. Here we assume that there are two projects, one safe and one risky. The expected return from the safe project is smaller than the expected return from the risky project. Furthermore, the entrepreneur can invest individually or as a part of a credit group. She therefore has three possible types of investment, (a) invest in a safe project as an individual, (b) invest in a risky project as an individual or (c) invest in a risky project as part of a credit group.[2] Similar to group loans, individual loan is given without requiring collateral. When compared to individual loans, group loans have three differentiating features. First of all, an entrepreneur has to pay a fee in order to be able to join the group. Secondly she will receive a return payment if her project fails. The third and final feature is a social prestige function.

In the literature, social environments, social pressure, and social benefit are increasingly considered as very important inputs into the decision-making process of an individual in a narrow environment as seen in developing countries (Mullainathan, 2004). As Rai and Sjöström (2004) mention, some entrepreneurs are reluctant to waste time and effort in weekly group meetings and monitoring the other entrepreneurs instead of using these resources for their own project. Harper (2007) goes further. In addition the "wasting time" argument, he argues that borrowers in groups have to carry a higher risk than individuals as they are liable for the other members of their group. And not to forget that members of a group lose a large part of their privacy. Harper (2007) also recognizes that, for a lot of people, there is no other way to enter the credit market. However, he says that the manner in which microfinance institutions provide this option is unsatisfactory just like "...shared toilets, primary school classes of 60 children, or clinics without doctors." Microfinance institutions seem to offer a "second rate service" to the poor (Harper, 2007, p.36). Khandker (2005) shows that if certain people are lazier than others, they could be excluded from a group and thereby from the entering the credit market and other social events in the community.

[1] A similar idea is presented in Madajewicz (2004). Our basic structure is different, we undertake a general equilibrium analysis and study efficiency.

[2] The fourth possible option to invest in a safe project as a part of a credit group is not optimal as there is no risk in the safe project due to the fact joining a credit group is not without cost. We therefore rule out this kind of investment.

As an extension to the existing literature, we capture these circumstances using a social prestige function which implies an externality. The externality is defined as the average effort of all entrepreneurs in groups. The social prestige function now makes a comparison of the individual effort to the average effort of an individual in a group. A less than the average working entrepreneur will be punished and vice versa, if we consider a negative externality. We look at a model without an externality as a benchmark and compare it to the model with a negative externality to get closer insights in the social impacts of group membership.

Finally we compare expected utilities for both investments. We thereby calculate the threshold of wealth at which a change in credit types, i.e. from group lending to individual lending, becomes utility maximizing. Furthermore, we compare whether a switch at this threshold is welfare maximizing or not.

In the model without an externality, we find that group lending should be avoided. The decentralized solution is optimal. The level of wealth to switch is identical in both allocations. If the externality is negative, we find that there is too much group lending in microfinance. A borrower should leave the group if she exceeds a specific threshold of wealth and borrow individually in order to maximize her expected utility. While the externality becomes stronger, i.e. more negative, the threshold to switch increases. This means that in a more competitive and narrow environment, the optimal point to switch credit types takes place at a higher threshold of wealth than in a less competitive and narrow environment. In terms of welfare, we find that borrowers leave groups too soon. Borrowers invest too much effort into a group loan compared to the optimal allocation. Here we find a sample for the “rat-race” equilibrium first described by Akerlof (1976) and verified by Landers et al. (1996). The stronger the externality appears, the stronger this phenomenon becomes, i.e. the narrower the social community seems to be.

With this new perspective of group lending, we provide an initial theoretical explanation why group lending is gradually being replaced by individual lending in microfinance. We suggest that development policy should support individual lending over group lending in order to increase borrower’s expected utility and the welfare of the economy as a whole.

The rest of the article is structured as follows: In section 2, we show the model and the optimality conditions. In section 3, the analytical solution for the equilibrium is considered. The numerical solution is given in section 4 and the results are described in section 5. In section 6 we offer some concluding comments.

2 Model and optimality conditions

2.1 Setup

We assume a large number of risk-averse entrepreneurs i where $i = 1, ..., n_g, ...N$. Every entrepreneur owns an individual level of wealth in the beginning which we denote by w where $w = 0, ..., \widetilde{w}, ..., W$. Wealth is normally distribute. Banks, which lend capital, and insurers, which handle the insurance mechanism, are other actors in our model. We will explain the meaning of these actors below. We consider a one-period model. The entrepreneur invests capital k and effort e in the morning and consumes the complete profit in the evening. We assume two projects, one safe and one risky, with a higher expected return from the risky project compared to the safe return, i.e. $E(r) > s$. Investment in the risky project is limited to the amount k, investment in the safe project is unlimited.

We consider three options for investment. In case (a), the individual borrower invests in a safe project. As long as investment in the safe project is unlimited and not related to any kind of uncertainty, the loan will definitely be repaid. The second option is (b) to have an individual loan and invest in the risky project. In this case, the amount invested in the project can be decreased by the individual wealth w of the entrepreneur. The amount invested in the project is given by $k - w$ where $0 \leq w < k$. Finally, we have (c) a group loan and investment in the risky project. Here we have two features that differ from the individual loan in case (b). To make use of a group loan, the entrepreneur has to pay a fee f. This fee will be used to provide an insurance payment at the end of the period to any borrower in a group who fails. The second feature is a social prestige function. This function covers the social status of an individual within her group. An entrepreneur values a high social prestige. The amount invested in the risky project can be decreased by individual wealth w in the group case as well. Thus, the amount of credit is given by $k + f - w$ where $0 \leq w < k$. As the first case (a) is obvious, we concentrate our consideration on the latter cases (b) and (c), i.e. investments in risky projects.

Looking more closely at case (b), we have an individual investment in a risky project. The entrepreneur invests the amount $k - w$, which is borrowed from a bank. The bank demands the interest rate $1+r$ for the loan. In our model, every entrepreneur has her own individual probability of success, which is dependent on her individual level of invested effort. The probability of success $p(e(w))$ is assumed to be a concave function between zero and one, characterized by $p(0) = 0, p(\infty) = 1, p'(e(w)) > 0$ and $p''(e(w)) < 0$. At the end of the period there could be two different outcomes. With probability $p(e(w))$, the project succeeds and the entrepreneur can obtain the outcome y. She will use this outcome to repay her loan including the interest to the bank. The remaining amount will be used for consumption. In failure, with probability $1-p(e(w))$, the entrepreneur is faced with an outcome of zero. She would not be able to repay the loan and cannot consume anything. In both cases the effort the entrepreneur invests into the project reduces the expected utility by $\phi e(w)$. Utility given consumption c and costs of effort ϕ is $u = v(c, \phi)$. Only consumption is uncertain. So the expected utility is $Eu = pv\left(c^{\text{good}}, \phi\right) + (1-p)\,0$. Now we specify $v = u(c) + x(\phi)$ such that we find an individual entrepreneur's expected utility as

$$E(u_I) = p(e(w))\, u\left(c_I^{\text{good}}\right) - \phi e(w) \tag{1}$$

where

$$c_I^{\text{good}} \equiv y - (1+r)(k-w). \tag{2}$$

Case (c) describes an entrepreneur that invests in a risky project and is a member of a credit group. We assume that every entrepreneur receives a loan for an individual project in a credit group as well. Thus, she invests in her own risky project and is independent from the other members when it comes to the investment decision. The first difference from individual lending is a payment of f in order to be allowed to join the group. But why should she do so? With this payment and membership in a group, the entrepreneur is insured if the project fails. Let us consider the investment by the entrepreneur in a group and the related expected utility. At the beginning of the period, the entrepreneur borrows the amount $k+f-w$ from a bank and invests the capital $k-w$ in the risky project. The fee f will be paid to the insurer. At the end of the period, with probability $p\left(e\left(w\right)\right),$ the entrepreneur obtains outcome y. She will repay her loan including the interest and consume the rest. If the project fails, with probability $1-p\left(e\left(w\right)\right)$, the outcome is zero. However, now that she is in a group, she will receive an insurance payment $\alpha\left(e\left(w\right)\right)$ which will be provided by the insurer. The utility from the payment if she fails will always be smaller than the utility of the outcome if she succeeds. Otherwise there would be no incentive for the entrepreneur to invest effort into the project.

There is a second feature that differ an individual loan from a group loan; the social prestige function. Members of groups value their social prestige within this group or within their social community. The social prestige function is given by $q=q\left(e\left(w\right),\overline{e}\left(w\right)^{\chi}\right)$. This function is a combination of the effort that an entrepreneur invests and the integral of the effort of all other entrepreneurs in groups. We treat the latter input factor as an externality. Thus, the externality $\overline{e}\left(w\right)^{\chi}$ is given by

$$\overline{e}\left(w\right)^{\chi}=\left(\int_{w=0}^{\widetilde{w}}e_{G}\left(w\right)h\left(w\right)dw\right)^{\chi} \tag{3}$$

where $\chi\geq0$. We have to make some general assumptions for the social prestige function that should be fulfilled. So every function that follows the assumptions produces the same results in our model. We will provide a sample for such a function in the numerical solution part later. We have

$$\frac{\partial q\left(e\left(w\right),\overline{e}\left(w\right)^{\chi}\right)}{\partial e\left(w\right)}>0. \tag{4}$$

The more effort the entrepreneur invests into the project, the more her prestige rises. If we look at q in terms of $\overline{e}\left(w\right)^{\chi}$ where $\chi>0$, i.e. a negative externality, we find

$$\frac{\partial q\left(e\left(w\right),\overline{e}\left(w\right)^{\chi}\right)}{\partial\left(\overline{e}\left(w\right)^{\chi}\right)}<0. \tag{5}$$

If all the other entrepreneurs in the group invest a high level of effort into their projects, the high level of effort made by the observed entrepreneur does not produce a high social prestige in the social community. The high level of effort is something that is expected from the entrepreneur within her social community. On the other hand, if all the other entrepreneurs invest only a low level of effort, an individual entrepreneur will receive a high social prestige if she is observed to be investing a high level of effort. We denote this effect in the following as the benchmark effect of $\overline{e}\left(w\right)^{\chi}$. The larger the average effort in a group, the smaller the social prestige the observed entrepreneur will receive for her effort.

Also in the group loan case, the invested effort reduces the expected utility by $\phi e(w)$. Utility given consumption c, prestige q and effort ϕ is $u = v(c, q, \phi)$. Only consumption is uncertain. So expected utility is $Eu = pv\left(c^{\text{good}}, q, \phi\right) + (1-p)\, v\left(c^{\text{bad}}, q, \phi\right)$. Now we specify $v = u(c) + x(q, \phi)$ such that we find the expected utility of an entrepreneur in a group is given by

$$E(u_G) = p(e(w))\, u\left(c_G^{\text{good}}\right) + (1 - p(e(w)))\, u\left(c_G^{\text{bad}}\right) + q\left(e(w), \bar{e}(w)^{\chi}\right) - \phi e(w) \tag{6}$$

where

$$c_G^{\text{good}} \equiv y - (1+r)(k + f - w) \tag{7}$$

and

$$c_G^{\text{bad}} \equiv \alpha(e(w)). \tag{8}$$

Looking at the banks, we assume the bank to make zero profits. Of course competitive markets with perfect information are far from reality in developing countries. Nevertheless, we use these assumptions in the model to show the mechanism. The bank collects capital, lends money and charges interest rates. The bank demands $1+r_I$ from individual borrowers and $1 + r_G$ from borrowers in groups. If the project is successful, the bank receives the complete repayment including interest. If the project fails, the bank receives nothing in the individual case and likewise nothing in the group case.

The insurer collects f from every borrower in the group. At the end of the period she provides an insurance payment of $\alpha(e(w))$ to every borrower in the group who fails. The insurance payment is dependent on the amount of effort the entrepreneur invests in the project. The more effort the entrepreneur invests, the higher the insurance payment will be. However, we have $\alpha(e(w)) < y - (1+r)(k + f - w)$ to avoid free riding in a group.

2.2 Optimization of the entrepreneur

In order to calculate an entrepreneur's optimal level of effort, we have to consider two steps. For the first step, she has to choose which kind of loan she wants to use. In the second step, the entrepreneur maximizes her utility and finds the optimal level of effort. In our calculations we have to solve this problem backwards. First we calculate the optimal effort for both loan types. We then compare them in a second step. Then we obtain the entrepreneur's decision by choosing the maximizing type of loan.

The individual entrepreneur maximizes her expected utility given in equation (1) with respect to her individual level of effort e. We bear in mind that the level of effort is different for each individual level of wealth. We henceforth denote effort by e only, instead of $e(w_i)$. The optimal level of effort for an individual entrepreneur, e_I, is given as

$$p'(e_I)\, u\left(c_I^{\text{good}}\right) = \phi. \tag{9}$$

On the left-hand side of the equation (9) we have the marginal utility, which equals the marginal costs on the right-hand side. If the marginal costs for investing effort into a project are close to zero, the entrepreneur maximizes her effort as this maximizes her utility.

An entrepreneur in a group maximizes equation (6) with respect to e_G. She has to take the externality, $\overline{e}(w)^{\chi}$, as a given. As we assume there to be many borrowers in groups, the single contribution of one entrepreneur to the externality is too small to have a significant effect. The optimal level of effort for an entrepreneur in a group, e_G, then results in

$$p'(e_G)\left[u\left(c_G^{\text{good}}\right) - u\left(c_G^{\text{bad}}\right)\right] + (1 - p(e_G))\frac{\partial u\left(c_G^{\text{bad}}\right)}{\partial c_G^{\text{bad}}}\frac{\partial c_G^{\text{bad}}}{\partial e_G} = \phi - \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G}. \tag{10}$$

On the left-hand side of equation (10) we have the marginal utility. On the right-hand side we see the marginal costs and the marginal effect from the social prestige function. As we are faced with a differential equation, analytical solutions are not easy to interpret anymore. For this reason we shift the explanation of the insights concerning this equation to the numerical part of the paper.

Considering all of the factors together, we have a decision for individual loan if the expected utility from an individual loan is larger than the expected utility of a group loan, such that $E(u_I) \geq E(u_G)$.

2.3 Optimization of the banks

Banks collect capital from creditors and allocate it to the borrowers. We assume that the bank is realizing zero profits for every single entrepreneur it gives a loan to, regardless of whether the entrepreneur is part of a group or whether the entrepreneur borrows own her own[3]. For each individual loan the bank refinances the amount of capital $k - w$ from the capital market price s. The bank transfers this capital to the individual entrepreneur. If the project succeeds, the bank receives the repayment of the capital including the interest rate $(k - w)(1 + r_I)$. If the project fails, the bank receives nothing. At the end of the investment period, the bank has to repay the collected capital including interests, $(k - w)(1 + s)$, to the creditor. Thus, the bank is faced with the following expected profit from an individual loan

$$E\pi_{BI} = p(e_I)(1 + r_I)(k - w) - (1 + s)(k - w) = 0. \tag{11}$$

[3] We do not look at cross subsidization at this point. If it were possible to make profit with one kind of loan or another, other banks would enter into the market and raise competition to the level of zero profits. So in the long run, cross subsidization in impossible. Nevertheless, it could be profitable in the short run.

Rewriting equation (11) gives the interest rate requested by the bank depending on the effort by the individual borrower,

$$(1 + r_I)\, p\,(e_I) = 1 + s. \tag{12}$$

In equation (12) we see the bank's expected profit on the left-side and the costs on the right-hand side. Given a probability function where $0 \leq p\,(e_I) \leq 1$, a bank will demand an interest rate that lies between an infinitely high interest rate and the capital market rate s.

For every loan given to an entrepreneur in a group, the bank refinances the amount $k + f - w$ from the capital market. This capital is transferred to the borrower. The bank receives a repayment including capital and interests, $(k + f - w)\,(1 + r_G)$, if the entrepreneur's project is successful. If the project fails however, the bank receives nothing. At the end of the investment period, the bank has to repay the lent capital, including the interest rate, $(k + f - w)\,(1 + s)$, to its creditors. This gives a bank the following expected profit from a group loan

$$E\pi_{BG} = p\,(e_G)\,(1 + r_G)\,(k + f - w) - (1 + s)\,(k + f - w) = 0. \tag{13}$$

Rewriting gives

$$(1 + r_G)\, p\,(e_G) = 1 + s. \tag{14}$$

The only difference between an individual loan and a group loan for a bank is given by a possible higher amount of loan in the group case and a different, but for the bank exogenously given, level of effort by the entrepreneur. The bank receives no additional payment if the project fails for a group loan[4]. For all of these calculations we assume complete information and perfect foresight. When calculating an interest rate, the bank knows the level of effort that an entrepreneur will invest.

2.4 Optimization of the insurer

It is also important to know how high the fee for joining a group will be. As the fee is directly linked to the payment if the project fails we consider these two features together. The payment in the case where the project fails depends on the level of effort invested by an entrepreneur. This mechanism should illustrate the mutual liability in a loan group. The payment is not made to a bank, it remains with the borrower. We model this mechanism as an insurance mechanism in order to make it easier to consider this mutual liability. We therefore will denote the person who handles the mutual liability as the "insurer". She is assumed to be fair. This means that she will not make any profit. Thus, we have a fair insurance mechanism. The insurer receives the fee, f, from every

[4] We exclude this often used mechanism because we would like to show an unbiased comparison of both types of loan. With this mechanism, we avoid banks having a preference towards groups by demanding lower interest rates than in the individual case.

entrepreneur joining a group at the beginning of the investment period. She invests the money in a safe project with return s. At the end of the investment period, she receives $(1+s)\,f$ from the safe project and has to pay $\alpha\,(e)$ to the failing borrower. The project failing has the probability $1-p(e)$. This gives the following condition for the insurance mechanism

$$E\pi_{FP} = (1+s)\,f - (1-p\,(e_G))\,\alpha\,(e_G) = 0. \tag{15}$$

Rewriting gives the optimal fee, f, as

$$(1+s)\,f = (1-p\,(e_G))\,\alpha\,(e_G)\,. \tag{16}$$

On the left-hand side of equation (16), we see the marginal return of the insurance and on the right-hand side the expected payments, the marginal costs. Here we have to make the necessary assumption that there are enough entrepreneurs in groups paying the fee, f, so that every failing borrower can receive her insurance payment $\alpha\,(e)$. Considering this group of only four or five people and one insurer per group would not be enough. In a case like this, the probability of the insurer "running out of money" is very high. So we could assume that the insurer is responsible for all the groups in one village or even for all groups in several other villages to make sure the payment in case the project fails will be secure. However, by the law of large numbers, we can assume equation (16) to hold.

3 Social prestige and the critical threshold of wealth

3.1 The decentralized allocation

In the individual case, we use equation (9) and equation (12) to determine the equilibrium. Equation (9) gives the optimal level of effort for an entrepreneur depending on a given level of interest rate. Equation (12) defines the level of interest rate given a level of effort. We are now faced with two equations with two unknowns. Solving these, we get

$$p'\,(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right) = \phi \tag{17}$$

where

$$\widehat{c}_I^{\text{good}} \equiv y - \frac{1+s}{p\,(e_I)}\,(k-w)\,. \tag{18}$$

We see with an increasing outcome y and an increasing level of wealth, the optimal level of effort increases, ceterus paribus. If interest rate r or the amount of loan k increase, the level of effort is decreases, ceterus paribus. Different levels of optimal effort result from different levels of individual wealth. Each entrepreneur has an individual optimal level of effort and is therefore faced with an individual interest rate.

When we consider a borrower in a group we take equation (10) and replace $1+r$ by equation (14) and f by equation (16). So we get

$$p'(e_G)\left[u\left(\widehat{c}_G^{\text{good}}\right)-u\left(c_G^{\text{bad}}\right)\right]+(1-p(e_G))\frac{\partial u\left(c_G^{\text{bad}}\right)}{\partial c_G^{\text{bad}}}\frac{\partial c_G^{\text{bad}}}{\partial e_G}$$

$$=\phi-\frac{\partial q\left(e_G,\overline{e}^{\chi}\right)}{\partial e_G} \tag{19}$$

where

$$\widehat{c}_G^{\text{good}}\equiv y-\frac{1+s}{p(e_G)}\left(k+\frac{(1-p(e_G))\,\alpha(e_G)}{1+s}-w\right) \tag{20}$$

for the optimal equilibrium level of effort. As we are now handling a differential equation, a simple analysis similar to the individual case is not straightforward. For this reason we will delay this until the numerical section.

The decision to switch from group lending to individual lending is made if the expected utility from an individual loan is equal to or higher than the expected utility from a group loan. Thus, we can calculate the critical level of wealth in the decentralized case, $\widetilde{w}$, as

$$p(e_G)\,u\left(\widehat{c}_G^{\text{good}}\right)+(1-p(e_G))\,u\left(c_G^{\text{bad}}\right)+q\left(e_G,\overline{e}^{\chi}\right)-\phi e_G \tag{21}$$

$$=p(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right)-\phi e_I. \tag{22}$$

3.2 The planner allocation

The central planner is looking for an optimal allocation that maximizes the welfare of the society. We assume a market where individual and group loans exist side-by-side. Here we denote the critical level of wealth as w^*. In the optimal allocation, we have to assume a distribution of wealth, as the planner is maximizing the welfare function of the economy. For now, we limit our calculation to borrowers with $0 \leq w \leq w^{\max}$. For this, we use a truncated normal distribution of wealth. The truncated normal distribution is the probability distribution of a normally distributed random variable whose value is either bounded below and/or above. We have

$$h(w)=\frac{f(w)}{F\left(w^{\max}\right)-F(0)}. \tag{23}$$

We denote the density at a specific level of wealth w with $h(w)$. The welfare of the economy can be described as the integral of the expected utilities from all entrepreneurs that choose a group loan, $w \leq w^*$, plus the integral of the expected utilities from all entrepreneurs that choose individual lending, $w > w^*$. Thus, the planner maximizes

$$E(W)=\int_{w=0}^{w^*}E(u_G)\,h(w)\,dw+\int_{w=w^*+1}^{w^{\max}}E(u_I)\,h(w)\,dw. \tag{24}$$

The second part of equation (24) denotes the expected utility of an individual loan in the economy. Deriving equation (24) with respect to e_I for an individual entrepreneur with $w \geq w^*$, we find $p'(e_I)\, u\left(\widehat{c}_I^{\text{good}}\right) = \phi$, which is exactly the same expression as in equation (17). Thus the optimal level of effort for an individual loan is identical to the decentralized model.

The expected utility of entrepreneurs in a group is given in the first part of equation (24). For the planner, the externality $\overline{e}(w)^{\chi}$ is not exogenous, so that the expected utility for a borrower in a group is given as

$$E(u_G) = h(w)\begin{pmatrix} p(e_G)\, u\left(\widehat{c}_G^{\text{good}}\right) + (1 - p(e_G))\, u\left(c_G^{\text{bad}}\right) \\ +q\left(e_G, \overline{e}^{\chi}\right) - \phi e_G \end{pmatrix} \tag{25}$$

where $c_G^{\text{good}} \equiv y - (1 + r)(k + f - w)$, $c_G^{\text{bad}} \equiv \alpha(e_G)$ and, in contrast to the decentralized case, $\overline{e}^{\chi} \equiv \left(\int_{w=0}^{w^*} e_G h(w)\, dw\right)^{\chi}$. Maximizing equation (24) for a borrower in a group, $w < w^*$, we get

$$\begin{aligned} p'(e_G)\left(u\left(\widehat{c}_G^{\text{good}}\right) - u\left(c_G^{\text{bad}}\right)\right) + (1 - p(e_G))\, \frac{\partial u\left(c_G^{\text{bad}}\right)}{\partial c_G^{\text{bad}}} \frac{\partial c_G^{\text{bad}}}{de_G} \\ = \phi - \left(\frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G} + \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial \overline{e}^{\chi}} \frac{d\overline{e}^{\chi}}{de_G}\right) \end{aligned} \tag{26}$$

which differs from equation (19) due to the additional part in the derivation of the social prestige function.

To quantify the difference of the optimal allocation compared to the decentralized maximization, we have to compare the derivations of the social prestige functions. In the decentralized allocation, we derive only the first part of the social prestige function as the externality is exogenous for the entrepreneur. In the optimal allocation, the planner derives the complete social prestige function as the externality is endogenous for him. Thus, the resulting derivation we find is given by

$$\frac{dq\left(e_G, \overline{e}^{\chi}\right)}{de_G} = \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G} + \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial \overline{e}^{\chi}} \frac{d\overline{e}^{\chi}}{de_G}. \tag{27}$$

If we assume the externality to be negative with equation (5), we see the second part on the right-hand side of equation (27) will be smaller than zero for $\chi > 0$. So, we find that the first derivative of the social prestige function in the optimal allocation is smaller than in the decentralized allocation for all $\chi > 0$. Given this information, we can conclude that the right-hand side of equation (26) will always be larger than the right-hand side of equation (19). Therefore, we know that the optimal level of effort for a borrower in a group in the maximization of a central planner is always smaller than in the decentralized allocation. There is too much effort in the decentralized equilibrium for all wealth levels.

The phenomenon is called the "rat-race" equilibrium first shown by Akerlof (1976) and verified empirically by Landers et al. (1996). Adverse selection can lead to overwork in the economy (Landers et al., 1996) as we can also observe in our model.

3.3 Effects of the externality

Now we consider how the externality affects the critical level of wealth at which an entrepreneur would decide to leave group lending and borrow individually. With this consideration, we are able to study whether an entrepreneur should switch her loan type in general or not. If yes, we can further analyze whether the decentralized level for switching for wealth $\widetilde{w}$ is lower or higher than the level for switching for wealth w^* in the optimal allocation. Knowing this allows us to understand the fundamental question posed in the title: Is there too much group lending?

The critical $\widetilde{w}$ in the decentralized setup is determined by equation (21). To calculate this level, we have to use the first order conditions from the optimization part which determine the optimal levels of effort in the group case and in the individual case, i.e. equation (19) and equation (17). Furthermore, we have to apply the externality equation (3) and the equilibrium consumption in the group and in the individual case, equation (20) and equation (18). For a summary presentation of all equations, see appendix A. In order to examine the effect of the externality on $\widetilde{w}$, we take the system of equations, note that $\widetilde{w} = \widetilde{w}(\chi)$, and release the relation $\partial\widetilde{w}/\partial\chi$ numerically. The critical level of wealth in the optimal allocation w^* is determined by the system of equations shown in appendix B. The equations are similar to the equations explained above, with the exception of equation (19). Equation (19) will be replaced by the combination of equation (26) and equation (27) as the externality is endogenous for the central planner. Also, here the switching level of wealth is a function of χ. Thus, we consider the effect of the externality by releasing $\partial w^*/\partial\chi$ numerically.

We start the analysis at a common value of χ at which the critical levels in the decentralized case and the optimal allocation are equal, $\widetilde{w} = w^*$. We can then use $\partial\widetilde{w}/\partial\chi$ and $\partial w^*/\partial\chi$ to study whether the entrepreneurs switch too soon, $\partial\widetilde{w}/\partial\chi < \partial w^*/\partial\chi$, or too late, $\partial\widetilde{w}/\partial\chi > \partial w^*/\partial\chi$, for a welfare maximizing equilibrium.

4 Qualifying the excessive use of group loans

In order to obtain quantitative results, we solve the decentralized and planner allocation numerically. We assume a CRRA utility function in the form

$$u(c) = \frac{c^{1-\sigma} - 1}{1 - \sigma}, \tag{28}$$

a concave probability function as

$$p(e) = 1 - \exp(-\beta e) \tag{29}$$

where $p'(e) = \beta \exp(-\beta e)$, a function for the failure payment in a group

$$\alpha(e_G) = c_{\min} + de_G \tag{30}$$

where $c_{\min}, d > 0, \alpha(0) = 0$, and $\alpha(e_G) > 0$, a social prestige function

$$q(e_G) = -a + b\left(\frac{e_G}{\overline{e}^{\chi}}\right)^{1+\varepsilon} \tag{31}$$

where $a, b, > 0$, and $\varepsilon > 0$, and the following parameters

variable		value
slope of probability function, $p'(0)$	β	$= 0.3$
outcome	y	$= 500$
capital market interest rate	s	$= 0.06$
amount of loan	k	$= 100$
cost of effect of e	ϕ	$= 1$
social penalty for $e = 0$	a	$= 1$
social benefit for $e > 0$	b	$= 0.11$
externality parameter	χ	$= 1.1$
parameter in social prestige for $e > 0$	ε	$= 0.15$
parameter for risk aversion	σ	$= 0.9$
minimum insurance payment	$c_{\min}$	$= 0.5$
benefit in insurance for $e > 0$	d	$= 0.5.$

Table 1 *Starting parameters for the numerical solution*

4.1 The decentralized allocation

For the calculation of the optimal effort in the individual loan case, we use the probability function in the form $p(e_I) = 1 - \exp(-\beta e_I)$. We take equation (9) and rewrite it with respect to $1 + r_I$. We then make use of the probability function, equation (29), and the utility function given in equation (28) to get

$$1 + r_I = \frac{y - \left(1 + \frac{\phi(1-\sigma)}{\beta \exp(-\beta e_I)}\right)^{\frac{1}{1-\sigma}}}{k - w} \tag{32}$$

Assuming $p'(0) = \beta$ and $p'(\infty) = 0$, we look at equation (9) at $e_I = 0$ to obtain the maximum interest rate an entrepreneur is willing to pay as

$$1 + r_I = \frac{y - \left(1 + \frac{\phi(1-\sigma)}{\beta}\right)^{\frac{1}{1-\sigma}}}{k - w}. \tag{33}$$

Afterwards, we look at the bank's interest rate equation (12) and replace the expression $p(e_I)$ with the probability function to get

$$1 + r_I = \frac{1 + s}{1 - \exp(-\beta e_I)}. \tag{34}$$

So we have two equations that determine $1 + r_I$. Equation (32) gives the view of interest rates for the entrepreneur and equation (34) shows the bank's calculation. The equilibrium interest rate and optimal level of effort are given by combining these two functions. We illustrate these equilibrium levels of effort for the individual case in figure 1.

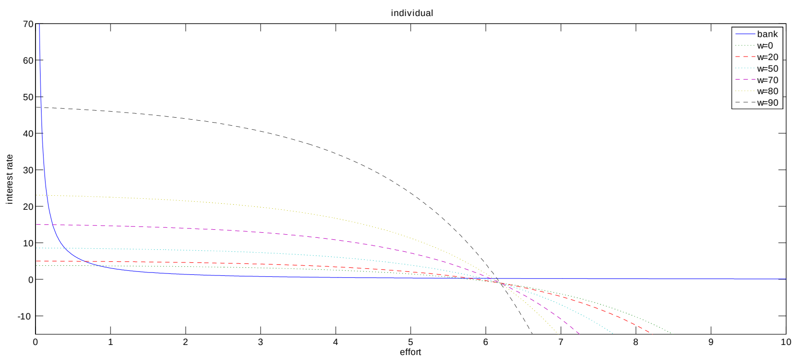

Figure 1 *Intersections of optimal interest rates in the individual case*

The blue line is the bank's equilibrium interest rate depending on the effort invested in the project. The dashed lines are the optimal interest rates from the borrower's view. The lowest line is measured with no wealth and the lines above are measured with wealth at $w = 20, 50, 70, 80, 90$. For each level of wealth, we find two equilibrium interest rates. The intersections on the right are the optimal ones as the utility is higher for each level of wealth.

If we solve for a group loan, we use the probability function in the form $p(e_G) = 1 - \exp(-\beta e_G)$. To obtain the equilibrium, we look at equation (10). We rewrite equation (10) with respect of $1 + r_G$ and use equation (28), equation (29), and equation (30). Thus, we get

$$1 + r_G = \frac{y - \left[\frac{1-\sigma}{\beta \exp(-\beta e_G)} \left(\ \phi - \gamma - \eta + (c_{\min} + d e_G)^{1-\sigma} \ \right)\right]^{\frac{1}{1-\sigma}}}{k + f - w} \tag{35}$$

where $\gamma \equiv (1-(1-\beta\exp(-\beta e_G)))\,(c_{\min}+de_G)^{-\sigma}\,d$, $\eta \equiv b\,(1+\varepsilon)\,e_G^{\varepsilon}\bar{e}^{-\chi(1+\varepsilon)}$ and the fee for the group as

$$f = \frac{(1-(1-\exp(-\beta e_G)))\,(c_{\min}+de_G)}{1+s}. \tag{36}$$

We use the probability function in equation (14) to consider the bank's view on interest rates for group loans and get

$$1+r_G = \frac{1+s}{1-\exp(-\beta e_G)}. \tag{37}$$

Again, we obtain two equations that define 1+ r_G. Combining these two equations gives the equilibrium interest rate and optimal effort for a borrower in a group. The illustration of the intersections in the group case is illustrated in figure 2. As before, the blue line shows the optimal interest rate seen by a bank and the dashed lines for the borrower. Here the intersections on the right are also utility maximizing.

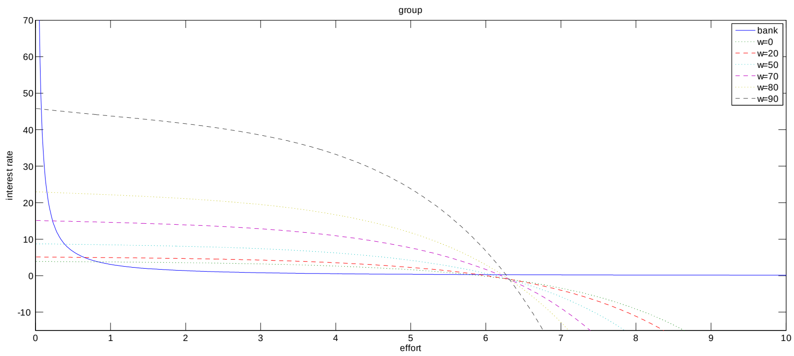

Figure 2 *Intersections of optimal interest rates in the group case with externality*

As the next step, we can calculate the expected utility an individual entrepreneur is able to realize with equation (1) as

$$Eu_I = p\,(e_I)\,u\left(\widehat{c}_I^{\,\text{good}}\right) - \phi e_I. \tag{38}$$

We take equation (12) and include the utility, equation (28) and the probability, equation (29). So, we observe

$$Eu_I = \frac{1-\exp(-\beta e_I)}{1-\sigma}\left[\left(y - \frac{1+s}{1-\exp(-\beta e_I)}\,(k-w)\right)^{1-\sigma} - 1\right] - \phi e_I. \tag{39}$$

The expected utility of an entrepreneur in a group is given by equation (6) as

$$Eu_G = p\,(e_G)\,u\left(\widehat{c}_G^{\,\text{good}}\right) + (1-p\,(e_G))\,u\left(c_G^{\text{bad}}\right) + q\,(e_G, \bar{e}^{\chi}) - \phi e_G. \tag{40}$$

By using equation (14) and equation (28), equation (29), equation (30), equation (31) and the assumed parameter for the numerical solution, we find

$$Eu_G = \frac{1-\exp\left(-\beta e_G\right)}{1-\sigma}\left(\left[y - \frac{1+s}{1-\exp(-\beta e_G)}\left(k+f-w\right)\right]^{1-\sigma} - 1\right) + \frac{1-\left(1-\exp\left(-\beta e_G\right)\right)}{1-\sigma}\left(\left[c_{\min}+de_G\right]^{1-\sigma}-1\right) + \left(-a+b\left(\frac{e_G}{\overline{e}^{\chi}}\right)^{1+\varepsilon}\right) - \phi e_G \tag{41}$$

with the fee for joining a group, f, given in equation (36). Now we can observe the level of wealth $\widetilde{w}$ for switching in the decentralized case at $Eu_I = Eu_G$. Given this level, we solve for all other variables. The description of the methods used for the numerical solution is given in appendix D.

4.2 The planner allocation

The planner allocation is given in equation (24). The numerical solution for the individual borrower remains the same as in the decentralized case as the externality only effects the borrowers in groups. As the externality is endogenous for the planner, we consider a changing equation (35) as η becomes

$$\eta \equiv b\left(1+\varepsilon\right)e_G^{\varepsilon}\overline{e}^{-\chi(1+\varepsilon)} - b\left(1+\varepsilon\right)e_G^{1+\varepsilon}\overline{e}^{-\chi(2+\varepsilon)}\chi\overline{e}^{-\chi\frac{(\chi-1)}{\chi}}h\left(w\right) \tag{42}$$

In the planner optimization, we have an additional part in equation (42) which accounts for the endogeneity of the externality. The comparison of the expected utilities changes as we use equation (42) in equation (35). All other equations remain the same.

5 Stigma makes them switch, (but) too soon

We structure our consideration in two parts. First, we control in general whether a switch to individual lending is utility maximizing. Further on, we study if the switching point in the decentralized solution is optimal compared to the planner solution. For this we have to look at the solution in two cases. Initially, we assume no externality as a benchmark and then extend the consideration to a negative externality.

5.1 Model without an externality

In a model without externality, i.e. $\chi = 0$, we find individual lending is always utility maximizing, i.e. $\widetilde{w} = w^{*} = 0$. Entrepreneurs should not switch to group lending. They should choose an individual loan right from the beginning. Looking at this situation in welfare terms, we find no difference in the decentralized and optimal allocation as the second part of the right-hand side of equation (27) becomes zero. Equation (26) therefore becomes identical to equation (19). Thus for $\chi = 0$, we know $\widetilde{w} = w^*$. The analytical proof is given in appendix C.

5.2 Model with a negative externality

Introducing a negative externality, i.e. $\chi > 1$, we talk about stigma in a group. We now find that borrowers should start with group lending and switch to individual lending at the specific levels $\widetilde{w}$, respectively w^*, in order to maximize their utility. Both levels are lower than the maximum level of wealth $w^{\max}$ for every $\chi > 1$. If we compare in terms of welfare, we find that entrepreneurs do switch to individual lending, but they do so too early when compared with the planner's optimal allocation as shown in figure 3.

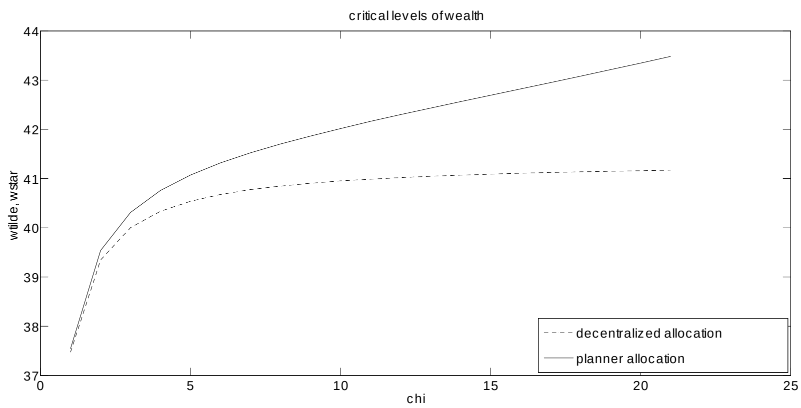

Figure 3 *Critical values of wealth in the decentralized and planner allocation*

The straight line shows the critical level of wealth to switch, w^*, in the planner allocation and the dashed line the critical level of wealth, $\widetilde{w}$, in the decentralized allocation. We find $\widetilde{w}$ is always higher than w^*. We therefore find here an application of the "rat-race" equilibrium as described by Akerlof (1976). Borrowers are investing too much effort into the decentralized case in equilibrium as shown in figure 4.

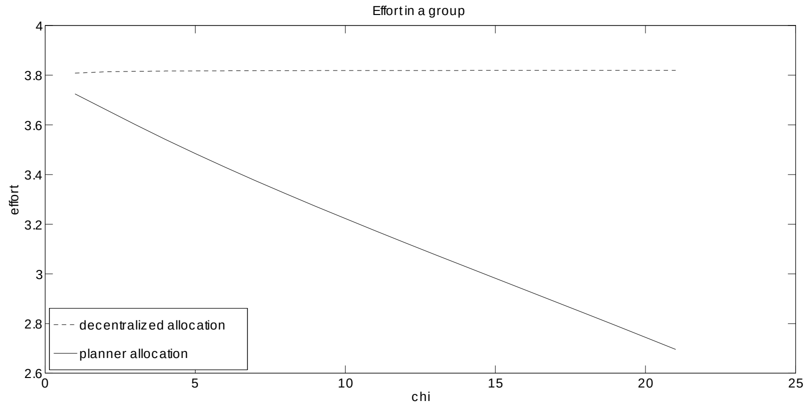

Figure 4 *Effort invested in a group loan*

They leave the group too early in order to avoid social pressure and time wasting. If we look at the mechanism more closely, we find two key factors driving the results. On the one hand, we have the insurance that makes group participation attractive, see figure 5.

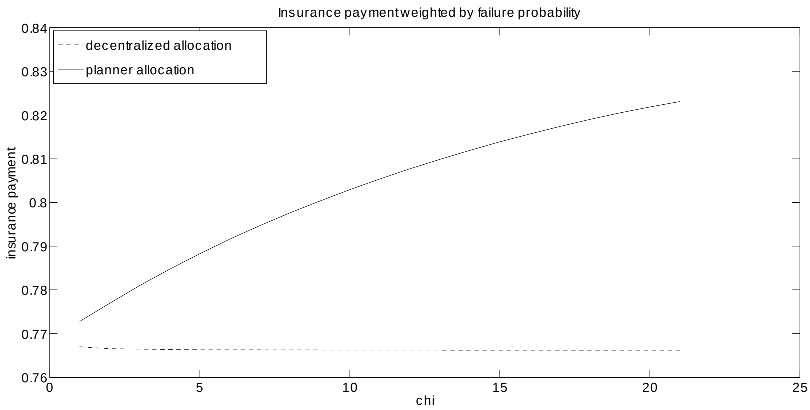

Figure 5 *Insurance payment weighted by the probability of failure for a borrower in a group*

For the decentralized case, we have a slightly falling curve for the planner allocation as the insurance payment is clearly increasing for a stronger externality, i.e. an increasing χ. As the insurance function, $\alpha(e_G) = c_{\min} + de_G$ weighted by $1 - p(e_G)$, is strongly dependent on the level of effort, we can see an explanation for the very small change for the decentralized case when compared to the planner allocation as effort changes much more in the latter case, see figure 4. On the other hand, the borrowers in a group are faced with the social prestige function, given by $q(e_G) = -a + b(e_G/\bar{e}^{\chi})^{1+\varepsilon}$. A illustration of the social prestige functions is shown in figure 6.

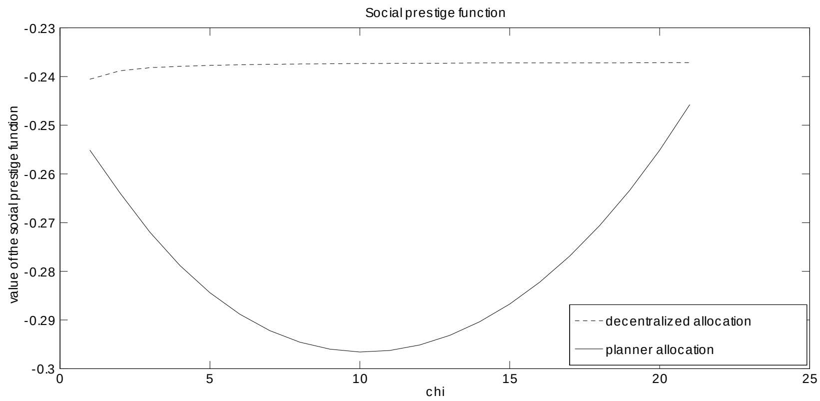

Figure 6 *Social prestige function*

In the decentralized case, the value of the social prestige function is negative and slightly increasing. In the planner allocation the function is u-shaped and also negative. The stronger the externality becomes, the lower the level of effort needed to increase her social prestige. The joint effect of insurance and social prestige function is illustrated in figure 7.

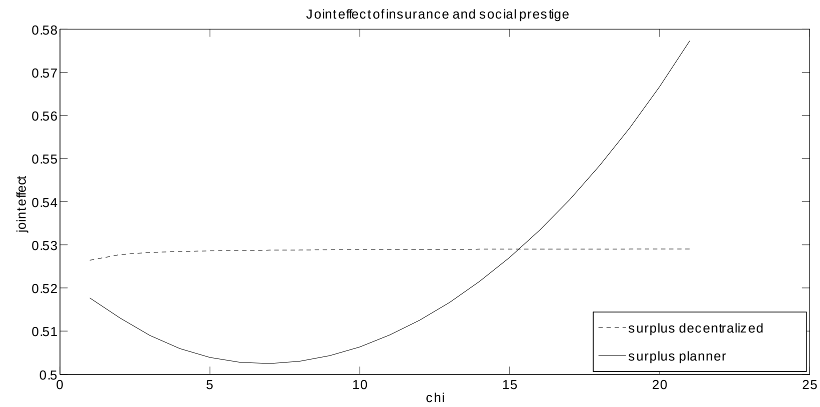

Figure 7 *Joint effect of insurance and social prestige function in a loan group*

This could be explained by the increasing insurance payment, if the externality becomes stronger. The weighted insurance payment increases as the probability of failure increases as the level of effort decreases. The level of effort needed to increase her social prestige is not as high in a strong externality environment as when the externality is weak. At low levels of χ, the surplus in the decentralized solution is higher. However, given the excessive effort, the expected utility is smaller than in the planner case as investing effort produces costs. We illustrate the optimality of the planner allocation by comparing the expected utilities in figure 8.

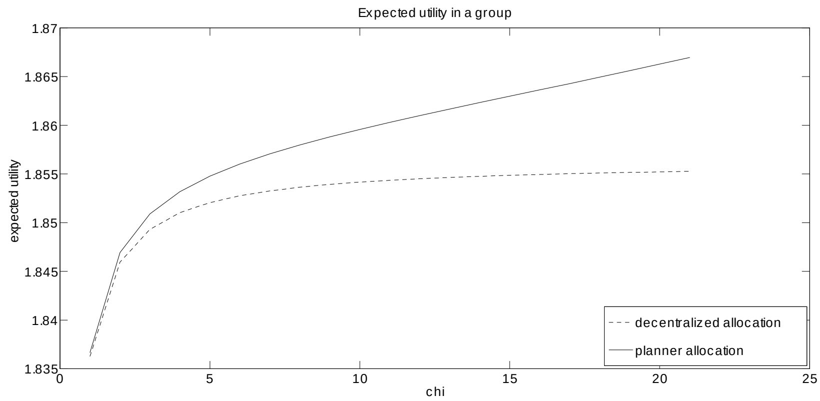

Figure 8 *Expected utility in a group*

The expected utility for the planner allocation is larger than the decentralized utility for all $\chi > 1$.

For that we have two results to be named. We show that with a negative externality, a switch in loan types from group lending to individual lending should take place in order to maximize utility. Furthermore, we find entrepreneurs are switching too late in terms of wealth when compared to the optimal level of wealth for switching, i.e. $\widetilde{w} < w^*$.

6 Concluding comments

We study whether individual lending can fit the needs and wants of borrowers in microfinance better than group lending. In order to do so, we enriched standard economic analysis by a social component, the social prestige function with an externality. We develop a model where individual and group loans coexist in the market. When compared to individual lending group lending consist of three additional mechanisms: the fee for joining a group, a payment in case her project fails and the social prestige function. The entrepreneur could invest in two projects, in each case either individually or as a part of a group. We consider the investments in risky projects and compare the resulting expected utilities to resolve the optimal lending strategy for an entrepreneur.

We looked at the model with no externality and with a negative externality. In general, we find that there is too much group lending in microfinance. If we have no externality, borrowers should borrow individually only. If we have a negative externality, entrepreneurs should start with group lending if they are very poor. Entrepreneurs that have more than a critical level of wealth should borrow individually. As the externality becomes stronger, the threshold for switching credit type increases.

Furthermore, we look at the model in welfare terms. Here we find an evidence for the “rat-race” equilibrium as described by Akerlof (1976). With a negative externality, borrowers are investing too much effort in their projects in the decentralized allocation and would therefore switch to individual lending too early when compared to the central planner's optimal allocation. Nevertheless, a change of credit type is also optimal in the planner allocation at a specific threshold of wealth and above.

With this new view on group lending, we provide an initial theoretical explanation for the gradual replacement of group loans by individual loans in microfinance as we see it in developing countries today. We would suggest to support individual lending in development policy as opposed to group lending in order to increase borrower's expected utility and the welfare of the economy as a whole.

However, this work needs to be developed further. So, we would like to analyze the model in a dynamic framework to illustrate a possible accumulation of wealth and the impacts of such a possibility. Furthermore, one can introduce monopolistic power of banks into the market to consider which changes an increasing interest rate would cause for individual utility and welfare of the economy. The consideration of a positive externality could also give more insight to the model.

A The system of equations for the decentralized equilibrium value of $\widetilde{w}$

In order to determine the level of wealth for switching from group lending to individual lending, we have the following system of equation with six unknown variables.

(I) The level of wealth, $\widetilde{w}$, for switching is determined at the intersection of the expected utility from the group loan with the expected utility from the individual loan as

$$p(e_G)\,u(\widehat{c}_G^{\text{good}}) + (1-p(e_G))\,u\left(c_G^{\text{bad}}\right) + q\left(e_G, \overline{e}^{\chi}\right) - \phi e_G = p(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right) - \phi e_I. \tag{43}$$

(II) The optimality condition in the individual case is determines the optimal level of effort as

$$p'(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right) = \phi. \tag{44}$$

(III) The optimality condition in the group case gives the optimal level of effort as

$$p'(e_G)\left[u\left(\widehat{c}_G^{\text{good}}\right) - u\left(c_G^{\text{bad}}\right)\right] + (1-p(e_G))\frac{\partial u\left(c_G^{\text{bad}}\right)}{\partial c_G^{\text{bad}}}\frac{\partial c_G^{\text{bad}}}{\partial e_G} = \phi - \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G}. \tag{45}$$

(IV) The externality is given by

$$\overline{e}^{\chi} = \left(\int_{w=0}^{\widetilde{w}} e_I h(w)\,dw\right)^{\chi}. \tag{46}$$

(V) The consumption in the equilibrium in the success case for an individual borrower consists of

$$\widehat{c}_I^{\text{good}} \equiv y - \frac{1+s}{p(e_I)}(k - \widetilde{w}), \tag{47}$$

and

(VI) the equilibrium consumption in the success case in the group case $\widehat{c}_G^{\text{good}}$ of

$$\widehat{c}_G^{\text{good}} \equiv y - \frac{1+s}{p(e_G)}\left(k + \frac{(1-p(e_G))\,\alpha(e_G)}{1+s} - \widetilde{w}\right). \tag{48}$$

B The system of equations for the optimal equilibrium value of w^*

Equilibrium conditions for the social optimum are replicated here for completeness sake. However, it is worth pointing out that only equation (51) differs from the corresponding equation (45) in the decentralized equilibrium.

(I) The level of wealth, w^*, for switching is determined bythe point at which the expected utility of the group loan is equal to the expected utility for the individual loan as

$$\begin{aligned} p(e_G)\,u(\widehat{c}_G^{\text{good}}) + (1-p(e_G))\,u\left(c_G^{\text{bad}}\right) + q\left(e_G, \overline{e}^{\chi}\right) - \phi e_G \\ = p(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right) - \phi e_I \end{aligned} \tag{49}$$

with

(II) the optimality condition in the individual case determining the optimal e_I as

$$p'(e_I)\,u\left(\widehat{c}_I^{\text{good}}\right) = \phi, \tag{50}$$

(III) the optimality condition in the group case determining e_G as

$$\begin{aligned} p'(e_G)\left[u(\widehat{c}_G^{\text{good}}) - u\left(c_G^{\text{bad}}\right)\right] + (1-p(e_G))\,\frac{\partial u\left(c_G^{\text{bad}}\right)}{\partial c_G^{\text{bad}}}\frac{\partial c_G^{\text{bad}}}{\partial e_G} \\ = \phi - \left(\frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G} + \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial \overline{e}^{\chi}}\frac{\partial \overline{e}^{\chi}}{\partial e_G}\right), \end{aligned} \tag{51}$$

(IV) the externality as

$$\overline{e}^{\chi} \equiv \left(\int_{w=0}^{\widetilde{w}} e_G h(w)\, dw\right)^{\chi}, \tag{52}$$

(V) the equilibrium consumption in the success case for an individual borrower $\widehat{c}_I^{\text{good}}$ as

$$\widehat{c}_I^{\text{good}} \equiv y - \frac{1+s}{p\left(e_I\right)}\left(k - w^*\right), \tag{53}$$

and

(VI) the equilibrium consumption in the success case in the group case $\widehat{c}_G^{\text{good}}$ as

$$\widehat{c}_G^{\text{good}} \equiv y - \frac{1+s}{p\left(e_G\right)}\left(k + \frac{\left(1-p\left(e_G\right)\right)\alpha\left(e_G\right)}{1+s} - w^*\right). \tag{54}$$

C The model without an externality

Let us assume that $\chi = 0$. We have no externality in the model. If we look at the decentralized maximization in appendix A, we see

$$\overline{e}^{\chi} \equiv \left(\int_{w=0}^{\widetilde{w}} e_G h\left(w\right) dw\right)^{\chi} = 1 \tag{55}$$

for all i and therewith

$$\frac{\partial q\left(e_G, \overline{e}^{\chi} = 1\right)}{\partial e_G} = \frac{dq\left(e_G\right)}{de_G}. \tag{56}$$

Looking at the central planner's optimal allocation, we consider that

$$\overline{e}^{\chi} \equiv \left(\int_{w=0}^{\widetilde{w}} e_G h\left(w\right) dw\right)^{\chi} = 1. \tag{57}$$

The derivation of the social prestige function equation (27) becomes

$$\frac{dq\left(e_G, \overline{e}^{\chi} = 1\right)}{de_G} = \frac{dq\left(e_G\right)}{de_G}. \tag{58}$$

This is because the second part on the right-hand side of the derivation in the planner case

$$\frac{dq\left(e_G, \overline{e}^{\chi}\right)}{de_G} = \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial e_G} + \frac{\partial q\left(e_G, \overline{e}^{\chi}\right)}{\partial \overline{e}^{\chi}}\frac{d\overline{e}^{\chi}}{de_G} \tag{59}$$

becomes zero, because

$$\frac{d\overline{e}^{\chi}}{de_G}|_{ext=1} = 0. \tag{60}$$

All equations in appendix A are thereby identical to the equations in appendix B for $\chi = 0$. The maximization of both problem sets would lead to an identical allocation, which is optimal. Thus, we know that for $\chi = 0$, the critical levels for switching from group lending to individual lending will be identical, i.e. $\widetilde{w} = w^*$.

D Numerical solution

We use Matlab for the numerical solution to solve the equilibrium given in appendix A and appendix B. We are faced with a multiple fixed-point problem as the true value of the externality and the value of the critical level of wealth must be assumed in the beginning, while they are determined during computing. Thus, we apply bisection routines for both hypothetical values to find the true value during computation.

We start by using the hypothetical values for the calculation of the optimal level of effort for an individual and for a group loan with fzero routine. For every function, individual and group lending, we get two values of optimal effort. The first at the lower intersection and the second at the utility maximizing larger intersection. In order to find these values, we have to split the function into two different sections as the fzero routine demands different signs to find a solution. We therefore need three marginal values. One very low, one very high and one in between. The middle frontier value is then calculated separately for the individual and the group loan as the average of the low and high value.

We then calculate the optimal levels of effort using both hypothetical values, the one for the externality and the one for the critical level of wealth. We use the higher level of wealth to calculate the expected utility in both cases at the optimal level of effort, given the hypothetical values. Then we compare these values and adjust the hypothetical value for the critical levels of wealth $\widetilde{w}$. If the difference between the two values of wealth used in the bisection calculation is smaller then a given precision, we assume the value to be the true critical level of wealth. Having the true level of wealth for switching we calculate the corresponding true externality. Here we also check whether the difference of the two hypothetical values of the externality is smaller than a given number. If not, we continue the bisection routine; if it is smaller we stop here. The true value of the externality is then assumed to be the average of the last two values used in the bisection routine.

Having now found the true externality and the true level of wealth for switching, we can solve for all other values in the model

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